Company valuation with trading multiples: Theoretical background and evidenced-based strategies on maximizing accuracy

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FLORIAN DEGLMANN

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Table of contents

List of figures

List of tables

Abstract

This dissertation is concerned with company valuation using the practically popular trading multiple approach. To counterbalance dogmatic criticism regarding the concept's arbitrary nature, "intrinsic multiples" are introduced, which provide an analytical connection between multiples and fundamental valuation. Furthermore, I propose an adjustment framework to appropriately reflect firm-specific economic properties such as minority interest or net pension liabilities in multiple valuation. The "Law of One Price" is identified as key governing principle of multiple valuation and it is argued that industry peer selection combined with valuation multiple aggregation through the median of peer pricing multiples is generally appropriate. Evidence is obtained from a combined European and U.S. sample of publicly traded firms spanning 22 half-years. First, I find that accuracy of multiple types varies greatly and thus the right valuation driver choice is important; with median absolute valuation errors of just 18.5%, price/earnings (P/E) performs strongest among 13 multiple types studied, notably also relative to practically relevant intrinsic valuation alternatives (DDM, DCF); this might support the existence of a "feedback loop" corridor between price and P/E. Accounting-based multiple types outperform their cash flow-based counterparts, suggesting accruals positively affect the ability of single-period valuation drivers to represent a firm's future economic potential, which is conceptually crucial for trading multiples. Multiple types inconsistently introducing additional features (such as return-indiscriminate growth) or ignoring value-relevant aspects (such as profitability) suffer from biases consistent with intuition. Second, my results suggest that there are merits of adjusting enterprise value multiples (median error reduction of up to 0.89%-pts) on the basis of the proposed framework, whilst results for equity value multiples provide no accuracy improvements. Third, improvements in multiple valuation precision of up to 0.507%-pts are shown to be achievable if peers with similar financial characteristics are weighted over-proportionately by applying a parsimonious rank sum method to intrinsic multiple differences. Forth, I find that an optimal trade-off between forecasting uncertainty and the forward-oriented nature of valuation is to determine a multiple's valuation driver on the basis of estimates relating to a 12 month period starting in a year, resulting in valuation error improvements of c. 0.5–1%-pts compared to an immediately starting 12 month forward period. Fifth, substantial precision improvement is possible if firm-specific multiple types are chosen; an implementation of multiple type choice by industry, however, fails to yield significantly improved valuation accuracy. This dissertation adds to a growing academic literature on multiple valuation, which, however, still does not reflect its considerable practical relevance. On the basis of empirical findings, my results also provide a number of suggestions to practitioners wishing to maximize valuation accuracy, notably around adjusting multiples, valuation driver type and timing selection as well as justification for incorporating peer financial similarity into multiple valuation.

Kurzzusammenfassung (German-language abstract)

Diese Dissertationsschrift hat die in der Praxis beliebte Unternehmensbewertung mit Multiplikatoren börsennotierter Vergleichsunternehmen zum Gegenstand. Um wissenschaftlicher Kritik an Ermessensspielräumen der Methode entgegenzutreten, werden «intrinsische Multiplikatoren» vorgestellt, die eine Verknüpfung mit Fundamentalbewertungen erlauben. Ferner wird ein Adjustierungsmodell eingeführt, welches unternehmensspezifische Eigenschaften mit möglichen Bewertungsimplikationen, wie etwa Minderheitenanteile oder Pensionsverpflichtungen, abbildet. Die «Gesetzmässigkeit des einen Preises» wird als zentrales Wirkprinzip identifiziert und der Standpunkt vertreten, dass die Berechnung eines Bewertungsmultiplikators über den Median der auf Basis von Industriezugehörigkeit ausgewählten Vergleichsunternehmensmultiplikatoren geeignet ist. Empirische Daten einer kombinierten Stichprobe börsennotierter europäischer und U.S.-amerikanischer Unternehmen werden über einen Zeitraum vom 22 Halbjahren erhoben. Es zeigt sich, erstens, dass die Präzision von Multiplikatorbewertungen von der Auswahl des Bewertungstreibers abhängt; mit einem Median absoluter Bewertungsfehler von 18,5 % erzielt das Kurs-Gewinn-Verhältnis («KGV») das beste Ergebnis von 13 untersuchten Multiplikatortypen und zudem auch hinsichtlich praktisch relevanter intrinsischer Bewertungsalternativen (DDM, DCF); dies lässt auf eine möglichen «Feedbackschleifen»-Korridor zwischen KGV und Aktienkurs schliessen. Multiplikatoren, welche auf Rechnungslegungsgrössen basieren, zeichnen sich ferner durch höhere Genauigkeit aus, als Multiplikatoren, die auf Cashflow abstellen; die Rechnungsabgrenzung scheint sich mithin positiv auf Repräsentationsfähigkeit von (einperiodigen) Bewertungstreibern für das wirtschaftliche Potenzial eines Unternehmens auszuwirken, was für Multiplikatorbewertung konzeptionell bedeutsam ist. Multiplikatortypen, welche in inkonsistenter Weise zusätzliche Aspekte zu berücksichtigen versuchen (etwa renditeunabhängiges Wachstum) oder bewertungsrelevante Aspekte ignorieren (etwa Profitabilität), weisen erwartbare Verzerrungen auf. Zweitens zeigen die empirischen Resultate, dass die Anpassung von Unternehmenswert-Multiplikatoren anhand des vorgeschlagenen Adjustierungsmodells Präzisionsverbesserungen gestattet (Fehlerreduktion von bis zu 0,89 %-Punkten), wohingegen Eigenkapital-Multiplikatoren keine klaren Verbesserungen aufweisen. Drittens reduziert eine überproportionale Berücksichtigung von Vergleichsunternehmen mit ähnlichen finanziellen Kenngrössen Bewertungsfehler um bis zu 0,507 %-Punkte. Viertens ist der optimale Berechnungszeitraum für den Multiplikatorbewertungstreiber der Einjahreszeitraum, welcher in einem Jahr nach Bewertungsdatum beginnt (Bewertungsfehlerverbesserung von ca. 0,5–1 %-Punkten verglichen mit dem unmittelbar zukünftigen Einjahreszeitraum). Fünftens erzielen unternehmensspezifische Bewertungstreiber substanziell präzisere Bewertungen; jedoch zeigen industriespezifische Multiplikatortypen kein signifikantes Verbesserungspotenzial. Diese Abhandlung trägt zur wachsenden, aber im Vergleich zu praktischen Bedeutung von Multiplikatoren weiterhin geringen Literatur bei. Anhand empirischer Ergebnisse gibt sie konkrete Handlungsempfehlungen zur Präzisionsmaximierung von Multiplikatorbewertungen durch die Wahl geeigneter Bewertungstreibertypen und -zeiträume, Adjustierung sowie die Berücksichtigung der Werttreibervergleichbarkeit.

FIRST PART

OVERVIEW, DEFINITIONS, DATA

Synopsis In Chapter 1, a core problem of trading multiple valuation is identified as an imbalance between practical popularity—motivated by simplicity—and dogmatic skepticism driven by perceived elements of arbitrariness. This has resulted in insufficient academic guidance relative to the importance of the concept. Based on 4 research questions, 8 in-scope research topics are developed and the "horse race of errors" between alternative multiple valuations is introduced as the main empirical research approach. Figure 1.1 summarizes the course of investigation and, for the reader in a hurry, Table A.1 sets out a tabulated summary of the dissertation, covering prior results, hypotheses, own findings, high-level interpretation and limitations. In Chapter 2, multiples in three contexts are defined: pricing multiples computed for public peer companies, aggregated valuation multiples describing trading multiple valuation outcomes and intrinsic multiples, which are derived from fundamental valuation input variables. The extended Law of One Price is introduced as a conceptual multiple valuation prerequisite and contrasted to efficient market theories. A number of classification parameters are devised, including around valuation driver timing and the choice of meaningful valuation driver types. Features of specific common multiple types such as price/earnings and enterprise value/net sales are discussed. Already in Chapter 3, the sample is introduced to provide a directional quantitative sense of multiples and other key financial metrics. The sample comprises a total of 19,139 firm-half-years of STOXX® Europe 600 and the S&P 500® constituents, customarily excluding financial sector firms and measured between January 2005 and July 2015.

Background literature Textbooks containing the foundations of trading multiple valuation such as Damodaran (2012a), Peemöller (2009), Mondello (2017), Koller, Goedhart, and Wessels (2010), Penman (2013) and practitioner-centric textbooks such as Rosenbaum and Pearl (2009); studies on practical multiple usage, including Matschke and Brösel (2013) and Schönefelder (2007); empirical studies on valuation driver timing and multiple types such as Schreiner (2007), J. Liu, Nissim, and Thomas (2002), M. Kim and Ritter (1999); textbooks, theoretical considerations and studies on efficient markets such as Fama (1970), Tobin (1984) and Mercer and Harms (2017).

CHAPTER I

Introductory remarks and distinguishing features of this dissertation

"Bewerten heisst vergleichen"
—ALFRED MOXTER[1]

1.1 Practitioner popularity vs. scientific skepticism

1.1.1 Core problem statement

This dissertation is concerned with trading multiples. As a relative, market-comparison-based tool for valuing companies, a multiple can be described as the quotient between a measured *price reference* and a chosen *valuation driver*, with the objective to standardize the price for each unit of valuation driver.[2] Common multiple types include price/earnings, enterprise value/Earnings before interest and taxes (EBIT) and price/book value of equity.[3] The fundamental problem trading multiples are facing as a valuation concept is the disparity between their considerable popularity among practitioners—driven by simplicity, among other

[1] "Valuation means comparison" (Moxter, 1983, p. 123; own translation from German); Alfred Moxter (1929–2018), Professor for business administration at the University of Frankfurt-on-Main between 1965 and 1997. One of the most influential German academics concerned with accounting and business valuation of his time. "Bewerten heisst vergleichen" introduces Chapter 17 on "general valuation criteria" of his book "Grundsätze ordnungsmäßiger Unternehmensbewertung." It compresses the essence of multiple valuation like few other statements (while at the same time not being limited to multiples) and is therefore a excellent segue into the first Chapter of this dissertation
[2] Compare the discussion in below Subsection 2.1 (p. 19) regarding an appropriate definition of multiples
[3] Compare Table 2.2 (p. 53) for additional examples of common multiple types

aspects—and skepticism from the scientific community motivated by the claimed arbitrary nature, which lacks theoretical sophistication and grounding in corporate finance theory.

1.1.2 Popularity of multiples among practitioners

TABLE 1.1: Frequency of trading multiple and DCF valuations

Method	Author(s)	Frequency of usage: Trading multiples	Frequency of usage: DCF[k]	Geography	N
Fairness opinions	Schönefelder, 2007, p. 93[a]	94%	94%	US	179
	Schönefelder, 2007, p. 93[b]	100%	100%	CH	13
	Berndt, Froese, et al., 2014, p. 750	98%	100%	CH	c. 40[e]
Prospectuses	Cassia et al., 2004, p. 117	87%	80%	Italy	83
Company survey	J. R. Graham et al., 2001, p. 197	c. 39%[dg]	c. 73%[g]	US	392
	Matschke et al., 2013, p. 821	85%	93%	Germany	53
	Welfonder et al., 2017, p. 177[f]	68%	89%	Germany	48
Broker reports	Fernández, 2001, p. 2[h]	c. 52%[dg]	c. 19%[g]	Europe	N/A
	Asquith et al., 2005, p. 252	99%[d]	13%	US	1126
Investor survey	Mondello, 2017, p. 541[j]	81%[d]	c. 36%[cg]	Global	137

Note: Own analysis based on previous studies on popular valuation methodologies employed in different contexts; disregards the study of Manigart et al. (2000) since results (which are directionally consistent) are not reported in a comparable manner; furthermore disregards other valuation concepts (e.g. residual income valuation approaches) which in all studies play a minor role; [a] U.S. part of the sample studied by Schönefelder (2007) [b] Swiss part of the sample studied by Schönefelder (2007) [c] relates to fundamental valuations in general [d] relates to price/earnings multiples specifically [e] based on discussions with the authors [f] data relates to survey answers for "always" and "often" [g] percentage read from unlabeled bar chart [h] based on data from Morgan Stanley [j] based on data from Bank of America Merrill Lynch [k] Discounted cash flow analysis

Table 1.1 (p. 2) documents the *highly common practical use* of trading multiples as analyzed in prior studies of publicly available fairness opinion valuations, surveys and reviews of equity research analyst reports: the use of multiples appears even more common in *investor-driven* valuation settings,[4] where their use outnumbers fundamental/intrinsic alternatives such as discounted cash flow to the firm valuation analysis (DCF). Surveys among firms indicate that, from a *companies' perspective*, the use of multiples is common; however, fundamental valuations are even more so. *Fairness opinions* appear to rely on a combination of trading multiples and fundamental throughout. Overall, Table 1.1 suggests that multiples as a valuation concept are as popular or slightly more popular than fundamental concepts.[5]

Unfortunately, few studies exist as to the causes of why multiples are so commonplace. However, a number of authors including Mondello (2017, pp. 435–436), Damodaran (2012a) and Creutzmann and Deser (2005, p. 2) have speculated on possible reasons:

[4] Which I argue are of particular relevance given their importance for price determination in the context of trading multiples, also compare the suggested feedback loop corridor in Subsection 7.10 (p. 324)

[5] The average and median use of trading multiples across all studies considered for Table 1.1 is 80% and 86%, respectively; this compares to 70% and 84% for fundamental valuations, respectively

- *Intuitive nature:* The standardization concept embodied in multiples can be easily explained to counterparts not familiar with principles of corporate valuation. It resonates with common-sense standardization metrics such as rent per square meter in the real estate market. In a negotiation-driven transactional setting[6] it is a helpful argumentative tool and also allows companies to communicate any acquisitions or disposals to the capital market in a straightforward manner

- *No[7] reliance on predictions:* Fundamental valuation concepts rely on a computation of future cash flows and—depending on the degree of sophistication required—complex operating models are necessary to inform such computations.[8] A considerable percentage of fundamental value commonly relates to the terminal value, a highly simplistic assumption regarding the cash flow potential of a firm in steady state. Valuations are sensitive to growth rate- and cost of capital assumptions, among other aspects. Multiple valuation in contrast is more indefinite in nature[9] in that it requires little prediction about the future.[10] This translates into a cost advantage for the preparer of the valuation

- *Market-related valuation:* "Multiples reflect the market mood" (Damodaran, 2012a, p. 454) and "multiples are a market-oriented form of valuation in a most consequential manner" (Creutzmann & Deser, 2005, p. 5).[11] Whilst the flip side of this attraction is volatility of the valuation outcome depending on prevailing market prices used, this aspect can be considered "a feature rather than a bug," in particular to the extent a market-based valuation is desired or it can be shown that there is a systematic element of over-valuation of intrinsic concepts in public markets as is suggested by some prior research[12]

[6]e.g. corporate Mergers & Acquisitions (M&A) negotiations

[7]Depending on the timing of the valuation driver used, a one period prediction for the next fiscal year might be necessary, compare Subsection 2.3.2.2 (p. 42). Contrary to a full operating model, it can, however be obtained from equity research consensus; alternatively, multiples can rely on historical valuation drivers. In any event substantially less future predictions are needed for multiple valuation than for fundamental valuation

[8]Compare Equations 4.3 and 4.18 documenting the need for extensive projections in the context of intrinsic valuations

[9]One can argue that trading multiple valuation can be seen as an equivalent of passive investment strategies such as index tracking investments: the views by the market on the future of peers embedded in trading multiples is applied to the firm under investigation without forming a definite opinion if this individual firm is actually a better or worse business than its peers. One could argue that if all market participants would only use trading multiples, quasi "free riding" on the work of investors trading on their views regarding the future, the accuracy of multiple valuations could diminish

[10]Compare Thiel and Masters (2014) for a simplistic but effective matrix on (in)definite and optimistic/pessimistic views about the future; an indefinite view about the future is consistent with low investment (in the context of valuation: shying away from the cost of sophisticated non-multiple based approaches)

[11]Own translation from German

[12]Compare e.g. Berndt, Deglmann, and Schulz (2014) with some evidence from fairness opinion valuation pointing towards this direction

1.1.3 Dogmatic skepticism regarding multiples

Whilst the early influence of proponents of *value investing*, most notably B. Graham and Dodd (1934), has resulted in a more *balanced perspective* on trading multiples as a valuation concept in the U.S., the German literature in particular has traditionally expressed a strong preference for *fundamental* valuation approaches over multiples (Peemöller, 2009, p. 569);[13] [14] numerous authors have consequently commented on perceived shortcomings of multiple valuation approaches with an objective to dissuade their use in favor of fundamental valuation concepts. The more substantive points of criticism can be summarized as follows:

- Multiple valuations are argued to *lack theoretical justification* (Matschke & Brösel, 2013, p. 689);[15] according to this logic, preferable valuation concepts are intrinsic valuations such as dividend discount model valuation analysis (DDM) and DCF approaches, and—given their simplistic nature—trading multiples at best have a role to cross-check valuation outcomes (Koller et al., 2010, p. 313)[16]

- *Trading multiple valuation implicitly (and incorrectly) assumes that value equals price* (Lorson, 2004, p. 225; Buchner & Englert, 1994, pp. 1579–1580). This interpretation of multiples challenges on the one hand the concept of market efficiency;[17] on the other hand, some more dated German authors go as far as to argue that no market prices for companies exist given their individuality.[18] In more recent literature[19] a more nuanced discussion of the ambiguous relationship between multiples and market efficiency takes place: Whilst market efficiency is assumed between a firm and its peer group, justifying the validity of multiples as a concept, pricing of the individual firm under investigation

[13] Against this backdrop, the more remarkable is the progressive nature of the quote of Moxter (1983, p. 123) at the beginning of this chapter

[14] Also note that multiples are not an American invention per se: Münstermann (1966, p. 11) discusses small business valuation in 1930ties France on the basis of weekly or yearly turnovers

[15] Other that they can be described as a one-year inverted rate of return (Ballwieser, 2004, pp. 213–215; Ballwieser, 1991, p. 55)

[16] As will be demonstrated in Chapter 4 (p. 89), it is possible to link multiples to corporate finance theory in a more sophisticated manner than inverted yields. Moreover, contrary to the argument by Ballwieser (2004, p. 215), simplicity is a desired feature: as long as precision is not compromised, company valuation does come at a cost to the preparer and, ceteris paribus, a simple valuation approach is therefore superior to a complex concept. Notably, I will argue that the valuation driver should not necessarily be seen as the overly simplistic one-period cash flow representative but rather as a proxy for the future economic cash generation potential; consequently, much room will be given to choosing the right valuation driver and consequently multiple type

[17] Notably the fundamental market efficiency definition by Tobin (1984, p. 2), compare Subsection 2.1.5.2 (p. 28)

[18] Compare Münstermann: "Für Unternehmungen existieren indes selbst in der Marktwirtschaft keine Marktpreise. Jede Unternehmung nämlich repräsentiert für sich einen Güterverband solch individueller Natur, daß sich für sie ähnlich wie für andere individuelle Güter ein Marktpreis nicht bildet" (1966, p. 11)

[19] Compare e.g. Mondello (2017, p. 436)

is assumed *not* to be subject to efficiency or else a strategy investing into a specific firm on the basis of its multiple would not result in superior returns[20]

- *No established standards on multiple valuation* result in numerous unwarranted areas of judgment, i.e. approaches practitioners claim can "reasonably be argued for." this opens the door to arbitrary personal choices and therefore a lack of desirable objectivity to valuation (Hommel & Dehmel, 2011, p. 66; Damodaran, 2012a, p. 454; Mondello, 2017, p. 436). Indeed, multiple valuation depends on numerous judgment calls, including: type and timing of valuation driver, adjustments in the computation of multiples, peer group formation and aggregation of peer group multiples. Under the proposition that objective valuation outcomes are desirable, theoretical considerations and empirical results regarding those judgment calls are as important to the robustness of valuation outcomes as they are to a rebuttal of this argument all together. Indeed, this is the key focus of this dissertation

It is worth noting that not all academic literature is as dismissive on multiple valuation as are some of the above referenced authors. A common intermediary position is argued for by Peemöller (2009, pp. 572–574) among many, according to which multiples should play a role to *confirm* rather than to *drive* valuation outcomes. The survey results on common multiple use presented in Table 1.1, however, suggest that multiples might play a far more important role in many practical applications and empirical evidence on relative levels of accuracy can be a crucial aspect in assessing if this limitation is justified. Finally, fundamental valuations are not market comparison-fee, either: notably, for private companies, the cost of equity will need to be derived from public company benchmarking.

1.1.4 Implications for prior research on multiples

The incongruence between practice and academic literature has a number of implications on prior research of multiples as a valuation approach:

- A relatively *underdeveloped theoretical background* to multiples as a valuation concept[21]

[20] In response to this point of criticism, I will, argue that the conceptual difference between market efficiency and the Law of One Price offers an explanation for this ambivalence; for some more considerations, in particular around differentiation between the Law of One Price and market efficiency compare Subsection 2.1.5.1 (p. 27)

[21] This aspect offers an opportunity to further develop the concept of "intrinsic multiples" in Chapter 4 (p. 89) on the basis of deliberations of authors in particular from the German speaking area such as Schwetzler (2003), Herrmann and Richter (2003), Kelleners (2004) and Schreiner (2007)

- Scarcity of *consistent and concrete guidance* from the academic community to practitioners on the "dos and don'ts" of meaningful multiple valuation, accepting that the practice of multiple valuation will continue to be utilized by practitioners. This is in particular the case insofar as different stakeholder groups (e.g. equity research analysts, accounting standard setters) are concerned[22]

- A growing but still comparably *exiguous body of empirical* literature on multiple valuation performance compared to their considerable practical importance.[23] However, a number of helpful concepts around measuring multiple valuation accuracy have been established[24]

- *Inconclusive results* of prior studies on aspects pertaining multiples[25]

- A number of obvious questions, which surprisingly appear to *not have received any academic attention*, such as the comparison of practically common DCF and DDM valuations with trading multiple valuations[26] or the need of adjusting multiples, which while widely discussed theoretically, has seen little empirical assessment[27]

- Limited understanding of *integrated and behavioral aspects* of multiple valuation, i.e. on the potential two-way interaction of multiple valuation and market prices, where multiples not only take the role of a measurement tool but also act as drivers of market prices.[28] Some empirical studies are furthermore not sufficiently grounded in propositions around how valuation practitioners might conduct multiple valuations[29]

The above suggests that the discrepancy between practical relevance and theoretical criticism has resulted in numerous drawbacks to the detriment of meaningful multiple valuation, which this dissertation aims to help resolving.

[22]Compare Chapter 8 (p. 329) for such considerations of the findings in this dissertation
[23]Compare Subsection 6.4.3 (p. 234)
[24]Compare Subsection 6.4.1.1 (p. 222)
[25]As a example regarding a comparison of multiple valuation accuracy of the theoretically preferred enterprise multiple to the equity multiple approach; whilst some studies such as Lie and Lie (2002, p. 48) appear to confirm theoretical considerations, J. Liu et al. (2002)
[26]Regarding some considerations on this aspect compare the theoretical discussion around market efficiency in Subsection 2.2 (p. 35) and the results presented in Subsection 7.6 (p. 291)
[27]Compare e.g. the question on the benefits of properly adjusting multiples for certain economic aspects as discussed at length in Chapter 5 (p. 129)
[28]This is discussed in greater detail in Subsection 7.10 (p. 324) around the potential existence of a "feedback loop" between price/earnings and market prices
[29]In oder to counteract this shortcoming, I propose a parsimonious quantitative approach to mirror what I perceive valuation practitioners may conduct in a qualitative manner with the concept of weighted multiple, compare Subsection 7.8 (p. 310)

1.2 Objective: Synthesize best practices backed by theory and empirical insight

1.2.1 Summarizing the 4 central research questions

The core research questions of this dissertation follow directly from the discussion on the discrepancy between practical relevance of multiples and the academic preference for intrinsic valuation approaches described in the preceding Subsection 1.1:

1. As a consequence of **theoretical considerations**, which **best practices** should be applied in trading multiple valuation, also considering the potential **cost of sophistication** attached to valuation?
2. On the basis of **empirical data**, can those best practices be shown to **positively influence** multiple valuation **accuracy**?
3. Is it possible to explain multiple valuation **errors** in a **systematic manner**?
4. What can be said about the relationship between **trading multiple valuations** as an empirical heuristic, **intrinsic valuations** as a theoretical approach and empirically measured **stock prices**?

1.2.2 The 5 steps involved in trading multiple valuation

In particular with regards to the first central research question it is instructive to briefly describe the steps involved in trading multiple valuation since this not only provides some broader context to multiple valuation but also allows to uncover some of the judgment calls multiple valuations are subject to.

Typical trading multiple valuation involves establishing the value for a firm under investigation by means of considering "*comparable companies*"[30] (Penman, 2013, p. 76; Rosenbaum & Pearl, 2009, p. 11; Henschke, 2009, p. 15; Koller et al., 2010, p. 315).[31] The concept of multiples can be best understood by identifying the *different stages* it encompasses. Even

[30]Comparable companies are also commonly referred to as "peers," "comparables" or, in short form, "comps"

[31]While this disregards the important use of multiples to assess current market prices for a specific company relative to market prices over a period of time for that same company by means of a "through the cycle multiple valuation" (see Damodaran, 2012a, pp. 477–479, Rossi and Forte, 2016, pp. 67–70 and Löhnert and Böckmann, 2009, p. 585 for a brief discussion and example charts; alternatively compare Panel A of Figure 7.10, p. 298), which does not typically require any comparable companies, this simplification is still suitable to introduce the concept of multiples

though it is a common view in literature that multiple valuations involve several steps, views on the actual number of stages vary between three (Henschke, 2009, p. 15; Penman, 2013, p. 76), four (Schreiner, 2007, p. 49; Seppelfricke, 2014, p. 151; Hommel & Dehmel, 2011, pp. 76–77) and five (Rosenbaum & Pearl, 2009, p. 12; Löhnert & Böckmann, 2009, pp. 575–580; Schacht & Fackler, 2009, p. 274). This discrepancy is more stylistic and sequential in nature, while there is broad agreement on the overall tasks involved in conducting a valuation using multiples. An amalgamation of the above proposals, the following 5 steps provide a suitable framework:

1. *Analyze the company under investigation*[32] *and its industry against the features and limitations of trading multiple valuation:* All valuation concepts benefit in a first instance from a good understanding of the company under investigation and its industry. For the concept of multiples, however, this aspect is of relevance as a foundation of the following steps: A multiple can be calculated absent any precise knowledge of the sector and/or detailed analysis on the firm under investigation; in fact, this simplicity in application is one of the advantages of multiple valuation regularly quoted (Damodaran, 2012a, pp. 453–454). However, any lack of detailed understanding of firm and industry is poised to backfire at later stages in the form of ineffective comparable or multiple type selection and a lack of the ability to separate premium and discount valuations from potential valuation imprecisions. A similarly propaedeutic consideration relates to an understanding of the *Law of One Price*,[33] which is the conceptual backbone of trading multiple valuation
2. *Choose comparable firms:* The Law of One Price postulates that comparables should be as similar as possible to the firm under investigation. While the theory presented in Chapter 4 (p. 89) suggests that pricing multiples can be expected to depend on a relatively small number of common valuation input variables such as cost of capital, growth, and return on invested capital/return on equity,[34] a highly common practical approach remains the consideration of companies operating in the *same or a similar*

[32] Throughout this dissertation, I'll use the term "company (or: firm) under investigation" to differentiate the company for which a multiple valuation is eventually sought to differentiate it from "peer companies" or "comparables," which denote firms used to obtain such valuation through computing pricing multiples, which are the aggregated to a valuation multiple applicable to the company under investigation. Alternative nomenclature for "company under investigation" includes "valuation object" or "target firm" (Sommer, Rose, & Wöhrmann, 2014, p. 33)

[33] See Subsection 2.1.5.1 (p. 27) for a more detailed discussion of the basic Law of One Price and its necessary extension for the purposes of multiple valuation

[34] And, as will be discussed in greater detail in Chapter 4, their respective input variables such as risk and financial leverage

industry as peers. Industry membership can be understood as proxy for the financial input variables and potentially other influencing factors beyond the theoretical frameworks discussed in Chapter 4

3. *Select suitable type(s) of multiple(s):* While various authors have argued for a very specific type of multiple such as price/earnings or enterprise value/Earnings before interest and taxes (EBIT) to be used for all companies,[35] others stressed that certain kinds of business models or industry characteristics might favor specific multiple types.[36] Empirical results on the accuracy of certain multiple types provide additional guidance; an understanding of some theoretical foundations of different types of multiples is none the less beneficial[37]
4. *Calculate the individual pricing multiples for the peers:* Once a specific type of multiple has been selected, valuation accuracy can expected to benefit from an accurate and consistent calculation of the pricing multiple for each peer group firm. It is therefore instructive to understand concepts for consistent, comparable and conceptually appropriate pricing multiple computation[38]
5. *Determine a valuation multiple, which stipulates the valuation for the company under investigation and hence the ultimate valuation objective:* This last step is concerned with aggregating peer pricing multiples into one single valuation multiple, which can be applied to the firm under investigation in order to determine its value. In practice, this aggregation will be either a "mathematically precise" exercise—e.g. selecting the median or mean of peer pricing multiples—or a more judgment-driven approach of weighting peers, which reflects the experience or believe of the valuation expert. Independently of the method chosen, it is important to obtain a proper understanding of valuation errors and strategies to interpret and potentially minimize them

Table 1.2 (p. 10) summarizes how the following Chapters relate to different steps involved in multiple valuation.[39]

[35] Such as e.g. Koller et al. (2010, pp. 315–316) expressing their strong preference for enterprise value/EBITA in the context of non-financial companies

[36] E.g. Damodaran (2012a, p. 500) enterprise value/Earnings before interest, taxes, depreciation and amortization (EBITDA) for companies depending on heavy infrastructure

[37] I argue that it is the valuation driver, which ultimately determines the multiple type and such multiple type is to be found, which best represents the economic cash generation potential of a firm in one single number, compare Subsection 2.1.5.4 (p. 33)

[38] Such discussion forms part of Chapter 5 (p. 129)

[39] It is worth pointing out that the 5 step approach outlined in this section relates to the standard corporate finance approach on multiple valuation with an ambition to obtain a multiple-based valuation for a specific firm under investigation. Other multiple valuation purposes such as more holistic reviews of general valuation levels over time of an index—at times conducted e.g. by central banks—will follow a different approach: notably,

TABLE 1.2: Matching the 5 steps involved in multiple valuation to subsequent chapters

Step	Key elements	Chapter/section
1. Analyze the company under investigation and its industry against the features and limitations of trading multiple valuation	• Understanding of the firm and its industry • Provides a foundation for further steps of multiple valuation • Envision the Law of One Price	• Sec. 2.1.5, p. 27
2. Choose comparable firms	• Industry affiliation as common and empirically reasonable core criterium • Question of further similarity restrictions on the basis of intrinsic drivers	• Sec. 2.1.5.3, p. 32 • Sec. 6.2, p. 185
3. Select suitable type(s) of multiple(s)	• Classification of multiple types • Anchoring of multiples in corporate finance theory • Relative empirical performance of different types of multiples • Benefits of industry-specific multiples	• Sec. 2.4, p. 52 • Sec. 2.3, p. 41 • Ch. 4, p. 89
4. Calculate the individual peer pricing multiples	• Consistency of calculation between valuation driver and price/value reference • Historical vs. forward multiples	• Sec. 2.3.2.2, p. 42 • Ch. 5, p. 129
5. Determine a valuation multiple and the valuation for the investigated firm	• Translation of pricing multiples into valuation multiples through various aggregation methods • Combination of several multiples vs. individual multiples • Nature and explainability of valuation errors	• Sec. 6.3, p. 196

Note: Own illustration.

1.2.3 Defining the dissertation scope on the basis of 8 research topics

Masked by their simplicity, trading multiples offer considerable opportunity to assess potential research topics from a theoretical and empirical perspective. It is therefore as crucial to define what is to be analyzed in this dissertation as it is to determine what will not be a focus area or only discussed in a cursory manner. Table 1.3 (p. 12) provides an overview, translating the 4 core research questions discussed in Subsection 1.2.1 (p. 7) and the 5 steps of multiple valuation outlined in Subsection 1.2.2 (p. 7) into 8 more concrete research topics. Table 1.3 furthermore indicates the focus areas of this dissertation from a scoping perspective, including a discussion of the rationale on out-of-scope[40] areas. Whilst Table 1.3 cannot

only aspects of step 3 (multiple type selection, including multiple types specific to such analyses such as the popular cyclically-adjusted P/E ("cyclicality-adjusted price/earnings multiple, sometimes also referred to as "Shiller-P/E" (CAPE)") first suggested by Campbell and Shiller (1988) and further developed in numerous additional papers since), step 4 (actual pricing multiple calculation) and step 5 (aggregation, most commonly through index medians or means) will be necessary. The 5 stage approach, however, is presumably the most comprehensive concept, hence can serve well as basis even for more restrictive applications

[40]Highlighted with a pale red background

claim completeness, it also represents the major research topics in precedent literature around multiples in combination with yet to be studied open subject matters; notably, it identifies 8 research topics, which warrant further theoretical and empirical assessment.

In response to core research questions 1 and 2,[41] the selected research topics for this dissertation are concerned with:

1. *Valuation accuracy of different multiple types/valuation drivers:* This question in essence relates to an investigation, which type of multiple (e.g. price/earnings,enterprise value/EBIT, price/book, etc.) performs better than alternative types. Whilst this aspect has been studied to some extent previously,[42] existing studies are more anecdotal in nature and do not offer a sufficiently conclusive theoretical framework to detect which groups of multiple types[43] outperform others

2. *Valuation driver timing, also considering M&A consolidation:* Previously analyzed by a number of authors at some level,[44] this discussion will be extended to investigate if consolidation in the context of M&A transactions is to blame for biases in historical and near-term future valuation drivers

3. *Industry-specific multiples …* Some of the earlier studies suggest that the valuation accuracy of certain multiple types vary with industry affiliation.[45] Even considering some more recent studies,[46] evidence remains inconclusive and hence warrants some further assessment

   … operationalized through combined multiple concepts: Combined multiple concepts, i.e. multiple valuation relying on more than one type of multiple at the same time, are challenging to operationalize from an empirical perspective[47] given a way to determine weights is to be devised. It is therefore beneficial to study this aspect jointly with another research topic and for, this dissertation, industry-specific multiples are chosen to provide weighting guidance

4. *Adjusted vs. unadjusted multiples:* A comprehensive theoretical framework will be offered in Chapter 5 and will be empirically tested to assess the benefits of adjustments

[41] Compare Subsection 1.2.1, p. 7
[42] Compare Schreiner (2007), J. Liu et al. (2002) and Lie and Lie (2002), among others
[43] As discussed in the taxonomy of multiples below, Subsection 2.3 (p. 41)
[44] Compare e.g. J. Liu et al. (2002), Yoo (2006) and Harbula (2009)
[45] LeClair (1990), Baker and Ruback (1999)
[46] Harbula (2009), Schreiner (2007)
[47] Compare e.g. the approaches by Schreiner (2007), who relies on a simple 50:50 weighting

TABLE 1.3: Scope of this dissertation: From research questions to concrete research topics

Core research question	Corresponding step in multiple valuation	Universe of concrete research topics	Scope[b]	Considerations
1. Best practices for trading multiple valuation on the basis of theoretical deliberations, considering cost of sophistication 2. Best practices based on empirical data: positive influence on valuation accuracy?	Select suitable type(s) of multiple(s)	Valuation accuracy of different multiple types/valuation drivers	✓✓	• Important aspect as the nature of the valuation driver as the best single-period[a] proxy for the long-term economic cash generation potential • "Systematic behavior" of valuation drivers would establish a theoretical understanding
		Valuation driver timing…	✓	• Forward-looking drivers ex ante more consistent with forward-looking nature of valuation
		…considering M&A consolidation	✓	• Potential bias from M&A consolidation so far not empirically explored
		Industry-specific multiple types…	✓	• Consistent with textbook literature (Mondello, 2017; Hasler, 2011) • Theoretically justifiable as an expression of different value drivers—and hence different single period proxies—in different industries
		…operationalized through combined multiple concepts	✓	• Already studied (Yoo, 2006; Deng, Easton, & Yeo, 2010) and challenging to operationalize without another concept beyond the rather crude approaches (compare e.g. Schreiner, 2007) • Some theoretical considerations offered and applied to industry specific multiples
		Multi-period valuation drivers	×	• Dilutes simplicity of the concept (prediction-light approach) • Already studied to some extent previously (Courteau, Kao, O'Keefe, & Richardson, 2006)
	Calculate the individual peer pricing multiples	Adjustments to multiples	✓✓	• Comprehensive adjustment framework much beyond the few existing studies (Berndt, Deglmann, & Vollmar, 2014; Chullen, Kaltenbrunner, & Schwetzler, 2015)
		Performance-adjusted multiples	×	• Repeatedly proposed in prior studies (Henschke, 2009); however, perceived not intuitive • Peer weighting offered as more intuitive alternative
	Analyze the company under investigation and its industry Choose comparable firms	Improved valuation accuracy through peer weighting depending on the similarity of financial characteristics	✓✓	• Intuitive concept, expanding on more restrictive concepts around a strict limit to the number of peers (Herrmann & Richter, 2003)
		Fixed limit to the number of peers	×	• Previously studied (Cooper & Cordeiro, 2008; Herrmann & Richter, 2003) • Proposed weighting concept an alternative presumably more consistent with practitioners' qualitative peer group formation arguments
		Consider peers beyond industry affiliation	×	• Argued for in textbook literature (Damodaran, 2012a, pp. 483-486) and in some studies (Herrmann & Richter, 2003), albeit with limited success • Of lesser practical relevance
	Determine a valuation multiple for the firm investigated	Aggregation of multiples through median, including value relevance of negative multiples	✓✓	• Median as a suitable aggregation method widely studied and theoretically justified (Dittmann & Maug, 2008), none the less instructive to provide sample-specific data • A more recent topic in multiple valuation research (Sommer & Wöhrmann, 2011)
3. Systematic explanation of valuation errors		A closer analysis of valuation errors…	✓✓	• With previous studies picking independent variables in valuation error explanation somewhat at random (Henschke, 2009), there is opportunity for a theoretically more justifiable approach
		…and strategies for their reduction	✓	• Some initial evidence on a potentially very comprehensive field
4. Relationship between trading multiple valuations, intrinsic valuations and stock prices		Trading multiple valuations vs. fundamental valuations	✓✓	• Surprisingly given its obviousness, this aspect has received very little prior attention for broader trading multiple studies with prior studies (e.g. Kaplan and Ruback (1995)) focusing on particular situations
		Benchmarking against other concepts	×	• Could include transaction comparables, residual income valuation • Not considered as (a) pairwise match challenging (for transaction comparables) and (b) low practical relevance (RIV) and (c) to some extent studied already (Courteau, Kao, O'Keefe, & Richardson, 2006; Henschke, 2009)
		Devise superior investment strategies on the basis of trading multiples	×	• Some prior studies in the field do exist (Rossi & Forte, 2016) but generally open to further research

Note: Own analysis; [a] Or as the case may be for stock multiples point in time [b] scope of this dissertation: ✓✓: focused coverage; ✓ covered; ×: of lesser focus to trading multiples. This complements evidence from a number of previous studies[48] focused at narrower time frames, selected multiple types (notably enterprise value multiples only), selected markets and a less complete list of proposed adjustments

5. *Improved valuation accuracy through peer weighting depending on the similarity of financial characteristics:* Deduced from intuition and benefiting from a more parsimonious nature compared to precedent concepts,[49] a novel approach used in this dissertation argues that the aggregation of peer pricing multiples into a valuation multiple for the firm under investigation should rely on a weighting concept, giving higher influence to peers with financial metrics closer to the company under investigation

6. *Aggregation of multiples through median, including value relevance of negative multiples:* After discussing theoretical benefits and empirical attractions of median as the standard aggregation concept for multiples, this aspect is concerned with extending prior studies on the value relevance of negative multiples[50] to investigate whether median aggregation—which is shown to be least biased relative to other methods as far as negative multiples are concerned—results in accuracy improvements

In response to core research question 3, one research topic comprising two parts deserves further attention:

7. *A closer analysis of valuation errors …* One approach to investigate multiple valuation precision is to consider strategies, which minimize valuation errors: under this premise, a specific multiple valuation is successful if it performs better than other valuation alternatives, be it other multiple valuations or different valuation approaches all together.[51] However, for a systematic analysis of multiple valuation, it can also be of interest if resulting valuation errors can be *explained*.[52] Consequently, the theory developed in Chapter 4 will be applied to test if it successfully explains valuation errors

   … and strategies for their reduction: Once and to the extent valuation errors can be systematically understood, the question arises if there is opportunity to *improve* valuation outcomes by addressing systematic error biases

[48] Notably, Berndt, Deglmann, and Vollmar (2014) and Chullen, Kaltenbrunner, and Schwetzler (2015)
[49] Such as Henschke (2009)
[50] Notably Sommer and Wöhrmann (2011)
[51] The majority of empirical valuation error studies is based on this fundamental principle
[52] Also compare Henschke (2009, pp. 3–4) on this insight

Finally, concerning research question 4, this dissertation will focus on the following research topic:

8. *Trading multiple valuations vs. fundamental valuations:* In order to gain an understanding of how trading multiple valuation compares to intrinsic valuation concepts, a comparison of both methods will be undertaken, operationalized through intrinsic multiples

A number of other potential and past research topics in the context of multiples are identified in Table 1.3, which, for various reasons indicated, will not be covered more than in a cursory manner in this dissertation. Reasons for their exclusion from the selected list of topics include (a) an already relatively broad body of literature as is e.g. the case with fixing the number of peers based on intrinsic similarity;[53] (b) a concept of little practical relevance and little empirical gains shown previously, e.g. other valuation approaches such as the residual income valuation (RIV) or peer formation across industries; (c) aspects decidedly deemed too remote relative to the topics and techniques covered, including investment strategies relating to trading multiple assessments, which are up to further research.

1.3 Core methodology: a "horse race" of absolute valuation errors

While this dissertation will rely on a number of statistical analyses in order to assess various formal hypotheses quantitatively, at its core it will be based on a more stringent form of the common approach of concurrent "*horse races*"[54] used in numerous precedent studies on trading multiple valuation:[55] The computation of a valuation error[56] of a particular multiple valuation approach is followed by a comparison of that valuation error relative to *alternative approaches* in order to determine *superior performance* of one valuation methodology versus the other. As is common in prior studies, this dissertation will chiefly rely on a valuation error concept, in which the *result of a trading multiple valuation* for a specific company under investigation derived from its peers is compared to the *contemporaneous market price* for that very company. In most instances, the valuation error will be expressed (a) in *absolute terms*,

[53]Compare e.g. Cooper and Cordeiro (2008) and Herrmann and Richter (2003)
[54]See e.g. Yee (2004a) or Plenborg and Coppe Pimentel (2016)
[55]Compare Figure 6.6 (p. 235) and Table A.5 (pp. A28–A35) for an overview
[56]As also referred to in core research question 3, compare Subsection 1.2.1 (p. 7)

implicitly assuming that there is no difference between over- and undervaluations[57] and (b) as a relative metric[58] such that the errors can be aggregated meaningfully for the sample.[59]

Whilst it is instructive to assess the errors obtained in that manner on a standalone basis to determine the general level of valuation accuracy achieved for a specific multiple in the sample at hand—e.g. for price/earnings multiples the median absolute valuation error obtained is 18.5%[60]—any assessment to guide towards meaningful multiple valuations will require additional context in form of a comparison to multiple valuation alternatives: e.g., in the sample at hand, the corresponding median absolute equity valuation error for enterprise value/EBIT amounts to 20.7%;[61] at face value, one could therefore conclude that price/earnings might be the superior valuation methodology compared to enterprise value/EBIT given the former displays, on median, lower valuation errors than the latter. Numerous precedent multiple valuation studies stop at such assessment of valuation error comparisons;[62] it offers the advantage that several approaches can be considered *in parallel* with the "winning horse" being the concept with the lowest error. This dissertation will none the less extend the quantitative assessment by two important aspects, adding rigor to the results: first, introduction of the concept of *pairwise valuation differences*, where an analysis of the respective two valuation approaches takes place on a sample company-by-sample company level rather than on an aggregated basis[63] and, second, the use of *statistical testing* to assess differences in the underlying distribution between one valuation concept and another by means of a non-parametric *Wilcoxon sign-rank test*.[64]

The assessment of multiple valuations in this dissertation therefore relies on a number of implicit presumptions:

1. **Meaningful multiple valuation can be characterized through low valuation errors;** in other words high valuation accuracy is the necessary and sufficient condition for successful multiple valuation

[57]i.e. accuracy rather than upward or downward bias

[58]i.e. a percentage number

[59]For a more detailed discussion including on the rationale for using log- rather than percentage errors compare Subsection 6.4.1.1 (p. 222)

[60]Compare Panel A of Table 7.2, p. 245

[61]Compare again Panel A of Table 7.2

[62]Compare e.g. Schreiner (2007) or Rossi and Forte (2016)

[63]Additional details on the pairwise valuation differences metrics approach are provided in Subsection 7.2.3.3 (p. 251)

[64]Compare Subsection 6.4.1.4 (p. 227) for a discussion on why the Wilcoxon sign-rank test is chosen. Its application is in line with a minority of previous studies on multiple valuation accuracy. To avoid issues with repeated testing, resulting p-values are subjected to a Holm–Bonferroni adjustment

2. Whilst it is anecdotally instructive to look at the data obtained for valuation errors by itself, it is even more meaningful to **consider errors in context**, i.e. relative to an **alternative** multiple or other valuation concept, over time or in a comparison between specific firms

3. For the most part, there is **no qualitative difference between over- and undervaluations**. In an accuracy assessment, it is generally appropriate to compute **absolute valuation errors** rather than relying on signed valuation errors (biases)

4. Company valuation **carries a cost for its preparer**. Hence, ceteris paribus, the simpler method should be preferred over a more complex alternative

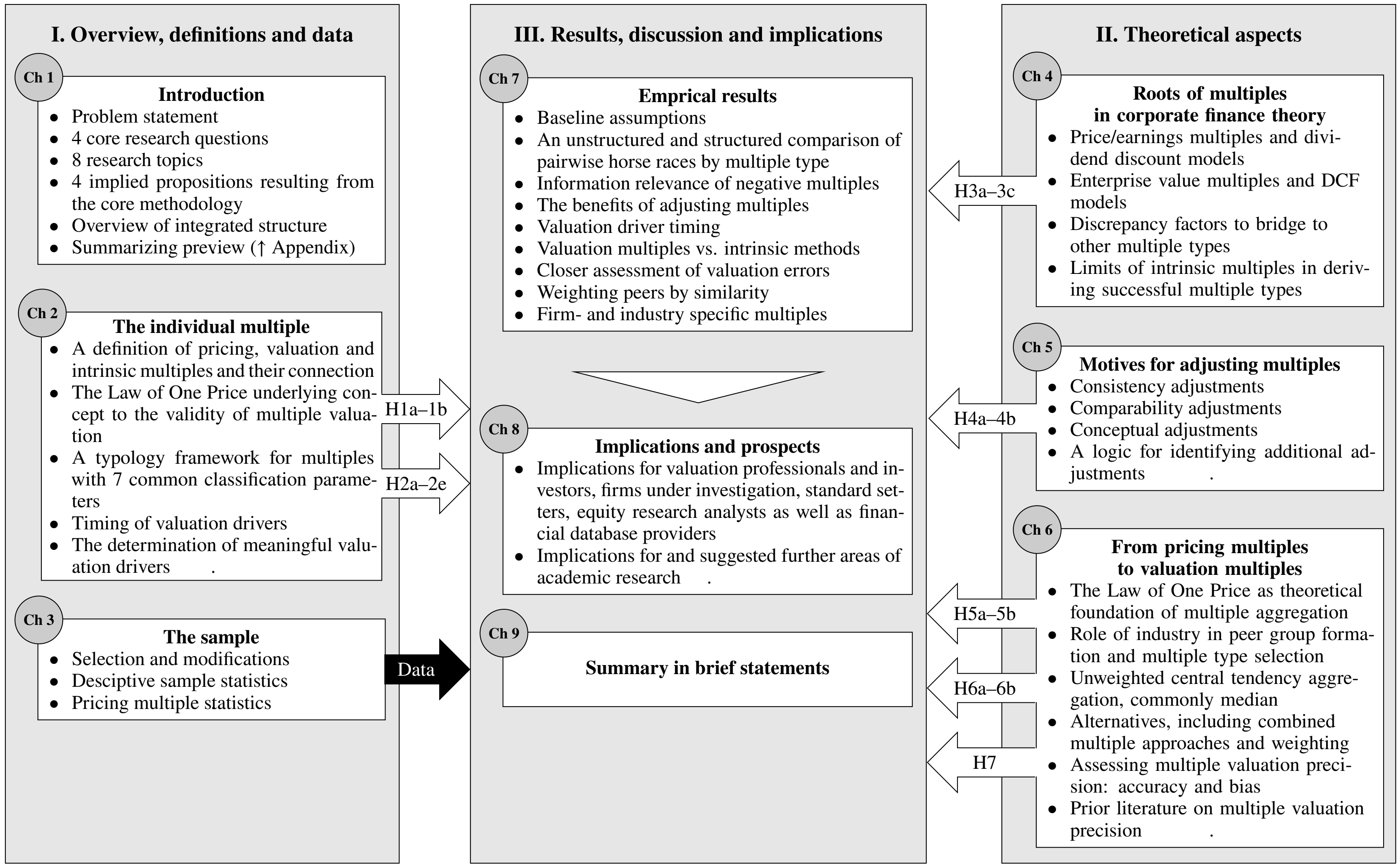
1.4 Course of investigation: an integrated structure

This dissertation will follow an integrated approach with regards to descriptive data, hypothesis formulation and literature review. The sample is presented relatively early on in Chapter 3, which allows to contextualize the theoretical considerations on multiples in Chapter 4 on the basis of common descriptive statistics applicable to sample company metrics rather than in a theoretical vacuum. Furthermore, I present the formal hypotheses in an integrated manner, i.e. together with the theories they relate to. The literature review, too, is embedded into the theoretical Chapters to maximize its contextual impact. Since it is common for much of the focused empirical studies on multiples to rely on valuation error metrics of some sort, a summarizing empirical literature overview is provided in the context of the theoretical discussion of valuation multiple accuracy, compare Subsection 6.4.3 (p. 234).[65] Beyond those integrated aspects, the dissertation follows a relatively standard structural approach and Figure 1.1 (p. 17) sets out the course of investigation in greater detail. For the reader in a hurry, Appendix Table A.1 (p. A2) presents a summary of the research topics, key prior findings, formal hypotheses, an overview of methodologies used and results obtained.[66]

[65]And most notably Figure 6.6 (p. 235) and Table A.5 (pp. A28–A35)

[66]Table A.1 also includes references to where in the dissertation theoretical considerations, formal hypotheses and results are located. Naturally, Table A.1 is a simplified short form; its purpose is, however, not to explain all details but to act as a quick reference of the dissertation

FIGURE 1.1: Visualizing the course of investigation in this dissertation



Note: Own illustration; arrows reference hypotheses as indicated; Ch = Chapter, H = Hypothesis

CHAPTER 2

Preliminary considerations on the individual multiple as a valuation tool

"Everything is worth what its purchaser will pay for it."
—PUBLILIUS SYRUS[67]

2.1 An attempt at defining multiples in 3 contexts

2.1.1 Scarcity of existing definitions of multiples

There have been relatively few definitions in prior literature of what might constitute a multiple. Hasler defines multiples as "a performance figure which sets a flow (e.g. sales, earnings or cash flows) or stock figures (e.g. net asset values) in reference to a value figure (e.g. stock price, transaction value)" (2011, p. 284[68]), which is in line with the definition of Pratt, according to which "[a] market value multiple is the result of dividing a numerator, which represents dollars of price or value, by a denominator, which usually represents dollars of a financial variable

[67]Maxim No. 847, as reported by Lyman (1856, p. 71). Publilius Syrus (fl. 85–43 BC) known for his brief moral sayings ("sententiae"). The maxim shows that considerations around valuation, value and price are not exclusive to the modern age. Even more relevant for the context of trading multiples is that Publilius Syrus appears to argue that market prices play an important role in establishing value. Essentially all which was left for future generations to discover is the concept of standardizing values through valuation drivers as discussed further in this Chapter

[68]Own translation from German to English

of a company" (2005, p. 4). Choosing a narrower definition, Penman considers multiples as "simply the ratio of the stock price to a particular number in the financial statements" (2013, p. 78). Other authors jump right into examples, most commonly the price/earnings multiple[69] or implicitly cover multiples in the context of broader multiple valuation definitions.[70]

While multiple definitions are relatively scarce compared to the conceptual importance and general definition benefits, prior attempts at defining multiples are in themselves consistent and uncontroversial. A more material definitory vacuum relates to *multiples in different contexts*, which require differing calculation approaches: Namely, multiples, can be

- *computed out of a combination of a measured market price references* and a valuation driver—defined below as "pricing multiples": a concept to measure a multiple, potentially with a view to utilize it as one ingredient to value other firms or analyze its movement over time,
- *derived from input variables on the basis of a function,* which usually will have its roots in corporate finance valuation theory and where all respective input variables need to be known but neither the valuation driver[71] nor a measured market price reference is required—defined below as "intrinsic multiples," or
- *calculated by means of an aggregation methodology* on the basis of several pricing or intrinsic multiples—defined below as "valuation multiples"—which, if applied to the corresponding valuation driver for a firm under investigation, can ultimately result in a valuation outcome for that firm

The following sections explain and define those 3 very different use-cases in greater detail.

2.1.2 Pricing multiples

I propose the following definition for pricing multiples:

> *A **pricing multiple** is the quotient between a measured price in the numerator and a chosen valuation driver in the denominator with the objective to standardize the price for each unit of the valuation driver.*

[69] Ross, Westerfield, and Jaffe (2005, p. 125)
[70] Wagner (2005, p. 5), Hommel and Dehmel (2011, p. 65)
[71] Unless part of the input variables

This definition carries a number of relevant implications:

- *Valuation driver and measurable price as key determinants:* The proposed definition stresses the two elements characteristic of every multiple: the valuation driver[72] and some expression of value or price. Concerning the latter, the above definition is focusing on a market-based view as expressed by the term "measured price" and this price must be measurable or at least derivable from market pricing for a multiple to constitute a pricing multiple according to the proposed definition. In line with Massari, Gianfrate, and Zanetti (2016, p. 351), Herrmann and Richter (2003, p. 200) and Bernstrom (2014, p. 70) I refer to the multiple derived according to the above definition as a "*pricing* multiple" to indicate it is a multiple, which has been derived from a measurable price, which differentiates it to multiples obtained through fundamental valuations[73] or calculated as a valuation estimate.[74] Ultimately, pricing multiples reflect a view that "[m]ultiple valuation concepts are market-oriented valuations in a most forceful form"[75] (Wagner, 2005, p. 5; similar: Seppelfricke, 2014, p. 141)

- *Broad set of possible valuation drivers and price references:* Contrasting the definition of Penman (2013, p. 78), a pricing multiple is open to valuation drivers not immediately available from financial statements such as equity research forecasts of financial statement items, e.g. next fiscal year earnings, to metrics which, while not readily found in a single financial statement, can be easily computed such as EBITDA or a combination thereof.[76] There is equally more flexibility with regards to price references beyond stock prices, consider e.g. the definition of Hasler (2011, p. 284) regarding transaction valuations but also the concept of enterprise value as opposed to stock price or market capitalization

- *Implementation of the Law of One Price through direct proportionality between valuation driver and price:* The definition clarifies the important element of "*standardization*" (Damodaran, 2012a, p. 454). Sometimes also referred to as normalization (Koller

[72]Sometimes referred to as value driver (J. Liu et al., 2002, p. 140, Schreiner, 2007, p. 49), however, it is more precise to refer to it as the valuation driver (i.e. the driver used in the valuation) as it is ex ante unclear whether the metric is indeed a driver of value, valuation anchor (O'Hanlon, Peasnell, & Peng, 2007), performance driver (Seppelfricke, 2014, p. 147), performance measure (Kaplan & Ruback, 1995, p. 1067), performance indicator (Drukarczyk & Schüler, 2007, p. 486), financial or value indicator (Sommer & Wöhrmann, 2011, p. 4; Sommer et al., 2014) or basis of reference (Meitner, 2003, p. 23)
[73]See below regarding "intrinsic multiples"
[74]See below regarding "valuation multiples"
[75]Own translation from German
[76]Compare Subsection 2.3.2.2 (p. 42) for a discussion of forward looking valuation drivers

et al., 2010, p. 332),[77] standardization is necessary to address difference in size of the valuation driver, i.e. to express the value in terms of one unit of the valuation driver chosen.[78] Under the theoretical assumption that one could find a "perfect comp," which would show the same absolute earnings quantum as the company under investigation, no calculation of multiples would be necessary at all: according to the Law of One Price,[79] one could immediately utilize the share price of the "perfect comp" for the company under investigation. Computation of a multiple is hence only necessary because, in practice, absolute valuation driver quantums measured in monetary units tend to differ between companies and hence need to be standardized.[80] Standardization in the context of multiples imposes one critical assumption, namely that company valuations are directly proportional to the valuation driver utilized (J. Liu et al., 2002, p. 142)[81]: Consequently, it is crucial that the valuation driver in fact does have relevance for the measured market price. Wagner (2005, p. 17) postulates a number of requirements for suitable valuation drivers such as, low volatility, little dependency on accounting standards and firm accounting policies within those standards; they furthermore should be readily derivable and straightforward to forecast[82]

- *Differentiation to yield metrics:* A set definition of numerator and denominator differentiates multiples from yield and return metrics, which can be thought of as an *inverse of a multiple*, i.e. measurable price in the denominator and valuation driver in the numerator. such as dividend yield (Rosenbaum & Pearl, 2009, p. 62) or free cash flow yield. While one could derive similar valuation conclusions on the basis of a price/dividend multiple, the valuation yield approach does offer the advantage of intuitive comparability to other commonly used yield metrics e.g. the yield to maturity popular in bond markets.[83] [84] Furthermore, some empirical studies focus on the inverse of multiples[85] given certain

[77] Not to be confused with normalization for one-off items, see (Koller et al., 2010, p. 321)
[78] E.g. if earnings is chosen as the valuation driver, a price/earnings multiple expresses the value of comparable companies for one unit of their respective earnings.
[79] See below, Subsection 2.1.5.1 (p. 27 for a more in-depth discussion of the Law of One Price
[80] Note this discussion disregards any arguments on whether large companies should be valued at higher or lower valuations given their size: such value differences would translate into different multiples
[81] This direct proportionality does not assume any intercept. J. Liu et al. (2002, p. 144) also propose a model with intercept, which, while yielding better quality valuations, is as they admit of lesser practical relevance (J. Liu et al., 2002, p. 161)
[82] A broader discussion on the determination of suitable valuation drivers can be found in Subsection 2.4.1 (p. 52)
[83] Damodaran (2012a, p. 478) presents an instructive chart comparing "EP ratios" to interest rates over a 50 year time period
[84] See e.g. Fabozzi (2004, pp. 92–122) on further details for bond yield calculations
[85] E.g. an "earnings yield" metric defined as earnings divided by price

desirable statistical characteristics (J. Liu et al., 2002, p. 146), comparison with other valuation methodologies (Lee, Myers, & Swaminathan, 1999, p. 1708) or, some more dated analyses (Beaver and Morse, 1978, p. 72, Litzenberger and Rao, 1971), in the context of regression analyses

- *Consideration of a price or value:* The definition avoids the potentially confusing term “ratio.” At times, multiples are referred to as “market value ratios” (Brigham & Daves, 2004, p. 241) or “price-earnings ratios” (Dittmann & Maug, 2008), however, as Schreiner (2007, p. 39) points out, this could lead to confusion with operational or financial ratios such as e.g. profit margins. Multiples differ from ratios in that they contain a value, valuation or price reference rather than a benchmarking metric of financial items[86]

Analytically, a pricing multiple $\mu_{i,t}$[87] for the i^{th} comparable company at valuation time t can be defined as

$$\mu_{i,t} = \frac{P_{i,t}}{VD_{i,t}} \tag{2.1}$$

where $P_{i,t}$ refers to the measurable price[88] of the i^{th} comparable company at time t and where $VD_{i,t}$ refers to the chosen valuation driver[89] of the i^{th} comparable company at time t. While symbols used vary, Equation 2.1 is consistent with Kuhner and Maltry (2016, p. 312), Schreiner (2007, p. 40) and J. Liu et al. (2002, p. 142), among others.

2.1.3 Intrinsic multiples

As will be discussed at greater length in Subsection 4.2 (p. 90), it is possible to link multiples to (intrinsic)[90] valuation methodologies established in corporate finance theory, notably DDMs, DCF models or the RIV. Utilizing the term “intrinsic multiples,”[91] the following definition appears appropriate:

[86] To further elaborate on terminology in this context, less commonly, multiples are referred to as “multipliers,” compare e.g. Beatty, Riffe, and Thompson (1999)

[87] As necessary, indices *MT* and *MP* are used at times in this dissertation to specify certain multiple types (*MT*) and time periods (*MP*), i.e. $\mu_{i,t}^{MT;\,MP}$

[88] In a broader sense, including enterprise value and market capitalization as the case may be

[89] Which is to be further defined, with examples including earnings, EBITDA, or book value of equity, compare Subsection 2.4 (p. 52)

[90] Sometimes referred to as “fundamental”

[91] Which notionally follows Schreiner (2007, pp. 31–32)

> *An **intrinsic multiple** is a multiple, which is calculated using a functional relationship derived from corporate finance theory, considering input variables specific to that multiple.*

The specific input variables commonly comprise financial metrics, which relate to growth, profitability/efficiency, risk and capital structure of the firm considered, and they will need to be measurable or in some form estimated for an intrinsic multiple to be computed. The functional relationship will be justified by some kind of theoretical valuation model.[92]

As academia has analyzed multiples and suggested theories to link multiples to the broader corporate finance literature, most notably fundamental valuations, there have been a number of proposals to develop intrinsic multiples, including Spremann (2002, pp. 148–151), Schreiner (2007, pp. 31–38), Henschke (2009, pp. 67–68), Kelleners (2004, pp. 103–158), Schwetzler (2003) and Rossi and Forte (2016, pp. 9–14). Spremann (2002, p. 149) and Schreiner (2007, p. 38) admit that practitioners will consider multiples as a market-derived concept and are not normally seek to bridge their fundamental assumptions into a multiple-based valuation.[93] None the less, intrinsic multiples are of considerable practical appeal, as they:

- build a *bridge* between multiples and a long standing and well accepted body of literature around diverse *fundamental valuation* approaches—particularly important since multiples are a concept often criticized among academia for their arbitrary nature and lack of objectivity,[94]
- open a door to better understanding a potential source of *valuation errors*, notably a match of errors to differing input variables, allowing for an explanation of—if not a fix for—valuation errors,
- might solidify views derived from high or low multiples around the *mis-pricing* of a specific firm's security: According to this argument, if input variables point to a specific intrinsic multiple diverging from the pricing multiple, mis-pricing might explain that discrepancy,

[92]Compare in much greater detail Chapter 4, p. 89

[93]There is some evidence from studies of fairness opinions (Berndt, Deglmann, and Schulz, 2014, Schönefelder, 2007) and equity research report content analyses (Asquith, Mikhail, and Au, 2005) to support a distinct perception among practitioners around multiples on the one hand and fundamental valuations on the other hand

[94]Compare e.g. Hommel and Dehmel (2011, p. 66), Damodaran (2012a, p. 454) and Mondello (2017, p. 436)

- can be utilized as a "second best" solution to value firms, for which *no comparables* with suitable market prices are available and
- shed a light on *industry-specific* multiples, as intrinsic multiples usually are independent of an industry-specific logic, while they do depend on potentially industry-specific input variables much like fundamental valuation approaches

Analytically, an intrinsic multiple $\hat{\mu}_{i,t}$ for the i^{th} comparable company at valuation time t can be defined as

$$\hat{\mu}_{i,t} = \frac{f(\mathbf{x}_{i,t})}{VD_{i,t}} = \frac{V_{i,t}}{VD_{i,t}} \tag{2.2}$$

where $\mathbf{x}_{i,t}$ is a set of input variables to be further specified such as growth, profitability/efficiency, risk or capital structure—among other possible variables—connected to $\hat{\mu}_{i,t}$ via function f, which is further to be specified on the basis of corporate finance theory such as DDMs, DCF models or RIV models; in any event, it results in a valuation estimate $V_{i,t}$ for the company considered. For consistency of expression to the concept of multiples, the valuation obtained through f is then divided by a suitable valuation driver $VD_{i,t}$.[95]

2.1.4 Valuation multiples

In many instances, the objective of multiple valuation lies in deriving a value for a firm under investigation on the basis of its comparables. For any number of comparables exceeding one,[96] it becomes necessary to find a suitable way of aggregating the individual pricing multiples[97] to form one multiple.[98] This multiple can subsequently be utilized to calculate a valuation for the firm under investigation through multiplication with the firm's respective valuation driver. I consider such multiples "valuation multiples":[99]

[95] The notation of the intrinsic multiple $\hat{\mu}_{i,t}^{MT;\,MP}$ differs from the pricing multiple $\mu_{i,t}$ through the hat "^," indicating its implied nature; indices *MT* and *MP* are used at times in this dissertation to specify certain multiple types (*MT*) and time periods (*MP*) but withheld where not required

[96] There is some doubt if a peer group of one really constitutes a widely enough basis for a proper multiple valuation. In a U.S. court case, a one peer comparable group was despite great fit rejected as not making a market (Pratt, 2008, p. 274)

[97] Or alternatively, as the case may be: intrinsic multiples, however, from a practical perspective that would be less common

[98] Alternatively in practice, multiple ranges rather than singular valuation multiples may be used. Still the upper and lower boundaries of those ranges will need to be determined on the basis of the pricing multiples

[99] Alternative semantics for valuation multiples include "synthetic multiples"(Schreiner, 2007, p. 52; Massari et al., 2016, p. 342)

> *A **valuation multiple** is derived through an aggregation of several pricing or intrinsic multiples of comparable companies.*

More formally, valuation multiples can be explained in the following manner: In order to determine the value of the company j under investigation, it is customary to utilize a number of same-sector comparable companies $i = 1, ..., I$. Hence, a way to aggregate the information contained in the individual $\mu_{i,t}$ for all the I respective comparable companies must be found. It has been suggested that a *measure of central tendency* such as mean or median might be most suitable (Henschke, 2009, p. 15; Schreiner, 2007, p. 52); mean and/or median are also metrics typically shown in practitioners' multiple valuation outputs.[100] [101]

Analytically, it is therefore possible to express the valuation multiple $\hat{M}_{j,t}$ for the company j under investigation on the basis of I peer pricing multiples $\mu_{i,t}$ at time t through

$$\hat{M}_{j,t} = f(\mu_{1,t}, ..., \mu_{i,t}, ..., \mu_{I,t}) \tag{2.3}$$

where the exact nature of the aggregation function f requires further discussion.[102] As an illustrative example, in the case of choosing the arithmetic mean[103] as aggregation function, the estimator multiple would be specified as

$$\hat{M}_{j,t} = \frac{\sum_{i=1}^{I}(\mu_{i,t})}{I} \tag{2.4}$$

The valuation multiple $\hat{M}_{j,t}$ can subsequently serve to calculate the valuation of the company (or price estimate, $\hat{P}_{j,t}$) under investigation through simple multiplication with its valuation driver $VD_{i,t}$:

$$\hat{P}_{j,t} = \hat{M}_{j,t} \cdot VD_{j,t} \tag{2.5}$$

[100] See e.g. the illustrative output tables of Hasler (2011, p. 288), Rosenbaum and Pearl (2009, p. 15), Koller et al. (2010, p. 372) or Löhnert and Böckmann (2009, p. 562)

[101] As will be discussed later on in Subsection 6.3.2.1 (p. 199), it appears that harmonic mean or median might be suitable approaches

[102] See Subsection 6.3.2.1 (p. 199); there might even be a preference to express the valuation multiple and consequently the valuation outcome as a range

[103] Arithmetic mean is chosen here as a practically common illustrative example for multiple aggregation. It can be shown that alternative concepts such as median and harmonic mean are preferable, compare Subsection 6.3.2.1 (p. 199)

2.1.5 The Law of One Price and its extension for multiple valuation

2.1.5.1 The extended Law of One Price as an implicit presumption in valuation multiples

The core prerequisite for accepting the validity of trading multiple valuation through what has been defined in the preceding Subsection as valuation multiples is the "*Law of One Price*" (Hasler, 2011, p. 285; Schreiner, 2007, p. 48; Cornell, 1993, p. 336, among others): Identical companies[104] should trade at identical prices, or else arbitrage opportunities would lead to eventual price convergence (Esty, 2000, p. 24).[105]

In practice, it is unlikely that completely *identical* companies can be found for a large number of valuation settings, so the concept will need to be relaxed in order to cover *similar* companies. Multiple valuations hence implicitly extend the postulate of the Law of One Price in two ways: First, a company (i.e. the firm under investigation) should be valued *at the same price* as its similar—but not identical—comparables.[106] Second, since different companies will usually have different sizes, a way to *standardize size* will need to be found to implement the Law of One Price and in the context of multiple valuation, this role is carried by the valuation driver. I will first discuss the element of similarity to later[107] return to the point of standardization.

If a valuation of a company under investigation is to be conducted, a reasonable level of similarity for its valuation peers is a prerequisite since a negative interpretation of the Law of One Price suggests that different companies can well trade at different values, which may

[104] Or any asset for that matter

[105] Meitner (2006, pp. 30–31) discusses this aspect on the basis of 2 identical companies in his immediate valuation approach, acknowledging that the practical application of this approach must fail given no fully identical companies exist. However, some examples can be found which actually do come close: One example would be the existence of several stocks of one issuer as is the case for Anglo-dutch consumer goods company Unilever (Unilever PLC shares trade on the London Stock Exchange vs. Unilever NV shares trade on Euronext Amsterdam; an equalization agreement ensures that PLC and NV shareholder rights are as far as possible the same, see Unilever (2018)), a similar case is Dutch/UK oil company Shell (Ross, Westerfield, & Jaffe, 2008, p. 384) and Dutch brewer Heineken (Heineken N.V. vs. Heineken Holding N.V.). For some of those examples and others, deviations to theoretically expected relative trading have been observed on a regular basis, consistent with potential arbitrage opportunities, albeit more recently they faded (compare for more details de Jong, Rosenthal, and van Dijk, 2009). A somewhat comparable and well-studied case are American depositary receipts ("ADRs"), which are U.S. traded equivalents of foreign stocks, and for which some arbitrage opportunities appear to exist, see Hsu and Wang (2008) for ADRs of Hong-Kong stocks, Suarez (2005) for French stocks and Ghadhab and Hellara (2015) for a more international sample also comprising Canadian direct listings

[106] This clarification and extension is the more worth highlighting as the Law of One Price has traditionally been described as a counterbalancing force to arbitrage opportunities of one good in different marketplaces (Mankiw, 2002, p. 671); also, some authors (e.g. Ernst, Schneider, and Bjoern (2017, p. 221)) suggest that similar companies should be valued at *similar* valuations, however, in my view it is preferable to speak about *same* valuations to avoid a level of arbitrary elements

[107] See below, Subsection 2.1.5.4 (p. 33): The valuation driver is argued to have a role as standardization factor

potentially lead to valuation errors for the company under investigation. In order to, in later steps of the valuation exercise, avoid this potential pitfall, it is of paramount importance, that, in a first step, a solid understanding of the company under investigation is developed (Löhnert & Böckmann, 2009, p. 575), for only reasonable comprehension of the company under investigation enables an assessment of the similarity of its peers.

An additional relevant extension to the Law of One Price can be observed in the context of multiple valuation: Since valuation multiples in comparable company analysis will be determined by aggregating several peers, it is good enough if the Law of One Price applies to this *aggregation* rather than the individual peer company: For as long as the aggregation method ensures differences of all peers utilized *offset each other*, the process of reducing the many pricing peer multiples to a single valuation multiple still provides de-facto consistency with the Law of One Price (Nissim, 2013, p. 329; Henschke, 2009, p. 15; Schreiner, 2007, p. 48), even though it might be violated for individual peers.[108] As this aspect is ex-ante challenging to determine, it appears none the less strongly preferable to ensure *all* peers considered are highly similar to the firm under investigation.

2.1.5.2 The Law of One Price, objective value and market efficiency

Objective value The objectivity element of the Law of One Price can be connected to the classical theory of *"objective value"* popular in German theoretical valuation literature, which postulates that the objective economic potential of a business[109] is crucial to determine its value (among many: Matschke and Brösel, 2013, pp. 14–17; Moxter, 1983, pp. 27–28). Moxter (1983, p. 35) argues that objective valuation may often mean simplified valuation so as for the valuation practitioner not to get lost in too detailed analytics, a view very consistent with the conceptual spirit of multiple valuation.[110]

[108] This argument also addresses the assertion by Mondello (2017, p. 434), that multiple valuation assumes efficient markets for the peer group whilst it assumes inefficient markets for the individual company, as else, a multiple valuation concept would not be suitable to identify mis-priced companies: As long as the Law of One Price applies to the whole peer group, it can be suitable to identify individual companies displaying mis-pricing

[109] As opposed to individual investor or valuation practitioner sentiments—described in literature as "subjective value"—or a consideration of valuation goals, which can lead to different valuation outcomes even for one individual investor—the so called "functional value"

[110] Trading multiple valuation furthermore often relies on generally accepted—and hence arguably objective—equity research consensus estimates for valuation drivers (compare Subsection 2.3.2.2, p. 42), which can be considered input variables open to "everyone" (or at least the arguably market-making institutional investor community with access to such consensus numbers) and consequently "everyone" should come to the same valuation outcome, an important aspect of objective value (Matschke & Brösel, 2013, p. 14). Consider Meitner (2006, pp. 9–13) for a more exhaustive discussion of value theories in the context of comparable company valuation

Efficient market hypothesis The somewhat lesser concern of objective value theory with market prices[111] is at the core of *market efficiency* theories. Originating from the seminal paper of Fama (1970), depending on the information incorporated in the stock prices, three levels of market efficiency can be distinguished[112] and all levels have been studied extensively.[113] The results in particular for the *semi-strong version* of market efficiency—which is prima facie particularly relevant for multiple valuation since it relies on price references in addition to forecast valuation drivers estimated by research analysts using publicly available financials combined with proprietary forecasting techniques but lacking insider information[114]—have been interpreted unequivocally and inconclusively.[115] Thus, market efficiency according to the semi-strong form as proposed by Fama (1970) cannot ex ante be relied upon in the context of multiple valuation.

Tobin's concept of fundamental valuation efficiency Whilst the efficient market hypothesis and the forms developed by Fama (1970) play a tremendously important role for assessing market efficiency, they are strongly focused on information and *information dissemination* as well as the ability of investors to *earn excess returns*: it is sometimes argued that markets do not need to reflect "correct" price levels at all times; they are efficient as long as investors

[111] The introduction of price by market efficiency theory is relevant: In contrast to the "objective value" theory discussed above, not everyone will need to be following the objective value: It is sufficient if, *on average*, objective value results, as objective value is the market-clearing price

[112] Compare among many Ross, Westerfield, and Bradford, 2014, p. 340; the 3 forms are: the weak (all past pricing information is reflected in today's stock prices, technical analysis is useless), semi-strong (all *public* information is reflected in today's stock prices, technical and financial statement analysis is useless) and strong forms (all public *and private* information is reflected in today's stock prices, even insider information is useless); as Spremann (2006, p. 159) points out: a lack of market efficiency may potentially result in sustained excess returns for investors with the "right" investment algorithm, e.g. a weak form efficiency would allow investors considering a firm's financial statements or even possessing insider information to outperform investors who do not consider those types of information in their investment decision

[113] Compare e.g. Meitner (2006, pp. 62–65) for a detailed discussion of sources and approaches

[114] Since providing company insider information selectively to equity research analysts would constitute asymmetrical information disclosure, which firms at least in theory should be supposed to avoid

[115] While Spremann (2006, p. 161) argues that most scientists agree the main stock exchanges display semi-strong efficiency, Meitner highlights that "no definite statement can be made yet" (2006, p. 63) as a result of anomalies observed in some cross-sectional studies—none the less Meitner (2006, p. 70) admits, that informational efficiency on major stock markets is high and that any abnormalities to semi-strong market efficiency are temporary—including some which consider pricing multiple-based strategies: Compare e.g. on the price/earnings multiple strategies Sanjoy Basu (1977), Peavy and Goodman (1983), Garz (2000, pp. 137–140) and Rossi and Forte (2016, pp. 91–114). Ross et al. argue that the absence of a substantial number of professional investors earning excess returns "lend[s] some credence to the semistrong form version of market efficiency" (2014, p. 339), while not providing an ultimate proof for market efficiency. Koller et al., who do not follow the differentiation by Fama (1970) argue that—as a result of some empirical examples around the theoretically explainable value-irrelevance of corporate actions such as, index inclusion, stock splits, dual listings, earnings volatility, goodwill accounting and different accounting standards, among others (Koller et al., 2010, pp. 357–380)—markets are "typically" (2010, p. 397) efficient

cannot earn excess returns in a sustainable manner (Malkiel, 2003, pp. 60–61).[116] This interpretation is can be contrasted to Tobin (1984, p. 2), who differentiates 4 distinct market efficiency types,[117] among which the concept of *fundamental valuation efficiency* stipulating that price corresponds to future payments of the asset under investigation. It is this concept of efficiency, which is of even larger relevance than the standard efficient market hypothesis defined by Tobin (1984, p. 2) as information-arbitrage efficiency in the context of multiple valuation.[118] Under the assumption of efficient capital markets, (objective) values and market prices can be assumed to correspond to each other.[119]

The interaction of Law of One Price and market efficiency in the context of multiples
Table 2.1 (p. 31) describes the interaction of market efficiency and the Law of One Price and potential consequences for multiple valuation in a summarizing manner. The Law of One Price can be perceived as an *intra-company efficiency* at the time of valuation, in contrast to the much further reaching concept of general market efficiency.[120]

In efficient capital markets[121] and under the Law of One Price:

- Values are well represented by market prices as dictated by the fundamental valuation market efficiency assumption (Tobin, 1984, p. 2),
- values between similar companies should be similar as suggested by the Law of One Price and
- market prices are a suitable metric to compare values in the context of multiple valuation

In other words, the combination of efficient capital markets and a functioning Law of One Price is quite trivial: multiple valuations will be meaningful and consistent with market prices and intrinsic valuations.

[116] Interestingly, Fama did discuss explicitly in an earlier publication that he shared the view that market prices would always reflect valuation levels: "[I]n an efficient market at any point in time the actual price of a security will be a good estimate of its intrinsic value." (1965, p. 56)
[117] which include: information-arbitrage efficiency, fundamental valuation efficiency, full-insurance efficiency, and functional efficiency, the two latter of which are of lesser relevance in the context of multiple valuation
[118] It is worth noting that other authors subsume aspects of price/value congruence under market efficiency, too, including Ross et al. (2014, p. 338) and Matschke and Brösel (2013, p. 27); notable for Tobin (1984) is the differentiation between information-arbitrate and fundamental valuation efficiency
[119] Also compare on this aspect Ross et al. (2014, p. 338) and Matschke and Brösel (2013, p. 27)
[120] A distinct perspective between the Law of One Price in the context of multiple valuation is also advocated for by Rossi and Forte (2016, p. 8), whilst e.g. Henschke (2009, p. 15) places little emphasis on this aspect
[121] And that should be the more true on the more restricted definition of perfect capital markets (Watson & Head, 2007, p. 35; Schreiner, 2007, p. 86)

TABLE 2.1: Interaction of Law of One Price and market efficiency in the context of multiples

<table>
<tr><th></th><th></th><th colspan="2">Degree of general market efficiency[a]</th></tr>
<tr><th></th><th></th><th>High</th><th>Low</th></tr>
<tr><td rowspan="2">Applicability of the Law of One Price</td><td>Full</td><td>• Results of multiple valuations and intrinsic concepts can be expected to correspond to each other
• Multiple valuations can be relied upon to value companies not traded on that market—simple alternatives to intrinsic approaches with presumably lower cost of valuation</td><td>• Multiples can serve to detect mis-pricings
• A (cautious) use of multiples allows for valuations in line with observed market levels—unachievable by intrinsic concepts
• Potential exposure of multiple approaches to mis-pricings suggests a cross-check with intrinsic valuations required</td></tr>
<tr><td>None/ limited</td><td>• Challenging to implement meaningful multiple valuations
• Reliance on intrinsic valuations necessary
• Most commonly an issue of missing suitable comparables—if those would exist and markets are efficient, it is challenging to imagine the Law of One Price not to function</td><td>• Likely significant pricing challenges and presumably elevated volatility</td></tr>
</table>

Note: Own illustration. [a] Considering the definition of Tobin (1984, p. 2) for fundamental valuation efficiency

The more interesting question relates to a scenario, in which certain general market efficiency imperfections arise, while the Law of One Price still applies. I argue that multiple valuation can provide meaningful insight *even under a lack of market efficiency*, as far as the Law of One Price remains valid. In situations where, as some might argue,[122] there are mis-pricings in the form of bubbles,[123] [124] multiples can contribute to establishing relative valuations—at market-wide elevated valuation levels common for bubbles, given stock prices reflect consensus views rather than intrinsic values (Schreiner, 2007, p. 87; Nissim, 2013, p. 329). Positively interpreted, the additional information on market sentiment carried by comparable companies over intrinsic valuations can be beneficial (Meitner, 2006, p. 70).[125] On the flip side, this feature of multiple valuation can, however, be considered a potentially dangerous drawback

[122] Compare the book of Shiller (2015) on "Irrational exuberance" and many other authors such as Koller et al. (2010, p. 391)

[123] Stock market bubbles could reasonably be considered as signs for the lack of semi-strong form market efficiency as they could be uncovered by their unusually high pricing levels, unjustified by earnings expectations

[124] This aspect is notoriously difficult to test since it is unclear what is the intrinsic valuation level assumed by the market, all what can be measured is price. None the less, views are unequivocal: e.g. Meitner (2006, p. 68) quotes studies showing that analyst reports based on DCF valuations managed to support the prices during the "dot-com" bubble in the early 2000s. General market fluctuations and volatility, which can be linked to reasonable assumption changes are a sign for (not against) market efficiency (Ross et al., 2014, p. 340)

[125] This view is particularly compatible with the argument that even during bubbles, markets display a semi-strong form of efficiency

since it may lure investors to continue to trade stocks at pricing levels *unjustifiable through intrinsic valuation* and hence further fuel any bubble.[126] [127]

Finally, Table 2.1 presents a scenario in which the Law of One Price cannot be applied, whilst general market efficiency occurs. I argue that this situation is mostly caused by a *lack of comparables*: Assuming enough peer companies for multiple valuation are available and general market efficiency is given, it appears challenging to argue for a situation, in which the Law of One Price would not function.

To summarize, it appears that the Law of One Price, which can be interpreted as intra-company market efficiency at a specific point of valuation, is a necessary prerequisite for meaningful multiple valuation. Multiple valuation, however, sets a low bar for general market efficiency, as long as it is acknowledged that the valuation outcomes might share the biases from inefficient markets[128] if relying on the prices observed therein.

2.1.5.3 Implementing the Law of One Price through peer selection

The Law of One Price is operationalized in multiple valuation through comparable company selection. Whilst generally starting on the basis of *industry affiliation*,[129] additional qualitative and quantitative selection criteria for peers can be imposed or counterbalanced with more generous industry demarcations.[130] *Qualitative* topics may potentially include:

- Overall future strategy
- General market characteristics
- Geographic and segmental market presence
- Universe of competitors

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[126] Vice-versa, during busts/market-wide depressed valuation levels, current trading multiples may not send an appropriate undervaluation signal to investors regarding intrinsically “cheap” companies, aggravating their reluctance to trade

[127] The concept of valuation multiples can also be further developed into a highly useful tool to assess current valuation levels in the market place relative to long-term historical averages by utilizing “*through the cycle*” trading multiples (compare e.g. Panel A of Figure 7.10 (p. 298) for a visual illustration of a “through the cycle” multiple chart), which map multiple valuation levels over time and allow an assessment of relative pricing levels in particular if mean reversion of valuation is assumed (Löhnert & Böckmann, 2009, p. 584). More sophisticated concepts such as the Campbell and Shiller (1988) cyclically adjusted price/earnings multiple(“CAPE”) have been developed with this aspect in mind, too

[128] According to the fundamental type defined by Tobin (1984, p. 2)

[129] Compare in greater detail Subsection 6.2 (p. 185), which also discusses prior empirical findings on the validity of the industry approach

[130] Below lists of topics should be considered illustrative and by no means complete. Loosely based on Rosenbaum and Pearl (2009, pp. 16–19) and Sharma and Prashar (2013, p. 30). Also compare Schönefelder (2007, p. 104) for a set of criteria used by the authors of fairness opinions and see Subsection 6.2.3 (p. 188) for empirical studies on finer peer selection beyond industry affiliation

- Regulatory environment
- Supplier relationships and raw material exposures
- Customer base and route to market/distribution channels
- Quality of the management team

It can be beneficial to consider both key attractions[131] as well as potential risks and, if applicable, mitigants of individual peers and the firm under investigation. While an in-depth review of the company under consideration will be time-consuming, it might result in a good understanding of the broader industry, which will be helpful for choosing comparable companies in a later step.

Quantitative and financial aspects could include

- Historical financial performance, in particular growth, cash generation and profitability
- Normalizations and adjustments to earnings, including for one-off items, currency impacts and M&A transactions
- Anticipated financial performance, e.g. on the basis of a business plan or management guidance
- Capital efficiency, sizable one-off capital expenditure requirements and return on investment targets
- Balance sheet aspects, including the overall liquidity position and financing profile, stock option programs, rent and leasing commitments as well as pension liabilities
- Equity investments, minority interest and assets held for sale

2.1.5.4 The Law of One Price and valuation driver selection

Existence of a suitable valuation driver as prerequisite to implementing the Law of One Price in multiple valuation A crucial aspect of any multiple valuation is the choice of the appropriate valuation driver, which will—together with a consistent price reference—determine the type of multiple. The Law of One Price offers additional conceptual insight in valuation driver selection. The concept of multiple valuation *standardizes* the price reference by the valuation driver (Damodaran, 2012a, p. 454; Koller et al., 2010, p. 323), postulating direct proportionality between price reference and valuation driver (J. Liu et al., 2002, p. 142).[132] However, the role of the valuation driver is materially more substantial than a simple scale factor: The Law of One Price can only play if a *suitable* valuation driver is found, i.e. a

[131] At times referred to as "equity story"

[132] For a visual representation of this aspect also compare Figure 6.1 (p. 196)

valuation driver, which—in no more than one figure—represents well the economic future of the company for which the pricing multiple is calculated and, moreover, of all peer companies considered and of the firm, to which the multiple valuation is ultimately applied. With the concept of multiple valuation, which stipulates the Law of One Price, the valuation preparer puts all of his or her "eggs in one basket," namely the valuation driver. If this valuation driver is a good representation for valuation proportionality, multiple valuation can be superior to fundamental valuation, as it "incorporates contemporaneous market expectations on future cash flows and discount rates" (Kaplan & Ruback, 1995, p. 1067)—on the other hand, the existence of and ability to identify such a suitable valuation driver is a key success factor of multiple valuation.

The all important suitability criterion can be studied from different perspectives[133]—but also from a higher-level theoretical perspective on what differentiates valuation drivers: their quality as good proxies for the *future economic cash generation potential*.[134]

A multiple valuation is usually based on a valuation driver relating to a 12 month period such as next twelve months earnings or last fiscal year EBITDA.[135] Particular focus is hence required to ensure the valuation driver is properly understood as, contrary to multi-period valuations such as a DCF, discrepancies may perpetuate themselves.[136]

Learnings for accounting-based valuation driver selection from the Functional Fixation Hypothesis Whilst not providing any further concrete argument for the existence of a generally suitable single-period valuation driver, which allows to operationalize the Law of One Price through multiples, some high-level theoretical perspective is available on which group of valuation drivers—notably *cash-flow or accounting-focused drivers* could be more suitable.

It is widely argued in corporate finance theory that valuation should be based on some functional expression of *future cash flows*.[137] An ex ante reasonable conclusion would be to

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[133] Including from an empirical perspective (compare the evidence on valuation driver accuracy in Subsection 7.2, p. 242), from a theoretical relative perspective of different multiple types (compare Subsection 2.4.2.1, p. 55) for a comparison of price/earnings and enterprise value/EBITDA), from a qualitative perspective (compare e.g. Wagner (2005, p. 17) who postulates that valuation drivers should display low volatility, little dependency on accounting standards, open to straightforward forecasting and readily derivable)

[134] In the words of B. Graham and Dodd (1934): "earnings power"

[135] Unless stock multiples are used, compare Subsection 2.3.2.1 (p. 42)

[136] If a public company is investigated, equity research reports may contain suitable information on both qualitative and quantitative aspects as well as complement information available from the company under investigation directly (Rosenbaum & Pearl, 2009, p. 20)

[137] Namely a discount to present value formula; compare the Equations developed and discussed in Chapter 4 (p. 89), notably Equations 4.1, 4.2 and 4.18. It is important to note though that the considerations offered

argue that valuation drivers, too, should cash flow-based. However, there is reason to believe that valuation drivers with roots in the profit and loss (P&L) statement, i.e. earnings-based concepts, might fare better than their cash flow-based alternatives: Through the concept of accruals, earnings-based valuation drivers such as net income or EBIT are by nature somewhat "normalized over time" and hence might be more suitable single-period proxies for the long-term economic cash generation potential of a firm than more volatile cash flow metrics.[138] A number of accounting research theories offer support for this presumption albeit from a more investor-driven perspective. Notably, it is argued by both the "Mechanistic Hypothesis" and the "Functional Fixation Hypothesis" that market prices will establish themselves as a multiple of capitalized earnings (Hand, 1990, pp. 743–744; M. Kim & Ritter, 1999, p. 423). However, those hypotheses are seen as a "contrast" (Hand, 1990, p. 743) to the Efficient Market Hypothesis—rather than its complement: a multiple of earnings is taken as a shortcut to valuation rather than investors unpacking the cash flow of a firm under investigation in greater detail. While this is a useful definition to study the impact of accounting changes on valuation as is commonly conducted in the context of the Functional Fixation Hypothesis,[139] the argument here is slightly different: Accounting-based figures could well be the intrinsically best single-figure proxy for the future economic cash generation potential and hence be a more suitable than single-figure cash-based line items as valuation drivers; the Functional Fixation Hypothesis implies some form of (potentially undue) pricing impact from earnings instead.[140]

2.2 Assessing the connection between pricing, valuation and intrinsic multiples

2.2.1 The triangle of multiple valuation (im)precision

The (extended) Law of One Price concept, which suggests similar companies should trade at similar prices, was previously identified as a key governing principle of multiple valuation.[141]

in Chapter 4 are more investigative in nature; i.e. they allow to determine sensitivities of input factors on multiples rather than conclusive logic for best valuation drivers

[138] While I cover prior evidence around valuation driver accuracy in Subsection 2.4.3 (p. 61), it is worth to highlight that there is evidence on the strong performance of earnings over more cash-like streams such as operating cash flow and dividends by J. Liu, Nissim, and Thomas (2007), who on the basis of a sample size of all together more than 1.6mm firm-months find that, earnings significantly outperforms cash-like streams

[139] Compare Kothari (2001, pp. 196–200) for an overview of research referencing the Functional Fixation Hypothesis

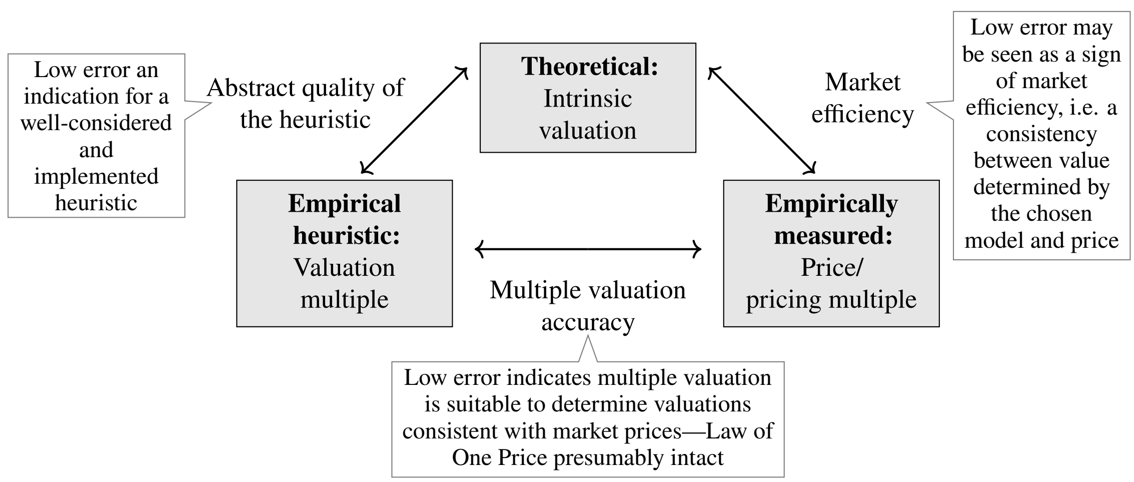
[140] Also compare the following Subsection 2.2 (p. 35) on the potential difference between intrinsic and market-observed prices from a perspective of multiple errors

[141] See above, Subsection 2.1.5.1, p. 27

Conversely, its absence, i.e. an expectation that identical or at least similar companies can sustainably trade at substantially differing prices, challenges any meaningful multiple valuation approach: if multiple valuation was none the less applied, quite likely, valuation errors would be a result. I have argued that precision, i.e. the absence of valuation errors can be considered a core feature of successful multiple valuation;[142] it is therefore of particular relevance to conceptualize such imprecisions, a discussion also yielding valuable insights for the relationship between the 3 contexts of multiples suggested above: pricing, valuation and intrinsic multiples.[143]

As also argued in the context of the Law of One Price,[144] requirements regarding general market efficiency for trading multiple valuation presumably are relatively low; a lack of general market efficiency would still lead to a potentially undesired divergence of intrinsic value and prices and multiple valuation outcomes should be qualified as such. This relationship, which is instructive for a better understanding of valuation errors, can be depicted in tri-angular form and is displayed as such in Figure 2.1 (p. 36).

FIGURE 2.1: The triangle of multiple valuation errors: Measurement points



Note: Own illustration

Figure 2.1 indicates that there are 3 measurement points for multiple valuation errors, which can be located between the respective pairs of the three different multiple definitions suggested in Subsection 2.1 (p. 19): pricing, valuation and intrinsic multiples. According to this framework, discrepancies between each pair—or a lack thereof—provide meaningful insight on the quality of multiple valuation.

[142]Compare above, Subsection 1.3, p. 14

[143]This will then be followed up by some more technical considerations in Subsection 6.4.1 (p. 222) to measure valuation errors most appropriately

[144]Compare Subsection 2.1.5.2, p. 28

- A comparison of the empirically measured *pricing multiple* and the peer-group derived empirically suggested *valuation multiple* for the company under investigation is the most common measurement point for valuation errors.[145] The underlying premise is that multiples are market-based valuations, which are operationalized through a heuristic (Henschke, 2009, p. 44) relying on the Law of One Price. The aspect is typically studied empirically by analyzing the distribution parameters of valuation errors determined by comparing the measured pricing multiple for each sample company under investigation with its peer group-derived valuation multiple. Any such deviation is considered an error and hence challenges the quality of multiples as a valuation concept and the Law of One Price more generally. Furthermore it is worth to note that circularity aspects might also be at play: If multiple valuations really play an as high role as is documented in studies of popular valuation concepts,[146] it can be reasonable to argue that investors might price shares according to their firms' respective multiple.[147] Thus, the question arises whether multiples are a good valuation concept because they reflect economic reality well or whether prices reflect the multiple, since this is what investors use to value shares[148]

- Some insights regarding this question is provided by a comparison of *pricing multiples* relative to the *intrinsically derived multiples* following the computation of the latter using concepts presented at length in Chapter 4 (p. 89). This aspect, which does not require any multiple aggregation but can instead be computed for each public company under investigation directly and without considering its peers, can be understood as a test for the fundamental market efficiency suggested by Tobin (1984, p. 2)—however, with the important caveat that it implies that the chosen model is suitable to determining the true value.[149] It is also independent of the valuation driver, i.e. identical to a comparison of the core valuation model outcome—e.g. DCF or DDM approach[150]—and the observed

[145]Compare e.g. the empirical results presented in Tables 7.2 (p. 245) and 7.4 (p. 249)

[146]Compare Table 1.1, p. 2

[147]This presumption is developed into a feedback corridor model for price/earnings multiples in Subsection 7.10 (p. 324)

[148]This is another attraction of the triangle presented in Figure 2.1, with the consideration of the theoretically expected intrinsic valuation shedding some further light on the forces at play

[149]As pointed out by Henschke (2009, p. 29) there is a joint-hypothesis problem in that tests for market efficiency takes place assuming the chosen model is correct. Both aspects are tested jointly (Kothari, 2001, p. 178; Lo & Lys, 2000, p. 339) and though it is best to qualify any market efficiency interpretations as relative to the respective model used

[150]Which, however may depend on the multiple type considered, i.e. DDM for price/earnings multiples and DCF models for enterprise value-based concepts, see Chapter 4 for details

price, market capitalization or enterprise value[151] [152]

- Finally, the presented framework allows to assess the *valuation multiple* obtained empirically relative to the *intrinsically derived multiple*. This idea has found indirect reflection in existing literature through modified peer group concepts, which reflect intrinsic differences among multiples, such as the approach of Herrmann and Richter (2003) utilizing performance-controlled multiples or similar approaches by Kelleners (2004). Theoretical considerations can furthermore offer insight regarding the source of valuation errors through regression analyses (Henschke, 2009, p. 82)[153]

Conceptually consistent with prior analyses, the focus of the empirical study in Chapter 7 (p. 239) will be on the comparison of *empirically measured price* to the *empirically suggested multiple valuation heuristic*, i.e. the determination of valuation errors between valuation and pricing multiples.[154] I will, however, seek to minimize this error through insights from a theoretical valuation aspects, which will indirectly serve as an analysis of market efficiency, too, since it is under market efficiency one would expect intrinsic valuation can be most effective to reduce valuation errors.

Given its importance and primary focus of this dissertation, the following definition for multiple accuracy is stipulated:

> ***Multiple valuation accuracy*** *is the absence of multiple valuation errors as computed by a comparison of the empirically suggested valuation multiple and the measured pricing multiple.*

[151] This identity might have led to a lower degree of popularity of intrinsic multiples in existing literature concerned with multiple valuation: If intrinsic valuation is desired, a “detour” via multiples is not necessary

[152] Some evidence exists that intrinsic valuation levels are higher than market-observed valuation levels, which can conceptually be ascribed to the fact that stock market prices reflect transactions of non-controlling interests in a company rather than the company as a whole, for which control premia of c. 30–40% are a common occurrence (Seppelfricke, 2014, p. 146; Matschke & Brösel, 2013, p. 27; Nowak, 2003, p. 167) (compare e.g. Berndt, Froese, Leverkus, and Ornik (2014), who argue that fundamental valuations presented in fairness opinions are at premium trading multiple valuations and unaffected share prices). On the contrary, if the outcome of the multiple valuation analysis is to be applied to private firms (i.e. companies, which are not publicly traded; sometimes referred to closely held companies) an argument can be made for a discount on the basis of illiquidity, and Seppelfricke (2014, p. 145) and Nowak (2003, p. 168) reference c. 30% as typical discount relative to publicly traded companies

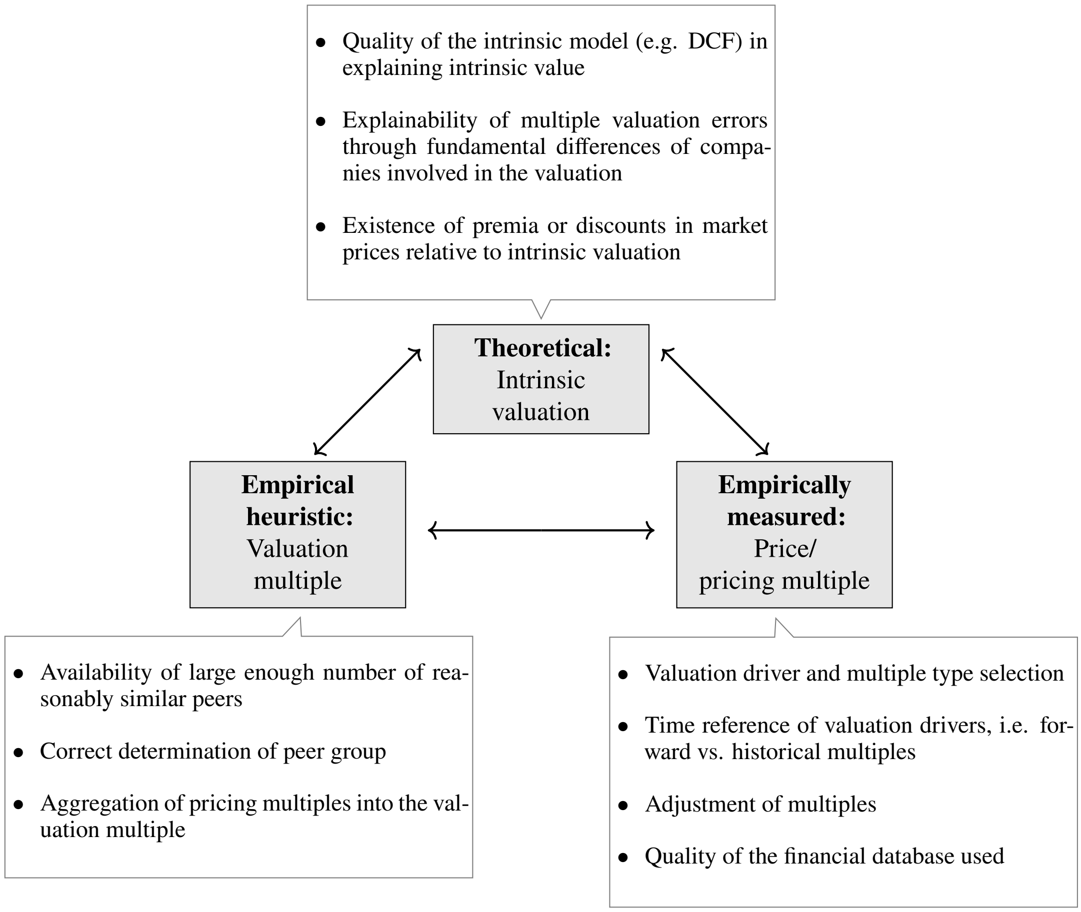
[153] Both those conceptual approaches are targeted at improving the precision of the multiple valuation heuristic, in which insights from fundamental valuation theory inform the empirical valuation multiple computation

[154] Compare Subsection 6.4 (p. 222) for considerations on computational implementation of error measurement

2.2.2 Potential causes of multiple valuation imprecisions

The triangle of multiple valuation errors presented in Figure 2.1 can be utilized to further classify sources of potential valuation errors by linking them to the aspect through which they will most likely impact valuation outcomes as displayed in Figure 2.2 (p. 39):

FIGURE 2.2: The triangle of multiple valuation errors: Potential sources of imprecision



Note: Own illustration

- On the level of *pricing multiple determination*, errors can primarily expected to result from the selection of unsuitable valuation drivers or multiple types, i.e. valuation drivers, which are an *imprecise proxy* for the economic value of the respective firm.[155] One example could be selection of an enterprise value/net sales multiple since sales can be regarded a comparably imperfect predictor of value;[156] however, the determination

[155]More generally, this might include the situation, where no suitable valuation drivers at all can be found, compare Subsection 2.1.5.4 (p. 33)
[156]Compare above, Subsection 2.4.2.2, p. 60

of suitable valuation drivers carries considerable judgment and should be anchored in empirical findings.[157] As is the case with all pricing multiple-related imprecisions, errors would arise at the level of pricing multiples—specifically for each of the peer group companies—and subsequently *manifest themselves* through valuation multiples relying on biased pricing multiples. Beyond selection of the valuation driver type, aspects of valuation driver computation can also result in valuation errors.[158] Another source of potential multiple valuation errors pertains to incorrect adjustments or a lack of adjustments to multiples all together in order to control for a number of economic aspects relating to the firms considered.[159] A second major source of errors during pricing multiple computation can result from *low-quality financial data* or biases if data is taken from different datasets and a number of studies have documented potential issues in greater detail[160] [161]

- Errors relating to *valuation multiples* are closely connected to the process of peer group selection and multiple aggregation discussed in Subsections 6.2 and 6.3 (pp. 185 and 196), respectively. Those imprecisions may arise even in cases of perfectly suitable peer group pricing multiples simply through choosing wrong peers, the judgment required between setting a boundary of peer sameness vs. a sufficient number of peers or through inappropriately aggregating peer multiples into the valuation multiple
- Contrary to the previously discussed error sources, the theoretical dimension of intrinsic valuation does not necessarily lead to errors in multiple valuation; on the contrary, it might offer an opportunity to explain observed valuation errors insofar as they relate to differences of peer companies in value-relevant properties or uncover a lack of market efficiency.[162] As discussed extensively in Chapter 4, multiples and valuation

[157] Compare above, Subsection 2.4.1, p. 52

[158] This includes the time reference chosen for the valuation driver in the context of flow multiples, where there is empirical evidence that forward-looking valuation drivers perform superior to backward-looking historical valuation drivers, compare Subsection 2.3.2.2, p. 42

[159] The "3 C"-framework presented in Chapter 5 and summarized in Table 5.3 provides some theoretical background as to why adjustments should ex ante be beneficial for valuation accuracy

[160] Compare for further background e.g. Waszczuk (2014, p. 1604), who also points out further empirical literature on errors in US market data sources or Abarbanell and Lehavy (2002), who discuss differences among commercial aggregated data providers

[161] Common issues relevant for trading multiple valuation specifically include the consideration of outdated equity research numbers in aggregated ("consensus") forecasts or reliance on only very few available brokers of limited quality as might be the case for smaller closely held companies with limited analyst following. They can be addressed through limiting peer groups to larger, well-covered companies, however, at the expense of potential selection biases

[162] Notably in situations where an earnings-driven valuation results in low valuation errors whilst at the same time high intrinsic valuation errors are displayed; this points to a combined lack of efficient markets and supports the Functional Fixation Hypothesis, compare Subsection 2.1.5.4 (p. 33)

outcomes on the basis of multiples are sensitive to intrinsic financial aspects; their understanding can support explaining valuation imprecisions and offer opportunities to improve multiple valuation quality[163] [164]

To summarize, the relationship between the 3 proposed contexts of multiple valuation, pricing multiples, valuation multiples and intrinsic multiples, can best be understood through the sources of possible discrepancies.[165]

2.3 A typology framework for multiples

2.3.1 The need for and benefit of classification

As a practitioner-led approach, multiples are distinct from other valuation concepts given the judgment involved in their application (Arzac, 2008, p. 79): This has resulted in some "creativity" among practitioners to utilize a wide spectrum of approaches, presumably at times with an ambition to match the concept to preconditioned views around valuation outcomes. In fact this perceived element of *arbitrariness* has led to academic criticism around the concept of multiple valuation all together (Schwetzler, 2003, p. 81).[166] To provide some orientation and since possible permutations of combining valuation drivers with prices references and hence the type of multiples imaginable are indeed virtually limitless and potentially confusing, it is helpful to develop a general classification framework. Numerous classification aspects, which carry a specific implications, have been identified in prior literature; however, they have mostly been presented in an episodic manner. The below section first discusses *seven common typologies* proposed in prior literature, many of which are subsequently aggregated to a classification framework in Table 2.2 (p. 53).[167] With the exception of valuation driver timing, hypotheses relating to the classification framework will be formulated in Subsection 2.4.5 (p. 64) toward the end of this Chapter.

[163] Methodologically, regression approaches where multiples are the depended variable and intrinsic factors feature as independent variables can be employed to uncover such connections, compare Appendix, p. A14 for a discussion of prior literature on this aspect

[164] It is worth to consider in this context the discussion around the meaningfulness of intrinsic valuations for market-based valuations and the existence of discounts or premia, see above, Subsection 152 (p. 38)

[165] A more technical discussion of how to measure valuation errors will follow in Subsection 6.4 (p. 222)

[166] It is worth noting that this general criticism is not necessarily justifiable at least on a relative basis compared to other valuation concepts: intrinsic valuations also carry considerable discretion regarding value-critical assumptions, notably when it comes to discount rate/cost of capital and long term growth rate forecasts

[167] As will be obvious from the following Subsection, the classification of valuation drivers is strongly intertwined with the classification of valuation drivers since, in many instances, it is the valuation driver which determines the multiple type

2.3.2 Seven common classification parameters

2.3.2.1 Flow vs. stock multiples

From the definition provided by Hasler (2011, p. 284)[168] follows the general distinction between flow and stock multiples (Henschke, 2009, p. 17): In *flow* multiples,[169] valuation drivers relate to monetary amounts measured during a set time *period*, for the purposes of multiples commonly twelve months, and available or readily derivable[170] from a company's P&L or cash flow statement, such as: Net sales, EBITDA, EBIT, net income, earnings per share (EPS) or cash flow from operations.[171] *Stock multiples*,[172] on the other hand, relate to valuation drivers, which are measured for a specific *point in time*, most commonly the last available balance sheet date; examples of valuation drivers include such as book value of equity, invested capital[173] or book value of total assets. Since their valuation driver elements mainly stem from balance sheet line items, stock multiples can alternatively be referred to as balance sheet multiples. The differentiation logic between flow and stock multiples has also motivated consideration of results-oriented vs. capital invested-oriented valuation drivers separately (Wagner, 2005, p. 16).[174]

2.3.2.2 Historical vs. forecast valuation drivers

Taxonomy For flow multiples specifically, a further distinction can be made between historical[175] or forward-looking multiples: this aspect concerns the selection of time period the valuation driver relates to. Common approaches include:

- Historical twelve months to the last reporting date
- Historical twelve months to the past calendar year end

[168] And discussed in greater detail in Subsection 2.1.1 on p. 19

[169] sometimes referred to as earnings multiples (Asquith et al., 2005, p. 257) with a potential risk of confusion to the net income line in the P&L also referred to at times as earnings

[170] For historical or future periods, for the latter e.g. from equity research consensus estimates

[171] Part of the literature proposes a further differentiation, accrual flow and cash flow multiples (compare J. Liu et al. (2002, p. 140), among others), however, classification aspects of "hybrid" valuation drivers such as EBITDA require consideration in this instance (EBITDA is generally calculated by considering elements from both the P&L (operating profit) and cash flow statement (depreciation and amortization))

[172] At times also called asset multiples (Asquith et al., 2005, p. 252)

[173] See Subsection 4.3.1 on p. 103 for a brief discussion on invested capital definitions

[174] Subsection 2.4.5 (p. 64) will formulate Hypothesis 2c and Subsection 7.2.5 (p. 259) will present results on a comparison of flow vs. stock multiples when it comes to valuation performance

[175] Also at, also at times referred to as contemporaneous earnings Yee (2004b, p. 301) or "trailing" valuation drivers M. Kim and Ritter (1999)

- Historical twelve months proportionately "calendarized"[176] to the price measurement date, sometimes referred to as "trailing multiples" (Massari et al., 2016, p. 302) or "historical rolling multiples"
- Next twelve months ("NTM") period from the price measurement date obtained through proportional calendarization, sometimes referred to as "forward rolling multiples" or "NTM multiples"
- Twelve month period to the next calendar year end, which will comprise partly a historical time period and partly forecasted time period
- Time periods even further in the future[177]

Both forward and historical valuation drivers typically require *"calendarization,"*[178] i.e. they need to be interpolated on the basis discrete financial information available for fiscal years,[179] commonly through simple weighting methodologies on a by-month basis.[180] Damodaran (2012a, p. 458) highlights in this context the aspect of *uniformity*, i.e. all valuation drivers within the peer group should be calculated on the same time period, whatever it might be.[181]

Appropriateness The common use (Löhnert & Böckmann, 2009, p. 582) of forward trading multiples[182] is sometimes theoretically justified by the general concept of valuation as being a *forward-looking exercise*: much like a DCF analysis, which is considering future cash flows only, forward-looking valuation drivers are ascribed to have higher relevance than historical valuation drivers (Koller et al., 2010, p. 321): this presumption is also consistent

[176] Sometimes also referred to as "recalendarized"
[177] Such as e.g. valuation drivers relating to a one year time period of the next calendar year or a 12 month time period starting in 12 months, sometimes referred to as "NTM+2" or "NTM+1"; in this dissertation, "NTM+2" is chosen
[178] Sometimes referred to as "recalendarization"
[179] While one could consider utilizing quarterly data which might allow for more granular calendarization in particular for high-growth companies, practitioners appear to prefer the simpler use of annual fiscal year data. Interestingly, empirical studies at times disregard calendarization aspects or deal with off-cycle calendar years by simply removing firms from their sample, compare e.g. Dittmann and Weiner (2005, p. 5) disclosing their elimination approach
[180] Compare Rosenbaum and Pearl (2009, pp. 39–41) for an example of such computation: e.g. recalendarizing flow valuation drivers for a company with December year end to June would entail computing $\frac{1}{2}$ of the current and $\frac{1}{2}$ of the last fiscal year end financials assuming the company has a December reporting year end
[181] This uniformity aspect for trading multiples is usually interpreted differently for transaction multiples, as transactions happen at different times so utilizing the same time period would lead to different relative time gaps between the valuation driver an the transaction date. Therefore, it is widely accepted to utilize valuation drivers relating to the last twelve months up to the transaction announcement
[182] Given a lack of publicly available forecasts, *transaction* multiple valuations tend to be more commonly based on historical valuation drivers

with the "Vorschauanalyseprinzip" of Moxter in the German literature: valuations should reflect "an anticipation of future dispositions" (1983, p. 102).[183] Despite the counterargument that forward-looking valuation drivers might introduce imprecisions through forecasting uncertainties or biases, a couple of other reasons exist, which motivate choosing future rather than historical drivers. Damodaran (2012a, p. 498) references the advantage that forward-looking valuation drivers might overcome the *non-negativity restriction* for historically loss-making firms. This consideration can also be applied in the context of valuation drivers affected by one-off impacts of non-recurring events on the business (Koller et al., 2010, p. 321; Massari et al., 2016, pp. 302–303): e.g. historical reported earnings might be lower or higher given very specific events which happened unexpectedly or expectedly in the past.[184] Future earnings should at least be immune to *unexpected one-off items* and there is a case to exclude or normalize for those effects given the valuation driver should be a good representation of the long-term economic prospect of the firm under investigation.[185] Another argument relates to their normally *higher currency* and regarding recent value-relevant information (Yoo, 2006, p. 111): After a fiscal year end comes to a close, the respective historical numbers are usually "cut in stone,"[186] swiftly become "stale" and will not fluctuate with the current business trading environment. On contrary, forecasts can and will change regularly to factor in most current information.[187]

Availability There are furthermore some *theoretically appealing aspects* of forward valuation drivers: Intrinsic multiple deductions are simplified as they can rely on forward earnings ($ERN_{i,1}$) directly rather than having an additional term of $(1 + g_i)$ in the intrinsic multiple valuation formulas.[188] Lastly, Yee proposes a theoretical approach, which suggests that, while linear accrual rules do not result in accurate historical earnings-value relations in the case of uncertainty, forecasted earnings-value relations can be accurate—"the more forward the more

[183] Own translation from German into English

[184] Those events do not necessarily need to be negative such as in the case of M&A transactions (acquirer perspective), which might render historical financials irrelevant for the pro forma business going forward

[185] In the case of M&A transactions (and any other known future one-off effects), it is hence common practice for transactions, which have not closed yet to adjust acquirer valuation drivers such that they reflect the transaction was closed at the beginning of the measurement period for the valuation driver, a process referred to by practitioners as "pro-forma'ing" the valuation driver

[186] Excluding more material re-statements, which actually turn out not to be so infrequent, compare e.g. Kieso, Weygandt, and Warfield (2013, p. 1342) for some data on re-statements over time

[187] This is in particular the case if consensus equity research forecasts are used: whilst one analyst might stick to his or her forecasts for quite some time, averaged consensus numbers comprising many analyst forecasts can be expected to change much more frequently

[188] While at first look just cosmetic in nature, forward earnings allow Equation 4.12 to reflect a two stage growth model, separately considering 1-period forward earnings growth through implicitly through $ERN_{i,1}$ and long-term growth beyond the first period through g_i

accurate" (2004b, p. 301).

Multiples commonly rely on single-period valuation drivers, which should be immediately available e.g. from equity consensus or own estimates.[189] This supports valuation driver timing closer to the measurement date, since forecast work for fewer future time periods needs to be undertaken, which might also introduce unfavorable noise and biases from general uncertainty of the future (Mondello, 2017, p. 450). Practically most common are future valuation drivers looking ahead 1–2 time periods[190] (Rosenbaum & Pearl, 2009, p. 49) also since—from a practical perspective—the availability of equity research forecasts for time periods beyond 2 years in future drops meaningfully, narrowing down the peer group, which can be considered.[191]

To summarize, future valuation drivers appear to offer numerous advantages over historical valuation drivers; however, I argue that reliance on time periods too far out introduce noise from forecasting imprecisions. Therefore, and consistent with practitioner approaches, valuation drivers relating to time periods in the near future might be the reasonable and balanced choice. This leads to the following first hypothesis, which will be empirically investigated in Subsection 7.5 (p. 287):

Hypothesis 1a *Valuation drivers computed on the basis of forecasted financials for the near future outperform valuation drivers relying on historical time periods and those relating to time periods further ahead*

Prior evidence Some empirical evidence on future valuation drivers exists: On the basis of their much cited empirical study on trading multiples, J. Liu et al. (2002, p. 163) conclude that forward-looking earnings rank ahead of historical earnings as valuation drivers when it comes to valuation precision, which they ascribe to the information content of forward-looking valuation drivers (2002, p. 162). This is consistent with the findings of M. Kim and Ritter (1999, p. 430), who observe a gradual and material decline in valuation errors as they move from historical, via the measurement year's to the next year's forecasted earnings from 55.0% to 28.5% on the basis of a regression model in the context of initial public offerings and Deloof, De Maeseneire, and Inghelbrecht (2009) see valuation errors dropping from 58.1% to

[189] However, avoiding the need of building a complex model, in which event a fundamental (DCF) analysis could be conducted anyways

[190] Valuation of smaller high-growth startups may rely on valuation drivers relating to time periods more out in the future, however

[191] Compare the sample sizes indicated in Table 7.10 (p. 288) for some data on this aspect: on the back of valuation driver availability, sample sizes reduce materially beyond the 2 year out time horizon

23.9% when moving from historical to forecast earnings in the context of Belgian initial public offerings.[192] Schreiner (2007, p. 108) finds that continuously improving valuation precision for a number of different valuation driver types such as net sales, EBITDA, EBIT, earnings before taxes (EBT) and earnings if forecasted rather than trailing valuation drivers are utilized: for EBIT, median valuation errors are 8.49%-pts lower if 1 year forecasts are utilized and 13.54%-pts lower if 2 year forecasts are employed, each relative to trailing numbers.

Rossi and Forte (2016, pp. 65–68) provide error distribution statistics confirming increasing valuation accuracy as valuation drivers relating to time periods further in the future are selected: While historical valuation drivers (in this case earnings) achieve an accuracy within 25% of the observed price in less than 23% of cases,[193] this frequency increases gradually to 41.9% of cases if 3 year forecast earnings figures are utilized. Prima facie, this points to information content of valuation drivers computed on the basis of further-out future financials outweighing any uncertainty biases, which might be introduced from forecasting valuation drivers over a longer time period; however, no conclusive explanation as to why this should be the case has been offered yet.

A proposed explanation I argue that imbalances between pricing references and valuation drivers stemming from *M&A activity* might play a role in the strong performance of outer-year valuation drivers, as they will benefit from a higher natural consistency of pro-forma financials forecasted by research analysts in outer periods and the immediate announcement effect on price references. Whilst it is—within limits—possible to adjust multiples for M&A activity as explained in greater detail in Subsection 5.3.4 (p. 149), none of the above mentioned studies have done so, also as a consequence of considerable complexity of adjustment automation for a larger sample. This leads to a second hypothesis to be empirically tested in the context of valuation driver timing:

Hypothesis 1b *The strong performance of multiples computed with outer-year valuation drivers results from M&A biases suffered by nearer-year valuation drivers*

Subsection 7.5 (p. 287) will further discuss the methodological approach and results of an empirical investigation of Hypothesis 1b. In the spirit of a replication study, it relies, first, on

[192] For initial public offering (IPO)s, there is also the specific situation that forecasted earnings are not available as widely as for already publicly traded companies, in particular normally no consensus (i.e. broker average) on forecasts will be available. Furthermore, historical valuation drivers depending on the pre-IPO financing structure may be particularly prone to errors since in many instances primary IPO proceeds are used to reduce leverage of the firm consistent with a publicly traded entity

[193] Depending on the methodology used for calculating the historical earnings figure

a reconfirmation that outer-year valuation drivers outperform nearer-year valuation drivers for the sample utilized in this dissertation[194] consistent with prior literature and, second, on a repetition of this comparison for firms, which have been identified to *not* have engaged in M&A activity: a more leveled performance of nearer- and outer-year valuation drivers could then be interpreted M&A activity being a central driver behind the strong outer-year valuation performance.

2.3.2.3 Theoretical derivation of multiples from different sources of intrinsic valuation

Another classification, which has been covered already in the context of multiple definitions,[195] can be undertaken if considering how a multiple type can be derived from theoretical (i.e. intrinsic or fundamental) valuation concepts: Drukarczyk and Schüler (2007, pp. 477–485) and Schreiner (2007, p. 38) differentiate multiples depending on how they can be linked to divided discount models (price/earnings (P/E) multiple), DCF model (Enterprise value/EBIT multiple) and RIV (price-book multiple). Similarly, Penman (2013) discusses the relationship of accrual accounting to price-book and price/earnings multiples in separate chapters on the basis of their intrinsic foundations.[196]

2.3.2.4 Financial vs. non-financial multiples

Damodaran (2012b, p. 640), Ballwieser (2004, p. 212) and Koller et al. (2010, pp. 330–332) highlight the fact that particularly in some industries such as the tech sector, operational data points e.g "website views" or "number of subscribers" have been used as valuation drivers. The multiples resulting from such valuation drivers are described as non-financial (Damodaran, 2012b, p. 640; Krolle, 2005b, pp. 54–56; Wagner, 2005, p. 16), operational (Frykman & Tolleryd, 2003, p. 59) or business multiples (Massari et al., 2016, p. 298). Their general utilization or even preference over financial multiples is usually justified by either of two rationales: first, the lack of (positive) earnings, i.e. a necessary *last-resort alternative* to financial multiples or, second, particular value relevance for a specific industry, i.e. a structurally preferable alternative with possibly more precise valuation outcome.[197]

[194] Compare Chapter 3 (p. 69) for details on the sample
[195] See above discussion on pricing and intrinsic multiples, Subsections 2.1.2 (p. 20) and 2.1.3 (p. 24), respectively
[196] Compare Chapter 4 (p. 89) for the foundation of multiple types in intrinsic valuation
[197] In particular during the dot-com era at the beginning of the century a number of non-financial multiples swiftly emerged to popularity (see Beaton (2010, p. 7) for examples on valuation drivers) motivated by the idea of "moving up" the business model and speculating that e.g. "website views" will eventually lead to revenues and revenues will eventually lead to earnings. Such multiples also constitute a last resort if no or only

Empirical results suggest that non-financial metrics such as web traffic can have an impact on valuation (Hand, 2001) and that this impact can actually be larger than the relevance of financial information on valuation in certain instances (Amir & Baruch, 1996). None the less, non-financial multiples have attracted criticism on the translation in to value aspect but equally on their lack of cross-industry comparability (Damodaran, 2012b, pp. 640, 790).[198] A somewhat different case are multiples based on valuation drivers, which practitioners have considered useful for *certain types of sectors*, despite the nature of those industries generally allowing calculation of financial multiples, e.g. by utilizing "barrels of oil equivalent" or "megawatts installed" as valuation drivers.[199]

2.3.2.5 Direct vs. indirect multiples

Massari et al. (2016, p. 301) propose an interesting classification, which differentiates multiple types between those with direct valuation drivers vs. those with indirect valuation drivers: *direct valuation drivers* are those which express economic results directly, e.g. earnings or EBIT. In contrast, *indirect valuation drivers* such as book value or equity or net sales require a firm to generate returns before they should translate into value. Ex ante it would seem reasonable to assume that direct valuation drivers might be more appropriate for valuation purposes as they might measure "closer to the source"[200] and some empirical results regarding this proposition will be presented in the context of analyzing flow vs. stock multiple types.[201]

considered obviously irrelevant financials are available to serve as valuation drivers, since a non-negativity restriction applies to valuation drivers (Meitner, 2003, p. 108). It is worth highlighting that the non-negativity restriction is not advocated for uniformly. Compare for a more nuanced discussion Subsection 6.3.3.2 (p. 210)

198 More recently, promising hybrid approaches have emerged, which, while acknowledging the impact of accounting conservatism on earnings, remain within the realm of financial metrics, e.g. through consideration of research & development expenses (R&D) and advertising expenditure as growth investments (Gama, Segura, & Figueiredo Milani Filho, 2017). Venture capital stage valuation has in general moved on from non-financial multiples to other concepts, see Carver (2012) and Beaton (2010) for possible approaches. (Financial) multiples can play a role for valuing early-stage companies in the context of potential exit considerations in a couple of years from the point of investment, see Carver (2012, pp. 92–93)

199 See Massari et al. (2016, p. 298) for additional examples. While a clear and well-established logic may exist on how those non-financial multiples may translate into value, cross-industry analysis will still suffer given the high degree of sector specificity. Those non-financial multiples can however play a role as an additional benchmark number rather than sole valuation driver (Schacht & Fackler, 2009, p. 272). While the discussion around non-financial multiples is instructive for a broader understanding of multiple valuation, the objective of this dissertation is to provide cross-industry guidance on trading multiple best practices. It will therefore focus on financial rather than non-financial multiples

200 The discussion is not dissimilar to non-financial multiples. However, non-financial multiples suffer from additional drawbacks given their last-resort nature and lack of inter-sector comparability as described above

201 Compare Subsection 7.2.5, p. 259

2.3.2.6 Equity value vs. enterprise value multiples

A popular classification for multiple types relates to the value their respective valuation drivers should be set in direct reference to: *equity value*[202] versus *enterprise value*, i.e. the value of the firm including debt and certain other adjustments.[203] As discussed previously,[204] multiple valuation assumes direct proportionality between the measured price and the valuation driver utilized. It is hence of relevance to measure the price in a *manner most consistent* with the valuation driver and this means using enterprise value for valuation drivers that correspond to enterprise value such as Net sales, EBITDA and EBIT as well as using equity value for valuation drivers corresponding to equity value such as net income or earnings before tax: The valuation driver determines the choice of equity or enterprise value multiple and the consistency of the multiple has been referred to as the "principle of equivalence" (Sommer & Wöhrmann, 2011, p. 4).[205] In most cases it is straightforward to assess what a valuation driver calls for: if compensation claims of debt holders, namely *interest*, are included in the valuation driver, an enterprise value price reference is most appropriate. If those compensation claims have been subtracted, an equity value price reference is most appropriate.[206]

Which group—equity or enterprise value multiples—are theoretically preferable? Damodaran (2012a, p. 543), Koller et al. (2010, p. 314), Massari et al. (2016, p. 300), Schreiner (2007, p. 57), Wagner (2005, pp. 15–17), Pereiro (2002, pp. 254–255) Schwetzler (2003, p. 79) as well as Hachmeister and Ruthardt (2015, p. 1703), among others, provide further theoretical considerations: There appears to be an *overall preference for enterprise value multiples* given their independence of the capital structure of the individual comparable: enterprise value multiples presumably offer a theoretically beneficial additional layer of standardization over

[202] Sometimes synonymously referred to market capitalization, however, under other definitions, equity value is calculated on the basis of market capitalization and then adjusted for other equity claims such as employee share option program (ESOP)s, compare Damodaran (2012a, p. 219)

[203] This enterprise value would compare to the immediate outcome of a DCF valuation using weighted average cost of capital as discount factor. In particular enterprise value calculation theoretically requires a number of additional adjustments; See in great length: Chapter 5 (p. 129) enterprise value is sometimes synonymously referred to as firm value, however other authors such as Damodaran (2006, p. 293) differentiate between the two on the basis of cash, which is backed out of enterprise value but not firm value. Less common is the description of enterprise value as the "market value of invested capital" (MVIC) used by Pratt (2005, p. 15) or the term "entity value" (Sommer & Wöhrmann, 2011, p. 10)

[204] See Subsection 2.1.2, p. 22

[205] Compare Subsection 5.3.1 (p. 140) for a more in-depth discussion of the principle of equivalence

[206] Meitner (2003, p. 79) provides an instructive chart on the basis of a price/net sales multiple to show how dependent it is on leverage of the respective company and hence how limited its theoretical foundations are for company valuation. None the less, there is some popularity both in practice (Kames, 2000, pp. 101–103), and even some empirical studies report results on the basis of multiples with inconsistent price and valuation drivers, e.g. the EBITDA/price inverted multiple shown by J. Liu et al. (2002, p. 149) and various net sales and EBIT multiples shown by Schreiner (2007, p. 100)

equity value multiples.[207] [208]

In the case of pricing multiples on the basis of trading comparables it is worth noting that enterprise value cannot be directly measured: Instead, it is derived from equity value which in itself originates from share price, so enterprise values as measured prices can be understood as equity values adjusted for financial debt,[209] underlining the close relationship between both metrics. Furthermore, the question of equity and enterprise value multiples is not to be confused with the ultimately desired valuation outcome, as valuations on both levels can reconciled into each other in a trivial manner through bridging the respective elements—notably net debt and potentially other adjustments—for the company under investigation.[210]

2.3.2.7 Level of measurement

As pointed out by Seppelfricke (2014, p. 147) multiples can be measured on two levels: on *individual share level* as well as on *overall firm level*. This is particularly the case for equity value multiples given both components, measured price and valuation driver, are available or reported on a per share level: as share price and earnings or dividends *per share*,[211] respectively. The price/earnings multiple takes its name from a per-share view, as otherwise it would be more appropriate to refer to it as a "market cap/net income multiple." While both levels can be reconciled in what appears at first glance to be a straightforward manner, i.e. multiplying by the number of outstanding shares[212] in both the numerator and the denominator, there are a

[207] Also see Subsection 2.4.2.1 (p. 55). At the core of the argument is that different leverage levels should result in different residual costs of equity. Hence a valuation on price/earnings multiple level might introduce a valuation error as it stipulates such differences do not exist

[208] The differentiation between enterprise value and equity value multiple has conceptual parallels to the differentiation of utilizing weighted average cost of capital in a DCF entity value approach (Penman, 2013, pp. 114–116) versus cost of equity in the valuation of equity income streams (e.g. dividends in a DDM; 2013, pp. 111–114). Those considerations date back to Modigliani and Miller (1958) and Modigliani and Miller (1963); for an overview table see Schacht and Fackler (2009, p. 241) or Schueler (2017, p. 5)

[209] And potentially certain other adjustments as detailed at length in Chapter 5 (p. 129)

[210] Compare Damodaran (2012a, pp. 12–13); this aspect applies in an analog manner to computation of multiple valuation *errors*, which need to be expressed on the same basis as far as equity value and enterprise value multiples are compared, compare Equations 6.20–6.22 (p. 226)

[211] Per International Accounting Standards (IAS) 33 and Statements of Financial Accounting Standards (SFAS) 128, earnings per share ("EPS") is reportable by the company and calculated as profit or loss attributable to equity holders of the parent entity by the weighted average number of shares outstanding during the reporting period, see Deloitte (2018) for a high-level overview. As mentioned by Möhring and Eppinger (2008, p. 721), the ability to calculate price/earnings multiples in a straightforward manner is one of the reasons for requiring companies to produce the EPS number. Conveniently for the comparison of companies reporting under Generally Accepted Accounting Principles as used in the United States (U.S. GAAP) and International Financial Reporting Standards (IFRS), the respective rules have been drafted with convergence in mind, so differences should be limited (Stice & Stice, 2013, A-8); forward-oriented valuation drivers can be computed on EPS-level, too, given it is generally indicated by brokers in their P&L forecasts

[212] Market capitalization is usually defined on the basis of outstanding (rather than issued) shares, i.e. net of any treasury shares (Krolle, 2005b, pp. 28–29)

number of intricacies:

- *Several classes of shares:* Some companies have different classes of shares, e.g. preferred and ordinary shares.[213] Per IAS 33 and SFAS 128, earnings per share are measured on the ordinary class of shares, so as a consistent price measurement, i.e. the price of ordinary shares should be chosen[214]

- *Dilution:* IAS 33 and SFAS 128 require companies to not only report "basic" but also "diluted" earnings per share, i.e. reflecting the potential future part-loss of economic claims for current shareholders through the issuance of new shares to some shareholders or third parties such as employees or investors in convertible bonds for free or at discount, so called "potential ordinary shares" (Deloitte, 2018). While this raises the interesting question, which of the two valuation drivers, diluted or basic earnings, might be more effective for multiple valuations,[215] from a reconciliation perspective between the share level and the firm level, it is primarily important that market capitalization will normally be calculated on the basis of currently outstanding shares unadjusted for dilution[216]

- *Earnings per share forecast consistency:* If relying on future valuation drivers, care will need to be taken as far as a full understanding of the definition of EPS any equity research analyst might use is concerned[217]

[213]This is particularly the case for German companies, where "Stamm-" and "Vorzugsaktien" are common. In a U.S. context, a somewhat comparable concept are classes of voting and non-voting shares, while U.S. preferred shares might have some differing features. The wording in this paragraph refers to the German concept which is also popular in other Continental European countries

[214]Following IAS 33, earnings per share are usually corrected for the (common) incremental dividend entitlement of preferred shareholders (Lorson, Dogge, Haustein, Paschke, & Poller, 2015, p. 498), which, together with differing share prices, will need to be reflected in any reconciliation between price/earnings on a share level relative to price/earnings (or market capitalization/net income) on a firm level. As pointed out by Damodaran (2007, p. 8), market capitalization will usually comprise all classes of shares; equally net income will usually refer to the earnings on which both ordinary and preferred shareholders have claims

[215]A question, which will be investigated further in Subsection 7.4.3 (p. 285) in the context of adjustments to equity value multiples

[216]While this suggests that basic earnings per share might be a more consistent metric for the reconciliation with the firm level approach, it is worth noting that there might still be differences between the currently outstanding number of shares commonly utilized to aggregate the price per share into market capitalization and the average basic number of shares used to calculate EPS

[217]Fortunately, as Doyle, Lundholm, and Soliman (2003) point out, equity research analysts will be tempted to utilize similar definitions as the company since they will compare their estimates with prior period actual EPS performance and eventually seek a comparison of newly reported quarterly EPS figures to their forecasts to establish a quick view regarding over- or underperformance of announced quarterly earnings relative to their expectations

2.3.3 A suggested classification framework

To summarize, as a pricing multiple consists of two elements, the valuation driver in the denominator and measured price in the numerator,[218] it does not come as a surprise that classifications appear to follow those two components: the first five classifications—flow vs. stock multiples, historical vs. forward multiples, theoretical valuation driver derivation, financial vs. non-financial multiples and direct vs. indirect multiples—focus on the valuation driver, while the last two—equity value vs. enterprise value multiple and level of measurement—primarily stress different concepts of measured price. Considering a selected number of the above classification dimensions,[219] the framework presented in Table 2.2 (p. 53) appears instructive to link common multiple types with conceptual context.[220]

2.4 A closer look at choosing meaningful valuation drivers

2.4.1 Approaches on determining suitable valuation drivers

Whilst it is instructive to classify multiples—with Table 2.2 providing a framework—the obvious question is which multiple type is best suited to conduct a trading multiple-based valuation analysis; a number of approaches can shed further light on the relative quality of multiple types:

- Establish the *general theoretical understanding* of what are features of successful multiples: This approach, which argues that a valuation driver acting as a good (bad) proxy for the future economic cash generation potential is (not) suitable, has been further elaborated on in the context of the discussion on the Law of One Price and the Functional Fixation Hypothesis in Subsection 2.1.5.4 (p. 33)

- Derive determinants of multiples in a more concrete manner through *connecting multiple types to corporate finance theory* and alternative valuation approaches as will be discussed in Chapter 4 (p. 89). Whilst fostering a better understanding of the inner workings of multiples, I will, however, argue that such discussion does not necessarily provide guidance on the most appropriate multiple type

[218] See above, Subsection 2.1.2, p. 20

[219] Excluding, for simplicity reasons, non-financial multiples, theoretical valuation driver derivation and indirect vs. direct multiples

[220] With minor variations, many of the multiple types presented in Table 2.2 can also be found in the existing literature, including Löhnert and Böckmann (2009, p. 577), Hasler (2011, p. 301), Schacht and Fackler (2009, pp. 262–264), Wagner (2005, p. 16), Schreiner (2007), Rossi and Forte (2016, p. 18) and Kelleners (2004, p. 147)

TABLE 2.2: Types of financial value multiples—illustrative classification

Level of measurement	Price measurement	Common financial valuation drivers				Resulting multiple type	
		Accrual		Hybrid	Cash		
		Stock	Flow (historical vs. forward)			Stock	Flow (hist. vs. fwd)
Individual stock	– Price per share		– Earnings per share – Dividends per share – (Earnings per share/long term growth)				– P/E (share level) – P/D – PEG
⇕*Reconciliation:*	*× Number of shares*[b]						
Claims of all shareholders	– Market capitalization – Equity value	– Book value of equity[a]	– Net income	– Free cash flow to equity		– P/B	– P/E (firm level) – P/Free cash flow to equity
⇕*Reconciliation:*	*+/(−) Net debt/(cash)* *+/(−) Other adjustments*						
Claims of all capital providers	– Enterprise value	– Total assets[a] – Invested capital[a] – Capital employed[a]	– Net sales[a] – EBIT	– EBITDA – (EBITDA-Capex) – Free cash flow to entity	– Cash flow from operations	– EV/Total assets – EV/Invested capital – EV/Capital employed	– EV/Net sales – EV/EBIT – EV/EBITDA – EV/(EBITDA-Capex) – EV/Free cash flow to entity – EV/Cash flow from operations

Note: Own illustration considering elements of Seppelfricke (2014, p. 147) and Schacht and Fackler (2009, pp. 262–264) regarding level of measurement; illustratively selected metrics on the basis of common approaches, see e.g. Löhnert and Böckmann (2009, p. 577), Hasler (2011, p. 301), Schacht and Fackler (2009, pp. 262–264). [a] Denotes valuation drivers, which can be considered indirect per the definition of Massari, Gianfrate, and Zanetti (2016, p. 301); all other valuation drivers can be considered direct. [b] See discussion in Subsection 2.3.2.7 (p. 50) for details

- Theoretically *compare different multiple types* on a standalone basis and among each other to uncover relative strengths and weaknesses: An important practically relevant example of this discussion is the relative assessment of price/earnings vs. enterprise value/EBIT, which will take place in the following Subsection 2.4.2.1 (p. 55)[221] as well as the identification of theoretically challenged multiples such as enterprise value/net sales or price/earnings growth[222]

- *Empirically test*, which types of multiples perform better than others: a review of precedent studies will be given in the following Subsection 2.4.3 and own evidence will be presented throughout Chapter 7 (p. 239)

- Understand *in which circumstances* certain multiple or value driver types perform particularly well. While those circumstances could range from a variety of aspects such as specific time periods of an economic cycle,[223] specific markets[224] or certain calculated ranges of multiple valuation outcomes,[225] the topic of industry-specific multiples or valuation drivers is most common. Since there is a loose link (but no full congruence) between industry-specific multiples and peer group formation based on industry affiliation, this aspect will be discussed in the context of peer group formation, compare Subsection 6.2.5 (p. 193)

The ultimate objective of all approaches can be summarized as to finding multiple types resulting in highest valuation accuracy.[226] I furthermore argue that the multiple type is in essence determined by the valuation driver type. The choice of appropriate price reference follows from consistency considerations to the respective valuation driver chosen.[227]

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[221] Also specifically compare Table 2.3 (p. 59). This assessment also allows to derive strategies to address shortcomings of specific multiple types are presented in Subsection 5.6 (p. 169). A broader qualitative assessment of multiple types is available from a number of textbooks, compare among many: Peemöller (2009, p. 577) and Koller et al. (2010, pp. 317–321). Hence this dissertation takes a more issue-oriented approach

[222] Compare Subsections 2.4.2.2 (p. 60) and 4.6 (p. 122), respectively

[223] Compare e.g. Rossi and Forte (2016, p. 86) for some descriptive results on through the cycle valuation accuracy of different valuation drivers

[224] Compare e.g. the descriptive data on valuation error distribution by country presented by J. Liu et al. (2007, p. 65)

[225] This would be consistent with the connotation of eliminating certain valuation drivers or peers from a concrete multiple valuation analysis on the basis of the results obtained and is of course conceptually highly debatable

[226] Compare the definition in Subsection 2.2.1 (p. 38); multiple valuation precision is commonly empirically measured through a number of different valuation error concepts, compare Subsection 6.4.1 (p. 222) and Table 6.2 (p. 223)

[227] Notably, the "principle of equivalence." See Subsection 5.3.1 (p. 140)

2.4.2 Observations regarding specific valuation driver types[228]

2.4.2.1 Potential drawbacks of post-interest valuation drivers, notably earnings

A crucial value driver differentiation takes place at the level of financial claims of debt holders, i.e. the inclusion into the value driver of interest for flow multiples or financial debt for stock multiples. Since the valuation driver determines the appropriate corresponding price reference, this distinction is closely related to the discussion of equity value vs. enterprise value multiples;[229] to provide context, it can best be understood if the most common proponent of post-interest valuation driver multiples, *price/earnings*, is analyzed in greater detail.[230] The valuation with price/earnings multiples carries a number of implications:[231]

- *Aspects regarding the nature of price/earnings multiples as equity value multiples:* As is commonly the case with equity value multiples,[232] differences in leverage will not be reflected in a standard multiple valuation using price/earnings multiples. This has led to recommendations to utilize enterprise value-based multiples instead.[233] One casual counterargument could be that leverage should not be a concern at all since the DDM connected to price/earnings multiple valuation below[234] is not sensitive to leverage, the price/earnings multiple hence is in itself a consistent multiple. However, this is ultimately not convincing since the cost of equity r_i^{eq} is assumed to depend on leverage.[235] It is possible though to adjust the standard price/earnings multiple in such a way that differences in leverage are normalized for, enabling comparisons across companies with different capital structures (Penman, 2013, p. 466). However, this

[228] This Subsection focuses on the valuation drivers of earnings (i.e. the price/earnings multiple) and net sales (i.e. enterprise value/net sales multiple). For a discussion of the price/earnings growth multiple compare Subsection 4.6 (p. 122) given the additional theoretical background necessary for its evaluation

[229] Also compare above Subsection 2.3.2.6, p. 49

[230] As well as compared to common representatives of pre-interest valuation driver multiples, e.g. enterprise value/EBIT

[231] Some of which also stretch beyond the topic of interest inclusion; given the importance of price/earnings in valuation, those aspects in addition to mitigating factors will be elaborated on, too

[232] This is in contrast to enterprise value multiples, see discussion above, Subsection 2.3.2.6 (p. 49)

[233] See among others Damodaran (2012a, p. 543), Koller et al. (2010, p. 314), Massari et al. (2016, p. 300), Schreiner (2007, p. 57), Wagner (2005, pp. 15–17), Pereiro (2002, pp. 254–255) Schwetzler (2003, p. 79) or Hachmeister and Ruthardt (2015, p. 1703)

[234] See Equation 4.11 (p. 94) specifically

[235] Specifically, assuming the capital asset pricing model (CAPM) applies, r_i^{eq} is a function of the firm-dependent equity risk β_i^{eq}: $r_i^{eq} = r_{rf} + \beta_i^{eq} \cdot r_{ERP}$, where r_{rf} denotes the firm-independent risk-free return and r_{ERP} the firm-independent equity risk premium (among many: Damodaran, 2012a, p. 183). Even disregarding tax, β_i^{eq} is a function of leverage as suggested by *Hamada's Equation*: $\beta_i^{eq} = \beta_i^u \cdot (1 + \frac{D_i^{MV}}{E_i^{MV}})$, (Hamada, 1972), where β_i^u denotes the unlevered beta and $\frac{D_i^{MV}}{E_i^{MV}}$ the ratio of the market values of debt to equity for the i^{th} firm

adjustment is a theoretical translation of the price/earnings multiple into an enterprise value/EBIT multiple as is demonstrated in Subsection 5.6.1 (p. 169); it thus means nothing else than moving away from price/earnings all together. Schwetzler (2003, pp. 82–83) furthermore describes an inherent issue with the single-period nature of multiples and the implicit re-balancing between (growing) operational results from the underlying business and financial results from cash and cash equivalents, which assuming returns will be distributed remain at constant levels

- *Tax structures:* Massari et al. (2016, pp. 353–355) discuss the fact that earnings as a valuation driver in price/earnings multiples are affected by the tax rate the firm it is calculated for is paying and propose an adjustment to the price/earnings multiple to normalize for different tax rates; this is achieved by valuing tax shields separately. The price/earnings multiple is more consistent when it comes to tax that common enterprise value multiples such as enterprise value/EBIT or enterprise value/EBITDA, as the price/earnings multiple reflects different taxation levels, for which a strong case can be made since market participants can be expected to consider diverging corporate tax effects since their claims relate to post-tax amounts (Massari et al., 2016, p. 339). Therefore, the situation is ambiguous when it comes to considering tax effects for multiple valuation: On the one hand, there is an ambition to reach a common level in valuing operations of businesses, which is "portable" to other firms, thus independence of individual tax rates might be desired. On the other hand, price references can be expected to express different tax rates, suggesting a normalization of value drivers for taxes might introduce valuation errors. This aspect has more recently led to calls for utilizing taxed EBIT—or net operating profit less adjusted taxes (NOPLAT)—as a valuation driver: in the latest edition of *Valuation: Measuring and Managing the Value of Companies (University Edition)*, Koller, Goedhart, and Wessels (2015, pp. 361–363) propagate the use of NOPLAT as a valuation driver in cases where tax rates differ materially from each other[236] [237]

- *Earnings management and discretion:* Utilizing earnings as a valuation driver is rela-

[236]To provide further clarity on the benefits of taxed EBIT over the more common pre-tax EBIT as valuation driver, the empirical part of this dissertation will also cover taxed EBIT and EBITDA multiples: See e.g. Equation 4.44 (p. 119) for some further theoretical discussions and Chapter 7 (p. 239) for their general empirical performance

[237]Conceptually, the issue with NOPLAT as valuation multiple is that it artificially assumes that the company is financed 100% with equity (no interest payable and EBIT full taxable), which might be appropriate in fundamental valuation, where such assumption is moderated through the implicit leverage assumption in weighted average cost of capital, a normalization which, however, does not take place in the case of multiple valuation

tively more susceptible to accounting discretion (Löhnert & Böckmann, 2009, p. 577): Damodaran (2012a, p. 469) provides a number of such examples, including: acquisition accounting and earnings impact as well as capitalization and expensing policies. Beaver and Morse (1978, p. 558) discuss and Penman (2013, pp. 555–575) highlights in greater detail how—theoretically—conservative, neutral and liberal accounting practices impact a variety of metrics including price/earnings multiples: Penman (2013, p. 565) argues that for non-value added firms, companies with growing investment patterns[238] conservative accounting practices lead to lower earnings and hence—assuming no price impact—to higher price/earnings multiples.[239] Examples of conservative accounting practices according to Penman (2013, p. 571) are accelerated depreciation of tangible assets or amortization of intangibles, LIFO inventory methods and overestimates of contingencies and provisions. The consequence is that some noise might be introduced to the Law of One Price[240] in that economically similar companies electing different accounting practices might be treated differently in an undue manner.[241]

For the role of price/earnings multiples, it is important to differentiate though which of those elements can potentially be addressed through other valuation drivers such as EBIT and EBITDA and hence are a limitation of utilizing earnings and which ones require adjustments for virtually all P&L driven multiples: While the former is the case for D&A-related line items, which can be addressed through EBITDA as valuation driver specifically,[242] the latter applies to elements affecting cost recognition in cost of goods sold. Penman (2013) furthermore highlights that conservatism vs. liberalism in accounting policies has a possibly more profound effect on the price/earnings multiple compared to other types of multiples with valuation drivers "higher up" in the P&L: while the absolute impact remains unchanged, the relative impact on earnings multiples

[238] Arguably the default case for companies with an ambition to achieve net sales growth, further fulled also by inflation even for flat-volume growth or slightly declining volume growth companies—in the sample utilized in this dissertation, median forecast next 2 year top line growth across all observations is 5.6%, although median next twelve months capital expenditure as a percentage of sales (5.4%) is broadly in line with median next twelve months deprecitation and amortization expenses (D&A) (5.9%)

[239] The opposite is the case for "liberal" accounting practices which lead to higher earnings and consequently lower price/earnings multiples

[240] See Subsection 2.1.5.1, p. 27

[241] Beaver and Dukes (1973, p. 557) provide some empirical results for the case of accelerated ("conservative") and straight-line ("liberal") depreciation methods, which indeed confirm that conservative deprecation methods lead to higher price/earnings multiples—for their sample by about 10%—and that this discrepancy vanishes if the straight-line method is converted to the accelerated method. While Zarowin (1990) finds that other factors such in particular growth will have a very material effect on price/earnings multiples and it is not "just accounting methods" (Zarowin, 1990, p. 446), he does not provide a clear explanation as to why accounting methods would be irrelevant all together

[242] And has contributed to the high popularity of EBITDA as a valuation driver (Damodaran, 2012a, p. 500)

may be more substantial as earnings typically amount to a lower number than EBITDA or EBIT. More generally, there is a view that price/earnings multiples might be more affected by accounting policy aspects than EBIT or EBITDA multiples (Cassia, Paleari, & Vismara, 2004, p. 116; Sommer & Wöhrmann, 2011, p. 4)

- *General earnings volatility and perpetuation of extraordinary items:* As multiples are generally linked to single-period valuation drivers, i.e. in the case of earnings the earnings reported for a 12 months period, any extraordinarily positive or negative events during that 12 months period may affect multiple-based valuation outcomes excessively: With B. Graham (1949, Ch. 12) postulating "don't take a single year's earnings seriously" it is in essence what multiple-based valuations tend to result in and the impact of extraordinary items on earnings will generally be larger than for other multiple valuation drivers. This limitation can in part be overcome in that reliance on future earnings (e.g. equity research analyst-determined next twelve months or future fiscal year earnings) will usually be "automatically" normalized for extraordinary future items the research analyst is not aware of and does not foresee to impact the company.[243] In the instance of foreseeable extraordinary items, research analysts might furthermore provide adjusted or normalized earnings forecasts which can be utilized instead of their expectation for reported earnings[244]

- *"Technical" limitations:* A potentially imposed non-negativity constraint of the multiple valuation approach[245] is more of an issue for earnings as a valuation driver, which "sits quite low" in the P&L statement and thus has a higher likelihood of being non-positive (Meitner, 2006, pp. 94–95). This leads to more firms being "lost in an analysis" (Damodaran, 2012a, p. 500) compared to other valuation drivers. Practitioners might "climb up" in the P&L until a non-negative valuation driver can be identified (Sommer et al., 2014, p. 31). This may mean wandering "all the way up" to net sales (Schwetzler, 2003, p. 86) and is a common motivator in particular for valuations relying on many recently founded peer companies, which are currently and/or in the foreseeable future loss-making (Fernández, 2001, p. 9)

[243] Also compare Subsection 2.3.2.2 (p. 42) on a discussion regarding valuation driver timing

[244] Still, the issue remains as at times those normalizations are a "black box" and not all analysts might conduct them in a consistent manner, impacting consensus figures built on averages of analyst forecasts. Seppelfricke (2014, p. 161) highlights the specific situation in Germany, according to which many equity research analysts conduct their adjustments utilizing the DVFA scheme of normalizations, resulting increased comparability within the peer group and beyond

[245] Compare the more detailed discussion in Subsection 6.3.3.2 (p. 210)

Table 2.3: Limitations of P/E multiples and potential ways to mitigate limiting factors

Claimed limitation	Applicability to P/E multiples	Mitigating considerations
Net debt-agnostic: P/E multiple-based valuation ignores differing levels of financial leverage between firms, violating the Law of One Price[a]	• Applicable to P/E multiples given their nature as equity value-based multiple • Consistency is maintained but error might be introduced from a "value of operations" perspective translating into varying costs of equity for different amounts of debt not reflected by P/E • Further bias through excess cash and cash equivalents (Schwetzler, 2003, pp. 82–83)	• Compute an unlevered P/E multiple proposed by Penman (2013, p. 466) instead • This, however, translates into a de-facto use of a different valuation driver (EBIT) and multiple valuation concept (Enterprise value)
Tax structures: Earnings are affected by corporate income tax environment, which differs between countries and companies	• Equity valuation depends on taxation impact, the P/E multiple neutralizes this impact in a consistent manner • However, none the less counterintuitive compared to valuing operations as a whole	• Tax rate adjustment to P/E multiples proposed by Massari, Gianfrate, and Zanetti (2016, pp. 353-355) • Taxed valuation drivers for enterprise value multiples • Potential elimination of tax rate outliers from peer group
Earnings management: Company managements' discretion on accounting policy affects earnings as a valuation driver	• Applicable to many valuation drivers but earnings particularly prone given they "sit low" in the P&L and subject to more management discretion • Since earnings usually lower than other valuation drivers, the same absolute adjustments have relatively greater effect	• Utilize a valuation driver, which normalizes for the most obvious areas of earnings management such as depreciation policies—e.g. EBITDA • Rely on forecasted valuation drivers, which are more immune to ex-post earnings management
Extraordinary items: A single time period of earnings might be addected by extraordinary items	• Not specific to earnings, however, higher risk of discrepancies and larger relative impact than with other valuation drivers	• Consider utilizing forecasted future earnings and—if provided by the research analyst—normalized or adjusted earnings
Non-negativity: Valuation drivers must be positive as negative valuations are not meaningful	• Not specific to earnings, however, likelihood of negative earnings higher since earnings "sit low" in the P&L	• Consider utilizing valuation drivers which "sit higher" in the P&L and hence are positive, possibly even net sales, ensuring relevance of such drivers for valuation • Negative peer multiples can be addressed with methods discussed in Subsection 6.3.3.2

Note: Own illustration. [a] Assuming the Law of One price is applicable to enterprise value

Table 2.3 (p. 59) provides a summary of limitations and mitigating suggestions of the price/earnings multiple. It is obvious that many of the proposed mitigation strategies relate to the utilization of other valuation drivers such as EBIT (to account for financial leverage differentials), EBITDA to additionally address management discretion on depreciation schedules and even as far as net sales to address negative earnings.[246]

2.4.2.2 Net sales as a valuation driver inappropriately ignoring profitability

Another popular valuation driver is net sales, resulting in the corresponding enterprise value/net sales[247] multiple (Damodaran, 2012a, p. 543). Net sales is furthest distanced from the cash flow or earnings—i.e., as one could argue, more remote to the economic value creation potential of a firm—and thus its use is theoretically challenging to justify: notably it normalizes for profitability, which is perceived to be a key element with relevance to valuation since it bridges the top line to a metric better describing the benefits to investors (i.e. earnings metrics).[248] Application of an enterprise value/net sales multiple in peer group valuation will lead to a disregard of profitability margins, despite companies with higher margins theoretically trading at higher enterprise value/net sales multiples (Damodaran, 2012a, pp. 546, 548).[249]

There are none the less three main reasons for employing an enterprise value/net sales multiple (Damodaran, 2012a, p. 542; Löhnert & Böckmann, 2009, p. 577), many of which bear resemblance to the discussion between enterprise value/EBIT over price/earnings multiples:[250]

- It is possible to compute them even if other (preferable) valuation drivers are negative, which e.g. on EBITDA level might well be the case for recently established companies.[251] [252]
- Net sales as a P&L line item is (even) less exposed to volatility and opportunity for earnings management than EBITDA and any opportunity to manage will have an relatively smaller impact on sales than on other line items of the P&L

[246] In addition to theoretical considerations around price/earnings (Compare below, Subsection 4.2.1, p. 91), it is therefore instructive to discuss some background to the theoretical foundation of common enterprise value multiples (Compare below, Subsection 4.3.1, p.98)

[247] Sometimes also referred to as revenue multiple, or less commonly, turnover multiple

[248] Interestingly, profitability is not among the immediate ingredients of e.g. the intrinsic enterprise value/EBIT multiple formula, presented as Equation 4.34 (p. 103). However, profitability tends to impact return on invested capital—which can be expected to be higher for companies with higher profitability—as well as equity beta since less profitable companies can be considered subject to higher earnings volatility for a given variation in sales

[249] Also compare Equation 4.46 (p. 119), which offers additional analytical comfort to this statement

[250] Compare Table 2.3 (p. 59)

[251] Consider the illustration presented by Meitner (2006, p. 95)

[252] Exclusion of peers on the basis of negativity of their valuation drivers may lead to biased peer groups; hence, there is a trade-off between the quality of the valuation driver—an argument for a valuation driver reflecting profitability—and unbiased peer groups—an argument for sales as a valuation driver

- While of lesser relevance for public comparable company analysis but important for transaction multiples, sales figures tend to be more readily available for private companies than profitability metrics, again reducing peer group bias[253]

The above calls for additional empirical evidence on the relative performance of enterprise value/net sales multiples. On the basis of a more general signal-to-noise hypothesis on multiple valuation accuracy formulated as Hypothesis 2e (p. 66), Subsection 7.2.7(p. 266) and Table 7.5 (p. 267) present some empirical findings on the performance of enterprise value/net sales.

2.4.3 Existing evidence on valuation driver/multiple type suitability

A number of previous empirical studies have been concerned with the valuation quality of different valuation driver types and their respective multiples, either as focal areas of study such as J. Liu et al. (2002) or as topics considered peripherally.[254] Overall results are inconclusive, however, in particular against the backdrop of strong theoretical views around enterprise value vs. equity value multiples and the practically less common use of stock vs. flow multiples:

- *Initially strong performance of stock multiples (e.g. market/book) vs. flow multiples (e.g. price/earnings) has somewhat re-balanced if more recent studies are concerned:*[255] In the context of initial public offerings, M. Kim and Ritter (1999, p. 421) report that, measured by a number of common distribution metrics for absolute prediction errors, market/book value multiples appear to outperform common flow multiples such as price/earnings and price/sales. On the basis of a regression approach, valuation errors of market/book multiples are substantially lower at a mean 33.1% vs. 56.5% and 62.4% for price/earnings and price/sales multiples, respectively (1999, p. 422). Similarly, Lie and Lie (2002, p. 48) find a strong performance of stock multiples vs. flow multiples, with market/book outperforming the best flow multiple, enterprise value/EBITDA with mean absolute valuation errors of 32.2% vs. 36.5%, respectively.[256] [257] In contrast, in a study where different valuation drivers are the core focus subject, J. Liu et al. (2002, pp. 162–163) find that earnings and cash flow valuation drivers outperform, book

[253]Pratt (2005, p. 138) argues that, for many smaller businesses following common business models in a competitive market place, profitability levels will not be too dissimilar anyhow

[254]Also consider Figure 6.6 (p. 235) and Table A.5 on (p. A28–A35) for an overview of empirical valuation driver studies in the context other multiple accuracy aspects

[255]See for a discussion of both general types above, Subsection 2.3.2.1 (p. 42)

[256]Excluding cash adjustment and firms with negative earnings

[257]The strong performance of market/book multiples has also been observed by Nissim (2013), albeit for a sample of insurance companies with doubtful ability to generalize results for other industries

value;[258] unfortunately, though, they limit their error reporting to bias as opposed to accuracy.[259] Some additional more recent studies such as Rossi and Forte (2016, p. 65) and Schreiner (2007, p. 100) give flow multiples the edge over stock multiples

- *Ambiguous results on enterprise vs. equity value multiples:* There is no conclusive evidence backed by a pattern of studies that the class of enterprise value multiples (e.g. enterprise value/EBIT) would outperform the class of equity value multiples (e.g. price/earnings).[260] Whilst the results of J. Liu et al. (2002, p. 152) point to overall superior performance if standard deviation and median of price/earnings compared to enterprise value/EBITDA is considered, which is reinforced by visually more heavily tailed and for multiple purposes hence undesirable distribution (2002, p. 157), Lie and Lie (2002, p. 48) report consistently less favorable absolute valuation error distribution metrics for price/earnings vs. enterprise value/EBITDA. Those findings are in line with Alford (1992, p. 104), who discussed higher valuation errors for enterprise value/EBIT vs. price/earnings, with findings being significant according to a t-test. The picture presented by Schreiner (2007, pp. 100, 102) is more complicated as no direct comparison of EBITDA or EBIT and earnings or EBT is offered, which would comply with the principle of equivalence. If measured by market capitalization as pricing reference and median absolute error as distribution metric for quality, EBT appears to lead, followed by EBIT, earnings and finally EBITDA, but earnings and EBT switch ranks if mean is concerned, pointing to higher biases for multiples calculated on the basis of valuation drivers connected to enterprise value. In a more consistent presentation of results, albeit focused on mean absolute distribution errors only, Herrmann and Richter (2003, p. 209) present somewhat stronger respective performance by equity value multiples for both flow and stock classes (i.e. price/earnings outperforms enterprise value/EBIAT and enterprise value/EBIDAAT as well as market/book value outperforms enterprise value/invested capital), but differences are not tremendous, with e.g. price/earnings at 33.4% vs. enterprise value/EBIAT at 34.1%. More recent studies confirm the picture of varying outcomes: While Rossi and Forte (2016, p. 65) find that price/earnings performs better than enterprise value/EBITDA, the results of Chullen et al. (2015, pp. 654–655) indicate stronger performance of enterprise value/EBIT and enterprise value/EBITDA

[258] Compare the visually most instructive chart of pooled distribution pricing errors, (J. Liu et al., 2002, p. 157)
[259] Compare Table 6.2, p. 223 for details on both error measurement concepts
[260] A closely related but ultimately distinct question is the one whether there is empirical evidence for the principle of equivalence, i.e. the consistent computation of the price reference given a specific valuation driver, compare empirical literature mentioned in Subsection 5.3.1 (p. 140) and Footnote 439 (p. 139)

relative to price/earnings across a variety of aggregation methods—albeit at overall low levels of valuation accuracy compared to other studies. The strong performance of enterprise value multiples is confirmed by Berndt, Deglmann, and Vollmar (2014, p. 50), who report overall low absolute valuation errors in the order of c. 20%, with particularly high accuracy of enterprise value/EBIT at 18.5% median vs. 20.8% for price/earnings if calculated as percentage errors

- *Some valuation drivers with consistently weakest performance—net sales in particular:* Most studies including Rossi and Forte (2016, pp. 62, 65) Schreiner (2007, p. 100), Herrmann and Richter (2003, p. 209), Lie and Lie (2002, p. 48) and J. Liu et al. (2002, pp. 152, 157) appear to agree that sales is a weak valuation driver to choose, with absolute errors being substantial at 47–75% in absolute terms—resulting in questions around the general meaningfulness of net sales multiple valuations relative to other valuation drivers. Net sales are not the only disappointingly weak valuation drivers: In his study of over 25 valuation drivers, Schreiner (2007, p. 100) finds lackluster performance of cash flow multiples, too, with mean valuation errors in excess of 60%

To conclude it is fair to say that empirical results are not equivocal across a number of assessment criteria, notably stock vs. flow multiples and enterprise value vs. equity value multiples, with the exception of weak performance by net sales as valuation driver. Furthermore, much of this assessment is based on a descriptive rather than a statistical interpretation;[261] therefore, not only additional empirical data but also more sophisticated statistical tests can be instructive and will be presented in the empirical part of this dissertation.

2.4.4 Selection of multiple types for the purposes of this dissertation

It has been argued that, as one of its drawbacks, there is an element of arbitrariness in multiple valuation,[262] which in particular stems from a broad universe of valuation driver candidates.[263] The objective of this dissertation is to consider practically relevant multiple types and deduce on their basis directional insight regarding the performance different classes of multiples—e.g. enterprise value multiples vs. equity value multiples or flow vs. stock multiples. Therefore, multiple types selected for further investigation need to fulfill two main criteria, (a) practical

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[261] Other than the simple *t*-tests offered by Alford (1992, p. 104) and some more sophisticated Wilcoxon tests on a relatively small sample by Berndt, Deglmann, and Vollmar (2014, p. 52)

[262] Compare Subsection 1.1.3, p. 4

[263] With valuation driver selection ultimately determining multiple type selection, compare Subsection 2.3.1 (p. 41)

relevance[264] and (b) the property of being a typical representative of the respective class to be contrasted against other classes.[265] Those criteria in themselves carry some judgment and empirical results reported in this dissertation should be seen in light of that. None the less some guidance on common types is available from previous empirical studies such as Rossi and Forte (2016), Schreiner (2007) and J. Liu et al. (2002), proposed in textbook literature (Hasler, 2011, p. 286; Löhnert & Böckmann, 2009, p. 577), found to be relevant in survey-based studies (Mondello, 2017, p. 541; Matschke & Brösel, 2013, p. 824) and in published valuations such as fairness opinions (Schönefelder, 2007, p. 143). In summary, this results in a diverse set of 13 different multiple types deemed to deserve further investigation, of which 10 are flow multiples (6 enterprise value and 4 equity value multiples) and 3 are stock multiples; descriptive statistics of the respective pricing multiple distributions are available in Table 3.4 (p. 83).

2.4.5 Hypothesis formulation regarding the quality of multiple types

Since it is challenging to ex ante theoretically pinpoint a single-period[266] multiple type or its corresponding valuation driver, which best reflects the future economic cash generation potential, the hypotheses to investigate valuation driver accuracy further will need to be formulated somewhat more general. Hence, I first argue that valuation drivers differ in their ability to predict meaningful valuation multiples,[267] resulting in multiple valuations of a diverse range of accuracy:[268]

Hypothesis 2a *Impacted by their valuation drivers, different multiple types display materially diverging levels of valuation accuracy*

The objective of determining the best representative for future cash generation as a successful valuation driver might lead the casual observer to argue that a valuation driver which is close to the cash generation potential for the measurement period, e.g. free cash flow or cash flow

[264] As opposed to esoteric suggestions

[265] Compare the following Subsection 2.4.5 (p. 64) for hypothesis formulation regarding multiple type quality for further details

[266] For flow multiples such as price/earnings or enterprise value/EBIT, single period multiples are by far most common. In the case of stock multiples: single point in time valuation drivers

[267] At a first glance, this is might be counterintuitive relative to the discussion around deriving the connection between all sorts of multiple types and their fundamental input variables via the concept of “discrepancy factors” proposed in Subsection 4.4.1 (p. 114). However, discrepancy factors only allow to link valuation drivers to their intrinsic factors and do not uncover the multiple type or valuation driver, which is the best proxy for the long-term economic cash generation potential. In other words, Hypothesis 2a postulates that valuation driver selection does matter for multiple valuation accuracy

[268] As conceptually defined in Subsection 2.2.1 (p. 38)

from operations for the last or the next twelve months. However, as is evidenced also by some prior studies such as Schreiner (2007, p. 100) and J. Liu et al. (2002, p. 137), there could well be a difference between the best measurement of cash generation potential during the valuation driver measurement period and the ideal one-period[269] proxy for the long-term cash economic generation potential: In fact, it was argued in Subsection 2.1.5.4 (p. 34), that somewhat less volatile[270] accounting-based valuation drivers such as earnings, EBIT or EBITDA might outperform valuation drivers closer to one-period cash generation such as free cash flow or cash flow from operations given the latter might suffer from one-off period-specific biases, whilst the former are normalized as a consequence of accounting concepts applicable to them. Furthermore, the Functional Fixation Hypothesis[271] might provide support to accounting-based valuation drivers. This leads to another hypothesis on valuation drivers, notably:

Hypothesis 2b *Valuation drivers closer to single period cash flow do not necessarily outperform more cash flow-remote accounting-based drivers*

As discussed it is a challenge to ex ante deny any reasonable valuation driver its ability to act as a proxy for the future economic cash generation potential and hence its suitability to form a multiple utilizing it. However, it can be argued that certain valuation drivers are conceptually more "remote" than others to future economic cash generation, also consistent with the classification of Massari et al. (2016, p. 301) regarding direct vs. indirect multiples. Notably coming to mind are stock multiples such as market-to-book or enterprise value/total assets: the step from book value of assets to future cash generation might be a step too far. The counterargument could be that valuation should not be conducted at all on the basis of future cash generation but that net asset value is the more appropriate approach; this, however, is in contrast to much of the corporate finance literature which favors future cash flows over historical balance sheet information. This does not imply that stock multiples do not have a role in multiple valuation but it can be argued such role is more one of assisting other multiple types such as price/earnings in a combined multiple valuation approach.[272] These deliberations on stock multiples lead to another hypothesis regarding valuation driver suitability:

[269] Or in the case of stock multiples: one point in time

[270] The higher volatility of multiples closer to the measurement period's cash flow such as enterprise value/(EBITDA-capital expenditure (Capex)) or enterprise value/(taxed EBIT+D&A-CAPEX) is documented to some extent in Table 3.4 (p. 83) through higher standard deviation of the pricing multiples

[271] Compare Subsection 2.1.5.4, p. 33

[272] Another argument for stock multiples might be that comparable companies have similar return on capital requirements and hence considering capital is relevant. However, it is unclear as to why one would stop at capital rather than return, which then again is more consistent with choosing flow multiples

Hypothesis 2c *Flow multiples outperform stock multiples given their conceptually closer relationship with future cash generation potential*

As outlined in Subsections 2.3.2.6 and 2.4.2.1 (pp. 49 and 55, respectively) and in Table 2.3 (p. 59), some multiple types—notably equity value multiples such as price/earnings in their unadjusted form—suffer from the conceptual shortcoming that they do not normalize for different capital structures among the peer companies and relative to the company under investigation. This provides a much discussed conceptual advantage to enterprise value multiples.[273]

Hypothesis 2d *Multiples, which normalize for different capital structures outperform multiples, which do not consider capital structure differences*

Whilst the most obvious differentiation factor, Hypothesis 2d is not explicitly eluding to enterprise value vs. equity value multiples, which is a consequence of the potential leverage adjustment equity value multiples such as price/earnings proposed by Penman (2013, pp. 465–467) and discussed in greater detail in Subsection 5.6.1 (p. 169). Hypothesis 2d does none the less also comprise the assessment of enterprise vs. equity value multiples as the most obvious determinant for leverage-adjusted and non-leverage adjusted multiples.

Lastly, in Subsections 2.4.2.2 (p. 60) and 4.6 (p. 122), respectively, it was and will be argued that certain popular but theoretically challenged multiple types should best be avoided. For enterprise value/net sales this is due to the fact that it disregards the possibly valuation-critical profitability profile—in contrast to e.g. enterprise value/EBIT. On the other hand, price/earnings growth does contain additional valuation-critical information, namely expected growth, however, it does so in a theoretically unreflected manner since all types of growth, namely value destructive and value generative growth, is treated equally, whilst, in Subsection 4.2.2 (p. 94), a strong theoretical case is made to differentiate between growth created by projects where the return on equity exceeds the cost of equity (value creative, justifying higher valuation for higher growth) to and growth where this is not the case (value destructive, no justification of higher valuation for higher growth). Thus, price/earnings growth multiples can be expected to suffer from noise not observed in standard price/earnings multiples. This leads to the final hypothesis on multiple type comparisons:

[273] Compare among others Damodaran (2012a, p. 543), Koller et al. (2010, p. 314), Massari et al. (2016, p. 300), Schreiner (2007, p. 57), Wagner (2005, pp. 15–17), Pereiro (2002, pp. 254–255) Schwetzler (2003, p. 79) and Hachmeister and Ruthardt (2015, p. 1703)

Hypothesis 2e *Value-relevance of valuation driver composition is important for valuation accuracy of multiple types: Multiple types, which consider value-relevant aspects should outperform multiple types, which do not. Multiple types, which reflect information with ambiguous consequences on valuation underperform multiple types, which disregard such information*

In other words, Hypothesis 2e postulates that multiple valuation precision is a result of an optimal signal-to-noise ratio.[274]

Hypotheses 2a to 2e will be subjected to empirical assessment in Subsection 7.2 (p. 242).

[274]The expression signal-to-noise ratio is also utilized by J. Liu et al. (2002, p. 138) in the context of multiple valuation type accuracy. However, its meaning in the context of Hypothesis 2e is somewhat different to J. Liu et al. (2002, p. 138) in that it relates to noise, which *ex ante* can be qualified as bad noise in that it can theoretically be argued that valuation accuracy should suffer. In contrast, the interpretation of J. Liu et al. (2002, p. 138) appears to include general noise associated with the use of more complex intrinsic valuation drivers

CHAPTER 3

Pricing multiples in context: Impressions from the empirical sample

"[S]ome of the best theorizing comes after collecting data because then you become aware of another reality."
—ROBERT SHILLER[275]

3.1 Early introduction to the sample in spirit of an integrated approach

The objective of this dissertation is to connect practical approaches, theoretical arguments and empirical findings on trading multiple valuation in an integrated fashion. In order to provide context to theoretical aspects in later chapters, it is instructive to illustrate those arguments with descriptive empirical data: Figures informed by descriptive sample data are materially more straightforward and relevant to interpret. With directional knowledge of the underlying

[275] Compare Shiller (2013). Together with John Campbell, 2013 Nobel laureate Robert Shiller proposed the cyclically adjusted price/earnings multiple ("CAPE" or "Shiller P/E"), which adjusts market price/earnings multiples to detect longer-term market over- or undervaluations (Campbell & Shiller, 1988). The above quote is not to be wrongly construed as to invite to data mining; it rather stresses the importance of empirical data for economic theory as will be evident from the interview quoted. In the spirit of providing some guidance to relevant ranges for input variable sensitivities to intrinsic multiples in Chapter 4, there are benefits of describing the empirical ranges of those variables in advance, i.e. in this Chapter

data, the severity of restrictions imposed on as well as limitations deriving from theoretical models can be assessed more rigorously and described in a more illustrative manner.[276]

Furthermore, some large-sample descriptive data on trading multiples can be helpful for practitioners searching for a way to ensure their trading multiple computations are plausible and consistent.

The remainder of this Chapter is structured as follows: I will first discuss the motivation behind choosing the sample utilized, then elaborate on the databases considered to obtain the data, specify, which key data points have been collected in which manner, subsequently present some modifications to the collected sample and their respective rationale to conclude with some descriptive statistics on the underlying financials of the sample companies as well as on some of the common pricing multiples.

3.2 Sample selection considerations

The sample utilized throughout this dissertation relies on constituents of 2 broad commonplace commercial stock indices, the STOXX® Europe 600 and the S&P 500®, measured semi-annually on January 31 and July 31 during an 11-year period from 2004 to 2015. This sample selection is motivated by a number of considerations with particular relevance to multiple valuation:

- The choice of the 600 and 500 constituents, respectively, and at each measurement point in time, of the STOXX® Europe 600 and the S&P 500® indices reflects a selection of liquid large- and mid-cap stocks, which represent a substantial part of overall market capitalization amounting to c. 80% for the S&P 500 (Standard & Poor's Dow Jones Indices, 2018) and to c. 90% for the STOXX® Europe 600 (STOXX Limited, 2014)[277] [278]

[276] This notably includes some of the core theoretical topics covered, among others: Figure 4.2 (p. 110), which requires a "ceteris paribus" approach to all other input variables—choosing the median for all constant input variables other than the one sensitized variable appears a suitable approach; a good part of Chapter 5, which suggests adjustments to multiples might be beneficial for valuation accuracy but come at the expense of additional costs in data collection and computation—hence an early directional sense of the potential quantitative impact of some of the proposed adjustments is important; Figure A.1 (p. A12), which illustrates the considerable discrepancy of value-relevant financial metrics between industries but also within industries—an aspect to be aware of relative to the empirically common and practically preferred peer selection by industry affiliation; considerations around the distribution of multiples as shown in Figure 6.2 (p. 208) and a descriptive discussion of the distribution characteristics of key multiple valuation error measurement metrics as displayed in Figures 6.4 (p. 229) and 6.5 (p. 233)

[277] Number for the STOXX® Europe 600 relates to "developed" Europe

[278] Since I am only picking constituents of the STOXX® Europe 600 and S&P 500®, a broader discussion on the nature of the indices and common implications for returns etc. is not required

- A selection of reasonably large and liquid stocks is helpful in as far as reliance forward valuation drivers (such as earnings) is desired; such valuation drivers have shown better performance than reported (historical) valuation drivers.[279] On the basis of practical experience I speculate that firms with large and liquid stocks are covered by a higher number of experienced analysts, which should result in up-to-date forecasts of representative quality

- A diverse sample from a sectoral and geographical perspective. Both the STOXX® Europe 600 and the S&P 500® are cross-industry indices, covering a wide variety of different firms. The combination of STOXX® Europe 600 and the S&P 500® furthermore results in a geographically diverse sample, albeit with mature-market focus. The STOXX® Europe 600 covers companies in 17 countries (STOXX Limited, 2018),[280] with the S&P 500® focused on U.S. listed companies

- The combination of STOXX® Europe 600 and the S&P 500® has previously been used in multiple valuation accuracy studies such as Schreiner (2007, p. 10) and Berndt, Deglmann, and Vollmar (2014, pp. 22–27), ensuring some level of comparability of results

- An 11 year time period from 2004–2015 spans different stages of bull and bear markets, which should improve the ability to generalize the findings[281]

- Data is collected semi-annually, for January 31 and July 31 of each year. I believe those dates are suitable for investors and analysts to have reflected trading updates, which are commonly published within a 4–5 week period post quarter or half-year end[282] and in any event, my sample download is constructed in a way that all information downloaded (e.g. historical balance sheets) relate to the latest available information on the market pricing date, which should ensure informational consistency of the downloaded dataset with what market participants knew at the time, avoiding issues associated to "back-filled"

[279] Compare Subsection 2.3.2.2 (p. 42) above for a more detailed discussion

[280] Note: latest available coverage, which somewhat varies over the years: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom

[281] From my practical experience I am aware that the quality of the databases used has considerably improved over the years and thus there is benefits to limiting the sample to not go too far back

[282] This approach contrasts studies leaving a longer time period between measurement date and the fiscal year end date such as the 4 months used by Rossi and Forte (2016, p. 48) and Chullen et al. (2015, p. 649). There is also reason to believe that equity research will be more focused on trading updates and earnings announcements rather than publications of full balance sheets

data. A semi-annual approach somewhat mitigates seasonality biases from choosing a download frequency of once a year

- Reasonably large theoretical sample size of 24,200 observations is obtained,[283] ahead of previous empirical studies on multiple valuation[284]
- Cross-sectional nature of the sample, spanning time periods, markets and industries allows for analytical flexibility[285]

Whilst I do believe that the sample is therefore well suited for the purposes of a comprehensive multiple valuation analysis, providing a reasonable combination of signal-to-noise resulting in high valuation accuracy to start with, some limitations apply:

- The sample disregards emerging markets and selected non-European and non-U.S. mature markets such as Australia and Japan. Expansion of the empirical part of the study to those markets could be an eventual extension, much like inclusion of smaller companies for geographical markets studied, which could potentially allow for an interesting comparison of results
- The sample selection does not only limit companies for which a multiple valuation is conducted but equally also the universe of potential comparable firms to those, which are a constituent of the respective indices. However, it appears that there is in most instances still a very reasonable number of peer companies available[286]

3.3 Databases considered and data items collected

Archival financial data is obtained from the Reuters Global Fundamentals database,[287] and collected into Microsoft® Excel® via the module provided to download such information from Thomson Reuters databases. The data download is structured such that it relies only on information available at the respective pricing date—i.e. no ex-post data, avoiding issues

[283] $N = (500 + 600) \cdot 2 \cdot 11 = 24,200$ if number of constituents of the two indices are multiplied by the 2 pricing dates for each of the 11 years observed

[284] Median of 9,794 observations in 34 previous studies on multiple valuation reviewed for the purposes of this dissertation. Compare Subsection 6.4.3 (p. 234) and Table A.5 (p. A28) for a more detailed overview

[285] Compare e..g. the discussion of the out-of-sample nature in Subsection 6.4.2.2 (p. 232), which relies on a randomly selected sub-sample

[286] The number of peers available on the basis of the industry peer selection process described in Subsection 7.2.2 (p. 242) varies between 0 and $\max(n_{j,t})$ =56 with a median of $\tilde{n}_{j,t}$ =23. For industries other than Alternative Energy (ICB code 058) there are consistently 7 or more peers available, see Table 3.1 (pp. 78–79)

[287] Access available to students at the University of St.Gallen

with backward-filled data. Numerous components including market pricing (e.g. stock prices, market capitalization), latest historical balance sheet data (e.g. financial debt and cash positions, minority interest, equity investments), historical and future P&L and cash flow statement data (such as operating profit, depreciation, net income and earnings) as well as industry membership indicators (Industry Classification Benchmark (ICB) codes) and ancillary data (balance sheet dates, currency flags) are downloaded for the respective index constituent companies. ICB codes refer to the Industry Classification Benchmark, a commercial 4-level industry taxonomy scheme maintained by FTSE Russell available for more than 100,000 securities globally (FTSE Russell, 2018). Each firm covered is assigned a 4-digit hierarchical code and industry finesse can be gradually decreased by considering all four (resulting in 114 "subsectors," e.g. ICB code 3537: "Brewers") the first three (41 "sectors," e.g. ICB code 3570: "Beverages"), two (19 "supersectors," e.g. ICB code 3500: "Food & beverage") or one (10 "industries," e.g. ICB code 3000: "Consumer goods") digit(s) of the code.[288] The choice of classification system carries importance as it will be used to form industry peer groups, which serve as the basis for calculating valuation multiples.[289] Equity research-projected financials rely on Institutional Broker Estimate Service (I/B/E/S), a commonly used commercial database of aggregated broker forecasts ("equity research consensus") maintained by Thomson Reuters.[290]

3.4 Modifications to the sample

3.4.1 Currency conversion and calendarization

Since the data arrives in raw format, two main modifications are necessary for comparability purposes. First, data has been downloaded in local reporting currency. For comparison purposes, it will need to be converted into a *single output currency*.[291] The question arises, which exchange rate is most appropriate to use for those currency conversions, with average

[288] Compare (FTSE Russell, 2018)

[289] The ICB classification scheme has emerged into a popular competitor to the Standard Industry Classification (SIC) (Standard Industry Classification) classification concept, in particular for global/non U.S. empirical studies on multiples such as Schreiner (2007, p. 113), Paleari, Signori, and Vismara (2014, p. 23) and Chullen et al. (2015, p. 649). Other classification concepts with relevance to multiple valuation include the Global Industry Classification Standard ("GICS") (Rossi & Forte, 2016, p. 49)

[290] A number of other databases have been considered for specific aspects such as e.g. long-term growth forecasts, see Subsection 4.3.2 (p. 105) and lease capitalization tables by Moody's, compare Subsection 5.5.1 (p. 161); they will be discussed in the respective sections but their overall role is comparably minor

[291] While this is technically not needed for an assessment of multiples, since financial multiples normalize for currency given both the numerator and denominator are expressed in monetary units, it is none the less helpful for descriptive statistics of financials

historical, current spot or even future predicted exchange rates emerging as possible alternatives. In order to not affect local currency predicted growth rates, I argue that spot rates are most appropriate for this conversion. Second, and equally for comparability purposes, financial flow data such as earnings will need to be *recalendarized* such that they relate to the same time periods. This in an integral part of trading multiple valuation,[292] as all valuation drivers need to show time-related consistency, sometimes referred to as uniformity (Damodaran, 2012a, p. 458). Forward-looking valuation drivers have empirically shown the highest level of valuation accuracy, and hence all multiples I report will be based on next twelve months rolling forward financials unless noted otherwise. Consistent with common practice, recalendarization is achieved by apportioning fiscal year-reported financials such that they match to a next twelve month period.[293] For balance sheet/stock metrics such as financial debt, cash or minority interest, no calendarization is required. Instead, multiples will rely on the latest publicly available historical information from either annual, semi-annual or quarterly reports at the time of the pricing date. Both currency conversion and calendarization follow widely accepted industry standards and will ensure consistency with practitioner approaches.

3.4.2 Eliminations from the sample

It is customary in multiple studies to eliminate some sample companies on the basis of 4 main motivations: Lack of data, outliers, elective exclusion of certain industries and anticipated results bias. I utilize the following approach:

- *Consideration of non-financial companies only:* I exclude companies with the ICB industry code 8000, i.e. financial companies.[294] Exclusion of financial companies from an otherwise broad sample is relatively common practice in corporate finance studies.[295] The consideration of non-financial companies is motivated by materially

[292] Compare above, Subsection 2.3.2.2 (p. 42) for a discussion on forward vs. historical valuation drivers and related empirical studies

[293] E.g. for a multiple calculated on the basis of a July 31, 2012 pricing date and with a December calendar year end, the calendarization to next twelve months rolling earnings per share, EPS_{NTM}, would be as follows: $EPS_{NTM} = \frac{5}{12} \cdot EPS_{2012} + \frac{12-5}{12} \cdot EPS_{2013}$, where 5 is obtained by counting the months in the remaining fiscal year, i.e. from August to December 2012 in the given example

[294] This results in exclusion of all related supersectors, i.e. banks (ICB supersector code 8300), insurance companies (ICB supersector code 8500), real estate companies (ICB supersector code 8600) and financial services (ICB supersector code 8700)

[295] As an example, this includes Kang, Kim, and Stulz (1999, p. 522) more generally as well as Young and Zeng (2015, p. 2582), Sommer and Wöhrmann (2011, p. 32) and Kelleners (2004, pp. 206–207) for studies on multiples more specifically. It is, however, fair to say that a number of studies on multiples specifically are less concerned about the inclusion of financial companies in their sample. Neither Schreiner (2007), J. Liu et al. (2002), Lie and Lie (2002), Cheng and McNamara (2000) nor Alford (1992) appear to exclude financial

differing valuation dynamics of financial companies,[296] which might bias results in a pooled sample

- *Incomplete data:* On lack of data, at this stage, I only require availability of the ICB code for every sample company. Since peer formation on the basis of an industry approach is practically common and has been widely applied by empirical studies, it will also be utilized in the empirical part of this dissertation. Without ICB code, firms cannot be reliably aligned to industries, which motivates their removal. Together with removed financial companies, this results in a reduction of the number of observations in the basic sample from 24,200 by 5,061 to 19,139, of which 10,071 firm-half years relate to STOXX® Europe 600 constituents and 9,068 firm half-years relate to S&P 500® firms. Table 3.1 (pp. 78–79) provides a more detailed overview of the number of observations by industry and observation measurement date. There will furthermore be instances where computation of specific multiple types is poised to fail given constituents of valuation drivers[297] or price references[298] are unavailable. Consequently, those observations will need to be excluded and this exclusion is conducted on a multiple-specific basis only: i.e. other types of multiples will still be computed as permitted by available data

- *Outlier exclusion and potential result bias:* I introduce thresholds to eliminate cases of obviously non-meaningful pricing multiple computation outcomes, namely a non-negativity lower threshold.[299] The respective higher thresholds of meaningfulness are set at for all enterprise value/earnings multiples at 150x, for enterprise value/net sales at 50x,[300] for all equity value and price multiples at 250x and for yield metrics at 100%. This is consistent with how practitioners approach multiple valuations for obvious outliers in that such pricing multiples are usually set to "non/meaningful." To

companies. Herrmann and Richter (2003, p. 217) selectively present conclusions for non-financial companies separately

[296] Compare among many Koller et al. (2010, pp. 765–788), who argue that while valuation fundamentals apply equally to banks, certain modifications such as reliance on equity value cash flows are necessary. In terms of multiples, this would mean that price/earnings might be suitable but enterprise value multiples will be more challenging to justify

[297] Such as e.g. EBITDA forecasts

[298] Such as e.g. financial debt required to compute enterprise value from equity value or market capitalization

[299] Threshold for all enterprise value/earnings multiples (Such as enterprise value/EBIT, enterprise value/EBITDA and enterprise value/taxed EBIT) of 0x , for enterprise value/net sales of 0x , for all equity value and price multiples (Such as price/earnings, price/earnings before tax, price-earnings growth (PEG) and the market/book ratio; note this threshold is also used for enterprise value/invested capital) of 0x and for yield metrics (Notably, dividend yield) of 0%. Those lower thresholds are applied through this dissertation as a baseline, with the exception of analyses on negative multiples, compare Subsection 7.3 (p. 268), where they are lifted

[300] Note this threshold is also used for enterprise value/invested capital

reduce potential exclusion biases to a minimum, limits are set generously beyond what practitioners would likely identify as outliers[301]

- *Exclusion concepts in previous studies not applied to this sample:* Other samples exclusion techniques not applied relate to penny stocks (Young & Zeng, 2015, p. 2582; Sehgal & Pandey, 2010, p. 76), which appear less relevant here since constituent firms of leading global indices are utilized and most computations rely on multiples measured on the level of claims of all shareholders or capital providers or the requirement of certain fiscal year ends to correspond to typical reporting time frames (Dittmann & Weiner, 2005), which is not required given valuation drivers are recalendarized.[302] A number of studies on multiple accuracy furthermore require a minimum number of industry constituents or peers in order to retain an observation in the sample.[303] I do not a priori restrict the sample on that basis, also since a lack of industry peers appears a concern only for one specific industry at certain measurement point of times[304]

[301] Such thresholds are furthermore conceptually consistent with the approach in previous empirical studies to trim data on the basis of its quantiles, commonly the 1%–99% quantiles (Young & Zeng, 2015, p. 2582; J. Liu et al., 2002, p. 146); for enterprise value/EBIT and price/earnings, I eliminate 0.7% and 3.3% of observations, respectively, broadly in line with the 2% of the 1–99% quantile approach

[302] Compare Subsection 3.4.1 (p. 73)

[303] Compare below, Subsection 6.2.4, p. 191

[304] For industries other than Alternative Energy (ICB code 058) there are consistently 7 or more peers available, see Table 3.1 (pp. 78–79)

3.5 Descriptive sample statistics

This section presents some descriptive statistics on the key financial metrics and resulting pricing multiples of the sample. It is instructive to provide a high-level understanding of which numeric values multiples typically take and allows for a more meaningful interpretation of any multiple valuation result presented. First, in Table 3.2 (p. 80), key financial metrics relating to both, valuation driver elements and pricing references, are presented. Median market capitalization for the sample of EUR6,811mm is consistent with sample selection based on large- and mid-cap European and U.S. stocks with good liquidity and general availability of quality equity research forecasts. General data availability is solid, with c. 410 observations or 2.1% of the sample being lost due to lack thereof.[305] It is worth noting that a number of adjustment factors relevant to multiples discussed in detail in Chapter 4 such as equity investments or operating lease expenses are only applicable to some companies, whilst others do not feature those aspects.

Table 3.3 (p. 82) details selected financial ratios, including measures of profitability ("margins"), growth rates and capital structure/risk metrics such as net debt/EBITDA, gearing and levered equity beta, common in company analysis. It is instructive to consider directional quantities of those metrics as this allows a relative assessment of how any company under investigation compares to the overall market. A number of the metrics displayed in Table 3.3 furthermore form part of equations detailing intrinsic input variables of multiples as discussed in greater length in Chapter 4. Table 3.3 therefore contextualizes those analyses, equations and respective graphs, notably those shown in Figure 4.2 (p. 110).

[305] References of observations lost relate to median observations available in Table 3.2 of 18,729

TABLE 3.1: Observations by measurement date and industry affiliation

ICB classification[a]		Observations by measurment date[b]								
Code	Descr.	Jan-05	Jul-05	Jan-06	Jul-06	Jan-07	Jul-07	Jan-08	Jul-08	Jan-09
053	Oil & Gas Producers	46	47	47	48	49	48	48	49	52
057	Oil Equipment, Services & Distr.	13	13	13	14	20	20	21	24	26
058	Alternative Energy	0	0	0	0	0	0	0	0	5
135	Chemicals	25	25	24	25	25	27	27	25	26
173	Forestry & Paper	9	9	8	8	8	8	9	8	8
175	Industrial Metals & Mining	17	17	17	22	20	19	21	21	22
177	Mining	8	8	8	10	10	11	11	12	13
235	Construction & Materials	38	34	37	36	36	37	38	38	37
271	Aerospace & Defense	24	22	24	23	25	24	24	24	26
272	General Industrials	18	18	18	19	19	18	20	20	19
273	Electronic & Electrical Equipment	13	14	13	13	13	15	15	15	14
275	Industrial Engineering	29	28	30	30	30	31	35	38	34
277	Industrial Transportation	25	28	28	27	24	24	25	25	25
279	Support Services	44	45	42	41	44	44	45	46	45
335	Automobiles & Parts	22	22	22	22	21	21	22	22	21
353	Beverages	18	18	18	18	18	18	18	17	17
357	Food Producers	33	33	32	34	33	33	33	30	31
372	Household Goods & Home Constr.	19	18	18	18	20	18	17	16	13
374	Leisure Goods	10	9	9	7	8	7	8	8	9
376	Personal Goods	20	20	20	20	20	20	20	21	21
378	Tobacco	9	9	9	9	9	8	8	7	7
453	Health Care Equipment & Services	32	32	31	31	31	30	31	30	32
457	Pharmaceuticals & Biotechnology	41	41	42	41	38	39	38	39	42
533	Food & Drug Retailers	27	25	26	24	25	24	24	23	26
537	General Retailers	47	48	47	44	45	45	46	45	43
555	Media	53	54	57	53	51	50	49	48	39
575	Travel & Leisure	39	40	40	40	38	38	38	37	36
653	Fixed Line Telecommunications	19	18	17	17	15	15	14	15	13
657	Mobile Telecommunications	13	14	15	14	13	13	13	12	13
753	Electricity	44	45	45	47	49	47	46	46	46
757	Gas, Water & Multiutilities	20	21	22	22	22	21	21	21	21
953	Software & Computer Services	39	39	39	37	37	38	38	37	39
957	Technology Hardware & Equipment	48	49	46	46	45	45	45	46	45
Total considered for sample		862	863	864	860	861	856	868	865	866
o.w.: STOXX® Europe 600		452	454	454	451	451	447	456	454	454
o.w.: S&P 500®		410	409	410	409	410	409	412	411	412
8xx[c]	Excluded: Financials (and N/A[d])	238	237	236	240	239	244	232	235	234
Grand total		1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100

Note: Table should be read in conjunction with the table on the facing following page
[a] Industry Classification Benchmark by "Sector," which relates to the first 3 digits of the respective ICB codes and includes all respective "Subsectors," which are defined by the full 4 digit ICB taxonomy [b] The measurement date is the last trading day of the month and year specified in the column heading [c] All companies classified by ICB in the industry "Financials" (ICB code 8xx) [d] Includes companies for which no industry classification is available in the source database [e] "Total" column also includes corresponding line item of the table on previous page in the conjunction with which it should be read [f] Please refer to previous page for row labels (i.e. industries)

Observations by measurement date (contd.)[f]													
Jul-09	Jan-10	Jul-10	Jan-11	Jul-11	Jan-12	Jul-12	Jan-13	Jul-13	Jan-14	Jul-14	Jan-15	Jul-15	Total[e]
54	53	51	51	50	51	52	52	52	53	54	53	47	1,107
24	23	23	21	21	21	21	22	21	20	20	19	15	435
5	5	4	4	3	2	1	0	0	1	1	3	3	37
24	24	26	27	28	29	29	32	31	32	31	32	33	607
8	8	8	8	8	8	8	8	8	8	8	8	8	179
21	21	22	22	23	22	21	17	17	13	11	11	10	407
14	16	16	16	16	17	17	17	18	15	15	13	13	294
35	34	35	34	31	31	31	28	28	28	27	26	25	724
27	28	26	27	25	26	25	26	25	26	25	26	25	553
19	20	20	18	18	19	21	23	23	22	23	22	22	439
14	13	14	14	15	15	16	16	15	14	16	15	16	318
33	32	34	37	39	39	38	39	38	38	38	35	36	761
27	26	24	24	24	25	24	24	25	27	29	31	32	573
46	49	47	48	48	46	48	51	53	55	55	55	56	1,053
21	21	22	22	22	24	24	24	25	26	26	26	27	505
16	16	16	19	19	20	21	22	22	21	20	20	20	412
32	33	32	32	32	32	32	31	29	31	32	30	27	697
15	16	17	17	17	17	17	18	18	20	20	20	20	389
8	9	7	8	7	9	8	8	7	8	7	8	7	176
22	21	21	21	21	22	23	24	22	22	22	21	22	466
7	7	7	7	7	7	7	7	7	7	7	7	7	166
34	33	33	34	35	35	36	35	33	33	32	36	35	724
45	42	40	39	36	36	37	39	42	41	39	42	44	883
25	26	25	27	26	28	26	27	26	29	27	27	26	569
42	43	44	42	43	42	42	41	41	42	43	43	46	964
40	39	41	43	45	45	43	41	42	41	43	44	45	1,006
34	35	34	35	34	34	36	35	35	36	35	35	37	801
13	14	14	14	14	14	12	12	15	15	16	16	14	326
13	13	13	13	14	14	14	14	14	14	14	15	14	299
46	47	46	46	47	44	41	40	40	40	40	40	39	971
21	19	19	20	20	20	20	19	20	20	20	20	20	449
40	40	43	43	41	39	39	36	37	38	38	36	37	850
45	45	45	45	46	45	49	49	49	40	41	39	46	999
870	871	869	878	875	878	879	877	878	876	875	874	874	19,139
459	458	459	466	465	466	466	462	462	460	460	457	458	10,071
411	413	410	412	410	412	413	415	416	416	415	417	416	9,068
230	229	231	222	225	222	221	223	222	224	225	226	226	5,061
1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100	24,200

Note: Table should be read in conjunction with table on the facing page and footnotes apply accordingly

TABLE 3.2: Descriptive statistics of selected operating and financial metrics

		Distribution statistics[a]									Observations	
(Euros, mm)		Mean[b]	Median	SD[c]	5%	10%	25%	75%	90%	95%	n	nil
P&L and cash flow metics[d]	Net sales	14,265	5,696	28,377	934	1,328	2,518	13,567	33,845	56,273	18,182	21
	Operating lease expense	103	26	241	0	0	5	91	246	459	18,731	3,394
	EBITDA (unadj.)	2,737	1,094	5,150	231	322	542	2,594	6,171	10,650	18,422	0
	EBIT (unadj.)	1,960	778	3,768	163	229	387	1,830	4,428	7,816	17,891	0
	Net income	1,171	449	2,347	93	132	222	1,051	2,605	4,725	18,518	0
	Capital expenditure	1,214	345	14,735	38	63	136	995	2,535	4,105	17,712	3
Balance sheet metics[e]	Total assets	17,920	6,742	35,913	1,114	1,602	3,040	17,991	39,705	70,984	18,729	41
	Book value of equity	8,195	2,481	36,939	348	521	1,050	6,622	16,581	31,311	16,997	0
	Net debt or -cash (unadj.)[g]	3,349	905	12,523	-1,338	-573	43	3,272	8,731	14,223	18,729	62
	Net RBO[h]	260	21	875	0	0	0	162	584	1,152	18,731	7,269
	Minority interest	279	4	1,383	0	0	0	69	528	1,298	18,731	7,502
	Equity investments	431	0	2,094	0	0	0	83	720	2,000	18,731	10,390
Market value-related metrics[f]	Market capitalisation	16,144	6,811	29,643	1,438	1,948	3,361	15,077	37,414	65,511	18,731	0
	Enterprise value (unadj.)	21,076	8,987	38,125	1,958	2,635	4,481	20,497	48,281	86,104	18,729	0
	Enterprise value (adj.)	20,365	8,858	35,513	1,888	2,618	4,481	20,223	47,456	81,095	18,729	0

Note: Converted to Euros applying the exchange rate at the respective measurement date; nominal data, unadjusted for inflation; line items marked "(unadj.)" are prior to any of the adjustments for the purposes of consistent multiple calculations described in detail in Chapter 5; conversely, line items marked "(adj.)" reflect all of those adjustments [a] Percentage columns relate to respective quantiles [b] Arithmetic mean [c] Sample standard deviation [d] P&L and cash flow metrics recalendarized to measure the rolling next twelve months from the respective measurement date, proportionally calculated on the basis of time-weighted averages of future annual equity research forecast consensus (I/B/E/S) [e] Balance sheet data per latest available historical information from quarterly, semi-annual or annual statements published by the sample companies at or before the respective date [f] Market valuations measured on the basis of the closing prices of the respective measurement date or the last preceding trading day in the case stock markets are closed on the measurement date itself [g] Net debt balance denoted by a positive figure, net cash balance denoted by a negative figure [h] Net retirement benefit obligation

Table 3.4 (p. 83) provides an overview of selected types of pricing multiples and documents one common characteristic of multiples, namely that their values increase as valuation drivers "sitting lower" in the P&L are chosen.[306] The meaningful discrepancy between median and arithmetic mean for all pricing multiple types suggests distribution of multiples might not be symmetrical; this aspect will be further analyzed for the price/earnings multiple specifically in Subsection 6.3.3.1 (p. 205).

Multiples are a market-based valuation methodology and hence it is reasonable to expect they will vary over time similar to stock prices, which—via the pricing reference—directly impact pricing multiples. It is therefore instructive to gain a sense of how multiples vary over time, a concept also popular among practitioners in the form of "through the cycle" multiples (Rossi & Forte, 2016, pp. 67–70; Damodaran, 2012a, pp. 477–479; Löhnert & Böckmann, 2009, p. 585). "Through the cycle" multiples offer to the valuation practitioner an interesting perspective in the context of exit assumptions for finite investment horizons: Exit valuation can either rely on an estimate of the fundamental value at the anticipated point in time of exit or, at higher level, can be computed via an exit multiple. This exit multiple is typically set at the respective entry multiple; as an alternative and implicitly assuming mean reversion of multiples, exit at the averaged "through the cycle" multiple might be a reasonable approach. There is furthermore a perspective that multiple values systematically differ by industry, which is commonly linked to different industry-specific underlying growth, risk and efficiency properties.[307] It is hence interesting to report descriptive statistics of common levels of multiple valuation by industry.

Tables 3.5 (p. 84) and A.2 (p. A8) address both the aspects of "through the cycle" and industry-specific levels of pricing multiples for two common types of multiples, price/earnings and enterprise value/EBIT. They suggest that:

- *Variation of market valuations over time:* Multiples vary over time; e.g. the price/earnings multiple for the overall market ranges from 10.1x to 17.4x. In particular at the onset of the financial crisis in late 2008 and early 2009, valuations as expressed by both price/earnings and enterprise value/EBIT were depressed. Interestingly, valuation levels recovered quickly in mid 2009, which I ascribe to contraction in valuation drivers as a consequence of re-basing forecasts to lower anticipated levels

[306] This is discussed in greater detail for enterprise value/EBITDA vs. enterprise value/EBIT in Subsection 4.4.1, p. 114 (and most notably in Figure 4.4, p. 117)
[307] Compare among many Rossi and Forte (2016, pp. 52–56)

TABLE 3.3: Descriptive statistics of selected operating and financial ratios

		Distribution statistics[a]									Observations	
		Mean[b]	Median	SD[c]	5%	10%	25%	75%	90%	95%	n	nil
Profitability and efficiency	EBITDA margin[f]	24.2%	21.2%	14.9%	6.7%	9.0%	13.7%	31.3%	42.2%	53.8%	18,031	0
	EBIT margin[f]	17.5%	15.2%	13.7%	3.9%	5.5%	9.2%	23.0%	32.7%	40.2%	17,545	0
	Cash conversion[g]	65.7%	70.1%	22.2%	23.8%	35.3%	53.7%	81.4%	88.4%	91.8%	16,916	0
	Capital exp./net sales	10.2%	5.4%	17.6%	1.6%	2.2%	3.4%	10.1%	20.4%	32.8%	17,704	0
	Net sales/total assets	100.4%	81.9%	83.0%	28.5%	35.4%	53.9%	120.9%	180.1%	243.0%	18,141	21
	ROIC[m]	32.2%	15.4%	856.9%	3.7%	5.8%	9.3%	25.6%	46.1%	72.7%	16,327	0
	Tax rate[h]	27.3%	28.8%	8.4%	12.5%	12.5%	21.5%	33.6%	38.4%	40.0%	18,731	0
Historical growth performance[d]	Net sales, hist. growth	9.3%	6.2%	59.6%	-8.7%	-4.4%	1.0%	12.8%	22.6%	31.1%	18,072	0
	EBITDA, hist. growth	11.6%	7.5%	45.1%	-15.6%	-8.4%	0.5%	16.4%	31.8%	47.3%	18,120	0
	EBIT, hist. growth	15.9%	9.3%	52.6%	-22.6%	-12.0%	0.2%	20.8%	42.0%	64.6%	17,343	0
	EPS, hist. growth	19.3%	12.0%	64.2%	-31.2%	-17.6%	-0.5%	26.0%	52.0%	82.3%	16,550	0
Future growth expectations[e]	Net sales, fut. growth	7.2%	5.6%	10.9%	-1.4%	0.5%	3.2%	9.1%	14.5%	19.7%	16,253	0
	EBITDA, fut. growth	11.2%	8.5%	15.0%	-2.4%	1.0%	4.9%	13.7%	22.7%	32.1%	15,895	0
	EBIT, fut. growth	15.3%	10.6%	23.3%	-2.9%	1.4%	6.1%	17.8%	31.2%	46.6%	14,945	0
	EPS, fut. growth	18.5%	13.4%	26.0%	-5.4%	0.6%	7.7%	21.8%	38.4%	59.3%	16,207	0
	EPS fut. LT growth[i]	11.2%	10.0%	12.2%	-0.6%	2.8%	6.3%	14.6%	20.0%	25.6%	17,510	39
Capital structure	Net debt/EBITDA[f]	1.1x	0.9x	5.5x	-1.3x	-0.7x	0.1x	2.0x	3.2x	4.1x	18,422	58
	Gearing[k]	14.1%	16.0%	23.5%	-28.0%	-16.6%	1.2%	28.9%	40.2%	47.1%	18,688	22
	Levered equity beta[l]	0.99	0.98	0.33	0.50	0.59	0.76	1.20	1.40	1.53	18,580	0
	WACC[n]	9.0%	8.8%	2.5%	5.6%	6.3%	7.4%	10.2%	11.8%	13.1%	18,554	0

Note: Underlying financials recalendarized to the respective measurement dates; P&L and cash flow metrics refer to next twelve months unless denoted otherwise; balance sheet metrics refer to latest available historical balance sheet line items as of measurement date [a] Percentage columns relate to respective quantiles [b] Arithmetic mean [c] Sample standard deviation

[d] Historical growth performance measured as 2 year historical compounded annual growth rate (CAGR), up to the 12 month period ending on the measurement date

[e] Future growth expectations measured as 2 year future compounded annual growth rate (CAGR), starting from the 12 month period ending on the measurement date, unless denoted otherwise; based on I/B/E/S equity research consensus forecasts [f] Margins (i.e. respective metric as a percentage of sales) calculated prior to any adjustments of operating metrics for the purposes of consistent multiple calculations described in detail in Chapter 5 [g] Cash conversion defined as EBITDA less Capital expenditure, divided by EBITDA

[h] Effective tax rate, cut off at 40% [i] I/B/E/S metric on future long-term earnings growth (5 years) per I/B/E/S definition [j] Price earnings growth metric defines how much growth is priced into current price/earnings metric through dividing the price/earnings metric by the EPS future long term growth metric [k] Gearing defined as basic net debt dividend by total book value of assets

[l] Levered equity beta based on 3 year historical beta calculation as conducted by Reuters and readily available in the database, prior to any adjustments [m] Return on invested capital, including goodwill, see Subsection 4.3.1 for details [n] Weighted average cost of capital

TABLE 3.4: Descriptive statistics of sample pricing multiples

		Distribution statistics[a]									Obs.
		Mean[b]	Median	SD[c]	5%	10%	25%	75%	90%	95%	n
Enterprise value multiples[d]	EV/Net sales	2.2x	1.8x	1.8x	0.4x	0.6x	1.0x	2.8x	4.1x	5.5x	18,139
	EV/EBITDA	8.5x	7.8x	5.0x	4.0x	4.8x	6.1x	9.8x	12.2x	14.4x	18,359
	EV/EBIT	12.2x	11.3x	7.0x	6.0x	7.3x	9.3x	13.6x	16.7x	19.9x	17,760
	EV/(EBITDA-Capex[e])	14.2x	11.5x	11.5x	6.2x	7.3x	9.1x	15.0x	21.7x	29.8x	16,844
	EV/taxed EBIT	16.8x	15.7x	8.5x	8.4x	10.0x	12.6x	19.0x	23.1x	27.7x	17,741
	EV/(taxed EBIT+D&A[f]-Capex[e])	19.6x	15.7x	15.0x	8.3x	9.7x	12.2x	20.9x	31.3x	44.3x	15,753
Equity value multiples	Price/Earnings	16.4x	14.6x	11.2x	7.8x	9.2x	11.8x	18.1x	23.0x	28.4x	18,324
	Price/Earnings before tax	12.0x	10.6x	9.3x	5.4x	6.5x	8.4x	13.3x	17.2x	21.3x	18,332
	Price/Earnings growth[j]	1.7x	1.4x	7.2x	-0.8x	0.5x	1.0x	2.1x	3.4x	5.1x	17,400
	Price/Dividends	47.9x	36.8x	36.2x	15.2x	18.6x	25.6x	56.4x	91.3x	123.5x	15,388
Stock multiples	EV/total Assets	1.7x	1.3x	1.7x	0.5x	0.6x	0.9x	2.0x	3.1x	4.0x	18,645
	EV/Invested capital[g]	6.1x	2.8x	13.0x	1.0x	1.2x	1.7x	5.2x	12.9x	21.2x	16,709
	Price/Book value of equity	4.8x	2.9x	9.0x	0.8x	1.0x	1.7x	4.9x	8.7x	11.9x	16,967

Note: Table shows sample pricing multiples computed on the basis of measured market values and valuation drivers; valuation drivers determined on the basis of recalendarization to next twelve months per measurement date [a] Percentage columns relate to respective quantiles
[b] Arithmetic mean [c] Sample standard deviation [d] Multiples fully adjusted for consistency as specified in Chapter 5 [e] Capital expenditure abbreviated as Capex
[f] Depreciation and amortization abbreviated as D&A [g] Invested capital defined as the sum of book values of equity and net debt, compare Subsection 4.3.1 (p. 98) for a discussion around the definition of invested capital

TABLE 3.5: Median P/E multiples by measurement date and industry affiliation

ICB classification[a]		Median sector P/E multiple by measurment date[b]								
Code	Descr.	Jan-05	Jul-05	Jan-06	Jul-06	Jan-07	Jul-07	Jan-08	Jul-08	Jan-09
053	Oil & Gas Producers	13.5x	13.3x	11.4x	10.0x	10.3x	11.9x	11.9x	9.6x	9.5x
057	Oil Equipment, Services & Distr.	19.7x	22.1x	22.1x	17.1x	15.1x	16.0x	12.4x	13.4x	6.9x
058	Alternative Energy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10.2x
135	Chemicals	14.1x	13.9x	13.9x	13.7x	15.9x	18.0x	14.3x	11.1x	8.8x
173	Forestry & Paper	14.9x	16.6x	18.7x	16.0x	17.0x	15.1x	13.6x	13.3x	11.4x
175	Industrial Metals & Mining	9.0x	7.7x	14.0x	9.6x	11.3x	12.3x	9.2x	8.7x	6.9x
177	Mining	13.3x	11.3x	13.2x	9.5x	9.3x	11.3x	9.9x	9.1x	7.7x
235	Construction & Materials	14.1x	13.0x	14.3x	13.2x	14.8x	14.2x	10.9x	9.1x	7.3x
271	Aerospace & Defense	18.3x	17.1x	16.1x	14.9x	16.1x	15.7x	13.8x	11.4x	9.2x
272	General Industrials	15.6x	14.2x	14.2x	12.6x	14.5x	13.9x	12.3x	10.9x	8.3x
273	Electronic & Electrical Equipment	19.1x	17.0x	18.4x	14.4x	16.9x	16.3x	15.2x	13.1x	9.6x
275	Industrial Engineering	15.2x	16.0x	15.8x	13.8x	15.7x	15.8x	11.6x	11.3x	7.9x
277	Industrial Transportation	17.9x	16.6x	18.5x	18.5x	17.4x	17.4x	15.8x	15.2x	9.1x
279	Support Services	19.7x	16.7x	17.7x	15.4x	18.1x	17.2x	14.7x	14.2x	11.8x
335	Automobiles & Parts	11.4x	11.5x	12.5x	11.3x	13.2x	13.8x	10.0x	8.3x	8.0x
353	Beverages	16.5x	16.0x	15.9x	17.1x	17.7x	17.0x	15.2x	12.6x	9.7x
357	Food Producers	16.7x	15.4x	15.8x	16.6x	17.1x	16.7x	15.1x	14.7x	12.9x
372	Household Goods & Home Constr.	7.7x	9.0x	10.8x	9.8x	13.8x	13.4x	10.2x	9.5x	11.1x
374	Leisure Goods	15.0x	16.0x	17.3x	17.2x	18.8x	19.8x	15.6x	16.0x	12.3x
376	Personal Goods	18.4x	17.6x	17.9x	17.8x	19.6x	17.9x	15.8x	14.4x	10.0x
378	Tobacco	16.1x	14.5x	13.5x	14.4x	16.0x	14.9x	15.6x	12.9x	11.0x
453	Health Care Equipment & Services	23.2x	21.3x	21.4x	19.8x	22.1x	20.2x	18.3x	17.2x	13.3x
457	Pharmaceuticals & Biotechnology	17.2x	19.0x	18.2x	17.4x	18.1x	17.7x	15.6x	14.6x	12.0x
533	Food & Drug Retailers	15.1x	16.1x	15.8x	16.7x	17.5x	16.7x	15.0x	13.9x	11.4x
537	General Retailers	15.2x	16.3x	16.8x	14.8x	17.1x	14.9x	13.1x	12.3x	11.3x
555	Media	21.0x	16.7x	16.6x	15.0x	17.6x	16.1x	12.2x	10.5x	9.1x
575	Travel & Leisure	18.3x	17.1x	17.7x	14.6x	18.2x	18.0x	13.1x	12.0x	9.7x
653	Fixed Line Telecommunications	15.7x	14.1x	13.1x	13.0x	15.1x	14.8x	13.2x	9.8x	8.9x
657	Mobile Telecommunications	17.7x	15.4x	15.1x	14.4x	16.1x	15.2x	14.1x	11.8x	10.2x
753	Electricity	15.0x	16.1x	14.5x	14.7x	15.6x	14.9x	14.7x	13.4x	10.6x
757	Gas, Water & Multiutilities	15.9x	15.3x	14.3x	15.0x	16.1x	14.9x	15.0x	13.0x	10.2x
953	Software & Computer Services	24.8x	23.8x	20.6x	19.3x	19.4x	19.4x	16.9x	14.0x	11.0x
957	Technology Hardware & Equipment	18.7x	21.2x	19.6x	15.5x	17.9x	18.6x	14.3x	14.0x	12.6x
Median across industries		**16.6x**	**16.3x**	**16.2x**	**15.1x**	**16.4x**	**16.0x**	**13.7x**	**12.6x**	**10.1x**
o.w.: STOXX® Europe 600		15.9x	15.2x	15.7x	14.7x	16.0x	15.5x	12.5x	11.2x	9.4x
o.w.: S&P 500®		17.4x	17.5x	17.0x	15.6x	16.8x	16.5x	14.7x	13.8x	10.9x

Note: Table should be read in conjunction with the table on the facing following page. Color coding refers to relative difference between overall sample median price/earnings multiple shown at the intersection of total median column/ row (highlighted in bold): red (green) represents a discount (premium) to that multiple. Intensity of color indicates relative quantum of difference. All medians computed on the basis of individual observations (rather than related median aggregates) [a] Industry Classification Benchmark by "Sector," which relates to the first 3 digits of the respective ICB codes and includes all respective "Subsectors," which are defined by the full 4 digit ICB taxonomy [b] The measurement date is the last trading day of the month and year specified in the column heading. The valuation driver (earnings) is reclaendarized to a rolling next twelve month level [c] Sample as detailed in Table 3.1, excluding companies classified by ICB in the industry "Financials" (ICB code 8xx) [d] "Total" refers to median over time, also including corresponding line item of the table on previous page in the conjunction with which it should be read [e] Please refer to previous page for row labels (i.e. industries)

Median sector P/E multiple by measurment date[b](continued)[e]													
Jul-09	Jan-10	Jul-10	Jan-11	Jul-11	Jan-12	Jul-12	Jan-13	Jul-13	Jan-14	Jul-14	Jan-15	Jul-15	Total[d]
13.6x	13.4x	11.8x	14.4x	11.6x	9.9x	9.7x	11.6x	11.6x	11.9x	13.2x	15.6x	19.8x	**12.0x**
13.7x	16.3x	14.2x	17.5x	16.1x	12.9x	11.7x	12.2x	12.2x	11.3x	12.4x	9.1x	12.7x	**13.6x**
14.8x	14.8x	16.0x	16.7x	17.1x	8.6x	12.2x	N/A	N/A	24.4x	21.3x	14.2x	19.9x	**14.2x**
16.1x	16.3x	13.7x	14.3x	12.1x	12.3x	12.6x	13.9x	14.8x	15.4x	15.7x	17.0x	17.4x	**14.3x**
24.0x	20.1x	14.6x	12.8x	10.3x	13.1x	11.9x	12.9x	14.9x	15.7x	14.0x	15.3x	15.5x	**15.1x**
21.2x	16.1x	12.8x	13.2x	10.7x	12.5x	11.6x	14.0x	17.1x	14.6x	15.3x	12.7x	16.2x	**12.2x**
19.3x	12.2x	9.0x	9.1x	7.6x	8.5x	8.1x	11.7x	12.2x	14.9x	17.2x	13.9x	15.4x	**11.9x**
14.0x	14.4x	12.5x	14.1x	11.8x	12.8x	11.8x	13.8x	14.4x	15.2x	16.0x	17.5x	17.7x	**13.4x**
9.8x	13.0x	11.8x	13.3x	12.1x	11.6x	10.8x	12.3x	13.3x	14.9x	14.4x	15.9x	15.4x	**14.1x**
14.5x	14.5x	12.6x	13.0x	10.6x	11.1x	10.7x	13.7x	13.9x	14.6x	14.5x	15.0x	15.0x	**13.4x**
14.5x	14.9x	14.5x	15.3x	13.0x	12.8x	11.8x	15.3x	15.4x	17.7x	16.8x	17.0x	18.7x	**15.2x**
14.5x	16.7x	15.7x	15.6x	12.3x	12.9x	12.2x	14.0x	14.6x	15.7x	16.1x	15.5x	16.8x	**14.8x**
15.5x	16.0x	15.8x	15.7x	14.0x	14.4x	14.5x	15.3x	16.9x	17.4x	16.9x	17.9x	18.5x	**16.3x**
14.4x	15.0x	15.1x	15.4x	14.3x	13.8x	13.4x	15.1x	17.6x	17.0x	17.1x	16.9x	17.9x	**16.1x**
22.4x	16.1x	12.2x	11.0x	9.0x	8.0x	7.4x	8.9x	10.7x	12.4x	11.5x	12.4x	12.2x	**11.3x**
13.2x	13.5x	13.8x	12.9x	13.3x	14.3x	16.5x	16.5x	17.7x	16.8x	17.6x	19.9x	19.8x	**15.4x**
14.0x	14.1x	13.4x	13.1x	13.9x	14.2x	14.2x	15.8x	17.2x	16.2x	18.4x	19.4x	20.3x	**15.3x**
15.6x	15.6x	14.5x	14.1x	13.0x	12.8x	12.4x	13.4x	13.6x	13.9x	13.4x	15.5x	15.2x	**13.2x**
17.4x	17.7x	14.2x	15.0x	13.3x	12.8x	12.8x	12.8x	15.0x	14.9x	14.9x	15.2x	18.6x	**15.1x**
15.9x	17.8x	17.0x	16.9x	17.4x	15.5x	15.7x	17.7x	18.0x	16.8x	17.9x	19.1x	21.0x	**17.5x**
12.2x	12.0x	11.7x	11.9x	13.0x	13.2x	15.6x	14.1x	15.1x	13.8x	15.8x	18.0x	17.1x	**14.3x**
13.8x	15.9x	14.2x	16.0x	15.3x	13.9x	14.7x	15.2x	16.2x	17.7x	17.3x	19.0x	19.8x	**17.5x**
12.4x	12.6x	11.1x	11.8x	11.8x	12.1x	13.0x	15.6x	17.3x	18.7x	19.4x	18.7x	21.6x	**16.4x**
12.3x	13.1x	12.2x	13.6x	12.1x	12.1x	12.2x	12.7x	14.2x	15.7x	15.9x	16.9x	17.7x	**14.6x**
16.5x	14.1x	13.4x	13.3x	13.8x	14.3x	13.9x	14.0x	16.1x	15.3x	15.8x	17.5x	17.7x	**14.8x**
12.5x	13.6x	12.4x	12.9x	12.2x	11.2x	11.1x	12.7x	14.5x	16.0x	16.5x	16.4x	17.0x	**14.5x**
12.3x	14.2x	13.9x	13.7x	12.4x	13.6x	14.9x	16.0x	16.3x	16.3x	17.1x	16.8x	18.4x	**15.4x**
10.7x	10.5x	10.7x	10.2x	9.1x	8.5x	8.9x	10.5x	12.4x	14.1x	15.1x	16.3x	17.6x	**12.4x**
11.3x	11.9x	12.1x	13.1x	13.0x	11.9x	15.0x	13.4x	14.8x	16.7x	17.2x	17.1x	17.6x	**14.0x**
11.7x	11.8x	11.9x	13.1x	12.8x	13.1x	14.0x	14.4x	15.3x	14.2x	15.2x	17.4x	15.5x	**14.1x**
11.0x	12.2x	12.5x	13.3x	13.2x	12.3x	12.6x	14.0x	16.0x	16.0x	16.7x	18.7x	16.6x	**14.1x**
14.1x	14.3x	14.7x	16.5x	14.9x	14.8x	14.5x	17.4x	17.8x	20.1x	18.3x	18.4x	20.6x	**17.3x**
19.0x	15.8x	12.3x	14.0x	11.1x	13.7x	13.1x	15.1x	15.2x	14.9x	14.6x	14.3x	15.8x	**15.4x**
13.8x	**14.2x**	**13.3x**	**14.0x**	**12.7x**	**12.8x**	**12.7x**	**14.0x**	**15.3x**	**15.7x**	**15.9x**	**16.6x**	**17.4x**	**14.6x**
13.5x	14.4x	13.2x	13.5x	11.7x	11.9x	11.6x	13.4x	14.4x	15.2x	15.4x	16.3x	17.3x	**14.1x**
14.1x	14.2x	13.3x	14.4x	13.5x	13.6x	13.7x	14.6x	16.1x	16.1x	16.3x	17.1x	17.7x	**15.2x**

Note: Table should be read in conjunction with table on the facing previous page; footnotes apply accordingly

- *Variation of multiple valuations between industries:* Both price/earnings and enterprise value/EBIT appear to vary by industry, ranging from 11.3x to 17.5x for price/earnings if aggregated over all measurement periods. This provides prima facie support for the common approach of industry peer group formulation[308]

- *A combination of diverging and common trends between industries over time:* While not all industries follow valuation trends in a similar manner over time,[309] more profound negative shocks to the market such as in January 2009 weigh heavily on all industries

- *Discrepancy between U.S. and European valuation levels more pronounced on price/earnings:* On price/earnings, U.S. stocks appear to consistently trade at a premium to European firms of c. 1.1x.[310] This premium appears to materially reduce if enterprise value/EBIT is considered to -0.1x, which I argue can be ascribed partly to differences in the tax rate[311]

Median multiples presented in Tables 3.4, 3.5 and A.2 are directionally consistent with earlier studies such as Chullen et al. (2015, p. 650), Henschke (2009, p. 79) and Schreiner (2007, p. 97), albeit lower than other studies such as Rossi and Forte (2016, p. 52) as well as Herrmann and Richter (2003, p. 206),[312] which could be caused by different sample selection with relatively more companies from the higher-growth and "higher-valued information technology" sector (vs. Rossi and Forte, 2016) and diverging time periods (vs. Herrmann and Richter, 2003). For sake of completeness, Appendix Table A.3 (p. A10) furthermore reports Spearman and Pearson correlations of key operating and financial ratios and pricing multiple types.

The presentation of pricing multiples in addition to key financial metrics derived from the sample in this Chapter was aimed at providing the reader with a directional understanding of what numeric values those variables commonly take. It therefore contextualizes the discussion on the roots of multiples and financial inputs in corporate finance theory following in the next Chapter 4 as well as on the aggregation of pricing multiples into valuation multiples in Chapter 6.

[308] Even though evidence is not fully conclusive as other factors such as financial variables differing among industries might be the underlying drivers of this effect

[309] Compare e.g. 053 Oil & Gas Producers, 175 Industrial Metals & Mining or 335 Automobiles & Parts

[310] Premium for median over time

[311] I.e., a higher corporate tax rate of 35% on federal level in addition to state and local taxes in the US vs. tax rates in the mid to high 20% range in Europe during the measurement period

[312] Both of which find median price/earnings multiples of 20x and more

SECOND PART

THEORETICAL ASPECTS

Synopsis Against a backdrop of dogmatic skepticism around multiple valuation, its theoretical aspects will be assessed from three main perspectives: First, in Chapter 4, roots of multiples in corporate finance theory are uncovered: I argue that, via the concept of intrinsic multiples, the expected impact of fundamental valuation input variables—i.e. the drivers of DCF and DDM valuations such as growth and cost of capital—on multiples can be assessed. This sensitivity analysis, as graphically represented e.g. in Figure 4.2, is centered around Equations 4.12 and 4.34 for P/E and enterprise value/EBIT, respectively. Second, in Chapter 5, the argument for adjusting multiples from a consistency, comparability and conceptual perspective is made as well as techniques following a "gold standard" of expected maximum accuracy and—in light of a presumable cost of precision—a "reasonable approximation," respectively, are proposed and summarized in Table 5.3. A logic for identifying incremental case-by-case adjustments is presented in Figure 5.2. Lastly, in Chapter 6, theories for multiple aggregation—i.e. the process of computing a valuation multiple on the basis of peer pricing multiples—are developed: Emanating from the practitioner standard of industry peer selection, harmonic mean and median are argued to be the most appropriate central tendency aggregating functions; the practically common approach of qualitatively weighting peers based on their similarity can be emulated with weighted median concepts. Multiple valuation research is based on an established concept of "horse races" of valuation alternatives and a subsequent comparison of absolute valuation errors obtained; this methodological commonality allows for condensed and comprehensive review of prior empirical studies on multiple valuation in Figure 6.6.

Background literature Schwetzler (2003), Herrmann and Richter (2003), Kelleners (2004) and Meitner (2006) on theoretical background of multiples as well as Koller et al. (2010) on their "math of value creation;" Berndt, Deglmann, and Vollmar (2014) and Chullen et al. (2015) on empirical benefits of adjusting multiples. For backgrounds on adjustments common accounting textbooks such as Christian and Lüdenbach (2013) and Kieso et al. (2013). Studies on industry-based peer selection such as Alford (1992), Bhojraj and Lee (2002) and Herrmann and Richter (2003) and considerations around aggregating multiples such as Dittmann and Maug (2008) and negative multiples (Sommer et al., 2014; Meitner, 2006)

CHAPTER 4

Roots of multiples in corporate finance theory

"Nowadays people know the price of everything and the value of nothing."
—Lord Henry in OSCAR WILDE'S novel "The Picture of Dorian Gray"[313]

4.1 Benefits and limitations of intrinsic multiples as an investigative tool

This chapter discusses the links of common multiple types and corporate finance theory. It broadly follows the widely accepted arguments that price/earnings multiples can be connected to dividend discount model valuation analysis (DDM), various enterprise value multiples can be related to DCF valuations and stock multiples have a footing in RIV models[314] (Rossi & Forte, 2016, pp. 9–14; Koller et al., 2010, pp. 315–316; Schreiner, 2007, p. 38; Herrmann & Richter, 2003, pp. 197–201; Schwetzler, 2003, pp. 78–88; Kelleners, 2004, p. 158). In each instances, it is possible to derive intrinsic multiples, which connect input variables such as growth and efficiency to multiple valuation outcomes. This allows for an important understanding of what in theory should drive multiple valuations. As will be seen in particular

[313] Compare Chapter IV of the book. The quote epitomizes the potential divergence of value and price important in this Chapter, which considers pricing multiples an expression of price and intrinsic multiples an expression of fundamental value. As a reference from a 1890 novel, it moreover contextualizes aspects around valuation as a topic relevant to a wider public audience rather than being exclusively academic or technical in nature

[314] As will be demonstrated in Subsection 4.5 (p. 120), price/book and other stock multiples can also be derived from DCF valuation and the use of discrepancy factors

through introduction of discrepancy factors for enterprise value multiples,[315] it is possible to link a wide variety of multiples to intrinsic valuations. The role of intrinsic multiples, however, is limited to *forensics* on proposed multiple concepts—i.e. it might contribute to understanding expected sensitivities of input variables on multiples and uncover sources of valuation errors—rather than a suitable screening tool for multiple types with highest general levels of valuation accuracy.[316] For the latter, empirical analysis is necessary, which is covered in Chapter 7 (p. 239). Beyond the link between multiple- and fundamental valuation, this chapter also discusses other theoretical aspects such as conceptual shortcomings of certain types of multiples as well as consistency aspects in multiple computation and builds a theoretically reliable bridge between pricing multiples as well as valuation multiples through considerations on aggregation methods. Yet again, empirical analysis will be required to uncover the benefits on valuation outcome of the theoretical concepts advocated for.

4.2 The price/earnings multiple and its roots in DDM valuation

The price/earnings multiple arguably deserves to be discussed in greater detail as the first type of multiple for a variety of reasons: Its relatively long-standing tradition and rise to popularity with the evolution of value investing concepts in the 1930ties and 1940ties,[317] its wide popularity among valuation practitioners such as equity research analysts[318] but equally the wider public,[319] the fact that many valuation textbooks immediately jump to price/earnings multiples when discussing the concept of comparable valuation,[320] its common use in precedent financial market studies[321] and properties, which allow the price/earnings multiple to be rooted in fundamental valuation concepts, notably the DDM.

[315] See Equation 4.40 and the following discussion on generalizing discrepancy factors to link a broad set of valuation drivers to intrinsic enterprise value multiples

[316] Compare Subsection 4.7.1 (p. 124) for the 3 roles intrinsic multiples can play, however

[317] See B. Graham and Dodd (1934), B. Graham (1949)

[318] Fernández (2001, p. 2)

[319] Rosenbaum and Pearl references the price/earnings multiple as the "most broadly recognized in circles outside Wall Street" (2009, p. 11)

[320] Including among others: Spremann (2002, pp. 148–149), Ross et al. (2005, p. 125), (Brigham & Daves, 2004, p. 241)

[321] Compare e.g. the empirical study of Sanjoy Basu (1977) of the interaction of the price/earnings multiple with the CAPM

4.2.1 A connection of the P/E multiple and fundamental valuation

To understand some properties of price/earnings multiples better, I will first connect the concept to the DDM. There have been a number of similar proposals, which can be differentiated by either utilizing the principle of certainty equivalence[322] or on the principle of risk premium[323] (Hommel & Dehmel, 2011, pp. 67–70). Whilst Kelleners (2004, pp. 148–150), Schwetzler (2003, p. 79) and Herrmann and Richter (2003, p. 198) rely on the concept of certainty equivalence, others, including Leibowitz and Kogelman (1990), Schreiner (2007, pp. 32–33), Rossi and Forte (2016, p. 11), Drukarczyk and Schüler (2007) and Beaver and Morse (1978), appear to focus on risk premium. Given its practical relevance, I will show the connection between the price/earnings multiple and the DDM method on the basis of the *risk premium approach*. While there is a case to make that investors will pay taxes on dividends they receive, I will disregard this aspect for simplicity reasons.[324]

First, it appears instructive to adapt the standard cash flow discounting model,

$$V_0^{DCF} = \sum_{t=1}^{T} \frac{CF_t}{(1+r)^t} \tag{4.1}$$

to a DDM through the assumption that firm i will pay varying amounts of dividends, $DIV_{i,t}$ on an annual basis (time index t) to infinity, which are discounted at the cost of equity r_i^{eq} for firm i (Damodaran, 2012a, p. 323):

$$V_{i,0}^{DDM} = \sum_{t=1}^{\infty} \frac{DIV_{i,t}}{(1+r_i^{eq})^t} \tag{4.2}$$

[322] The concept of certainty equivalence proposes that uncertain or risky future cash flows should be adjusted so that they reflect the risk involved: this is the case when there are no arbitrage opportunities between the risky and the non-risky investments (Kelleners, 2004, pp. 68–82), or with regards to risk investments, when the risk of lower returns is in balance with the opportunity of higher returns (Moxter, 1983, pp. 146–149). It is a concept of backing out riskiness from future cash flows such that they can be compared to risk free future cash flows, rather than increasing the discount rate

[323] The principle of risk premium is commonly used as a result of relying on the CAPM developed by Sharpe (1964) and others. Therefore, it has tremendous practical relevance. However, it can also be applied on the basis of individual investor perception or appetite around risk (Drukarczyk & Schüler, 2007, p. 71). See Matschke and Brösel (2013, pp. 174–178) for a more detailed discussion on the two general concepts

[324] Furthermore, some investor types or investors in some geographies may be tax-exempt

Assuming each annual dividend $DIV_{i,t}$ can be expressed through a rate of growth $g_{i,t}^{DIV}$ relative to the prior-period dividend $DIV_{i,t-1}$, it is possible to describe $V_{DDM,i}$ as follows:[325]

$$\begin{aligned} V_{i,0}^{DDM} &= \sum_{t=1}^{\infty} \frac{DIV_{i,0} \prod_{\tau=1}^{t} (1 + g_{i,\tau}^{DIV})}{(1 + r_i^{eq})^t} \\ &= DIV_{i,0} \sum_{t=1}^{\infty} \prod_{\tau=1}^{t} \frac{(1 + g_{i,\tau}^{DIV})}{(1 + r_i^{eq})^t} \end{aligned} \tag{4.3}$$

Dividing both sides of Equation 4.3 by the next period or "forward" earnings,[326] $ERN_{i,1}$ yields:

$$\frac{V_{i,0}^{DDM}}{ERN_{i,1}} = \frac{DIV_{i,0}}{ERN_{i,1}} \sum_{t=1}^{\infty} \prod_{\tau=1}^{t} \frac{(1 + g_{i,\tau}^{DIV})}{(1 + r_i^{eq})^t} \tag{4.4}$$

As $g_{i,t}^{DIV}$ is defined as the growth rate of DIV_i between $t = 0$ and $t = 1$, it is possible to express $DIV_{i,0}$ as:

$$DIV_{i,0} = \frac{DIV_{i,1}}{(1 + g_{i,1}^{DIV})} \tag{4.5}$$

Furthermore, while $\frac{V_i^{DDM}}{ERN_{i,1}}$ is not a *pricing* multiple per the definition used in this dissertation,[327] it is the *intrinsic* form of a price/earnings multiple, hence can be replaced by $\hat{\mu}_{i,0}^{PE;FW}$ as a defining factor for a forward-looking price/earnings pricing multiple of firm i.[328] Therefore, the following Equation is obtained:

$$\hat{\mu}_{i,0}^{PE;FW} = \frac{1}{(1 + g_{i,1}^{DIV})} \frac{DIV_{i,1}}{ERN_{i,1}} \sum_{t=1}^{\infty} \prod_{\tau=1}^{t} \frac{(1 + g_{i,\tau}^{DIV})}{(1 + r_i^{eq})^t} \tag{4.6}$$

Equation 4.6 is instructive as it documents, which input variables the intrinsic price/earnings multiple $\hat{\mu}_{i,0}^{PE;FW}$ depends on:

- The firm-specific expected future growth rates of dividends $g_{i,t}^{DIV}$ for the t^{th} forecast period, to infinity

[325] Note the time index τ is utilized for notation purposes in this context only, not to be confused with the tax rate referred to as τ_i elsewhere

[326] Forward earnings is a common market practice term denoting the next period—usually twelve months—earnings utilized in price/earnings multiple calculations. Forward earnings have been shown to empirically result in lower valuation errors, see Schreiner (2007, p. 108), J. Liu et al. (2002, p. 146) and Subsection 2.3.2.2 (p. 42) for details

[327] Since $V_{i,0}^{DDM}$ is not measured, compare Subsection 2.1.2 (p. 20)

[328] As explained in Subsection 2.1.3 (p. 24), I will refer to such multiples which have been computed without the immediate input of a measured price as "intrinsic multiple" and denote those valuation multiples with a hat ("$\hat{\mu}$")

- The expected next period firm-specific dividend payout ratio $\frac{DIV_{i,1}}{ERN_{i,1}}$
- The time-independent[329] firm-specific cost of equity, r_i^{eq}

It is possible to develop Equation 4.6 further into a more parsimonious form by introducing a material restriction: assuming a constant growth rate of dividends g_i^{DIV} over time, which is delivered by a constant payout ratio over time and hence a constant earnings growth rate, g_i. For this specific case, it can be shown that[330] [331]

$$\begin{aligned} \hat{\mu}_{i,0}^{PE;FW} &= \frac{1}{(1+g_i)} \cdot \frac{DIV_{i,1}}{ERN_{i,1}} \cdot \frac{(1+g_i)}{r_i^{eq} - g_i} \\ &= \frac{DIV_{i,1}}{ERN_{i,1}} \cdot \frac{1}{r_i^{eq} - g_i} \end{aligned} \tag{4.7}$$

The theoretical consideration suggested by Equations 4.6 and 4.7, namely that price/earnings multiples depend on 3 variables,[332] has also been studied empirically with varying results.[333] In the simple model suggested by Equation 4.7, it is assumed that earnings can either be distributed through dividends (cf. $DIV_{i,1}$ in the above Equations) or retained within the firm, where $q_{i,t}$ can be defined as earnings retention rate and therefore

$$q_{i,t} + \frac{DIV_{i,1}}{ERN_{i,1}} = 1 \tag{4.8}$$

It can furthermore be shown through also considering book values of equity (Leibowitz and Kogelman, 1990, pp. 32–33; Kelleners, 2004 with further references; Schwetzler, 2003, p. 80; Damodaran, 2012a, pp. 312,471) that the growth rate g_i is determined by the return on the

[329] Under this simplistic risk premium model—a material difference to the certainty equivalence approach, see footnote 322 (p. 91) for more details on certainty equivalence
[330] Utilizing the formula for the future value of an at the same rate indefinitely growing cash flow
[331] Compare Adrian (2005a, p. 63), Equation 16, among others
[332] Namely cost of equity, growth and payout ratio
[333] Among the earliest studies, Whitbeck and Kisor (1963) seek to explain price/earnings multiples through a model considering growth, payout ratio and standard deviation of changes in earnings. Consistent with Equation 4.6, their findings suggest that growth and payout ratio each have a positive impact on price/earnings multiples. The standard deviation of changes in earnings might be interpreted as a proxy for risk as it describes volatility; therefore, unsurprisingly, it has a negative impact on the price/earnings multiple. Malkiel and Cragg (1970, pp. 610–611) consider growth, payout ratio on the basis of normalized earnings and equity beta as explanatory variables of the price/earnings multiple in a linear regression model and obtain for a 5 year period in the 1960ties annual coefficients of determination in excess of 0.70 and relatively low multicollinearity. A more recent study on 2010-2011 annual data also benefiting from larger sample sizes is presented by Damodaran (2012a, pp. 485–486). His results, however, show a relatively lower coefficient of determination (0.198), comparably high independent variable correlations and non-intuitive signs of the regression

incremental investment, r_i^{ROE}

$$g_i = q_i \cdot r_i^{ROE} \tag{4.9}$$

As pointed out by Schwetzler (2003, p. 80), the higher the return, the lower can the earnings retention rate remain—and the higher the dividend payout ratio can be; and vice versa. Regarding the dividend payout ratio it can as a consequence of Equations 4.9 and 4.8 be said that

$$\frac{DIV_{i,1}}{ERN_{i,1}} = 1 - \frac{g_i}{r_i^{ROE}} \tag{4.10}$$

It is now possible to utilize Equation 4.10 with Equation 4.7 to obtain

$$\begin{aligned} \hat{\mu}_{i,0}^{PE;FW} &= \left(1 - \frac{g_i}{r_i^{ROE}}\right)\left(\frac{1}{r_i^{eq} - g_i}\right) \\ &= \left(\frac{r_i^{ROE} - g_i}{r_i^{ROE}}\right)\left(\frac{1}{r_i^{eq} - g_i}\right) \\ &= \frac{1}{r_i^{ROE}}\left(\frac{r_i^{ROE} - g_i}{r_i^{eq} - g_i}\right) \end{aligned} \tag{4.11}$$

Through simple algebraic rearrangement, Equation 4.11 can be written as:[334]

$$\hat{\mu}_{i,0}^{PE;FW} = \frac{1 - \frac{g_i}{r_i^{ROE}}}{r_i^{eq} - g_i} \tag{4.12}$$

Equation 4.12 will be utilized as the central function to understand the impact of intrinsic variables on the price/earnings multiple.

4.2.2 Intrinsic input sensitivities on the P/E multiple

It is instructive to gain a better understanding on how the variables determining intrinsic price/earnings multiples affect multiple valuation. In oder to study the relationship between r_i^{ROE} and r_i^{eq} closer, introducing a factor h_i, which expresses r_i^{ROE} in relation to r_i^{eq} such that

$$r_i^{ROE} = h_i \cdot r_i^{eq} \tag{4.13}$$

and therefore

$$r_i^{ROE} \gtreqless r_i^{eq} \iff h_i \gtreqless 1 \tag{4.14}$$

[334] Also compare e.g. Herrmann and Richter (2003, p. 200) and Schwetzler (2003, p. 81)

allows to express Equation 4.11 as

$$\hat{\mu}_{i,0}^{PE;FW} = \frac{1}{h_i \cdot r_i^{eq}} \left(\frac{h_i \cdot r_i^{eq} - g_i}{r_i^{eq} - g_i} \right) \tag{4.15}$$

If the specific case where $h_i = 1$ i.e. $r_i^{ROE} = r_i^{eq}$ is considered, the resulting valuation multiple will be the inverse of r_i^{eq}:

$$\begin{aligned} \hat{\mu}_{i,0}^{PE;FW} &= \frac{1}{r_i^{eq}} \left(\frac{r_i^{eq} - g_i}{r_i^{eq} - g_i} \right) \\ &= \frac{1}{r_i^{eq}} \end{aligned} \tag{4.16}$$

Similarly, as is immediately obvious, from Equation 4.16, valuation multiples for companies with zero growth will be the inverse of r_i^{eq}. Equation 4.16 can also be studied regarding the sensitivity of some of its variable such as h_i and g_i on the valuation multiple $\hat{\mu}_{i,0}^{PE;FW}$: Most instructive is the first derivative of Equation 4.15 utilizing h_i as the differentiation variable:

$$\frac{\partial \hat{\mu}_{i,0}^{PE;FW}}{\partial h_i} = \frac{g_i}{r_i^{eq} \cdot \left(r_i^{eq} - g_i \right) \cdot h_i^2} \tag{4.17}$$

The following 2 reasonable restrictions will be imposed on the model[335]

- While g_i can take any value, only positive values for the cost of equity are allowed: $r_i^{eq} > 0$. Even in low or negative interest rate environments this restriction should be consistent with general market conditions since, according to e.g. the CAPM model, the cost of equity will always reflect a risk premium (Damodaran, 2012a, p. 160)
- The cost of equity must exceed the growth rate, i.e. $r_i^{eq} > g_i$, a natural restriction of Equation 4.7 (Adrian, 2005a, p. 62). Again this is not a particularly restricting aspect for longer-term period growth rates, particularly since g_i has been defined in this model as a multi-period growth rate to infinity. Damodaran (2012a, p. 326) points out that growth rates not exceeding even the (lower) risk free rate should be considered a constraint of the DDM

A closer inspection of negative and positive terms in Equation 4.17 to understand the sensitivity of h_i on the valuation multiple $\hat{\mu}_{i,0}^{PE;FW}$ then suggests the following:

[335]Those restrictions equally apply to obtain meaningful valuations with the Gordon Growth terminal value formula to obtain non-negative valuations (Damodaran, 2012a, p. 326)

- It is obvious that h_i will be positive for any meaningful values given the quadratic term
- r_i^{eq} will always be positive per above restriction
- $r_i^{eq} - g_i$ will always be positive per above restriction stating that $r_i^{eq} > g_i$
- g_i, however, can both be positive and negative, consistent with economic reality that some companies are operating industries, which are phased out[336]

In summary, as long as $h_i \neq 1$, Equation 4.17 will have:

- a positive sign—and hence Equation 4.15 will be monotonically increasing—for positive growth rates g_i
- a negative sign—and hence Equation 4.15 will be monotonically decreasing—for negative growth rates g_i

Table 4.1 on p. 96 provides an illustrative summary for different sensitivities of the difference between the return on incremental investment and the cost of equity, h_i, the growth rate g_i and the value multiple $\hat{\mu}_{i,0}^{PE;FW}$, starting from the "Base multiple" which is indicated by an asterisk ("*") for the specific case of $g_i = 0$ and/or $h_i = 0$.

TABLE 4.1: Illustrative multiple sensitivity on growth g_i and return on investment r_i^{ROE}

		Return of incremental investment sensitivity		
		$r_i^{ROE} > r_i^{eq}$ $h_i > 1$	$r_i^{ROE} = r_i^{eq}$ $h_i = 1$	$r_i^{ROE} < r_i^{eq}$ $h_i < 1$
	$g_i > 0$	$> {}^*\hat{\mu}_{i,0}^{PE;FW}$ Premium multiple	${}^*\hat{\mu}_{i,0}^{PE;FW}$	$< {}^*\hat{\mu}_{i,0}^{PE;FW}$ Discount multiple
Growth sensitivity	$g_i = 0$	${}^*\hat{\mu}_{i,0}^{PE;FW}$	${}^*\hat{\mu}_{i,0}^{PE;FW}$ Base multiple	${}^*\hat{\mu}_{i,0}^{PE;FW}$
	$g_i < 0$	$< {}^*\hat{\mu}_{i,0}^{PE;FW}$ Discount multiple	${}^*\hat{\mu}_{i,0}^{PE;FW}$	$> {}^*\hat{\mu}_{i,0}^{PE;FW}$ Premium multiple

Note: Own illustration. "Base multiple" is defined for the specific case of $g_i = 0$ and/or $h_i = 1$ and indicated by an asterisk ("*"). As demonstrated in Equations 4.16 and 4.17, for those specific cases, the value multiple will be the inverse of the cost of equity r_i^{eq} and this case can serve as a suitable basis for analyzing sensitivities to g_i and h_i. A "Premium multiple" refers to situations in which the valuation multiple and hence the valuation suggested by the multiple is higher than the "Base multiple", a "Discount multiple" to situations in which the valuation multiple and hence the valuation suggested by the multiple is lower than the "Base multiple"

The above considerations lead to the following economic interpretations:

[336] Damodaran (2012a, p. 308) presents the example of fixed-line phone producers with the advent of cellphones

- If the return on incremental investment r_i^{ROE} is the same as the cost of equity r_i^{eq}, the firm just about earns its cost of equity on the incremental investment and so such investment is value-neutral and will not affect the valuation multiple $\hat{\mu}_{i,0}^{PE;FW}$. In this case, which I refer to as "base multiple" case, the valuation multiple will be the inverse of the cost of equity. The valuation multiple is independent from longer-term growth and multiples provide a true single-period valuation model[337]

- If the return on incremental investment r_i^{ROE} is higher than the cost of equity r_i^{eq}, positive growth g_i leads to a higher valuation multiple $\hat{\mu}_{i,0}^{PE;FW}$ or "premium multiple" than in the base multiple case. This is consistent with intuition as such a firm relies on investments, which yield above-cost of equity returns

- If the return on incremental investment r_i^{ROE} is lower than the cost of equity r_i^{eq}, positive growth g_i leads to a lower valuation multiple $\hat{\mu}_{i,0}^{PE;FW}$ or "discount multiple" than in the base multiple case. This can be understood as a company engaging in value-destructive growth. A valuation multiple- and value-maximizing strategy could constitute in considering growth projects more selectively—and increase dividend payout ratio instead. The valuation multiple will be positively affected through a reduction of long-term growth to zero, which constitutes the optimal multiple valuation outcome for a company with $r_i^{ROE} < r_i^{eq}$[338]

- If the return on incremental investment r_i^{ROE} is higher than the cost of equity r_i^{eq}, negative growth g_i leads to a lower valuation multiple $\hat{\mu}_{i,0}^{PE;FW}$, which can also be referred to as "discount multiple." This suggests that shrinking companies may struggle with valuation multiples even if they have investment opportunities, which yield incremental returns in excess of their cost of equity. Such firms could consider pursuing incremental investments with an ambition to push growth into positive territory $g_i > 0$: in this instance they will be rewarded with the benefit of being a positive growth company with attractive returns on incremental investment and can be expected to trade at a premium multiple

[337] Since the valuation multiple $\hat{\mu}_{i,0}^{PE;FW}$ is defined on a forward-looking valuation driver, there is implicitly the next period growth embedded in the valuation

[338] It is, however, worth considering that valuation in $t = 0$ will depend on forward earnings according to this model. So a situation in which forward earnings are relatively higher will lead to higher absolute levels of valuation at the same valuation multiple. This effect might persist even if a valuation multiple is relatively slightly lower: lower valuation multiples do not automatically lead to lower absolute valuations, absolute earnings matter, too

- If the return on incremental investment r_i^{ROE} is lower than the cost of equity r_i^{eq}, negative growth g_i will lead to premium valuation multiples. This can be understood as a situation in which relatively less value-destructing investment at an r_i^{ROE} less than the cost of equity r_i^{eq} is taking place. Such companies can expect to trade at premium to firms which destroy value by growing with incremental investment returns of r_i^{ROE} less than their cost of equity r_i^{eq}

What counts for premium valuations expressed by high multiples is positive growth combined with returns on incremental investment, which are higher than the cost of equity: The absence of either growth or relatively higher incremental investment returns will at best lead to base multiples and might result in valuation multiple discounts in the case of negative growth or investment returns below the cost of equity. The above considerations are consistent with the discussion by Schwetzler (2003, pp. 80–81)—albeit under certainty equivalence[339]—and the relationship of r_i^{ROE} and r_i^{eq} has been described by Leibowitz and Kogelman (1990, p. 35) as the "Franchise Factor." It demonstrates a rooting of price/earnings multiples in fundamental valuation theory via the DDM.

4.3 EV/EBIT, its roots in DCF valuation and sensitivities

4.3.1 Theoretical foundations

Earnings before interest and taxes, "EBIT," has been suggested as a potentially more suitable valuation driver since it is independent of the financial leverage of the firm (Löhnert and Böckmann, 2009, p. 577).[340] Given EBIT is a valuation driver computed prior to deduction of any interest to debt capital providers and hence corresponds to claims of both equity and debt holders, it can be classified as a enterprise value multiple.[341] In a similar fashion as for the price/earnings multiple, the resulting intrinsic enterprise value/EBIT multiple, $\hat{\mu}_{i,0}^{EBIT;FW}$, can be connected to fundamental valuation concept, notably the DCF valuation.
Starting again from Equation 4.1, a DCF to firm valuation assumes that firm i will generate varying amounts of free cash flows to the firm, $FCF_{i,t}$ on an annual basis (time index t) to infinity, which are discounted at the weighted cost of capital r_i^{WACC} for firm i (Damodaran,

[339] See Footnote 322 (p. 91) for more details on certainty equivalence
[340] Also see above, Subsection 2.4.2.1 (p. 55) and Table 2.3 (p. 59)
[341] See above, Subsection 2.3.2.6, p. 49

2012a, pp. 14, 385):

$$V_{i,0}^{DCF} = \sum_{t=1}^{\infty} \frac{FCF_{i,t}}{\left(1 + r_i^{WACC}\right)^t} \tag{4.18}$$

Applying the equivalent logic behind Equations 4.2 and 4.7 and by limiting the model to a constant growth rate over time, g_i yields the following result:

$$V_{i,0}^{DCF} = FCF_{i,0} \sum_{t=1}^{\infty} \prod_{\tau=1}^{t} \frac{(1 + g_{i,\tau}^{FCF})}{\left(1 + r_i^{WACC}\right)^t} = FCF_{i,1} \cdot \frac{1}{r_i^{WACC} - g_i} \tag{4.19}$$

It is now necessary to connect the free cash flow to the firm, $FCF_{i,1}$, to EBIT. Damodaran (2012a, p. 381), among others, provides the following standard formula for the free cash flow to the firm:[342]

$$\begin{aligned} FCF_{i,1} = (1 - \tau_i) \cdot EBIT_{i,1} + \left(DPR_{i,1} + AMRT_{i,1} - CAPEX_{i,1}\right) \\ - \left(NWC_{i,1} - NWC_{i,0}\right) \end{aligned} \tag{4.20}$$

That is, the free cash flow to the firm, $FCF_{i,1}$, equals EBIT after tax assuming a tax rate τ_i applies,[343] $(1 - \tau_i) \cdot EBIT_{i,1}$, less the net investment into the firm as a consequence of

- the part of capital expenditure, $CAPEX_{i,1}$, which exceeds depreciation and amortization, $DPR_{i,1} + AMRT_{i,1}$, and
- increases in net working capital $NWC_{i,1} - NWC_{i,0}$

Koller et al. (2010, pp. 40–41) argue that the net investment equals the investment rate $\frac{g_i}{r_i^{ROIC}}$ times taxed EBIT:

$$\begin{aligned} \left(DPR_{i,1} + AMRT_{i,1} - CAPEX_{i,1}\right) - \left(NWC_{i,1} - NWC_{i,0}\right) \\ = \frac{g_i}{r_i^{ROIC}} \cdot (1 - \tau_i) \cdot EBIT_{i,1} \end{aligned} \tag{4.21}$$

[342] Note that amortization is actually not considered by Damodaran (2012a, p. 381), however it is in the comparable equation for his discussion of the EBITDA multiple (Damodaran, 2012a, p. 504)

[343] Taxed EBIT is sometimes e.g. by Koller et al. (2010, p. 40) referred to as NOPLAT or net operating profit after taxes (NOPAT); according to some definitions, NOPLAT might be adjusted for non-operating earnings whilst taxed EBIT is closer to P&L values (Damodaran, 2012a, p. 382)

Therefore, through combination of Equations 4.19, 4.20 and 4.21, $V_{i,0}^{DCF}$ can be expressed as

$$V_{i,0}^{DCF} = (1 - \tau_i) \cdot EBIT_{i,1} \cdot \frac{1 - \frac{g_i}{r_i^{ROIC}}}{r_i^{WACC} - g_i} \tag{4.22}$$

Dividing both sides of Equation 4.22 by $EBIT_{i,1}$ yields for the intrinsically derived forward enterprise value/EBIT multiple $\hat{\mu}_{i,0}^{EBIT;FW}$:

$$\hat{\mu}_{i,0}^{EBIT;FW} = \frac{V_{i,0}^{DCF}}{EBIT_{i,1}} = (1 - \tau_i) \cdot \frac{1 - \frac{g_i}{r_i^{ROIC}}}{r_i^{WACC} - g_i} \tag{4.23}$$

Equation 4.23 is consistent with Koller et al. (2010, p. 316), except that it focuses on EBIT vs. EBITA,[344] with Equation 3.24 of Schreiner (2007, p. 35), except for its nature as a forward multiple, which looks at the next period EBIT, consistent with Equation 6 of Schwetzler (2003, p. 84), except in that it does consider corporate taxes and is based on a risk premium rather than certainty equivalence approach and in line with Equation 12 of Herrmann and Richter (2003, p. 200), except that it is calculated on a pre-tax valuation driver, as a forward multiple and considers a risk premium (vs. certainty equivalence) approach.[345] [346] It suggests that an enterprise value/EBIT multiple will be affected by 4 variables:

- The growth rate g_i. With

$$\frac{\partial \hat{\mu}_{i,0}^{EBIT;FW}}{\partial g_i} = \frac{(\tau_i - 1) \cdot (r_i^{WACC} - r_i^{ROIC})}{r_i^{ROIC} \cdot \left(g_i - r_i^{WACC}\right)^2} \tag{4.24}$$

  positive for $\tau_i < 1$ (a reasonable tax rate assumption), $r_i^{ROIC} > 0$ (a reasonable assumption for return on capital invested) and firms, whose returns on capital invested r_i^{ROIC} exceed their weighted average cost of capital r_i^{WACC} results that higher growth translates into a higher multiple. For firms whose returns of capital invested fall short of their weighted average costs of capital, higher growth leads to a lower multiple

344 Koller et al. (2010) have a preference for EBITA, i.e. EBIT before amortization, which they claim is a "non-operating item" (2010, p. 317). As long as forward multiples are used an an impairment concept applies to amortization as will be the case in most instances, research analysts will most of the time not be engaged in actively forecasting amortization amounts so for forward valuation drivers both EBIT and EBITA will normally be identical. Also consider the discussion by Seppelfricke (2014, p. 160) on EBDIT vs. EBITDA as valuation drivers

345 See Footnote 322 (p. 91) for more details on certainty equivalence

346 The following restriction applies to Equation 4.23, in analogous application of the $r_i^{eq} > g_i$ restriction for the price/earnings multiple, compare Subsection 4.2.2 (p. 95): The cost of equity must exceed the growth rate, i.e. $r_i^{WACC} > g_i$

- The weighted cost of capital, r_i^{WACC}. With

$$\frac{\partial \hat{\mu}_{i,0}^{EBIT;FW}}{\partial r_i^{WACC}} = \frac{(\tau_i - 1)(r_i^{ROIC} - g_i)}{r_i^{ROIC} \cdot \left(r_i^{WACC} - g_i\right)^2} \tag{4.25}$$

  negative for $\tau_i < 1$ (a reasonable tax rate assumption), $r_i^{ROIC} > 0$ (a reasonable assumption for return on capital invested) and firms, whose return on capital invested r_i^{ROIC} exceed their growth rate g_i, higher weighted average cost of capital should result in a lower multiple

- The return on invested capital, r_i^{ROIC}. With

$$\frac{\partial \hat{\mu}_{i,0}^{EBIT;FW}}{\partial r_i^{ROIC}} = \frac{(1 - \tau_i) \cdot g_i}{\left(r_i^{WACC} - g_i\right) \cdot \left(r_i^{ROIC}\right)^2} \tag{4.26}$$

  positive for $\tau_i < 1$ (a reasonable tax rate assumption), weighted average cost of capital r_i^{WACC} exceeding the growth rate g_i (an implied assumption of the Gordon growth formula) and assuming a growing business,[347] $g_i > 0$, a higher return on invested capital r_i^{ROIC} should result in a higher multiple

- The tax rate, $\tau_i < 1$. With

$$\frac{\partial \hat{\mu}_{i,0}^{EBIT;FW}}{\partial \tau_i} = -\frac{1 - \frac{g_i}{r_i^{ROIC}}}{r_i^{WACC} - g_i} \tag{4.27}$$

  negative for weighted average cost of capital r_i^{WACC} exceeding the growth rate g_i (an implied assumption of the Gordon growth formula) and a positive growth rate g_i lower than the return on invested capital r_i^{ROIC}, a higher tax rate should result in a lower multiple.

When it comes to the tax rate specifically, the above sensitivity is simplifying, as it does not consider the potential impact of the tax rate on the weighted average cost of capital r_i^{WACC}. As it can be instructive to understand other drivers of r_i^{WACC} in the context of multiple valuation, a dissection of r_i^{WACC} is on order.

While in a world without taxes, the weighted average cost of capital is independent of financing choices, notably the amount of debt (vs. equity) financing as famously postulated by

[347] As is the case for much of the sample, compare Table 3.3 (p. 82)

Modigliani and Miller (1958, p. 268), corporate taxation is a fact of reality: the privilege of tax-deductibility of interest (vs. returns to equity holders) affects the weighted average cost of capital, favoring higher levels of leverage over more conservative debt financing policies. Assuming $r_i^{WACC;D=0}$ represents the weighted average cost of capital for a fully equity-financed firm with no debt, it can be shown[348] that the weighted average cost of capital r_i^{WACC} for a firm with some debt (D_i^{MV})[349] can be derived as

$$r_i^{WACC} = r_i^{WACC;D=0} \cdot \left(1 - \tau_i \cdot \frac{D_i^{MV}}{D_i^{MV} + E_i^{MV}}\right) \tag{4.28}$$

or, when introducing a "leverage factor" $\lambda_i = \frac{D_i^{MV}}{D_i^{MV}+E_i^{MV}}$

$$r_i^{WACC} = r_i^{WACC;D=0} \cdot \left(1 - \tau_i \cdot \lambda_i\right) \tag{4.29}$$

Combining Equations 4.23 and 4.29 results in

$$\hat{\mu}_{i,0}^{EBIT;FW} = (1 - \tau_i) \cdot \frac{1 - \frac{g_i}{r_i^{ROIC}}}{r_i^{WACC;D=0} \cdot \left(1 - \tau_i \cdot \lambda_i\right) - g_i} \tag{4.30}$$

Equation 4.30 poses two practical challenges: First, some of its derivatives are less intuitive to interpret given their complexity and second, $r_i^{WACC;D=0}$ is not straightforward to measure since it relates to a weighted average cost of capital for firms with no leverage while, in practice, many firms will have some debt. The second aspect can be overcome by estimating $r_i^{WACC;D=0}$ through the capital asset pricing model: With the standard CAPM formula stipulating[350]

$$r_i^{eq} = r_{rf} + \beta_i^{eq} \cdot r_{ERP} \tag{4.31}$$

where r_{rf} denotes the firm-independent risk-free return, r_{ERP} the firm-independent equity risk premium and β_i^{eq} the firm-dependent relative volatility factor, it is possible to utilize Hamada's Equation[351]

$$\beta_i^{eq} = \beta_i^{u} \cdot \left(1 + \frac{D_i^{MV}}{E_i^{MV}}\right) \tag{4.32}$$

[348] See e.g. Drukarczyk and Schüler (2007, pp. 133–134) among others

[349] And E_i^{MV} denoting the market value of equity

[350] Among many Damodaran (2012a, p. 183)

[351] See Hamada (1972); this implies the simplifying but common assumption that the beta of debt equals zero, see Brealey and Myers (2003, p. 535) and Damodaran (2012a, p. 195) for a more general approach including debt betas

on the unlevered beta β_i^u to obtain an unlevered cost of equity, or in other words a weighted average cost of capital:

$$r_i^{WACC;D=0} = r_{rf} + \frac{\beta_i^{eq}}{\left(1 + \frac{D_i^{MV}}{E_i^{MV}}\right)} \cdot r_{ERP} = r_{rf} + \frac{\beta_i^{eq}}{\left(1 + \frac{\lambda_i}{1-\lambda_i}\right)} \cdot r_{ERP} \tag{4.33}$$

Utilizing Equation 4.33 together with Equation 4.30 results in

$$\hat{\mu}_{i,0}^{EBIT;FW} = \frac{(1-\tau_i) \cdot \left(1 - \frac{g_i}{r_i^{ROIC}}\right)}{\left(r_{rf} + \frac{\beta_i^{eq}}{\left(1+\frac{\lambda_i}{1-\lambda_i}\right)} \cdot r_{ERP}\right) \cdot \left(1 - \tau_i \cdot \lambda_i\right) - g_i} \tag{4.34}$$

All variables in Equation 4.34 can be empirically measured or estimated for publicly traded companies; consequently, it will serve as the assessment function for enterprise value/EBIT.[352] This is more straightforward for some elements such as λ_i or τ_i, which are more or less readily available from the firms' financial statements or market data providers. For others, such as β_i^{eq}, principles have been established but practitioners use different calculation methods.[353] Possibly most contentious from a definition perspective is r_i^{ROIC}: Not only referred to with different labels,[354] one of its key components, invested capital ($IC_{i,t}$), is calculated excluding and including goodwill (Koller et al., 2010, pp. 71,143) as well as either on the asset side (2010, p. 40 and Brealey and Myers, 2003, p. 326) or the liabilities side (Damodaran, 2012a, p. 536; Rosenbaum & Pearl, 2009, p. 35).[355] Whilst the proposed calculation method of Koller et al. (2010, pp. 139–149) is conceptually most compelling, I will utilize the definition advocated for by Damodaran (2012a, p. 536) and Herrmann and Richter (2003, p. 201), i.e. to calculate invested capital through the sum of the book values of equity and net debt, since it can be operationalized more consistently for a large empirical sample. As pointed out by Brealey and Myers (2003, p. 326), any calculation method of invested capital is subject to upward biases since certain aspects, which conceptually can be considered more of an investment—such as

[352] In analogous manner to Equation 4.12 for price/earnings, compare Subsection 4.2.1 (p. 91)

[353] E.g. self-calculated "raw betas" directly on the basis of individual firm and market returns for a determined period of time, more predictive concepts such as "Barra betas" more simplistic weighting processes such as the "Bloomberg beta" (Damodaran, 2012a, p. 187) and betas which are adjusted for firm differences (Damodaran, 2012a, p. 199)

[354] E.g. Return on capital (ROC) is interchangeably used with return on invested capital (ROIC), (Damodaran, 2012a, p. 536), return on investment (Brealey & Myers, 2003, p. 326) or at times return on capital employed (ROCE)—not to be confused with other definitions titled ROCE such as the return on common equity of Penman (2013, p. 147)

[355] Koller et al. (2010) furthermore highlight the difference between ROIC of incremental, i.e. new projects, relative to ROIC of the overall firm. Similar to their simplifying assumption (Koller et al., 2010, p. 40), it is assumed that both return metrics are identical

R&D spending for in the pharmaceutical industry—are usually expensed. In addition to the above mentioned topic of goodwill stemming from acquisitions, there are other aspects such as "lease/rent vs. own" decisions, which will materially affect invested capital.[356] Fortunately, there is some more consistency on the numerator of ROIC, which is typically determined through taxed EBIT.[357]

4.3.2 Fade factors and comparable growth rate equivalents

For public companies with analyst following, some indication on growth and therefore g_i referred to in Equation 4.34 can be obtained from equity research projections of key P&L items such as earnings per share, EBIT or net sales growth. As earnings per share implicitly reflects future paydown of debt and anticipated movements in share count, EBIT growth is a preferable proxy for unlevered cash flow growth. Equation 4.34 requires use of a long-term growth rate into perpetuity, however equity research estimates—in particular consensus estimates—are usually only available for a limited number of forecast years.[358] Those limited number of years might also not be representative for longer-term growth rates in the mind of investors as they can be affected by management teams guiding equity analysts to one-time efficiency programs or even by the effects of M&A consolidation. There is furthermore empirical evidence (Koller et al., 2010, pp. 97–98) that in particular high-growth companies are subject to "growth decay," with growth rates stabilizing around the 4–5% mark eventually on average. This is consistent with Schönefelder (2007, p. 138), who finds that, in the context of fairness opinions, terminal growth rates of 3.9% on average have been used. Kaplan and Ruback (1995, p. 1083) also consider 4% as "economically most plausible," Rosenbaum and Pearl (2009, p. 132) advocate for a range of 2–4% and Penman (2013, pp. 215–216) references 4% as a long term growth rate, which he also reverse-engineers on the basis of price-to-book multiples for the S&P500®. In the context of his studies on trading multiples, Kelleners (2004, p. 237) implies long-term growth rates of between 3.7% and 6.3%. Damodaran (2012a, p. 307), among many, points out

[356] As an example, Koller et al. (2010, pp. 141, 151) adjust invested capital for capitalized operating leases in the context of DIY store chains—and consistently also add back operating lease expenses in their calculation of their taxed EBIT equivalent (NOPLAT) to ensure comparability among DIY store chains which actually own their outlets

[357] Compare any of the above sources discussing invested capital definitions

[358] In the sample utilized in this dissertation, it is possible to calculate for 97.9% of relevant firm-year observations a 2 year calendarized future EBIT growth rate (compounded annual growth rate (CAGR)) on the basis of consensus broker estimates, while the substantially lower availability of 3 year calendarized future EBIT forecasts only allows to conduct a growth rate calculation between future year 2 and future year 3 in 46.8% of relevant firm-year observations. While the data was not obtained beyond 3 calendarized years, I speculate that the drop will be even more substantial after year 3

that it is theoretically challenging to argue for terminal growth rates larger than the economy as otherwise one firm would in the very distant future constitute the whole economy. This points to another helpful data point: Long-term projections of gross domestic product (GDP) evolution. Assuming a nominal approach to forecasting growth,[359] the Fisher Equation[360] can be used to estimate nominal long term growth rates on the basis of producer price inflation π_t^{ppi} and real growth rate forecasts, g_t^{real} as:[361]

$$g_t = (1 + g_t^{real}) \cdot (1 + \pi_t^{ppi}) \tag{4.35}$$

With data obtained from commercial provider IHS for g^{real} and π^{ppi} for the 2025 to 2045 time period and averaged out on the basis of geometric mean, an annual global nominal growth rate of 5.1% results—at the upper end of the c. 4% range previously discussed. I ascribe this higher number in part to geographic discrepancies of earnings exposure in that the more mature-market companies referred to in the samples by Schönefelder (2007) as well as Kaplan and Ruback (1995) are relatively overexposed to mature markets and in part to the assertion of Damodaran (2012a, p. 307) that young (and possibly today not even founded) firms will also be reflected in global long-term growth rate forecasts, resulting in an implied lower growth rate for larger companies established today.[362]

It is furthermore necessary to determine, from when onwards the terminal growth rate should

[359] As opposed to forecasting cash flows utilizing real growth rates and a corresponding real weighted average cost of capital (Damodaran (2012a, p. 309), among many)

[360] See e.g. Meitner (2009, p. 499). The Fisher Equation was proposed to convert interest from real to nominal terms but it can be applied to growth rates in general

[361] Note this connection is not only purely mathematical. See Damodaran (2012a, p. 307) who argues that, in the long term, there is a link between the risk free rate and the growth rate of the economy

[362] For the sample used in this study and in efforts to address the first (but not the second) consideration, I calculate GDP-related long term growth rates $g_{LTG;GDP}$ as a 50% blend each of the global growth rate and the Western European growth rate for STOXX® Europe 600 constituents and the United States growth rate for S&P500® constituents, resulting in 4.1% and 4.6%, respectively. While it might be appropriate to consider those long term growth rates directly for all sample companies in particular as far as median values only are concerned it is worth acknowledging that industry differences do exist (Koller et al., 2010, pp. 90, 96). In order to account for those differences I utilize a metric offered by commercial data provider I/B/E/S called "long-term earnings growth." While this metric is available on a per-firm basis and can be aggregated to industry medians, it has 2 shortcomings: First, it applies to earnings post tax and second values tend to be substantially above the 4–5% reasonable target for long-term growth rate, with a median of 10%. I hence utilize the information merely as a re-scale factor to long term growth rate

$$g_{i,t}^{TGR} = \frac{g_{j,t}^{LTG;IND}}{\tilde{g}_t^{LTG;IND}} \cdot g_{LTG;GDP} \tag{4.36}$$

where $g_{j,t}^{LTG;IND}$ is the median of the long-term earnings growth rate of companies belonging to the j^{th} industry at measurement point in time t and $\tilde{g}_t^{LTG;IND}$ is the median of growth rates of all the j industries at measurement point time t. This results in an overall sample $\tilde{g}_{i,t}^{TGR}$ of 4.4%

apply, in other words how long growth rates differing from the terminal growth rate should be explicitly forecasted. Referencing text book suggestions of 10–15 years, Berndt, Froese, et al. (2014, p. 750) seem to find shorter time periods in Swiss fairness opinions, where only 7% of opinions utilize more than 8 years for fundamental valuation. Rosenbaum and Pearl (2009, p. 116) argue 5 years should be sufficient since it spans one business cycle, however also consider specific cases as high-growth companies or predictable-cash flow utility companies where 10 year and more forecast periods might be appropriate. According to the view advocated for here, 10 years appears to be suitable in most cases.

With a view on growth rates in the near 2–3 year future on the basis of explicit firm-related equity research consensus forecasts and an assumption on the terminal growth rate setting in after 10 years, the question arises how to best bridge between those two growth rates.[363] Further to Fuller and Hsia (1984), who propose a "h-model," which linearly drives down growth over 2 periods, a number of suggestions have been made: Damodaran (2012a, p. 341) discusses a 3-stage model, where high stable growth is followed by a linearly declining phase of growth, which eventually leads to infinite stable growth. Meitner (2009, p. 533) and Meitner (2003, p. 115) reference as well as Schwetzler (2003) explains in greater detail the concept of "fade factors," where a fade factor $ff_{i,t}$, with $0 \leq ff_{i,t} \leq 1$, and with $ff_{i,t}$ constant for all explicit forecast period years $(1 \ldots \tau \ldots T)$ is defined, which expresses the speed at which the growth decelerates: For all years of the explicit forecast period the next period growth rate $g^{\tau}_{i,t}$ can be determined on the basis of the previous year growth rate $g^{\tau-1}_{i,t}$ as

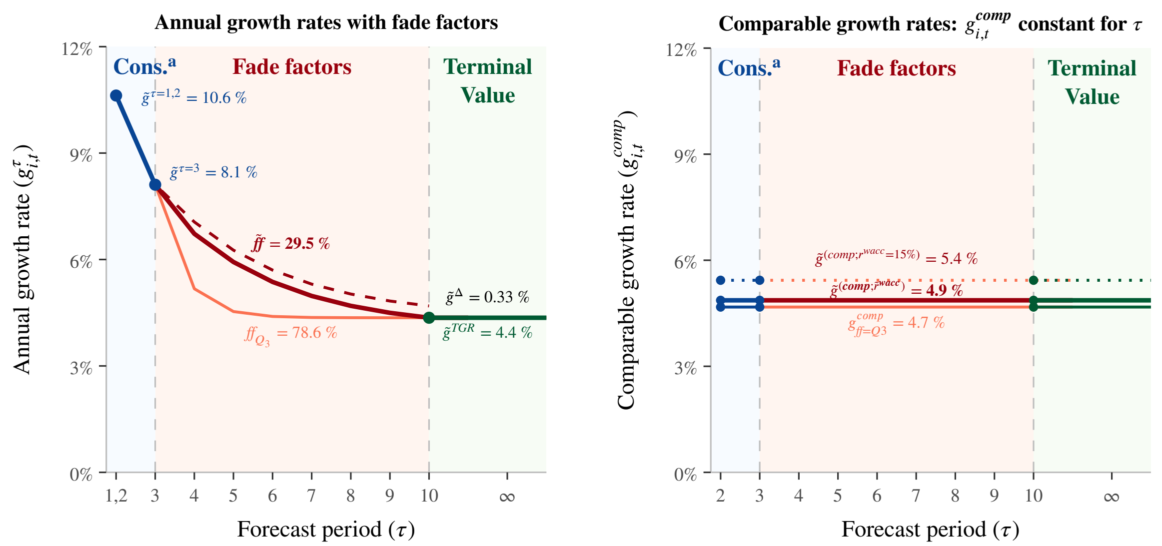
$$g^{\tau}_{i,t} = g^{\tau-1}_{i,t} \cdot (1 - ff_{i,t}) \tag{4.37}$$

Equation 4.37 is preferable over simple linear growth reductions as it tampers down growth in the outer years more gradually towards the terminal growth rate $g^{TGR}_{i,t}$, which is reasonable as a number of fundamental valuation items related to assets, capital expenditure and depreciation react sensitive to sudden growth rate changes, which is particularly critical as the terminal growth phase is entered. One drawback, however, is that fade factors require flexibility as to the forecast period, since they might only bring down higher explicit forecast growth to a target level of terminal growth beyond a 10 year time frame—or as the case may be even earlier. With valuation practitioners often having a certain explicit forecasting horizon in mind, they might be reluctant to utilize the concept. I hence propose a combination of fade factors with a several period linear model, where any remaining discrepancy between the

[363] See Lobe (2006) for a more in-depth discussion

fade factor-calculated growth rate in the last explicit forecast year and the terminal growth rate beyond that point in time is linearly apportioned in equal parts over the explicit forecast period. The left hand side chart of Figure 4.1 (p. 107) presents a visual representation on how (in most cases higher) growth forecasts based on equity research consensus estimates and be gradually transferred into (in most cases lower) terminal value growth forecasts.

FIGURE 4.1: Projecting growth using fade factors



Note: Figure based on sample distribution metrics, compare Chapter 3 for more details. Left hand chart depicts how fade factors can help bridging growth rates in a smooth manner from (relatively high) equity research consensus growth in years 1 and 2 ($g^{\tau=1,2}$) and year 3 $g^{\tau=3}$ (blue shaded area) to (relatively low) terminal growth rates (g^{TGR}; green shaded area). The higher the fade factor, the quicker the levels of terminal growth rate are achieved as depicted by the orange line illustratively based on the 3rd quartile fade factor of the sample. Fade factors estimated for each sample company on the implied fade factor between $g^{\tau=1,2}$ and $g^{\tau=3}$. Fade factors will at times lead to substantial discrepancies g^{Δ} between the last year of explicit forecast period $g^{\tau=10}$ and g^{TGR}, indicated by the dashed dark red line. A suggested way to overcome the issue is to linearly apportion g^{Δ} over the forecast period such that the solid dark red line results. Annual growth rates can subsequently be converted to comparable time-constant growth rates ($g_{i,t}^{comp}$, right hand chart; lowest line: time-constant growth rate equivalent to the ff_{Q_3} growth rate; middle line: time-constant growth rate equivalent to the $\tilde{ff}$ growth rate). This is in particular helpful if they are to be used in constant growth Equations such as Equations 4.23 and 4.34; it requires determination of a discount rate (e.g. r^{wacc}) and comparable growth rates are dependent on this discount rate: as indicated by the dotted line which illustratively assumes $r^{wacc} = 15\%$, a higher discount rate leads to a higher $g_{i,t}^{comp}$ in the case of growth rates reducing over time, as the earlier high growth rates have a higher weight in total value under higher discount rates. [a] Equity research consensus forecasts

As Equations 4.23 and 4.34 are based on the simplifying assumptions that growth rates will not vary over time, an approach has to be found to translate growth trajectories with differing annual growth rates—as is the case using a fade factor approach—into one single comparable growth rate yielding equivalent valuations. This can be achieved through an analogous formula following the approach of Schwetzler (2003, p. 80) in the context of a price/earnings multiple: With $FCF_{i,1} = FCF_{i,0} \cdot (1 + g_{i,1}^{FCF})$ follows from Equation 4.19:[364]

$$FCF_{i,0} \sum_{t=1}^{\infty} \prod_{\tau=1}^{t} \frac{(1 + g_{i,\tau})}{\left(1 + r_i^{WACC}\right)^t} = FCF_{i,0} \cdot \frac{(1 + g_{i,1})}{r_i^{WACC} - g_i} \tag{4.38}$$

or, solving for g_i, which is forecast period(τ)-independent and will for this purpose therefore be referred to as g_i^{comp}:

$$g_i^{comp} = \frac{r_i^{WACC} \cdot \sum_{t=1}^{\infty} \prod_{\tau=1}^{t} \frac{(1+g_{i,\tau})}{(1+r_i^{WACC})^t} - (1 + g_{i,1})}{\sum_{t=1}^{\infty} \prod_{\tau=1}^{t} \frac{(1+g_{i,\tau})}{(1+r_i^{WACC})^t}} \tag{4.39}$$

Equation 4.39 allows to compute a comparable growth rate constant over time, g_i^{comp}, on the basis of a known growth trajectory vector $\mathbf{g}_i = (g_{i,1}, g_{i,2} \cdots\ g_{i,\tau} \cdots\ g_{i,\infty})$ and a specified cost of capital r_i^{WACC}.[365] The right hand chart of Figure 4.1 (p. 107) references the comparable growth rates for the 2 fade factor models shown in the left hand chart in addition to a sensitivity for higher r_i^{WACC}. In the illustrative example shown in Figure 4.1, $g_{i,t}^{comp}$ is relatively close to g^{TGR} and does not vary widely for different fade factors, which poses the question if fade factors are useful after all. Since fade factors do have benefits in ensuring a steady-state projection trajectory is obtained gradually by the end of the explicit forecast period, there are benefits from a model consistency perspective, in particular if other assumptions of the model e.g. around the asset basis, capital expenditure and depreciation schedules are linked to growth rates.

To summarize, this Subsection is concerned with 2 important growth operationalization aspects of intrinsic multiples: first, to *bridge* growth rates between relatively high near-term broker forecasts and long-term macroeconomic growth rates via fade factors; and, second, to *convert* a growth rate vector obtained via such fade factors into a single equivalent figure. I

[364] In order to avoid confusion and undue complexity on time indexes between valuation points in time (generally denoted by an indexed t) and forecast years (generally denoted by an indexed τ), Equations 4.38 and 4.39 reference valuation points in time not separately. The index i for the respective sample company can be considered to represent a firm-year observation

[365] As the ambition here is to determine a comparable growth rate for a growth vector which after the explicit forecast period of T years has identical elements, it is actually sufficient to know a definite number of $T + 1$ growth rates, $\mathbf{g}_i = (g_{i,1}, g_{i,2} \cdots g_{i,\tau} \cdots g_{i,T}, g_{i,TGR})$. For computational purposes, Equation 4.39 will then comprise an explicit forecast term $\sum_{t=1}^{T} \prod_{\tau=1}^{t}$ and a terminal growth term, discounted back to the point in time of valuation. It should be noted that g_i^{comp} is solving for a comparable growth rate from $\tau = 2$ onwards only, i.e. the growth rate in the first time period under observation, $\tau = 1$, is the actual growth rate $g_{i,1}$. This feature of the terminal growth formula is actually welcome for this analysis, as the basic enterprise value/EBIT Equation is based on the next period EBIT, which is to be calculated on the basis of $g_{i,1}$ rather than g_i^{comp}

assert that the necessity of such (or any alternative) implementation may have affected the historically very slim amount of research devoted to empirical assessments of DCF valuations emulating practitioner approaches specifically; it therefore fills an important void in corporate finance research.

4.3.3 A visual representation of EV/EBIT sensitivity on input variables

4.3.3.1 The multiple as dependent variable of individual input variables

The concepts of fade factors and comparable growth equivalents still do not solve the lack of intuitive interpretation of Equation 4.34 based on its derivatives; however, this problem can be overcome by plotting the Equation for some illustrative varying values of its input variables. Illustratively utilizing median variables obtained from the sample in this dissertation[366] for all but one of the drivers of Equation 4.34 and varying that one variable under investigation for a range of values around its median value results in a number of instructive sensitivity charts shown in Figure 4.2 (p. 110).[367]

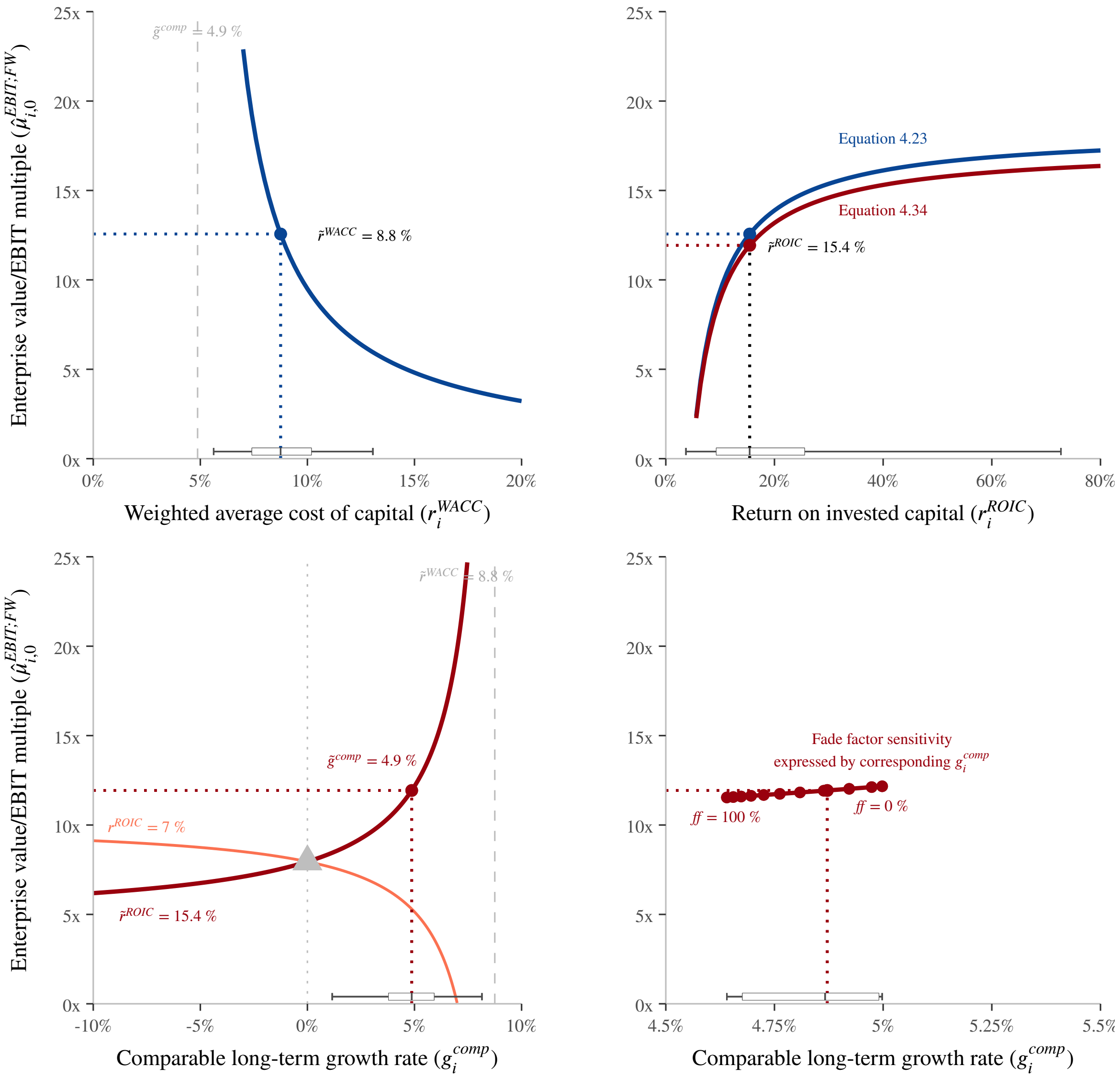
Assuming median value for all other input variables are applicable, ceteris paribus, weighted average cost of capital, equity beta, tax rate, risk free rate and growth fade factors have a negative relationship with the implied enterprise value/EBIT multiple: The higher those variables are, the lower is the resulting implied enterprise value/EBIT multiple and vice versa. Return on invested capital and financial leverage have a positive relationship with the implied enterprise value/EBIT multiple, as does growth. However, growth is somewhat ambivalent, as only translates into a higher multiple for firms whose return on invested capital exceeds weighted average cost of capital.[368] Many of the above described sensitivities are

[366]It is instructive to utilize some empirically observable variables as it allows to identify some obvious distribution statistics for the variables but also to directionally contextualize resulting implied valuations for $\hat{\mu}_{i,0}^{EBIT;FW}$; notably, $\hat{\mu}_{i,0}^{EBIT;FW}$ appears typically amount to values in the high single or low double-digit area, or broadly speaking from 5x to 20x. Utilizing sample median values for all variables determining $\hat{\mu}_{i,0}^{EBIT;FW}$ results for Equation 4.23 in 12.6x and for Equation 4.34 in 11.9x. This is not to say there are outliers but developing a broad understanding of sensible values for $\hat{\mu}_{i,0}^{EBIT;FW}$ is an important aspect of multiple valuation in order to understand computed results. The attraction of financial multiples over non-financial multiples is after all, that they should translate into value. More information on the sample utilized can be found in Chapter 3 (p. 69)

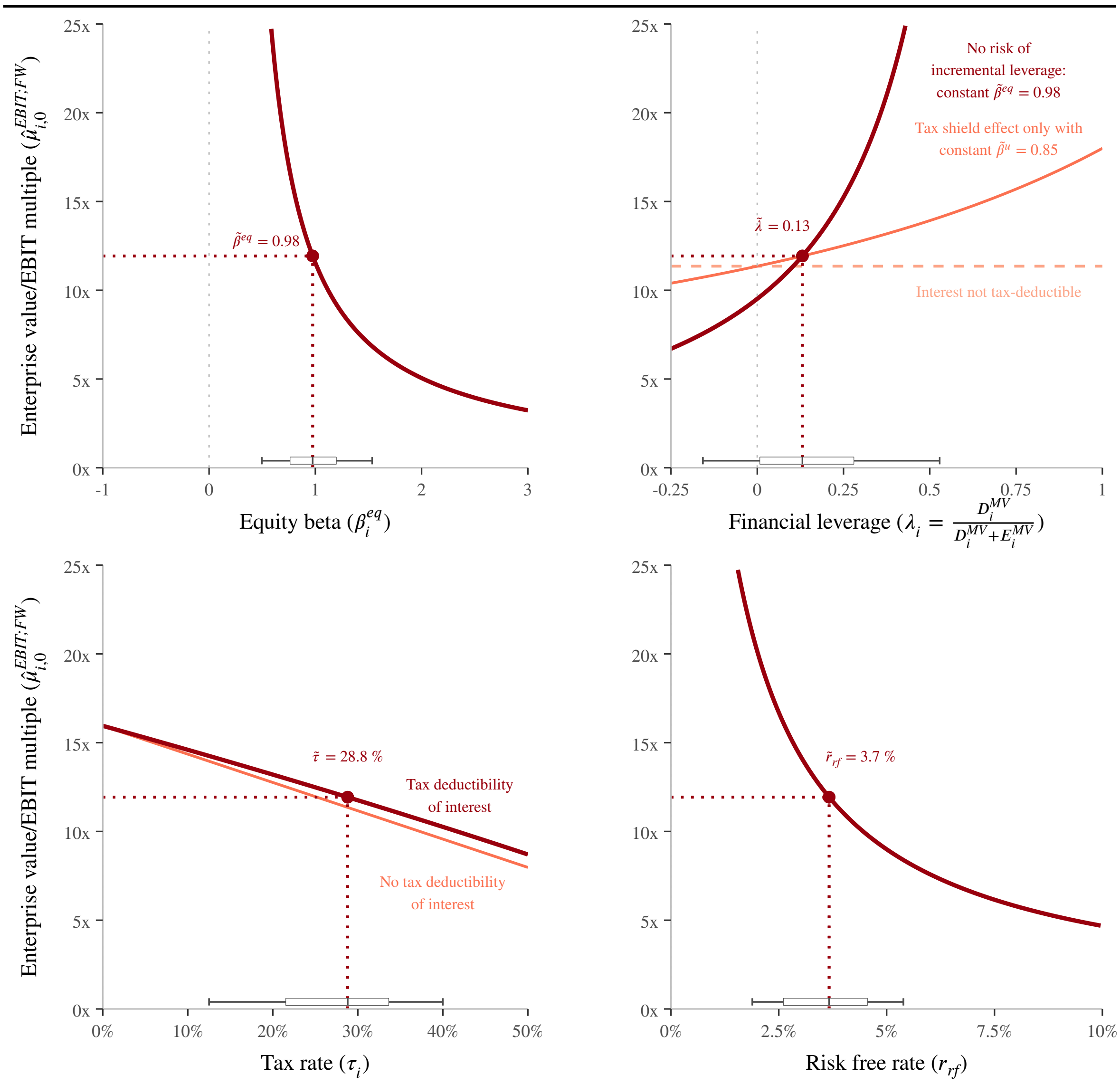
[367]To also study the weighted average cost of capital, Equation 4.23 is considered, as well, and plotted with a blue line. As indicated by the sensitivity of return on invested capital, there are some discrepancies between the results obtained from Equations 4.23 (blue line) and 4.34 (red line), which I speculatively ascribe to biases in utilizing the median values for the respective variables as well as biases driven by minor gaps in complete sample data availability for some measured metrics.

[368]The left sensitivity chart for comparable long-term growth rate visualizes the relationship by showing the

FIGURE 4.2: Sensitivity of selected input variables on Enterprise value/EBIT ($\hat{\mu}_{i,0}^{EBIT;FW}$)



Note: Charts derived using Equations 4.23 (blue lines) and 4.34 (red lines) through sensitivizing the variable indicated on the x-axis, respectively, and keeping all other variables at sample median levels. A dot connected with colored dotted lines to the axes marks the sample median value for the variable sensitized. Sample median values are: $\tilde{r}^{WACC} = 8.8\%$; $\tilde{r}^{ROIC} = 15.4\%$; $\tilde{g}^{comp} = 4.9\%$; $\tilde{ff} = 29.5\%$; $\tilde{\beta}^{eq} = 0.98$; $\tilde{\lambda} = 0.13$; $\tilde{\tau} = 28.8\%$; $\tilde{r}_{rf} = 3.7\%$; $\tilde{r}_{ERP} = 6.5\%$ (no chart shown) and $\tilde{r}_{CRP} = 0\%$ (no chart shown); boxplots show IQR (box) and 5%/95% quantiles ("whiskers") for respective sensitized variable. See Chapter 3 for details on the sample. Resulting $\hat{\mu}_{i,0}^{EBIT;FW}$ for Equation 4.23 of 12.6x and for Equation 4.34 of 11.9x, whith minor discrepancies in results for $\hat{\mu}_{i,0}^{EBIT;FW}$ speculatively attributed to bias of median value variables. (cont'd on next page)



It can be shown that the multiple in the sensitivity for r_i^{WACC} asymptotically approaches g_i^{comp} and the multiple in the sensitivity for g_i^{comp} asymptotically approaches r_i^{WACC} as indicated by grey dashed lines. $\tilde{g}^{comp}$ drives higher multiples as long as $\tilde{r}^{ROIC}$ exceeds $\tilde{r}^{WACC}$ (dark red line in the left $\tilde{g}^{comp}$ sensitivity) and vice versa (orange line). Both lines intersecting at $\tilde{g}^{comp} = 0\%$. Relatively minor impact of varying ff on $\hat{\mu}_{i,0}^{EBIT;FW}$; demonstrated for corresponding values of g_i^{comp}, varying ff in increments of 0.1 from 0 to 1. A simple variation of $\tilde{\lambda}$ disregards its interdependencey for larger changes with equity risk—higher leverage consistent with higher equity risk β^{eq} (dark red line in the $\tilde{\lambda}$ sensitivity). To eliminate the impact of leverage on β^{u}, the orange line considers a constant risk of unlevered operations, β^{u}. It demonstrates that, despite $\hat{\mu}_{i,0}^{EBIT;FW}$ being an enterprise value multiple, it does depend on financial leverage if taxes are present.

intuitive: Higher risk free interest rates or levels of risk result in higher cost of capital; higher cost of capital results in higher discount factors and hence lower valuations. Higher growth fade factors mean that growth fades quicker and hence the comparable long term growth rate is lower. A lower comparable long term growth rate leads to generally lower levels of valuation, however, considering the above described ambivalence. Higher return on capital leads to higher levels of valuation.[369] Figure 4.2 also provides an insight on variables with more material and variables with less meaningful impact on resulting implied enterprise value/EBIT, as indicated by the slopes of the presented chart lines. As those slopes will vary depending on the respective variables kept constant in the charts, caution is warranted. None the less, since sample median values have been utilized some illustrative conclusions can be drawn for firms with variable values close to sample medians. Small box plots next to the x-axes furthermore provide a broad indication on the distribution characteristics of the different variables in the sample. As any valuation practitioner can attest to, fundamental valuations are sensitive to long-term growth trajectories and the weighted average cost of capital; the charts offer confirmation. Variations of return on capital invested appear to be highly impactful on multiples at low levels, however there appears to be much lower impact on multiples at higher levels. The growth fade factors have a relatively minor impact on implied enterprise value/EBIT multiples as they do not translate into materially different comparable long-term growth rates. However, the impact of fade factors will be more material for higher-growth companies differing substantially from median growth levels, which is also where the concept has more relevance.

The limitation of varying only one variable at a time comes at the risk of disregarding mutual relationships between variables. This is in particular the case for financial leverage: Hamada's Equation[370] suggests that financial leverage will impact the equity risk. Hence, the sensitivity for financial leverage is also shown for a constant level of un-levered or firm risk, β^u, which normalizes the impact of leverage on risk given risk is studied separately in the sensitivity for Equity beta. Even then, a positive relationship between leverage and resulting enterprise value/EBIT multiple can be observed. This previously described effect (2003, p. 84, Löhnert and Böckmann, 2009, p. 576, Coenenberg and Schultze, 2002) can be attributed to a positive

positive relationship between growth and the implied enterprise value/EBIT multiple assuming return on invested capital exceeds weighted average cost of capital—as it does in the median case depicted by a dark red line with $\tilde{r}^{WACC} = 8.8\%$ and $\tilde{r}^{ROIC} = 15.4\%$; illustratively setting $r^{ROIC} = 7\%$ and keeping r^{WACC} at 8.8%, thus $r^{ROIC} < r^{WACC}$ indicates that higher growth leads to a lower multiple. This had also already been demonstrated by Equation 4.24

[369] As already demonstrated by Equation 4.26, p. 101

[370] See Equation 4.33, p. 103

impact of tax shields:[371] assuming a positive tax rate it is beneficial to maximize leverage from a firm perspective since less tax is payable. Consequently, it is intuitive that a firm with higher leverage is valued at a higher multiple. The tax rate sensitivity suggests that, at sample median levels of financial leverage, the negative impact of tax on enterprise value/EBIT multiple is substantially more material, as indicated by the relatively small difference between tax rate sensitivity with (dark red line) and without (orange line) tax deductibility of interest.

It is also fair to highlight that the above theoretical considerations on enterprise value/EBIT should by no means be considered fully conclusive: Further sophistication could e.g. be achieved by considering some of the adjustment factors to multiples discussed in Chapter 5 (p. 129) more explicitly.[372]

4.3.3.2 Iso-multiple lines: the multiple as conflated output of a multi-dimensional valuation framework

The implication of theoretical multiple dependency on a number of input variables as demonstrated in the preceding Subsection is that a specific intrinsic multiple valuation can be reached as a consequence of different input variable combinations: In other words, assuming the theoretical model proposed by Equation 4.34 holds, an enterprise value/EBIT multiple of say 12x will be a valuation outcome for an indefinite number of input variable combinations, i.e. growth trajectories, risk profiles and return on invested capital performance, among other factors. Therefore, a single multiple value may represent companies with quite a diverse set of properties. Consequently, from a valuation practitioner perspective a pricing multiple alone should not be over-interpreted as to representing a consistent financial and underlying business profile. This also limits the theoretical validity of strategies to screen markets for investment opportunities solely on the basis of “low” (“high”) multiples sometimes propagated by “value investors” (“growth investors”) as there might be a number of theoretical reasons for a specific pricing multiple, some of which such as average growth, return on capital but high risk might not be consistent with the properties actually sought, i.e. for a value investor presumably a combination of low growth at the benefit of lower risk. This important theoretical aspect has also been highlighted by Penman (2013, p. 1046) and Penman and Reggiani (2014, p. 19),

[371] The effect can be shown visually in the financial leverage sensitivity if interest tax deductibility is removed (orange dashed line)

[372] There have been some conceptual approaches to some of the proposed adjustments, e.g. the proposal of Nissim and Penman (2001, p. 117) to more explicitly deal with minority investments, however, for sake of simplicity there are benefits of not explicitly considering some of those adjustment factors, which can be addressed by utilizing adjusted input variables for intrinsic multiple calculation anyhow

who solve it through combining several multiple types, with each representing particular properties.[373] This applies to all multiple types depending on numerous input variables—i.e. all practically relevant multiple types—and is illustratively demonstrated through iso-multiple charts for the enterprise value (EV)/EBIT multiple in Figure 4.3 (p. 115).

In Figure 4.3, iso-multiple lines have been calculated on the basis of Equations 4.23[374] and 4.34[375] through sensitizing the input variables indicated on the *x*- and *y*-axes, respectively, and keeping all other input variables to Equations 4.23 and 4.34 at sample median values. The charts are instructive to demonstrate that an enterprise value/EBIT multiple of 12.6x[376]can result from a long-term growth / weighted average cost of capital combination of c. 0% and 5%, but equally from a combination of c. 7.5% growth and c. 10% weighted average cost of capital—thus firms one can argue with reasonably different growth/cost of capital profiles. Figure 4.3 hence demonstrates in an illustrative manner how multiple valuation deflates various valuation-relevant input variables into one single metric. As will be demonstrated later in this dissertation, a combination of several multiple types can pinpoint input variables to valuations in a more precise manner, with potential benefits for multiple valuation during the aggregation phase.[377]

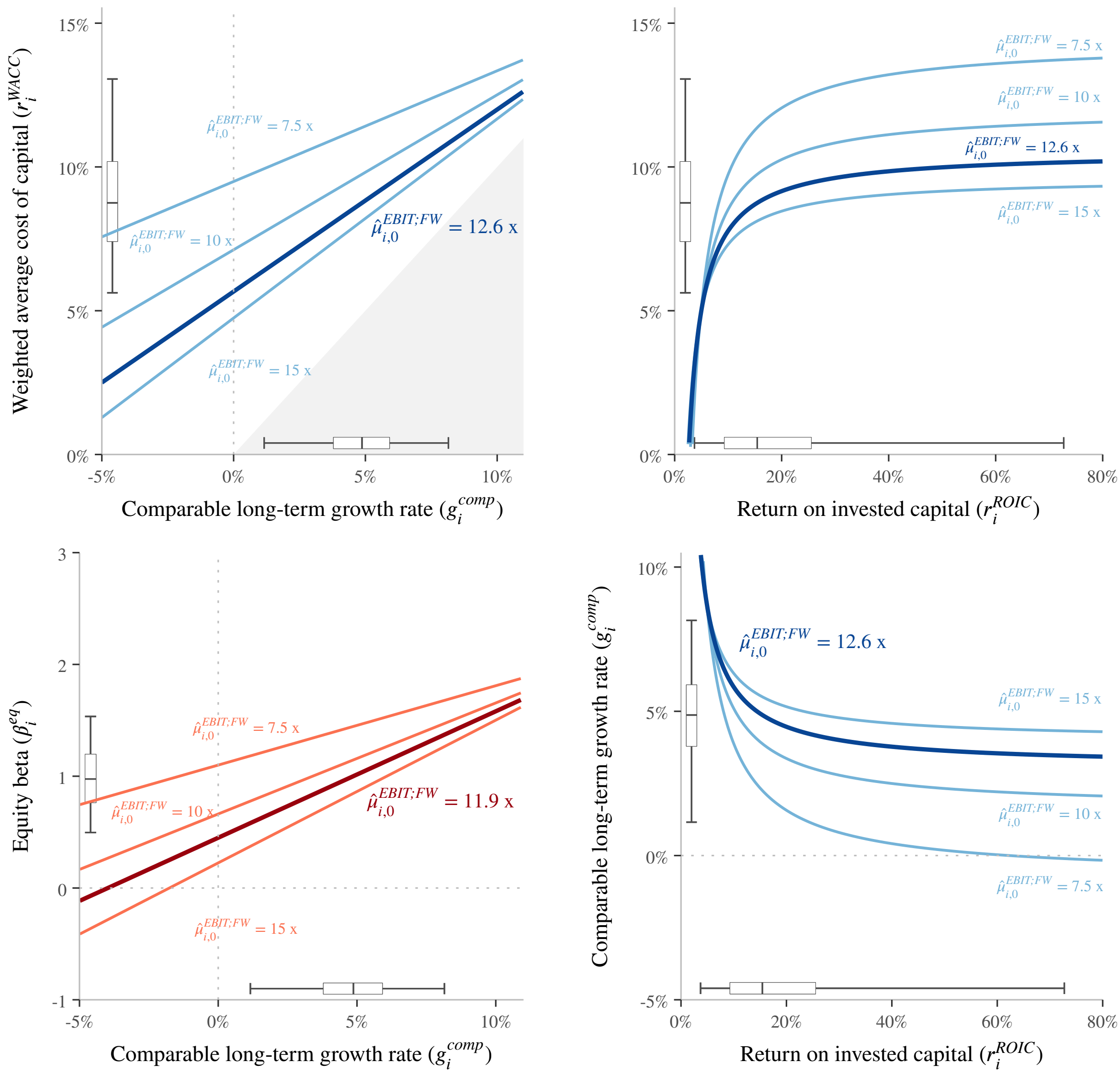
4.4 A generalization of intrinsic multiple valuation via discrepancy factors

4.4.1 Bridging to EV/EBITDA with the discrepancy factor approach

Among practitioners, enterprise value/EBITDA has emerged as a popular multiple type choice, in particular for companies with significant investment requirements in long-lifetime assets—e.g. infrastructure-related business (Damodaran, 2012a, p. 500). EBITDA refers to earnings before interest and tax as well as before deprecitation and amortization expenses (D&A). Thus, it normalizes differing D&A schedules and policies.[378] According to Seppelfricke (2014, p. 160), who also stresses the relative ease of calculation, an EBIT metric which is normalized for depreciation, is a good proxy for the operating pre-tax cash flow and further

[373] Some properties and empirical findings around combined multiples are discussed in Subsection 6.3.4 (p. 212)
[374] Blue lines
[375] Red lines
[376] i.e. the intrinsic enterprise value/EBIT multiple obtained for median input variables, compare Figure 4.2 (p. 110)
[377] Compare Subsection 6.3.4 (p. 212) for more details
[378] See above, Table 2.3 (p. 59) for a discussion on relative advantages of EBITDA over EBIT and earnings

FIGURE 4.3: Iso-EV/EBIT ($\hat{\mu}_{i,0}^{EBIT;FW}$)-lines, sensitizing for selected input pairs



Note: Charts derived using Equations 4.23—blue lines—and 4.34—red lines—through sensitizing the variables indicated on the x- and y-axes, and keeping all other variables at sample median levels. Lines represent pairs of sensitized input variables which result in equal implied FV/EBIT multiple (“iso-multiple lines”). Charts based on sample median input factors: $\tilde{r}^{WACC} = 8.8\%$; $\tilde{r}^{ROIC} = 15.4\%$; $\tilde{g}^{comp} = 4.9\%$; $\tilde{ff} = 29.5\%$; $\tilde{\beta}^{eq} = 0.98$; $\tilde{\lambda} = 0.13$; $\tilde{\tau} = 28.8\%$; $\tilde{r}_{rf} = 3.7\%$; $\tilde{r}_{ERP} = 6.5\%$ and $\tilde{r}_{CRP} = 0\%$; boxplots show IQR (box) and 5%/95% quantiles (“whiskers”) for respective sensitized variable. See 3 for details on the sample. Dark colored lines represent sample median $\hat{\mu}_{i,0}^{EBIT;FW}$ calculated using Equation 4.23 of 12.6x (blue lines) and calculated using Equation 4.34 of 11.9x (red lines), respectively, with minor discrepancies in results for $\hat{\mu}_{i,0}^{EBIT;FW}$ speculatively attributed to bias of median value variables. Grey shaded area: model not defined as $g_i^{comp} > r_i^{WACC}$, compare Footnote 346

sophistication can be achieved through normalization for amortization.[379] Critics of enterprise value/EBITDA such as Koller et al. (2010, pp. 320–321) have argued that depreciation is an

[379]The view of good cash proximity is shared by others such as Sommer and Wöhrmann (2011, p. 4)

important aspect, which is also connected to future capital expenditure to eventually replace the depreciated assets.

There are 2 main analytical approaches of connecting enterprise value to fundamental valuation, both of which are essentially based on a modified approach to the fundamental determination of enterprise value/EBIT and allow for similar conclusions:

- *Additive approach:* Damodaran (2012a, p. 504) adds to $EBIT_{i,1}$ in Equation 4.23 $DPR_{i,1}$ as well as $AMRT_{i,1}$ (which allows to replace $EBIT_{i,1}$ with $EBITDA_{i,1}$), however, this needs to be counterbalanced with an additional term of $-(DPR_{i,1} + AMRT_{i,1})$ at the same time (which results in an additive correction factor of $(1 - \tau_i) \cdot \frac{DPR_{i,1}+AMRT_{i,1}}{EBITDA_{i,1}}$ as well as a correction factor to the reinvestment term)

- *Ratio approach:* For their from a practitioners' perspective somewhat esoteric valuation driver *EBIDAAT*, an after-tax EBITDA metric, Kelleners (2004, p. 154) as well as Herrmann and Richter (2003, p. 201) utilize a "relation" of *EBIDAAT* and *EBIAT*[380] with $d_{i,t} = \frac{EBIAT_{i,t}}{EBIDAAT_{i,t}}$, also calculating a *EBIDAAT*-based $r_i^{ROIC;EBIDAAT}$, where $r_i^{ROIC;EBIDAAT} = \frac{EBIDAAT_{i,t}}{IC_{i,t}}$

I will conceptually follow the ratio approach,[381] excluding the proposed additional adjustment of r_i^{ROIC}, which does not further the understanding of enterprise value/EBITDA materially in my view. Defining a valuation driver discrepancy factor, $d_{i,t}$, as

$$d_{i,t} = \frac{EBIT_{i,t}}{EBITDA_{i,t}} \tag{4.40}$$

it is possible to re-write Equation 4.22 as

$$V_{i,0}^{DCF} = (1 - \tau_i) \cdot d_{i,1} \cdot EBITDA_{i,1} \cdot \frac{1 - \frac{g_i}{r_i^{ROIC}}}{r_i^{WACC} - g_i} \tag{4.41}$$

Dividing both sides of Equation 4.41 by $EBITDA_{i,1}$ yields for the intrinsically derived forward enterprise value/EBITDA multiple $\hat{\mu}_{i,0}^{EBITDA;FW}$:

$$\hat{\mu}_{i,0}^{EBITDA;FW} = \frac{V_{i,0}^{DCF}}{EBITDA_{i,1}} = d_{i,1} \cdot (1 - \tau_i) \cdot \frac{1 - \frac{g_i}{r_i^{ROIC}}}{r_i^{WACC} - g_i} \tag{4.42}$$

---

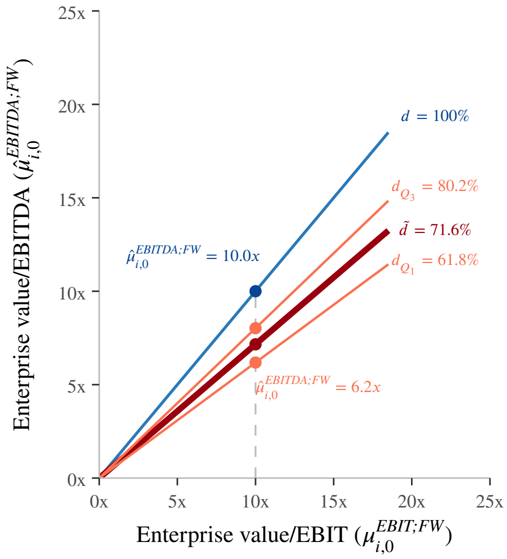
[380] An after-tax EBIT metric

[381] Since it is easier to avoid recursivity aspects of the valuation driver appearing on both sides of the equation

It is now instructive to compare $\hat{\mu}_{i,0}^{EBITDA;FW}$ to $\hat{\mu}_{i,0}^{EBIT;FW}$ for different values of $d_{i,1}$. Dividing Equation 4.42 by Equation 4.23 results in[382]

$$\hat{\mu}_{i,0}^{EBITDA;FW} = d_{i,1} \cdot \hat{\mu}_{i,0}^{EBIT;FW} \tag{4.43}$$

FIGURE 4.4: Determination of corresponding EV/EBIT and -EBITDA multiples



Sensitivity for the values of $d_{i;1}$ depending on EBIT margin[b] and depreciation as a percentage of net sales[a]

		EBIT margin[b]				
		5%	10%	15%	20%	25%
Depreciation[a]	0.0%	100%	100%	100%	100%	100%
	1.0%	83%	91%	94%	95%	96%
	2.5%	67%	80%	86%	89%	91%
	5.0%	50%	67%	75%	80%	83%
	7.5%	40%	57%	67%	73%	77%

Note: Left hand chart illustrates the corresponding enterprise value/EBITDA multiple ($\hat{\mu}_{i,0}^{EBITDA;FW}$) for combinations of enterprise value/EBIT multiples ($\mu_{i,0}^{EBIT;FW}$) and discrepancy quotients ($d_{i,1} = \frac{EBIT_{i,1}}{EBITDA_{i,1}}$). The vertical line demonstrates how one enterpise value/EBIT multiple can translate into different enterprise value/EBITDA multiples, depending on the discrepancy quotient. The sample median of $d_{i;1}$, $\tilde{d}$ equals 71.6%, i.e. a $\mu_{i,0}^{EBIT;FW}$ of 10x would correspond to a $\mu_{i,0}^{EBITDA;FW}$ of 7.2x. Assuming a non-negative value restriction for D&A, d_i will not be larger than 1 (the case of no depreciation and amortization) and $\mu_{i,0}^{EBIT;FW}$ will be larger (or equal) than $\mu_{i,0}^{EBITDA;FW}$. The relationship of $\mu_{i,0}^{EBITDA;FW}$ and $\mu_{i,0}^{EBIT;FW}$ is relatively sensitive to $d_{i;1}$: At equal multiples for $\mu_{i,0}^{EBIT;FW}$, there is a 29.7% difference in $\mu_{i,0}^{EBITDA;FW}$ (and consequently any valuation relying on this multiple) if the sample IQR for $d_{i;1}$ is considered. Right hand chart illustrates some possible values for $d_{i,1}$ on the basis of EBIT margin and depreciation as a percentage of net sales. Given the construction of $d_{i,1}$, it can also be understood as the ratio of $\mu_{i,0}^{EBITDA;FW}$ to $\mu_{i,0}^{EBIT;FW}$. [a] Depreciation and amortization expressed as a percentage of net sales; sample median 4.9% [b] EBIT margin: EBIT expressed as a percentage of net sales; sample median: 15.2%

Equation 4.43 can now be plotted to give a visual indication on the relationship between enterprise value/EBIT and enterprise value/EBITDA multiples. Figure 4.4 (p. 117) suggests that

[382] As Equation 4.21 suggests, $\frac{g_i}{r_i^{ROIC}} \cdot (1 - \tau_i) \cdot EBIT_{i,1}$ depends on $DPR_{i,1} + AMRT_{i,1}$, hence Equation 4.43 is limited to a specific sample firm in which all variables—including D&A—tie

- For positive amounts of D&A, d_i will be smaller than 1 and hence $\hat{\mu}_{i,0}^{EBITDA;FW}$ smaller than $\hat{\mu}_{i,0}^{EBIT;FW}$
- Depending on d_i, there are substantial differences between the intrinsically derived $\hat{\mu}_{i,0}^{EBITDA;FW}$ for identical $\hat{\mu}_{i,0}^{EBIT;FW}$, as indicated by the vertical dashed line in the left hand side chart. This is an important aspect in the context of multiple valuation: Only for comparable companies with identical d will the choice of multiple—enterprise value/EBITDA or enterprise value/EBIT—result in the same valuation outcome: Assuming the enterprise value/EBIT methodology is an intrinsically appropriate one—as suggested e.g. by Equation 4.23—utilization of enterprise value/EBITDA multiples will result in imprecise valuation outcomes, unless d_i is comparable between the firms used
- The enterprise value/EBITDA multiple suggests that depreciation differences and hence differences in d_i should be irrelevant for valuation purposes. While this is inconsistent with Equation 4.23 it may none the less be empirically preferable in the context of peer-based multiple valuation[383]
- d_i depends on two input variables: Depreciation[384] of the sample firm as well as its EBIT. The right hand table of Figure 4.4 expresses some results for d_i depending on illustratively selected common levels of EBIT margin as well as D&A expressed as a percentage of net sales

4.4.2 Discrepancy factors and other common enterprise value multiples

While of lesser practical relevance, Kelleners (2004, pp. 151,154) as well as Herrmann and Richter (2003, p. 200) utilize after-tax siblings of enterprise value/EBIT and enterprise value/EBITDA multiples, where *EBIAT* and *EBIDAAT* replace *EBIT* and *EBITDA*, respectively. This is consistent with a reversal of the normalization for different tax rates, acknowledging that pricing references might reflect the impact of taxation.[385] The computation of intrinsic multiples for *EBIAT* and *EBIDAAT* can be immediately derived from Equations 4.23 and 4.42 through moving the post tax term $(1 - \tau_i)$ to the other side of the equation and thus making it

[383] This of course would warrant further investigation and indeed I am exploring valuation precision of both types of multiples (and others) in Subsection 7.2 (p. 242)
[384] And as the case may be amortization
[385] See Subsection 2.4.2.1 (p. 56) for a discussion on the theoretical motivation

part of the valuation driver.[386] With $EBIDAAT_{i,t} = (1 - \tau_i) \cdot EBITDA_{i,t}$ one obtains

$$\hat{\mu}_{i,0}^{EBIDAAT;FW} = \frac{V_{i,0}^{DCF}}{(1 - \tau_i) \cdot EBITDA_{i,1}} = d_{i,1} \cdot \frac{1 - \frac{g_i}{r_i^{ROIC}}}{r_i^{WACC} - g_i} \quad (4.44)$$

The process of "moving over a term" to form part of the valuation driver is a very illustrative visual representation of the logic behind different enterprise value multiple valuation drivers: Elements moving from the left hand side of the equation to the multiple are *normalized for* as they transfer over, as is the case for $(1 - \tau_i)$ in the above example.

The concept of valuation driver discrepancy factors ($d_{i,t}$) introduced in Equation 4.40 can furthermore be generalized to other valuation drivers such as net sales or EBITDA less Capex[387] through division of $EBIT_{i,t}$ by the desired valuation driver:

$$d_{i,t}^{SALES} = \frac{EBIT_{i,t}}{SALES_{i,t}} \quad (4.45)$$

leads to

$$\hat{\mu}_{i,0}^{SALES;FW} = \frac{V_{i,0}^{DCF}}{SALES_{i,1}} = d_{i,1}^{SALES} \cdot (1 - \tau_i) \cdot \frac{1 - \frac{g_i}{r_i^{ROIC}}}{r_i^{WACC} - g_i} \quad (4.46)$$

and

$$d_{i,t}^{EBITDA\text{-}CAPEX} = \frac{EBIT_{i,t}}{EBITDA\text{-}CAPEX_{i,t}} \quad (4.47)$$

leads to

$$\hat{\mu}_{i,0}^{EBITDA\text{-}CAPEX;FW} = \frac{V_{i,0}^{DCF}}{EBITDA\text{-}CAPEX_{i,1}} = d_{i,1}^{EBITDA\text{-}CAPEX} \cdot (1 - \tau_i) \cdot \frac{1 - \frac{g_i}{r_i^{ROIC}}}{r_i^{WACC} - g_i} \quad (4.48)$$

Notably, $d_{i,1}^{SALES}$ is the EBIT margin, a common indicator of profitability. $d_{i,1}^{EBITDA\text{-}CAPEX}$ can be interpreted as a ratio which sets into reference D&A (an accounting-driven and backward-oriented metric) with capital expenditure, i.e. the current cash spending for investments. The fact that this intrinsic model suggests that enterprise value/sales multiples are sensitive to EBIT margins is of high relevance as it demonstrates the theoretical limits of enterprise value/sales: Since a trading multiple valuation implicitly assumes that the firm under investigation should

[386] Despite smaller practical relevance compared to their pre-tax equivalents, I will report results for *EBIAT* and *EBIDAAT*, labeled as "taxed EBIT" and "taxed EBITDA" in the empirical part of this dissertation

[387] A practically probably less but not totally uncommon metric which seeks to address the objection of Koller et al. (2010, pp. 320–321) that EBITDA has the shortcoming that it does not consider depreciation as a proxy for future Capex

trade at is peer company multiple,[388] obvious biases will result if enterprise value/sales multiples show variation relative to EBIT margins. So one can argue that Equation 4.46 is a strong analytical indication for the shortcomings of enterprise value/sales already theoretically discussed in Subsection 2.4.2.2 (p. 60).

The fact that pretty much all valuation drivers can be intrinsically justified utilizing the valuation driver discrepancy concept does of course not imply that all those valuation drivers would be suitable—for example as measured by their ability to result in market valuation outcomes of high precision. This is a main point of criticism regarding intrinsic multiple determinations: Just because a type of multiple can be derived intrinsically does not make it necessarily a good choice; empirical work is needed to establish its true quality. Importantly, however, intrinsic multiple concepts can potentially help systematically explaining valuation errors, in particular to the extent intrinsic input variables cause those discrepancies.

4.5 Price/book and other stock multiples

The most prominent stock multiples include the price/book multiple and the enterprise value/ total assets multiple.[389] Part of the literature, including Schreiner (2007, p. 38) and Rossi and Forte (2016, p. 12), link stock multiples to the RIV approaches going back to Ohlson (1990, 1995) and others.[390] However, as Herrmann and Richter (2003, p. 201) and Kelleners (2004, pp. 150, 153) demonstrate, an alternative is to yet again utilize valuation driver discrepancy factors ($d_{i,t}$). Defining the discrepancy factor for the book value of equity ($BE_{i,t}$), $d_{i,t}^{BE}$, as

$$d_{i,t}^{BE} = \frac{ERN_{i,t}}{BE_{i,t-1}} \tag{4.49}$$

[388] i.e. the valuation multiple as defined in Subsection 2.1.4 (p. 26)

[389] See Subsection 2.2 (p. 53) for a more comprehensive overview on stock multiples and their relationship with other multiple concepts

[390] The Ohlson (1995) and Feltham and Ohlson (1995) models and related RIV concepts have received considerable academic attention given their "landmark nature" (Lundholm, 1995, p. 749) for financial accounting research. However, in practice, RIV models play a relatively subordinated role in practice, which I assert might have to do with implementation and interpretation complexities relative to DCF approaches. Matschke and Brösel (2013, p. 821) reports for a survey study of German corporates that only c. 22% utilize in negotiations any type of residual valuation models, vs. c. 81% for DCF models (and c. 83% for trading multiples). In an empirical analysis of fairness opinions, Schönefelder (2007, pp. 53, 158) theoretically describes but does not report any results for RIV models, suggesting their use is very limited for this application, too. Therefore, insofar as possible, priority is given to explain the theoretical foundations of trading multiples through DDM and DCF approaches

Allows to express Equation 4.12 as

$$\hat{\mu}^{PB}_{i,0} = \frac{V^{DDM}_{i,0}}{BE_{i,0}} = d^{BE}_{i,1} \cdot \frac{1 - \frac{g_i}{r^{ROE}_i}}{r^{eq}_i - g_i} \tag{4.50}$$

As the return on equity can be understood as earnings divided by book value of equity,

$$r^{ROE}_i = \frac{ERN_{i,t}}{BE_{i,t}} \tag{4.51}$$

one obtains for Equation 4.50 the intrinsic price-book multiple $\hat{\mu}^{PB}_{i,0}$

$$\hat{\mu}^{PB}_{i,0} = r^{ROE}_i \cdot (1 + g_i) \cdot \frac{1 - \frac{g_i}{r^{ROE}_i}}{r^{eq}_i - g_i} = \frac{r^{ROE}_i \cdot (1 + g_i) - g_i}{r^{eq}_i - g_i} = \frac{r^{ROE;FW}_i - g_i}{r^{eq}_i - g_i} \tag{4.52}$$

where $r^{ROE;FW}_i$ expresses the forward expected return on equity. As pointed out by Schreiner (2007, p. 37), it can be instructive to understand critical values for $\hat{\mu}^{PB}_{i,0}$. The most obvious one is $\hat{\mu}^{PB}_{i,0} = 1$, referred to by Penman (2013, pp. 144–145) as the "normal" price/book multiple: $\hat{\mu}^{PB}_{i,0}$ will equal 1, if $r^{ROE;FW}_i$ equals r^{eq}_i, in other words when the forward return on equity the firm appears capable of achieving equals its cost of equity. Notably, $\hat{\mu}^{PB}_{i,0}$ is (relatively)[391] independent of longer-term growth for values of 1, but will of course depend on growth for firms, where $r^{ROE;FW}_i$ exceeds r^{eq}_i, driving up $\hat{\mu}^{PB}_{i,0}$ in those instances. More generally, Equation 4.52 provides theoretical justification for companies trading above—or below—their book value. In other words, reliance on book value of equity *itself* might not be prudent for valuation purposes.[392]

The intrinsic enterprise value/invested capital multiple[393] can be derived in an analogous manner from Equation 4.23 in combination with

$$d^{IC}_{i,t} = \frac{EBIT_{i,t}}{IC_{i,t-1}} \tag{4.53}$$

as[394]

$$\hat{\mu}^{IC}_{i,0} = \frac{V^{DCF}_{i,0}}{IC_{i,0}} = \frac{EBIT_{i,1}}{IC_{i,0}} \cdot (1 - \tau_i) \cdot \frac{1 - \frac{g_i}{r^{ROIC}_i}}{r^{WACC}_i - g_i} = \frac{r^{ROIC;FW}_i - g_i}{r^{WACC}_i - g_i} \tag{4.54}$$

[391]To be precise, the 1-period forward growth is embedded in $r^{ROE;FW}_i$

[392]While a book value *multiple* of course can carry valuation-relevance

[393]With $IC_{i,t}$ representing invested capital

[394]Since $\frac{EBIT_{i,t}}{IC_{i,t-1}} \cdot (1 - \tau_i) = r^{ROIC}_i$

A similar interpretation of $\hat{\mu}_{i,0}^{IC}$ as for $\hat{\mu}_{i,0}^{PB}$ suggests that firms whose forward return on invested capital ($r_i^{ROIC;FW}$) exceeds weighted average cost of capital (r_i^{WACC}) display enterprise value/invested capital multiples larger than 1 and vice versa. Equation 4.54 could also serve as a basis to derive other common stock multiples such as enterprise value/total assets by once again utilizing the valuation driver discrepancy factor.

4.6 PEG multiples—a useful extension to the P/E?

Certainly at a rudimentary level, practitioners have appeared to buy into the argument that anticipated growth might be a determinant of price/earnings multiple valuation,[395] on the basis of which the price-earnings growth or “PEG” multiple has experienced some popularity and frequency in use (Peemöller, 2009, p. 45), in particular in the context of high-growth companies (Damodaran, 2012a, p. 487). The price-earnings growth multiple is somewhat different to other multiples discussed in this chapter as one could argue it is a two-factor model (Meitner, 2006, p. 120), which utilizes both earnings but also (forecasted) earnings growth as input variables to the calculation of the multiple: namely, its valuation driver is the quotient of earnings and growth and the ambition of the PEG multiple is to normalize price/earnings multiples for growth to investigate if growth can explain price/earnings discrepancies (Arzac, 2008, p. 79). As highlighted by Damodaran (2012a, p. 488), there is a conceptual aspect, that in order to not double-count for growth, the PEG multiple should either be calculated on historical earnings or, alternatively, if—consistent with common price/earnings multiple calculations—forward earnings are to be used, any long-term earnings growth figure should be adjusted for the growth contribution of the forward earnings figure.[396] Following the latter approach, which is also employed by Adrian (2005b, p. 79) and offers a higher degree of

[395] An argument, which is consistent with Equations 4.12 and 4.7 and the broader discussion of Subsection 4.2.2 (p. 94)

[396] This is possible by computing a modified earnings long-term growth which strips out the first year earnings growth rate. Long-term earnings growth g_i^{LTG} provided by the commercial data provider I/B/E/S relates to a 5 year forecast period. On this basis the modified long term growth rate $g_i^{\tau=2\ldots5}$ can be obtained as: $g_i^{\tau=2\ldots5} = \left(\frac{(1+g_i^{LTG})^5}{1+g_{i,1}}\right)^{\frac{1}{4}} - 1$. This simplifying approach does not take into consideration time value of money but is possibly more straightforward to implement from a practitioners’ perspective and sufficiently precise. It is also the approach suggested by Damodaran (2012a, p. 488) and I will follow it henceforward in PEG calculations for my sample. One could furthermore argue that the comparable growth rate concept introduced for deriving intrinsic enterprise value/EBIT multiples (see Figure 4.1, p. 107) should be utilized instead (however on the basis of earnings rather than EBIT growth). While methodologically preferable, its increased level of complexity does not resonate well with the simplicity of the PEG multiple approach. As Damodaran (2012a, p. 496) points out, the above simplification might be appropriate for drawing reasonable conclusions since any potential bias of $g_i^{\tau=2\ldots5}$ will apply to all valuations

consistency with forward price/earnings multiples, the PEG multiple can be defined and its intrinsic value derived as follows:[397] [398]

$$\begin{aligned}\hat{\mu}_{i,0}^{PEG;FW} &= \frac{V_{i,0}^{DDM}}{ERN_{i,1}} \cdot \frac{1}{g_i^{\tau=2\ldots\infty} \cdot 100} \\ &= \frac{1-\frac{g_i}{r_i^{ROE}}}{r_i^{eq} - g_i} \cdot \frac{1}{g_i \cdot 100} \\ &= \frac{1}{r_i^{ROE} \cdot g_i \cdot 100} \cdot \frac{r_i^{ROE} - g_i}{r_i^{eq} - g_i}\end{aligned} \tag{4.55}$$

The major drawback of the PEG multiple is its limited theoretical backing: As discussed in Subsection 4.2.2 (p. 94), growth should only have a positive impact on price/earnings multiple if the *return on equity exceeds the cost of equity*: Higher growth leads to a higher price/earnings multiple, lower growth leads to a lower price/earnings multiple.[399] Critically, however, the price-earnings growth multiple might introduce biases if applied to firms whose return on equity does not exceed cost of equity, notably where this is the case for most other peers. Furthermore, even in the cases where all firms compared have the same relationship between their cost of equity and their returns on equity,[400] the price-earnings growth multiple stipulates a *proportional* relationship between growth and valuation, which is not consistent with the first derivative of Equation 4.15 for growth.[401] [402] Another notable aspect of the PEG multiple is the practitioners' rule of thumb proposed by Lynch (2000, p. 199), that a stock would be fairly valued if it showed a PEG multiple of 1. This is not consistent with some of the empirical data presented by Damodaran (2012a, p. 490)[403] but not too distant from the

[397] Note that since the price/earnings multiple is defined on forward earnings $ERN_{i,1}$, $g_i^{\tau=2\ldots\infty}$ equals g_i: The first year of growth will be implicitly considered by using a forward earnings metric, the subsequent growth trajectory is expressed by g_i

[398] The factor 100 is added to obtain PEG multiples of around 1–10x. Surprisingly, many definition formulas do not explicitly mention it, yet refer to values for the PEG multiple, which undoubtedly have been adjusted accordingly. See e.g. Bradshaw (2002, p. 35) for a correct definition

[399] Accepting this limitation, intuitively, a PEG multiple can therefore make sense as it reflects different levels of growth and provides justification for higher and lower multiples among peers with different growth trajectories

[400] Which proponents of the PEG multiple might argue could be a reasonable limitation of the model given usually companies within one industry are compares

[401] Without further details on whether a case can be made for proportional approximation considering typical values, $\frac{\partial \hat{\mu}_{i,0}^{PE;FW}}{\partial g_i} = \frac{d_i - 1}{d_i \cdot (g_i - r_i^{eq})^2}$ suggests a non-linear relationship between $\hat{\mu}_{i,0}^{PE;FW}$ and g_i. Damodaran (2012a, p. 495) furthermore empirically finds that the natural log of growth rates yields a more linear relationship in a regression against PEG multiples

[402] Adrian (2005b, p. 82), Schwetzler (2003, p. 81) and Meitner (2006, p. 121) provide charts, which further illustrate the interpretation challenges for PEG multiples depending on different growth trajectories and returns on equity

[403] Who finds median PEG multiples of 2x, however, for a point in time estimate in January 2011

median PEG multiple of the sample utilized in this dissertation of $\tilde{\mu}_{i,0}^{PEG;FW}$ =1.39x.[404] [405] The practical relevance of PEG multiples suggests a closer look at empirical performance might be fruitful, despite the material conceptual drawbacks described in this Subsection, given they might be moderated by similar return on/cost of capital dynamics found within one industry peer group.

4.7 Hypothesis formulation connected to intrinsic multiples

4.7.1 The 3 justifications for intrinsic multiples

In this dissertation, much room is given to considerations around multiple valuation accuracy stemming from a comparison of market prices and valuations through trading multiple approaches. The question arises, how insights from the concept of intrinsic multiples presented in this Chapter can be considered, as well.

Whilst I argue that intrinsic multiples are not fully capable to ex ante identify successful multiple types, they offer 3 important features: First, they can explain the expected *variability of multiples* for changes in input variables such as growth or return on equity as has been demonstrated in Figure 4.2 (p. 110). This suggests that multiple valuation imprecisions could be explained by differences in such factors. Second, the proposed Equations[406] allow for an *implementation of intrinsic valuation* within the concept of multiples—which in effect are intrinsic valuations normalized by the valuation driver chosen in the intrinsic multiple.[407] It is therefore obvious to compute such intrinsic valuations and compare the outcomes to those achieved for trading multiple valuations to determine the quality of the intrinsic model relative

[404]Easton (2004, pp. 78–81) provides an alternative RIV model approach, which suggests that, under certain restrictions, the price-earnings growth multiple is equal to the inverse of the square of the expected rate of return. Assuming Equation 4.55 holds though, and the restriction of $r_i^{eq} = r_i^{ROE}$ is introduced, it remains unclear why $g_i \cdot 100$ should equal $\frac{1}{r_i^{ROE}}$ for $\hat{\mu}_{i,0}^{PEG;FW} = 1$

[405]While Adrian (2005b, pp. 85–86) offers a more in-depth discussion on merits and challenges of PEG multiples, the theory of value-creating growth presented in Subsection 4.2.2 (p. 94) uncovers their conceptual shortcomings, which has led to wide criticism or at least caution by academics (Schwetzler, 2003, p. 81; Damodaran, 2012a, p. 494; Arzac, 2008, p. 79)

[406]Compare, among others, Equations 4.12 (p. 94) and 4.34 (p. 103) for price/earnings and enterprise value/EBIT, respectively

[407]The concept of intrinsic multiple valuations offers as advantage consistent cut-offs of outliers vs. trading multiple valuations and provides for some conceptual guidance regarding the relative comparison between the two general concepts, i.e. by default DCF for enterprise value multiples and DDM for equity value multiples

to trading multiples as well as relative to market prices. Third, at least *obvious theoretical challenges* with certain multiple types can be identified.[408]

4.7.2 Inconclusive prior empirical results and survey studies

In order to form a view regarding the concrete starting point for hypotheses concerning intrinsic multiples, it is possible to rely on 3 aspects: prior empirical studies on the relative valuation concept accuracy, survey-based studies on the most popular valuation types and theoretical considerations on what should be the preferable approach to valuation. Even though survey-based studies suggest multiple valuations tend to be as popular as fundamental concepts,[409] prior empirical studies on valuation accuracy are inconclusive with a slight edge of intrinsic methods over multiples:

- An early study of Boatsman and Baskin (1981) compares *CAPM-derived valuation errors* with valuation errors from price/earnings multiples. It displays outperformance or similar performance for all intervals of errors fractions (1981, p. 46)[410]
- LeClair (1990) studies the performance of price/earnings multiples relative to an *adjusted book value* approach. He finds that, multiple-based approaches outperform the proposed adjusted book value approach (1990, pp. 40–41). He admits though that results could well be biased by the undercomplexity of the proposed adjusted book value approach (1990, p. 39), which relies on illustratively imposed discount rates set on the basis of historical earnings volatility (1990, p. 36), rather than practically more common CAPM approaches[411]
- In their comprehensive trading multiple study, J. Liu et al. (2002, pp. 149–152) present a number of different common multiple types and compare their performance to intrinsic multiples, where value drivers consisting of RIV valuations. The approach appears to be different to the more obvious approach of computing RIV valuations directly

[408] As has e.g. been demonstrated for PEG multiples in Subsection 4.6 (p. 122)

[409] If not more popular with regards to price-determining investor preferences, compare Table 1.1 (p. 2); in particular in the institutional investor community (Mondello, 2017, p. 541) and among equity research analysts (Asquith et al., 2005, p. 242)

[410] Results, however, are based on a relatively narrow sample of 80 companies (even though the data relates to a 20 year period resulting in 1600 firm year observations), combined with a “collapsed” single-period CAPM approach (1981, p. 39) and thus all together not a decently suitable simulation of a DCF or DDM valuation market participants would likely conduct

[411] The results therefore remain inconclusive as to whether multiples outperform intrinsic (here: adjusted book value) valuations or if the chosen adjusted book value approach is overly simplistic and hence disadvantaged

as *RIV valuations* of peers are used to compute RIV-based multiples applied to the companies under investigation.[412] J. Liu et al. (2002, p. 154) conclude that simple earnings multiples outperform their intrinsic multiple suggestions and speculate that this might have to do with incremental noise introduced by the requirement to estimate discount rates, future abnormal earnings and terminal values. A more direct intrinsic valuation method based on RIV valuations is presented by Courteau, Kao, O'Keefe, and Richardson (2006).[413] The authors, who compare a direct RIV formulaic estimate by Penman,[414] a modified RIV model based on an industry horizon forecast for the terminal value, a 4-period price/earnings multiple and a hybrid approach giving equal weights to the multiple-based and the RIV concept, conclude that the hybrid approach results in the highest valuation accuracy with remarkably low median valuation errors of 15.9%, followed by the direct RIV model and the 4-period price/earnings multiple[415]

- Numerous *special situation-studies* have been published such as Kaplan and Ruback (1995) for leveraged buyouts or Gilson, Hotchkiss, and Ruback (2000) for bankrupt firms. They are of interest given their consideration of more practically relevant DCF concepts, however, results may not be applicable to broader trading multiple based situations given the specialist nature of situations considered. Both studies suggest fundamental valuations outperform multiple-based approaches. This contrasts Berndt, Deglmann, and Schulz (2014), who analyze consistence of fairness opinion DCF and trading multiple valuations with (unaffected) market prices and find that, while trading multiple valuations are broadly in line with market prices, DCFs appear to be upward-biased

To summarize, existing studies (a) are inconclusive on the relative performance of intrinsic vs. multiple-led approaches and, surprisingly, (b) no studies appear to exist, which rely on the practically more common DCF approaches in the context of broader, special situation-free,

[412]Furthermore, reliance of RIV—as opposed to the practically more common DCF or DDM models—limits the relevance of the results from a practitioner perspective

[413]Courteau et al. (2006) follows a directionally similar study (Courteau, Kao, & Richardson, 2001), which compares somewhat simplistic DCF valuations to RIV approaches, but does not consider multiple valuations. For another comparable study furthermore consider Francis, Olsson, and Oswald (2000), who compare nil-growth and 4% growth simplified DCF and DDM models with RIV approaches. Finally, Dittmann and Maug (2008) offer a similar comparison between RIV and DCF: Whilst they also discuss multiple aggregation methods, no comparison between the multiple and the fundamental approaches takes place, however, and valuation errors obtained are at the higher end of other studies, compare Figure 6.6 (p. 235)

[414]Compare e.g. Penman (2013)

[415]Whilst the study is based on a large sample of public companies, it compares very distinct valuation models with arguably low practical relevance, resulting in doubts regarding general applicability of results

cross-sectional market studies.[416] Lastly, textbook literature has been clear in their general preference of fundamental concepts over multiples.[417]

4.7.3 Hypotheses anticipating strong intrinsic valuation performance

With an inconclusive and incomplete picture from empirical and survey studies and acknowledging the considerable need for further research, I rely on textbook preferences for intrinsic valuations regarding the first hypothesis on intrinsic multiple valuation:

Hypothesis 3a *Intrinsic valuation approaches can be expected to outperform multiple-based approaches*

It is worth noting that the proposed intrinsic multiple concept suggested in this Chapter relies on certain simplifications and restricting assumptions, which may disadvantage intrinsic approaches specifically.[418] Hence, conclusions regarding Hypothesis 3a will need to be drawn in a measured manner.

The Law of One Price[419] stipulates that similar companies should trade at similar levels of valuation, as expressed by similar numeric values of their respective multiples; no concrete statement is made regarding companies whose characteristics differ. Previously in this Chapter 4, however, the framework of intrinsic multiples has been suggested, which links financial input variables to the outcomes of multiple valuations: it suggests that companies featuring differing input variables can be expected to trade at different multiples. For the approach of valuation multiples this means that imprecisions *must* be there insofar as peers feature different financial characteristics and those imprecisions can be explained by the impact of those financial characteristics on valuation.

Hypothesis 3b *Imprecision in valuation multiple computations can in part be explained by differing financial characteristics of peer companies considered*

416 There is an argument that, depending on the type of implementation, the RIV model is a close derivative of the DDM model (Dechow, Hutton, & Sloan, 1999, p. 4), so the DDM at least is “covered” by some of the above studies. It is none the less surprising that the additional constraints of the RIV model (such as clean surplus accounting) are widely accepted in the academic community over the more intuitive and practically relevant DDM model, in particular since dividend forecasts are available from equity research consensus for most public companies and therefore can be expected to play an important role in practitioner approaches

417 Compare among many Koller et al. (2010, p. 313) and Arzac (2008, p. 66)

418 This is no different to prior studies quoted in the preceding Subsection. If anything, I argue that the proposed intrinsic concept should be much closer to market practice than the much less common RIV approach

419 See above, Subsection 2.1.5.1, p. 27

With the concept of intrinsic multiples being closely connected to market efficiency and the concept of valuation multiples being an ally of the Law of One Price as suggested in Figures 2.1 (p. 36) and 2.2 (p. 39), Hypothesis 3b can be understood to relate market efficiency and the Law of One Price with each other: any empirical evidence in its support could be interpreted as a joint assessment of high valuation accuracy of valuation multiple approaches for similar firms (stipulated by the Law of One Price) and suitable means of explaining imprecisions on the basis of differing characteristics, which are (correctly) reflected by market participants (market efficiency).[420]

Whilst Hypothesis 3b argues that imprecisions of multiple valuation approaches can be *explained* by differing financial characteristics, the obvious next question is how such explanations could be utilized to further improve standard multiple valuation concepts. A number of concepts have been suggested, including by Henschke (2009, pp. 75–77), who computes a "peer score," which selects the 10 most alike industry peers or alternatively computes modified multiples or by Herrmann and Richter (2003, pp. 208–212) with their "performance-controlled multiple" approach, which requires the financial characteristics impacting valuation identified by the authors to be within a predetermined threshold for a firm to be considered a peer. The evidence presented suggests that there indeed can be benefits for valuation accuracy of such approaches. This leads to a further hypothesis:

Hypothesis 3c *Considering differing financial characteristics of peers allows for improved multiple valuations*

To assess Hypothesis 3c, I propose a parsimonious approach I argue is consistent with how practitioners might implicitly reflect peer financial characteristics in multiple valuations by means of judgment: Through weighting industry peers financially very similar to the company under investigation higher than financially more remote peers. This approach is novel in that it does not impose a hard cut-off for dissimilarity but reflects even remote peers in a more gradual manner.[421]

[420] Hypothesis 3b will be empirically tested in Subsection 7.7 (p. 304) through a regression of financial characteristic differences as independent variables on multiple valuation errors as dependent variable

[421] It is described in greater detail in Subsections 6.3.2.3 (p. 204) and results are presented in Subsection 7.8 (p. 310)

CHAPTER 5

Motives for adjusting multiples

"It's simply to say that managers and investors alike must understand that accounting numbers is the beginning, not the end, of business valuation."

—Warren Buffett[422]

5.1 A typology framework and some general aspects of multiple adjustments

5.1.1 The "3 C's" of multiple adjustments

The idea for adjusting multiples is born out of an objective to *maximize multiple valuation accuracy* and justified by theoretical deliberations on meaningfully reflecting peer *firm-specific economic particularities* in multiple valuation. It is an element of step 4—computing individual peer pricing multiples—of the process of multiple valuation as outlined in Table 1.2 (p. 10). In contrast to the concept of intrinsic multiples discussed above,[423] which is investigative in nature and offers ex post insight regarding reasons for a lack of multiple valuation accuracy—i.e. valuation errors—and roots multiples in corporate finance theory more generally, adjustments

[422]Compare Buffett (1983); Warren Buffett, a U.S. investor renown for following value investing strategies. This Chapter is concerned with the benefits of adjusting multiples. Most of the adjustment amounts are to be obtained from financial statements, either immediately or downloaded via common financial databases. In any event as will be shown at least a basic understanding of financial statement analysis is helpful in the context of this exercise

[423]See above, Subsection 4.1 (p. 89) as well as Subsection 4.2 (p. 90)

provide the valuation practitioner with concrete suggests on how to improve precision. Similar to intrinsic multiple considerations, such adjustments should, however, also stand the test of empirical examination to better understand their real benefits in actual valuation situations: some authors (M. Kim & Ritter, 1999, p. 423; Hand, 1990) have discussed the Functional Fixation Hypothesis, according to which investors might simply price reported (e.g. earnings-per-share) figures and be agnostic as to any adjustments with potential economic relevance—in which event such adjustments might be detrimental to valuation precision.[424] The following section can be seen as a theoretical foundation, which informs the empirical study in later chapters of the dissertation.[425]

A couple of potential sources of shortcomings can arise when it comes to multiple computation and it is instructive to first present a summarizing overview, also given a lack of meaningful multiple adjustment taxonomy in prior literature. Focus will be on enterprise value multiples, however, where necessary, reference to equity value multiples will be made.[426] This will be followed by a more detailed discussion of each adjustment aspect, building a catalog of multiple adjustments and, finally, some considerations on identifying additional adjustments in specific situations. Three main groups of adjustments—consistency, comparability and conceptual adjustments—classify concrete adjustment aspects in an instructive manner. Since all start with the letter "C" they can conveniently be referred to the "3C's of multiple valuation adjustments":

- **Consistency adjustments** pertain to adjustments ensuring consistency between numerator and denominator of a multiple:
  1. *Obvious consistency between numerator (valuation driver) denominator (measured price reference) of the pricing multiple—"principle of equivalence":* Relates to clearly identifiable mismatches around the confusion of equity value and enterprise value multiples as highlighted in Subsection 2.3.2.6 (p. 49)
  2. *More sophisticated consistency adjustments:* This concerns specific group structures such as minority interest and equity investments as well as adjustments in connection with cash and cash equivalents resulting in net financial debt as opposed to gross debt used for enterprise value calculation

[424] The Functional Fixation Hypothesis is often considered in contrast to the efficient market hypothesis (Hand, 1990, pp. 743–744), also compare Subsection 2.1.5.4, p. 33. Therefore one could argue that any tests for the benefits of adjusting multiples could also be seen as tests for market efficiency

[425] Notably Subsection 7.4 (p. 270) on adjusting multiples

[426] Compare for a more detailed conceptual discussion on the adjustments of enterprise value multiples vs. the adjustment of equity value multiples Subsection 5.1.4 (p. 136)

3. *Consolidation timing aspects:* Pro forma adjustments for acquisitions or disposals, motivated by a view that stock prices and hence multiple price references will immediately reflect those events upon announcement, whilst valuation drivers will only follow suit once a transaction closes

- **Comparability adjustments**, which normalize certain aspects some peers might feature with an objective to improve on peer group comparability:

4. *Potential future financial claims:* Some company-specific aspects warrant adjustments to multiples which are beyond valuation driver vs. price reference consistency such as adjustments for future net pension liabilities, anticipated stock option dilution or excess cash balances
5. *Business model peculiarities:* Certain adjustments might increase comparability of peers in one industry if different strategic management choices are normalized for: A prominent example are lease adjustments with the objective to allow comparability of firms utilizing considerable leasing structures with companies, which buy their assets outright
6. *Current operating performance aspects:* Since in a multiple valuation (single-period) valuation drivers act as proxy for the ad-infinitum valuation at today's prices—according to fundamental valuation concepts a reflection of an ability to create returns between the valuation point in time and infinity—it appears useful to select single-period valuation drivers which well represent the future and hence are normalized for extraordinary items relating solely to the valuation driver measurement period, masking the true multi-period long-term economic reality
7. *Adjustments for differing accounting standards:* This aspect is potentially relevant, if firms utilizing different accounting standards such as U.S. GAAP vs. IFRS form part of one peer group

- **Conceptual adjustments** considering "technical" aspects of multiple valuation and focused on the objective to improve the theoretical underpin of specific types of multiples:

8. *Adjustments to address shortcomings of certain multiple types:* One example is the proposed adjustment of Penman (2013, p. 466) to normalize price/earnings multiples for different levels of financial leverage

Table 5.1 (p. 132) provides a summarizing overview of a proposed multiple adjustment catalog on the basis of the "3C's" and a useful reference for the following more detailed discussion

TABLE 5.1: Multiple adjustment typology framework

Adjustment group	Adjustment aspects			
Consistency: Ensure that the price reference (multiple numerator) includes—or as the case may be omits—corresponding aspects considered the valuation driver (multiple denominator)	Principle of equivalence • Obvious numerator/denominator consistency: enterprise value vs. equity value multiples, ↑5.3.1, p.140	More sophisticated adjustments • Net debt aspects: cash and cash equivalents (↑5.3.2.1, p.141), market value of debt (↑5.3.2.3, p.143) • Group structures: Minority interest (↑5.3.3.1, p.144), equity investments (↑5.3.3.2, p.146), minority passive investments (↑5.3.3.3, p.148)	Consolidation timing • Numerator/ denominator consistency in the context of M&A transactions, ↑5.3.4, p.149	
Comparability: Improve comparability of peers through normalization for specific features	Future financial claims • Debt-like items: pension liabilities, ↑5.4.2, p.151 • Cash-like items: tax loss carryforwards, ↑5.4.3, p.153 • Hybrid items: Preferred stock, convertible debt (↑5.4.4, p.154), ESOPs and other warrants (↑5.4.5, p.156)	Business model differences • Operating leases, ↑5.5.1, p.159 • Other non-operating assets, ↑5.5.2, p.162 • Conglomerates and financing companies, ↑5.5.3, p.162 • Receivables securitization, ↑5.5.4.1, p.164	Current operating performance • Working capital seasonality, ↑5.5.4.2, p.164 • Extraordinary items (incl. provisions and earnings management; ↑5.5.5, p.165)	Accounting standard differences • Discrepancies between U.S. GAAP and IFRS in the context of an international peer group, ↑5.5.6, p.168
Concept: Address theoretical shortcomings of common multiple types	Leverage and earnings multiples • Leverage-adjusted P/E multiple as suggested by Penman (2013, pp. 465-467), ↑5.6.1, p.169		Tax and enterprise value multiples • Tax-adjusted enterprise value multiples as suggested by Massari, Gianfrate, and Zanetti (2016, pp. 353-355), ↑5.6.2, p.171	

Note: Own illustration. ↑ indicates the section and page number providing further details on background, rationale and proposed adjustments for the respective aspects

of those aspects. As described in greater detail on an adjustment-by-adjustment basis, the ingredients for Table 5.1 have been for the first time conceptually combined for the purposes of multiple valuation and were drawn from a number of sources namely:

- Existing theoretical literature and considerations on multiple adjustments, including Berndt, Deglmann, and Vollmar (2014), Chullen et al. (2015), Massari et al. (2016, pp. 335–341) as well as Seppelfricke (2014, p. 158) for a broader overview, Schmitt (2005a) for operating leases, Schmitt (2005b) for pensions as well as Damodaran (2012a, p. 501) and others for minority interest. It is fair to say that existing literature on multiple adjustments focuses on specific elements only, with no more comprehensive approaches having emerged yet

- Existing theoretical literature, which bridges from enterprise value to equity value, most notably Koller et al. (2010, pp. 273–295); this body of literature is relevant as enterprise value multiples rely on the premise that the observable market prices starting from market capitalization are to be bridged to enterprise value, offering some additional considerations not covered in the multiple-specific literature so far. Notably, a reversal of a comprehensive enterprise value to equity value bridge can be useful in deriving equity value from market capitalization and enterprise value from equity value

- A broader set of corporate finance study results with potential implications for multiple valuation, such as notably on the consolidation timing effects in M&A (Campa & Hernando, 2004; Jensen & Ruback, 1983)

5.1.2 Adjusted multiples and hypothesis formulation

Assuming valuation precision is the key objective of multiple valuation, it is a relatively straightforward exercise to formulate hypotheses relating to the adjustment of multiples. Adjustments are undertaken to better reflect economic reality. Hence their consideration should result in improved multiple valuation precision. This leads to the first hypothesis:

Hypothesis 4a *Adjusted multiples outperform unadjusted multiples as far as valuation precision is concerned*

As summarized in Table 5.1 (p. 132) and further amplified later on in this Chapter, there are a substantial number of common features comparable firms may display, which could economically warrant an adjustment. It is therefore instructive to formulate a second hypothesis on the benefits of each adjustment:

Hypothesis 4b *Each adjustment provides incremental valuation precision*

Hypothesis 4b is more restrictive than Hypothesis 4a in that it postulates *each* rather than the combination of all adjustments results in improved valuation quality. Both hypotheses will be subjected to empirical assessment in Subsection 7.4 (p. 270).

5.1.3 Multiple adjustments—a potential practitioner perspective

5.1.3.1 The tension between theoretical precision and cost of multiple valuation

Multiple valuation has often been described as a "quick" method for valuation (Creutzmann & Deser, 2005, p. 3; Mondello, 2017, p. 435), and hence a concept in which the balance between valuation efficiency and ultimate precision is a relevant consideration. Adjustments create *complexity and cost* in terms of time and effort to the valuation practitioner, which is multiplied by the fact that—contrary to fundamental valuation methods—they need to be undertaken on numerous peer companies: i.e. what might seem to be practically straightforward for one company under investigation may turn out a time-consuming exercise for a peer group of 20 companies. There are 3 ways of dealing with this practical aspect of multiple valuation:

- *Consistent inconsistency:* In the following Subsection 5.1.3.2 (p. 135), I will develop the concept of "Consistent inconsistency," which proposes adjustments are more central for elements, which *vary* between peer group companies and argues that the precision-cost trade-off might well shift towards cost of preparation[427] for adjustments, which are known to apply to all peers in a similar manner
- *Sophisticated adjustments versus valuation cost reduction through financial databases:* It is worthwhile noting that, from a practical perspective, costs of adjustment vary greatly depending on whether the information to conduct the adjustments can be readily downloaded from financial databases as opposed to a more tedious one-by-one research in the notes of peer company financial statements. I will therefore present in the following sections the theoretical "*gold standard*," however, in Table 5.3 (pp. 180–182) also provide a side-by-side comparison of those sophisticated adjustments and a more pragmatic way—*the reasonable approximation*—of adjusting for multiples on the basis of information available to the valuation professional in common financial databases
- *Empirical benefits of adjustments:* Finally, the empirical part of this dissertation[428] will uncover further evidence on the actual benefits for valuation accuracy of some of the proposed adjustments. From a practitioner-driven pragmatic perspective, one could obviously take the view that adjustments, which have been shown empirically not to improve valuation accuracy should not be undertaken

[427] i.e. deliberately not to undertake an adjustment
[428] Compare Subsection 7.4 (p. 270)

5.1.3.2 The concept of consistent inconsistency

Considering costs associated to any adjustment undertaken, there is an argument to make for pragmatically adjusting only those aspects, which differ or vary among peer group companies and the firm under investigation: Adjustments normalize valuation multiples for specificities of peer group constituents: In other words if all peer group companies feature certain aspects warranting an adjustment as does the firm under investigation, there is no need to adjust valuation multiples from a pragmatic perspective: While they could theoretically be considered not accurate, this lack of accuracy does not translate into a valuation error. Therefore, under the assumption of adjustment costs, an argument can be made to *deliberately not adjusting* for certain aspects, which are common and quantitatively comparable among peer group companies and the firm under investigation: this will typically be the case for industry-specific adjustments as opposed to company-specific adjustments. The deliberate disregard of such adjustments can be understood as a "consistent inconsistency." Consistent inconsistency can be motivated twofold: availability of precise data and information in a firm's financial reporting (availability argument) as well as a trade-off between expected valuation precision and costs associated to conducting the adjustment (efficiency argument).

One illustrative example might be excess cash balances: From the theoretical argument that the operating business should be valued separately to financial assets (Koller et al., 2010, p. 275), which are to be excluded for valuation purposes follows a differentiation between operating and excess cash, which is challenging to derive externally by means other than benchmarking (availability perspective). To the extent though all peers within one industry have excess cash balances, an differentiation between operating and excess cash balances is not required (efficiency perspective). While all enterprise value multiples will be artificially low,[429] applying the artificially low aggregated pricing multiple to the firm under investigation will not result in a valuation error as long as no differentiation between operating and excess cash is undertaken for it either. There are, however, a number of challenges with this approach:

- *The error must scale relative to the valuation driver:* To remain within the example of excess cash, for it to have no impact on an enterprise value/EBITDA valuation, the excess cash/EBITDA ratio for all peers and the firm under investigation must be identical. It might, however, well be that excess cash relates closer to—and hence scales with—another valuation driver such as net sales. Hence, what might work for one valuation driver does not necessarily work for the other

[429] Given all cash is deemed excess cash and subtracted from enterprise value

- *It must be clearly identifiable as an industry-specific adjustment:* It is in practice challenging to assess if this is the case without detailed analysis, which may include benchmarking. However, once a complete understanding and data is obtained, one could argue that the cost advantages of not considering the aspect have vanished anyways

- *In practice there might be a mixed effect between industry and company-specific aspects:* As soon as company-specific elements play a role, the adjustment should theoretically yield superior valuation outcomes. The general principle that multiples for the peer group and for the firm under investigation, which is to be valued on the basis of peer group multiples, should be calculated in the same manner—i.e. the consistency aspect of "consistent inconsistency"—is not to be violated (Wagner, 2005, p. 17)

To summarize, while focusing on company rather than industry-specific adjustments is conceptually tempting, the approach might practically suffer from limitations around the classification as fully industry- or company specific factors, respectively. In isolated cases, however, "consistent inconsistency" can offer a good trade-off of efficiency over theoretical precision and it is important for the valuation practitioner to be aware of it.

5.1.4 Adjustments of enterprise value vs. equity value multiples

It is instructive to differentiate between adjustments potentially applicable to enterprise value and to equity value multiples, respectively, from a number of perspectives:

- From a conceptual perspective, enterprise value multiples will require adjustments to be conducted in a different manner and for different reasons than equity value multiples. An example of differences include adjustments for group structures such as equity investments and minority interest, which are not necessary in the case of equity value multiples given their consistency automatism. The following catalog of adjustments will contrast the respective detailed adjustment differences for equity value vs. enterprise value multiples where applicable; for 2 prominent representatives of equity value and enterprise value multiples, price/earnings and enterprise value/EBIT, side-by-side differences are furthermore summarized in Table 5.2 (pp. 176–177)

- Considering the Functional Fixation Hypothesis (M. Kim & Ritter, 1999, p. 423; Hand, 1990), there is moreover a "philosophical argument" according to which, in particular for equity value multiples, an as simple as possible computation of multiples, which does not rely on any adjustments, is preferable. One could even go as far as to argue that prices are determined by unadjusted multiples and hence any test on adjustment benefits is deemed to fail given adjustments just introduce noise. This aspect might be easier to justify for common equity value multiples, notably price/earnings (Fernández, 2001, p. 2; Rosenbaum & Pearl, 2009, p. 11)

- Since the theoretical roots of equity value multiples relate to the DDM, they seem conceptually closer to an individual investor rather than an overall firm view.[430] Therefore, adjustments relating to per-share calculations, in particular the effect of earnings dilution, may play a substantial role in adjusting equity value multiples specifically. The per-share focus finds its expression in the wording of the most important equity value multiple, price/earnings, which implies a per share view[431]

The differentiation between adjustments of enterprise value and equity value multiples is therefore important both from a descriptive nature in the following Subsections as well as from an empirical perspective on the benefits of adjustments in Subsection 7.4 (p. 270)

5.1.5 The catalog of adjustments—limitations and other general aspects

5.1.5.1 A snapshot in time

As will be shown in the following Subsections, multiple adjustments rely on prevailing accounting standard rules on the basis of which the financial statements have been prepared. Thus, any catalog of multiple adjustments can only be a snapshot in time. This is particularly obvious for the adjustments around operating leases, which can expected to be simplified by revised accounting standards coming into force from 2019 onwards.[432] While, over a longer period of time, such changes—some in part also being driven by the standard setters' ambition for valuation relevant reporting—are the rule rather than the exception,[433] it is none the less likely that there will be a continued need for adjustments, since many accounting rules serve different purposes and hence their optimal reflection for multiple valuation purposes will remain a consideration. There is furthermore a timing aspect to contemplate when analyzing

[430] Compare Table 2.2, p. 53
[431] Since else it should be referred to as "market capitalization/net income" or "equity vale/net income"
[432] See Subsection 5.5.1 (p. 159) for a more in-depth discussion
[433] Other examples include improved transparency around pension reporting, see Subsection 5.4.2 (p. 151) for a discussion on the current situation

multiple valuations over time in order to separate underlying valuation movements from the potential effects of changing reporting standards.

5.1.5.2 A non-exhaustive approach

The proposed framework and catalog furthermore may at first glance suggest that there is a finite list of potential adjustments to derive a perfectly adjusted and theoretically indisputable multiple. However, the ambition of the 3C's of multiple valuation is limited to being as comprehensive as reasonably possible. The adjustment aspects described will discuss selective adjustments in a non-exhaustive manner only, prioritizing the perceived most relevant and impactful items. It is very likely that certain companies may require adjustments not explicitly covered in this Chapter. None the less, the framework should provide a good orientation to uncover the need for further adjustments, benefiting from a wide variety of sources considered in its design[434] and the Chapter furthermore concludes with a more abstract logic, which may support a case-by-case decision if an adjustment is necessary in case of novel items.[435]

5.1.5.3 Adjustments to vs. different types of multiples

Table 2.2 (p. 53) summarizes a number of common multiple types, many of which are connected through incremental adjustment elements: e.g. enterprise value/EBITDA is enterprise value/EBIT in addition to a normalization for D&A. The question therefore arises what constitutes an adjustment and what constitutes an alternative type of multiple all together. A suitable way is to consider the origin of the type of multiple in its valuation driver. Accordingly, the choice of valuation driver determines the multiple. The ambition of adjustments is then to ensure this valuation driver is (a) paired with the right general type price reference—principle of equivalence and wider consistency, (b) benefiting from comparability adjustments and (c) understood to have conceptual shortcomings and how they can be addressed. Thus, a price/earnings before R&D expenses[436] is a different multiple type to the traditional price/earnings multiple and enterprise value/EBITDA less Capex is a different multiple type to enterprise value/EBITDA or enterprise value/EBIT and each deserve some of the proposed adjustments: the objective of adjustments is to optimize theoretical valuation accuracy of selected multiple types, not the creation of new ones.[437]

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[434] See above under Subsection 5.1.1, p. 132
[435] Compare Subsection 5.7.3, p. 178
[436] As. e.g. discussed by Damodaran (2012a, p. 499)
[437] One notable exception are operating lease adjustments to enterprise value multiples as they result in a different multiple type at times referred to as enterprise value/EBITDAR; see below, Subsection 5.5.1 (p. 159) for

5.2 Scarcity of prior empirical results on the benefits of adjustments

The potential benefits of adjustments relate to a *theoretically anticipated* improvement of the valuation accuracy of multiples. Their costs are the increased effort required to undertake them, particularly considering the connotation of valuation multiples as a simple concept: In practice, the valuation expert on a tight time budget might face a trade-off between an approach where more dedication is given to selecting the appropriate comparables versus the time spent per comparable to ensure multiples are properly calculated and adjusted. Therefore, it is important to empirically understand the actual benefits of properly adjusted multiples for valuation accuracy and the considerations in this Chapter are aiming to set the basis to assess empirical findings later on in this dissertation.[438]

It is worth noting that the body of empirical literature on any adjustments to multiples beyond the obvious numerator/denominator consistency[439]—equity value vs. enterprise value multiples—is very narrow—surprisingly given the increasing acceptance of some of those adjustments in corporate finance textbooks such as Koller et al. (2010, p. 323) and Damodaran (2012a, p. 501).[440] The only two empirical studies on the benefits of a more comprehensive list of adjustments are Chullen et al. (2015) and a working paper I co-authored (Berndt, Deglmann, & Vollmar, 2014). Both studies find that adjustments are beneficial for multiple valuation accuracy. Both studies focus on enterprise value multiples, with no empirical literature on the benefits of adjusting equity value multiples yet in existence. There are furthermore some piecemeal analyses of certain adjustment aspects, such as cash balances, in Lie and Lie (2002, p. 48), who find that considering different cash levels in multiple computation does not improve valuation accuracy or has at the least ambiguous results.

A related question on empirical analyses of multiple adjustments relates to common market

additional details

[438]Compare Subsection 7.4 (p. 270) for the benefits of adjustments in terms of effect size

[439]This analysis of the basic principle of equivalence (see below, Subsection 5.3.1, p. 140), has peripherally been studied by a number of authors including J. Liu et al. (2002, pp. 154–155) who report valuation errors for both (consistent) enterprise value and their (inconsistent) equity value counterparts using sales and EBITDA as valuation drivers, finding no proof of an improvement in valuation accuracy of consistent multiples at this basic level and Schreiner (2007, p. 102) with similar results for a comparison of numerous consistent and inconsistent multiples

[440]It is probably also a fair consideration that some of those adjustments have more recently received higher degrees of attention. E.g. Koller et al. (2010, p. 323) have re-drafted and expanded their section on multiples to include a subsection on "Calculating multiples in a consistent manner" on the occasion of the 5th edition relative to previous editions. It now includes considerations on minority investments among other adjustment areas

practices. Yet again, literature is very scarce. Berndt, Froese, et al. (2014, p. 752) present findings on adjustments applied in publicly available fairness opinions for the Swiss market over a eleven year period ending in 2013: Accordingly, adjustments for net debt, non-operating assets and minority interest seem relatively common, whilst only very few fairness opinions appear to consider equity investments, pension liabilities or deferred tax assets.

5.3 Consistency adjustments

The following Subsections detail adjustments following the framework proposed above in Subsection 5.1.1 (p. 130). In Subsection 5.7.2 (p. 175), a summary in table format discussing both "gold standard"[441] and more pragmatic approximation approaches[442] will conclude the theoretical discussion on multiple adjustments.

5.3.1 The basic principle of equivalence

The principle of equivalence[443] relates to obvious numerator/denominator consistency with regards to the appropriate calculation of *matching price references and valuation drivers* at the *most basic level*.[444] Violations to the basic principle of equivalence in most instances comprise a lack of reconciliation between enterprise value and equity value highlighted in Table 2.2 (p. 53), with Price/EBITDA or enterprise value/net income multiples being a examples of inconsistent multiples. The inconsistency stems from a misalignment of the numerator of the multiple which includes and the denominator which does not include claims of debt capital providers[445] or vice versa. Consistency can be achieved by selecting appropriate metrics or through bridging the valuation driver or, more commonly, the price metric to the same respective level:

- If the valuation driver relates to *claims of all capital providers*, a price metric relating to all capital providers, notably *enterprise value* should be chosen; it can be calculated by adding financial debt[446] to equity value, which, for public trading comparable analysis,

[441] Usually requiring in-depth studies of each peer company's financial statements
[442] which can be operationalized in an automated manner through the use of commercial financial databases
[443] See e.g. Sommer and Wöhrmann (2011, p. 4) for the expression
[444] As discussed already Subsection 2.3.2.6 (p. 49) on the differentiation between enterprise value and equity value multiples
[445] As opposed to just equity capital providers
[446] For the common consideration of cash and cash equivalents with negative sign compare the following Subsection 5.3.2.1 (p. 141)

is measurable as market capitalization[447]

- If the valuation driver relates to claims to *equity providers only*, a pricing metric relating to equity value such as *market capitalization* should be chosen instead

The determination of whether a valuation driver relates to claims to all capital providers or to equity providers only is in practice relatively straightforward: If the valuation driver includes a subtraction of net interest expenses—i.e. is an *after-interest figure* (such as e.g. net income)—claims of debt providers have been considered and hence it is appropriate to compare it to equity value. Consequently, if the valuation driver is a *pre-interest figure* such as EBIT or EBITDA, it should be compared to an enterprise value price reference.[448] This aspect is widely accepted[449] among practitioners and in academia, see e.g. Damodaran (2012a, p. 457), Koller et al. (2010, p. 315) and Rosenbaum and Pearl (2009, p. 44), among many. At first glance contrary to theory, a number of empirical studies find that inconsistent multiples such as equity value/EBITDA and equity value/sales outperform consistent multiples, including J. Liu et al. (2002, p. 155), Schreiner (2007, p. 102) and Rossi and Forte (2016, pp. 65, 69). The much quoted study of J. Liu et al. goes as far as to transparently explaining that the authors "find this result surprising and are unable to provide any rationale for why such a result might be observed" (2002, p. 155).

5.3.2 Net financial debt and the computation of enterprise value

5.3.2.1 Cash and cash equivalents in general

The first more advanced and highly common form of consistency adjustment in the case of enterprise value multiples relates to *cash and cash equivalents*.[450] In the context of enterprise

[447] Compare compare Damodaran (2012a, p. 219) for possible definition differences between equity value and market capitalization, which can be disregarded at this level of adjustment granularity

[448] Consistency can theoretically be ensured in one of two ways, either through adjusting the valuation driver or through adjusting the price reference. However, adjustments to the valuation driver in essence would mean utilization of another multiple type, obvious equity value vs. enterprise value multiple consistency is more commonly achieved through picking a matching price reference, i.e. either enterprise value or equity value, depending on the nature of the valuation driver

[449] However, not universally applied: See e.g. the discussion by Mondello (2017, pp. 497–510) and Frykman and Tolleryd (2003, pp. 55–57) on price/sales multiples. Also compare a number of studies, which present multiples violating the basic principle of equivalence such as M. Kim and Ritter (1999), who utilize a price/sales multiple, despite presenting a somewhat improved valuation accuracy of enterprise value/net sales over price/sales later in their study in the context of relying on broker-chosen peer groups(1999, pp. 432–434)

[450] Under both U.S. GAAP and IFRS (and with subtle differences only regarding the treatment of bank overdrafts), cash equivalents relate to highly liquid short-term investments usually maturing within 90 days (Robinson, van Greuning, Henry, & Broidhahn, 2009a, p. 30; Wahlen, Baginski, & Bradshaw, 2010, p. 165). For most multiple application purposes, they can be treated much like cash

multiple calculations, cash balances are commonly "netted off" against financial debt to calculate a *net* debt figure,[451] [452] which forms the basis for deriving enterprise value[453] from equity value as part of the principle of equivalence.[454] While the merits of utilizing net- as opposed to gross debt is widely recognized[455] given its consistency with the ambition of valuing operational and financial assets of a firm separately[456] and the assumed ability to net off cash against gross debt should a company wish to do so as part of a refinancing, there has been in the instance of enterprise value multiples a discussion around operating vs. excess cash[457] (Koller et al., 2010, pp. 275–276): The common view is that *operating cash* should not be netted with gross debt as it is operationally required in the business much like working capital. Motivated by objective quantification challenges, there is an argument to be made for "consistent inconsistency"[458] by assuming that all cash is excess cash across all peer companies and ultimately the firm under investigation.

5.3.2.2 Excess cash and equity value multiples

Excessive cash balances can also be a factor prompting an adjustment to *equity value multiples* such as price/earnings. While cash balance adjustments for enterprise value multiples have been discussed in the context of consistency adjustments,[459] the corresponding adjustment to equity value multiples is not a true consistency adjustment as price can be expected to reflect the value of excessive cash balances and earnings will incorporate the return generated on cash in form of interest income: according to this logic, price/earnings is in itself consistent. None the less, if the ambition is to value operations separately from financial assets (Koller

[451] Damodaran (2005a, p. 18) highlights that in Europe and Latin America, this is even common for calculations of cost of capital weights

[452] Or as the case may be: a net cash figure in case gross cash exceeds gross debt

[453] Damodaran (2006, p. 295) defines enterprise value in a consistent manner and in contrast to "firm value," which according to his definition does not have cash backed out. In other contexts, firm value is used synonymously to enterprise value though

[454] See above, Subsection 5.3.1, p. 140

[455] Compare among many Koller et al. (2010, pp. 275–276)

[456] Compare the more detailed discussion by Damodaran (2005a, p. 25) between the "comprehensive" and "separate" approaches

[457] A firm might for a variety of reasons hold on to cash in excess of what is needed to operate the business, with potential rationales including financial flexibility, negative tax impacts of distribution in form of dividends, repatriation challenges or even as a protection to public tender offers. As the acquirer, who is primarily interested in the operations of a business would be required to pay a premium on cash balances, making a public tender offer relatively more expensive at the same headline takeover premium (which investors might benchmark to precedent transactions in order to determine acceptance of the offer). Excessive cash or cash equivalent balances might also be a consequence of recent cash inflows from financing activities such as notably IPOs (Schwetzler, 2003, p. 82)

[458] See above, Subsection 5.1.3.2, p. 135

[459] See above Subsection 5.3.2.1, p. 141

et al., 2010, pp. 275–276),[460] an adjustment can be argued for, as unadjusted price/earnings multiples imply that the multiple calculated as cash balance divided by interest income—i.e. the inverse of return on cash or (post-tax) cash interest rate—equals the (operationally derived) price/earnings multiple, which is normally not the case: "The only cases where cash holdings will not matter is if all firms in a sector have similar holdings (as a percent of market capitalization) or the even more unusual scenario where cash and operating earnings command the same multiple" (Damodaran, 2005a, p. 27).[461] Damodaran (2005a, pp. 27–28) proposes an adjustment to the price/earnings multiple, where the market value of excess cash[462] is stripped out of the market capitalization and interest income on cash reduces earnings. Even though the cash adjustment equity value differs from the enterprise value adjustment conceptually, for the purposes of multiple adjustments, one could yet again argue with the concept of "consistent inconsistency,"[463] also since Chan, Chang, and Chen (2013) find that peer companies tend to show similar industry-specific cash holdings.

5.3.2.3 The market value of debt

While some authors such as Damodaran (2006, p. 297) argue that, theoretically, it would be preferable to utilize the market value of debt, others (Koller et al., 2010, pp. 282, 283) highlight, that for non-distressed companies, the market value of debt is usually close to the book value of debt and therefore generally suitable as a proxy.[464]

5.3.3 Group structures

Group structures, including subsidiaries, joint ventures, affiliates and other shareholdings between a parent company and another firm are a further reason for potential multiple ad-

[460] This is where the difference between cash adjustments for enterprise- and equity value multiples lies: In the former case, a separate valuation of operations and financial items is achieved automatically and the adjustment is motivated by working capital nature of non-excess cash

[461] Damodaran (2005a, pp. 26–28) discusses this aspect at greater detail, including on the basis of an illustrative numerical example

[462] A number of studies have discussed the true market value of balance sheet cash with diverging results: While Pinkowitz and Williamson (2002) and Schwetzler and Reimund (2004) find evidence that cash holdings might be valued higher than their book values on the balance sheet (e.g. the results of Pinkowitz and Williamson (2002) point to the marginal market value of one dollar of cash to be \$1.25), which is attributed to operational flexibility and swift access to funding, Autukaite and Molay (2013) finds that investors undervalue cash, results consistent with Faulkender and Wang (2006, p. 1959), who quote an average marginal market value of \$0.94. A number of studies have focused on further investigating those discrepancies and linking them to firm/listing characteristics (Dittmar & Mahrt-Smith, 2007; Frésard Laurent & Salva, 2010) or to economic time periods (Y. Chang, Benson, & Faff, 2017)

[463] Compare Subsection 5.1.3.2, p. 135

[464] Damodaran (2012a, p. 62) also highlights that the market value of debt is challenging to estimate for firms which do not have bonds outstanding

justments. Two important protagonists relate to inter-company accounting[465] in the form of minority interest and equity investments and their adjustment is argued for in some popular textbooks, notably Damodaran (2012a, p. 501), Koller et al. (2010, p. 323), Massari et al. (2016, p. 337), Krolle (2005b, pp. 31–34), Seppelfricke (2014, p. 157) and Rosenbaum and Pearl (2009, p. 32). Both the minority interest and equity investment adjustments are typically *relevant only to enterprise value multiples* given the choice of valuation drivers—notably earnings—for equity value multiples will reflect proportional ownership levels appropriately (Damodaran, 2005a, p. 46; Massari et al., 2016, p. 337). The two consistency adjustments for minority interest and equity investments are by no means the only ones, however, considering the above cited literature they can probably be considered to be the most frequently proposed ones with likely the most material impact.[466] One other group-related consistency adjustments is discussed for Minority passive investments (MPI).

5.3.3.1 Non-controlling/minority interest

Non-controlling or minority interest[467] relates to an accounting classification of subsidiaries, which are not fully owned by the parent company under investigation but are usually considered "active" (Damodaran, 2005a, p. 40; Wahlen et al., 2010, p. 550) investments in that the parent company is an owner for a strategic or operational reason. According to both IFRS and U.S. GAAP,[468] non-controlling interest arises, when a parent company controls a subsidiary but

[465] Sometimes referred to as "cross holdings" (Damodaran, 2012a, pp. 434–435) or "group structures" (Massari et al., 2016, p. 336)

[466] Other proposals include e.g. the approach of Chullen et al. (2015, pp. 639–640) to adjust enterprise value/net sales—but not enterprise value/EBITDA or enterprise value/EBIT—for accounts payable since more (less) stringent payment terms to suppliers should in theory result in lower (higher) COGS which under the same amount of sales should translate into higher (lower) EBITDA: According to this argumentation, sales are distorted by payment terms vs. EBITDA and hence require an adjustment. Still, the inner logic of an adjustment to just enterprise value/net sales is not immediately obvious: As can be demonstrated with a simple numeric example, the adjustment will only be appropriate in a sense that for 2 firms with the same enterprise value/EBITDA multiple, they will have the same adjusted enterprise value/net sales multiple, if the excess accounts payable amount divided by the EBITDA impact such excess accounts payable equals the enterprise value/EBITDA multiple of the one firm relying on excess accounts payable relative to the other firm which does not. However there is no obvious direct connection between the amount of excess accounts payable and any corresponding EBITDA impact. Furthermore, the empirical results of Chullen et al. (2015, p. 657) show a consistent improvement in valuation accuracy for all multiples if accounts payable are added to net debt, challenging the merit of such adjustment only to enterprise value/net sales

[467] The historical term "minority interest" or minorities is still widely utilized by practitioners despite it being superseded by the term "non-controlling interest" ("NCI") under both U.S. GAAP and IFRS (Mard, Hitchner, & Hyden, 2011, p. 131). Both labels will be used interchangeably throughout this dissertation consistent with market practice

[468] For the purposes of this discussion, any finer points on differences according to IFRS and U.S. GAAP with regards to the definition of control (see e.g. Williams (2009, p. 632) for details); applicable IFRS rules are IAS 27 and IFRS 3, applicable U.S. GAAP rules are SFAS 141, SFAS 142, SFAS 141R and SFAS 160 (Williams, 2009, p. 607); also consider FASB ASC (para. 810) (Hoyle, Schaefer, & Doupnik, 2011, p. 140)

does not own its share capital fully. In such situations, assets and liabilities of the subsidiary are *fully consolidated* by the parent company as if it would own 100% of the share capital ("wholly owned subsidiary") and were one economic entity, despite the minority shareholders of the subsidiary having claims on the subsidiary as a function of their shareholding (Hoyle et al., 2011, pp. 140–141). This minority claim is dealt with as a separate line item in shareholders' equity (Wahlen et al., 2010, p. 577), under the label of "Non-controlling owners' interest" or similar. Whilst the lower threshold of minority interest accounting is "control,"[469] which is explicitly not tied to any specific ownership percentage, in practice more than 50% of voting capital are frequently considered a relevant criterion to assess if minority interest accounting is appropriate.[470]

The adjustment for minority or non-controlling interest, which is relevant only to enterprise value multiples, stems from the inconsistency of the (unadjusted) valuation driver—which, assuming typical enterprise value valuation drivers such as EBIT, EBITDA or net sales are selected, includes 100% of respective valuation driver contribution of the subsidiary *as if it were fully owned*—and the price reference, in which investors can be expected to price in the fact that the firm does not own 100% of control and economic claims on the subsidiary in question:[471] the result are downward-biased multiples, unless adjusted for. This numerator/denominator inconsistency calls for an adjustment, which could either be undertaken on the valuation driver[472] or on the price reference [473] As a consequence of data availability (Krolle, 2005b, p. 35), the latter approach is more common in practice: Companies will not usually report the non-controlled EBIT, EBITDA or net sales contribution of minorities but they do report in their balance sheet a *book value for the minorities*, which can be utilized.

[469] See e.g. Deloitte (2014) for a practitioners' oriented definition of control and Gluzová (2015) for exemptions to assuming control under IFRS

[470] Also consider the very instructive overviews presented by Wahlen et al. (2010, pp. 550–551) and Williams (2009, p. 607) comparing different illustrative thresholds for accounting principles of subsidiaries and associate investments

[471] This is in contrast to common equity multiple valuation drivers such as earnings, which will reflect a deduction for non-controlling interest in a proportional manner and hence does not require any adjustment for minority interest

[472] Through subtraction of the subsidiary EBIT, EBITDA or net sales contribution not owned by the firm under investigation, in effect translating into proportional accounting allowed under IFRS until 2013

[473] By adding a corresponding equity value (since net debt is fully consolidated already) of the minority stake not owned by the firm under investigation to compensate that the valuation driver includes 100%—as if shareholders of the parent company would value 100% ownership of the subsidiary; see Damodaran (2012a, pp. 501–502), who also proposes a third way of adjusting for minorities, which is to fully strip out the EBIT, EBITDA or net sales of the subsidiary and at the same time also adjust the price reference through subtraction of the proportional value. He then offers a recommendation as to which approach should in theory be followed, focusing on the industry fit of the subsidiary, which might be theoretically appealing but will practically often suffer from the detail of presentation of the subsidiaries in the financial statements of the parent

Whilst immediately after an acquisition of a majority stake in a subsidiary the respective balance sheet amount can be found to represent well the fair value of the non-controlling interest since it reflects any acquisition goodwill under U.S. GAAP and, potentially, under IFRS,[474] the balance sheet value might be less appropriate representation of the economic value of minority interest relating to acquisitions reaching back further to the past. Damodaran argues that the utilization of balance sheet values should be a “last resort” (2005a, p. 46). While in certain instances with detailed minority line item reporting it might be possible to utilize market capitalization references for publicly traded minority interest subsidiaries (Koller et al., 2010, pp. 276–277), this approach might fail in other instances, where subsidiaries are privately held with no publicly-traded shares or where it cannot be worked out on the basis of public information, which book values relate to which subsidiaries, should the company under investigation have several minority interest subsidiaries. In these situations, the common approach is to utilize the *balance sheet value* of minorities as a positive adjustment to enterprise value of the firm under investigation, also consistent with textbook literature (Damodaran, 2012a, p. 501 and Koller et al., 2010, p. 323, among others).[475] [476]

5.3.3.2 Equity investments/investment in associates

Equity investments[477] arise in the context of a firm (as a parent company) having minority active investments in another company (Williams, 2009, p. 607). Ownership levels will usually range from 20% to 50%;[478] while the parent company will be able to exert “significant”

[474] Non-controlling interest are measured at fair value under U.S. GAAP vs. either fair value (including goodwill) or at proportional asset fair value excluding goodwill under IFRS (Hoyle et al., 2011, p. 167; Wahlen et al., 2010, p. 577)

[475] As an alternative to utilizing book values, Koller et al. (2010, p. 278) and Damodaran (2005a, p. 47) suggest utilizing the parent company’s market-to-book ratio to derive a market value of its subsidiaries on the basis of their book values—an pragmatic and at the same time considerate approach, which is, however, limited to subsidiaries operating in the same industry (and with similar capital structures) as their parent company under investigation. Since this approach can be automated easily for large peer groups in practice and large samples in empirical studies, it will be followed as an alternative to book values in the empirical part of this dissertation

[476] The adjustment for minority interest is a consistency adjustment in its own right and should not be confused with a negative adjustment to the net debt of the company under investigation as is argued for by Chullen et al. (2015, p. 642), since conceptually it signifies an equity claim of minority shareholders. Consequently, Koller et al. (2010, p. 274) refer to it separately in the context of “hybrid” claims

[477] “Equity investments” or “equity method investments” is the U.S. GAAP preferred term, IFRS speaks of “investment in associates.” As is common among practitioners, the terms will be utilized interchangeably here independently of the actual accounting standard with a focus on “equity investments.” Koller et al. (2010, p. 275) refer to equity investments as non-consolidated subsidiaries

[478] Koller et al. (2010, p. 276) among many others

influence,[479] it will not have control.[480] In the case of equity investments, the equity income method is applied, where the parent company recognizes the share of income of the investment in a proportional manner in its income statement, whilst in the balance sheet, investments are reported at historical acquisition cost, to which the cumulative historical proportional income of the investment is added, and the cumulative dividends received are subtracted (Wahlen et al., 2010, p. 551).[481] [482] As can be seen from the example presented by Williams (2009, p. 614) for The Coca Cola Company, equity income will usually be presented below operating income in a firm's income statement (Chullen et al., 2015, p. 642) and hence will *not* be normally included in the most common enterprise value multiple drivers such as EBIT, EBITDA or net sales:[483] The result is an upward-biased multiple pre adjustments (Damodaran, 2005a, p. 47). Consequently, for the calculation of enterprise value multiples, a consistency adjustment is appropriate, which follows a similar logic—however with inverted sign—as the adjustment for minority interest: Assuming the price reference reflects the proportional value of the equity investment, either a proportional valuation driver contribution of the equity investment is added to the valuation driver of the firm under investigation,[484] or the proportional value of the equity investment needs to be eliminated through subtraction from the price reference utilized. With the latter solution being operationally more straightforward given the public data availability, it is the common approach in practice (Krolle, 2005b, pp. 32–33). Therefore the proposed adjustment to deal with equity investments consists of subtracting the book value—or preferably, if it can be determined easily, the market value[485]—from the price reference i.e. enterprise value.

[479] Significant influence may include board membership and substantial business transactions, see e.g. Williams (2009, p. 607) for a list of criteria providing evidence for significant influence

[480] As otherwise non-controlling interest accounting would be applicable, see above Subsection 5.3.3.1, p. 144

[481] Wahlen et al. (2010, p. 561) provides a discussion on the rationale of equity investment accounting

[482] Insofar as the equity method of accounting is utilized, which is normally the case, the same considerations also apply to joint ventures with the departure of the proportional consolidation method for joint ventures underIFRS

[483] This is in contrast to any earnings figure used for the calculation of the P/E multiple, which will usually reflect equity income at a proportional rate—hence no adjustment needed

[484] Unfortunately, the equity income amounts found in the income statement of the firm under investigation are not directly suitable, as they are earnings figures post tax and interest charges and hence incompatible to typical enterprise value multiple valuation drivers. Thus separate research into compatible proportional amounts will be required, which often fails in practice given missing publicity of those financials

[485] One relatively straightforward way to estimate market values from book values is to apply the parent company market-to-book value multiple to the equity investment book values reported in financial statements much like in the case of minority/non-controlling interest, compare above, Subsection 5.3.3.1 (p. 144), which also discusses limitations of this approach. None the less, this approach will be followed as an alternative to book values in the empirical part of this dissertation

5.3.3.3 Minority passive investments

The third major accounting classification group of investments with potential relevance to multiples relates to minority passive investments, in which the parent company usually owns less than 20% of the investment (Wahlen et al., 2010, pp. 551–552; Williams, 2009, p. 607). Accounting of minority passive investments depends on their association to one of three potential categories, held-to-maturity, held-for-trading or available-for-sale (Williams, 2009, p. 608; Damodaran, 2005a, p. 39).[486] From a multiple calculation perspective the following aspects are relevant, which—like in the case of other investment types—relate to numerator/denominator consistency:

- For both enterprise value and equity value multiples, price references—i.e. the equity value, share price or market capitalization—can be expected to reflect a pro-rated ownership in an appropriate manner
- Much like in the case of equity investments, valuation references comprise economic benefits of minority passive investments only if they are anchored in net income (like e.g. price/earnings multiples) but not if they are based on operating profit (like EBITDA or EBIT multiples) given where in the P&L the income streams are commonly reported. However, different to equity investments, net income valuation drivers will show the dividend income only, thus potentially understating the true economic contribution reflected by net income of the investment (Damodaran, 2005a, p. 46)[487]
- Balance sheets will usually reflect reasonable proxies for market value as in many instances a mark-to-market takes place, arguably advantageous over equity investments in the context of multiple calculations

From the above follows that, for enterprise value multiples, minority passive investments are best dealt with like equity investments, namely by subtracting their value from enterprise value, whilst no adjustment is needed for the valuation driver. For equity value multiples, an adjustment could be considered to "gross up" the dividend contribution to a more economically relevant net income contribution of the investment.[488]

[486] A detailed description on accounting aspects of each category is provided by the sources indicated, also considering designated fair value investments as a forth group (Williams, 2009, p. 609)

[487] In certain situations other aspects might be reflected in income statements, consider (Williams, 2009, pp. 610–611) for an illustrative numerical example with further details

[488] While theoretically convincing, the issue with such an adjustment is that not all minority passive investments are treated equally (i.e., in some instances additional aspects are reflected in the parent's income statement)

5.3.4 Timing aspects of accounting consolidation

Another consistency adjustment might arise from acquisition or disposal situations the firm under investigation could be involved in (Pratt, 2008, p. 300). In case a firm announces a sizable acquisition or divestiture and under the assumption of a widespread view among investors and the equity research analyst community that this transaction will eventually complete successfully—only after which P&L and balance sheet financials will reflect the effect of the acquisition or disposal[489]—a disconnect between measured price—for which there is ample evidence it reacts swiftly around the day of announcement to M&A transactions[490]—and (unadjusted) valuation drivers, the adjustment of which relies on accounting principles for acquisitions in connection with equity research community estimates on when the transaction will close, could result. This would introduce a bias for near-term future or historical valuation drivers, while longer-term e.g. two/three period forward valuation drivers might turn out consistent automatically since they might be pro forma for the acquisition or disposal, which will be expected to have completed by that time. This potential valuation driver inconsistency might be aggravated by a net debt or share count inconsistency to the extent the uncompleted transaction is financed with cash or acquirer shares, respectively.

A possible consistency adjustment would hence need to relate to both the numerator (price reference) and denominator (valuation driver) in that both figures will need to be "pro forma'ed" through (Rosenbaum & Pearl, 2009, pp. 43–44):

- Addition[491] of the acquired firm's valuation driver[492] contribution for the full time period the valuation driver relates to until anticipated completion—and hence pro forma consolidation—of the transaction
- Addition of the cash purchase price[493] or the value of the acquirer shares granted to the net financial debt of the acquirer as well as addition of any net financial debt assumed as part of the transaction[494]

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and informational limitations regarding available details from company reporting might render appropriate adjustments challenging in practice

[489] See Hoyle et al. (2011, pp. 41–44) for a more detailed discussion on the consolidation timing in the context of acquisitions, crucial is the acquirer achieving control

[490] See among many Campa and Hernando (2004) or Jensen and Ruback (1983)

[491] or subtraction for a disposal

[492] In the case of typical enterprise value valuation drivers such as EBIT, EBITDA and net sales; for earnings, more complex adjustments might be necessary to reflect the financing structure chosen by the acquirer

[493] Possibly including the dilution effect from share offerings at a discount (Massari et al., 2016, pp. 337–338)

[494] In the context of a disposal: reduction of the net financial debt by the compensation received for the disposed business in addition to any net financial debt contributed to the disposed business ahead of disposal

The premise of this adjustment is that the market price will immediately reflect the transaction impact but valuation driver consolidation and transaction financing required will hit the financial statements later, with the time period to the closing date of the transaction requiring adjustment as if the combined entity would have always operated in a combined manner.[495] I argue that some of the yet unexplained empirical results on multiple valuation accuracy improvements as valuation drivers are taken from time periods further in the future may relate to a lack of proper M&A adjustments in prior studies[496] and will propose a parsimonious elimination approach to test this aspect later in this dissertation.[497]

5.4 Financial claim adjustments

5.4.1 Economic aspects with potential valuation impact

A number of economic aspects suggest further adjustments of multiples might be on order. While they are heterogeneous in nature, they broadly fall into 2 categories:[498] Adjustments in light of aspects, which will eventually positively or negatively impact *net debt* such as future pension benefits or deferred tax liabilities/credits as well as *hybrid adjustments* for stock dilution, convertible debt or preferred equity. Those adjustments are not prompted by consistency considerations but for the most part seek to better incorporate economic realities in calculating enterprise value specifically such that it reflects possible claims or future benefits from various stakeholders of the company for which the multiple is computed. They can be considered an expression of valuing the operations of a firm separately to financial aspects, which is an ambition in multiple valuation since the operations are what is considered comparable in a narrower sense (Seppelfricke, 2014, p. 157; Koller et al., 2010, pp. 275–276).

[495] Note as is immediately obvious when considering historical valuation drivers, it is not appropriate to only adjust for the time period between announcement and closing according to this logic. When it comes to the valuation driver, its full time span needs to reflect a pro forma situation. The complexity—and cost—of such M&A consistency adjustments lies in the fact that consensus estimates may in themselves be erratic as to when (if at all) the underlying broker reports consider a transaction to be closing, which will usually require a careful broker-by-broker assessment. Moreover, information on proper adjustments might need to be estimated in particular for non-publicly traded target companies with limited public financial records

[496] See Subsection 2.3.2.2, p. 42

[497] Namely the exclusion of “M&A firms,” see Subsection 7.5 (p. 287)

[498] Following the proposed enterprise value to equity value bridge proposed by Koller et al. (2010, p. 274)

5.4.2 Debt-like items: pensions and post-retirement benefits

Pensions and post-retirement benefits[499] can create future liabilities and the question arises whether future pension liabilities warrant an adjustment to net debt in the context of enterprise value computations. In the instance of pensions, one can differentiate between defined contribution and defined benefit plans (among many: Kieso et al., 2013, p. 1185; Henry and Gordon, 2009a, pp. 556–559; Wahlen et al., 2010, pp. 672–673). While defined contribution plans are widely considered straightforward accounting-wise (Wahlen et al., 2010, p. 673) and from a valuation perspective (Koller, Goedhart, & Wessels, 2005, p. 349) since the company has fulfilled its obligation by contributing the agreed amounts,[500] *defined benefit plans* merit further analysis for a number of reasons:

- *Uncertainty around the quantity of the pension obligation:* Future benefits are subject to a variety of factors unknown today, thus the eventual amounts payable under the arrangements need to be estimated. This challenge can be overcome with the help of actuarial computations, which estimate the net present values of the obligation

- *Wide range of funded status policies:* Companies will follow different approaches to funding their plans, with empirical data indicating some common practices by industry[501] and regional differences.[502] The merit of adjustment will depend on the gap in the funded status of the plans with a well-funded plan causing a smaller[503] adjustment

- *Accounting complexity:* Pension accounting is a comparably complex matter, so costs for the valuation practitioner associated to a detailed assessment of economic substance might be considerable. Furthermore, there are some differences between accounting standards and alternative elections within standards—in particular when it comes to

[499] For the purposes of multiple computations, post-retirement benefits are economically similar to defined benefit pensions, whilst usually not pre-funded (Henry & Gordon, 2009a, p. 558). The discussion can therefore focus on pensions, which applies in a similar manner to post retirement benefits

[500] See, however, the discussion by Chullen et al. (2015, p. 641) regarding cash wage substitution and pensions: Assuming employees would not consider pension contributions equal to salaries/wages (i.e. implied 100% cash wage substitution) one could argue for an adjustment at an appropriate cash wage substitution differing from 100% to compare firms, which offer defined contribution plans to firms, which do not, in order to compare cost structures and ultimately valuation drivers of the 2 different scenarios

[501] E.g. Koller et al. (2005, p. 349) find that in the U.S. airline industry all 21 firms studied had underfunded pensions greater than 10% of enterprise value; moreover, defined benefit plans are more common in some of the traditional industries, with defined contribution plans gaining more and more in popularity (Kieso et al., 2013, p. 1186)

[502] E.g. the much-quoted example of Germany where companies have historically not funded pensions at all and used them as a source of financing much like working capital (Chullen et al., 2015, p. 640; Henry & Gordon, 2009a, p. 557)

[503] if not even a negative

considering pension expenses above operating profit vs. in financial expenses[504] vs. in other comprehensive income.[505] [506]

Which concrete adjustments for pensions and post-retirement benefits are advisable in the context of multiple valuation? Massari et al. (2016, p. 131) argues that future pension liabilities can conceptually be considered in one of two ways, either as personnel costs with delayed payment[507] or as a way of financing granted by employees and hence part of debt. Probably more common is the latter approach, advocated for by Koller et al. (2010, p. 587):[508]

- *Adjustment to the price reference (numerator of the multiple):* For enterprise value multiples, this entails considering the funded status of pension and post-retirement benefit plans as a debt-like item, increasing enterprise value in case of underfunding. Subsequent to a change of rules in 2006, the funded status balance sheets prepared in accordance with U.S. GAAP reflect the funded status well, while under IFRS there continue to be certain smoothing adjustments available to the balance sheet presentation.[509] Since any contributions to pension plans are normally tax-deductible by the firm as corporate expenses, an after-tax value can be utilized, which is obtained by multiplying the funded status with one minus the tax rate of the firm (Koller et al., 2010, p. 587).[510] The adjustment to enterprise value is relatively straightforward and inputs are also available from commercial market data providers

- *Consistency adjustment to the valuation driver (denominator of the multiple):* The question then arises if a corresponding consistency adjustment to the valuation driver regarding pension expenses is necessary, once the above adjustment to the price reference

[504] As an example, under U.S. GAAP, interest costs are part of operating costs, under IFRS they are part of financing costs (Koller et al., 2015, p. 416) and German Generally Accepted Accounting Principles (GAAP) there used to be optionality (Schacht & Fackler, 2009, p. 255), whilst since 2010 they have been part of operating costs (Chullen et al., 2015, p. 641)

[505] E.g. under U.S. GAAP re-measurements of plan assets are amortized utilizing a corridor approach, whereas they fall into other comprehensive income under U.S. GAAP (Kieso et al., 2013, pp. 1251–1252)

[506] Pension accounting has moreover been subject to considerable change and further changes are likely (Koller et al., 2015, p. 415; Kieso et al., 2013, p. 1263), rendering longer-term historical analyses with through-the-cycle multiples complex

[507] And hence part of a very long-term working capital

[508] And rendered more concrete in the latest edition (Koller et al., 2015, p. 416)

[509] However, footnotes will provide more precise indications to derive the funded status (Henry & Gordon, 2009a, pp. 561–562)

[510] Damodaran (2005a, p. 50) discusses the fact that punitive taxation may result if a company is seeking to unwind over-funded pension plans to the benefit of its shareholders; none the less, under the “going concern” assumption it is probably reasonable to apply the firm’s tax rate rather than the punitive higher rate to over-funded plans, since companies could elect to contribute less to the plans and hence balancing out the surplus

for enterprise value multiples has been undertaken. Pension expense recognition is somewhat more complex and there are challenges to unwind the economic substance most suitable for multiple computation purposes. Koller et al. (2015, p. 416) suggest that the overall accounting pension expense is added to the valuation driver to then subtract the service cost and amortization of prior service costs. This approach allows to disregard costs associated to the financial nature of pension plans, namely returns on plan assets and interest cost and is consistent with concerns raised by other authors (Schacht & Fackler, 2009, p. 255; Seppelfricke, 2014, p. 158; Schmitt, 2005b, p. 113), in that there is a risk of double-counting if interest- or interest-like expenses are subtracted from the valuation driver and at the same time corresponding debt-like items are added to the price reference. Fortunately, companies reporting under IFRS are more straightforward to deal with compared to firms reporting under U.S. GAAP since the pension expenses reported in operating costs under IFRS are closer to the above definition of service cost add-backs and hence no adjustment to the valuation drivers will be required (Koller et al., 2015, p. 416). Finally, expenses connected to defined contribution plans should not be adjusted for if considered a form of salary/wage sacrifice or substitution[511]

5.4.3 Cash-like items: Tax loss carryfowards

Tax accounting poses another relatively complex aspect to company valuation and the scope of potential adjustments to better express economic substance for multiples will be affected by disclosure limitations (Koller et al., 2010, pp. 543–544). In light of the character of multiples as a single-period valuation methodology the merits of considering detailed adjustments to valuation drivers as a consequence of deferred tax assets and deferred tax liabilities connected to the tax treatment of aspects like warranties, accelerated depreciation for tax purposes, acquired intangible taxation and pension contribution taxation will likely be small compared to the costs of collecting the information for a large peer sample.[512] None the less, one specific aspect of taxes, *tax loss carryforwards*, may warrant an adjustment (Massari et al., 2016, pp. 335–336; Seppelfricke, 2014, p. 158).[513] The argument is that tax loss carryforwards will be reflected by investors as part of market capitalization but are not operating in nature and

[511] i.e. are in lieu of direct salary/wage expenses

[512] See e.g. the discussion by Koller et al. (2010, pp. 543–557) on potential adjustments. There can be relevance in particular for determining an appropriate cash tax rate for multiples utilizing taxed EBIT as a valuation driver

[513] Also referred to as “net operating losses (NOL)” in a U.S. context (Koller et al., 2010, p. 555) or “tax credits” (Massari et al., 2016, p. 335)

hence have no equivalence in any of the common valuation drivers utilized for both enterprise and equity value multiples. Consequently, they should be subtracted as a cash like item from net debt, reducing enterprise value.[514]

There are, however, some considerations regarding this adjustment, which require further firm-specific diligence (Koller et al., 2010, p. 555): In many instances, tax loss carryforwards are limited in time and the company will require enough taxable earnings to ensure they can be fully utilized.[515] Since NOLs might be utilized over time, their balance sheet value should be discounted according to the schedule of expected utilization. Finally, it might not be straightforward to match earnings to eligible tax loss carryforwards, in particular given the territorial nature of tax loss carryfowards. Therefore, some valuation practitioners may elect to consider them in a multiple valuation on a case-by-case basis only if material.

5.4.4 Hybrid items I: Preferred stock and convertibles

Two hybrid forms of financing are *preferred stock* and *convertible debt*. They bear resemblance to both equity and debt and consequently questions arise how to treat them in a multiple valuation and if any particular adjustments are required.

5.4.4.1 Preferred stock

Preferred stock relates to instruments, which usually pay a fixed divided with preference over ordinary shares and have higher-ranked liquidation claims than common stock but in contrast to debt are unsecured. None the less, for the purposed of multiple computation, preferred stock issued by *North American* companies economically more closely resembles debt[516] more than equity (Koller et al., 2010, p. 119; Ross et al., 2005, pp. 392–393). Therefore, it should be added to net debt as a debt-like item when it comes to the price reference. Since preferred stock affords no guaranteed dividend claims, it is usually reported within equity[517] (Kieso et al., 2013, p. 836; Robinson, van Greuning, Henry, & Broidhahn, 2009b, p. 194). From a consistency perspective it should hence be backed out of the book value of equity for

[514] Massari et al. (2016, p. 336) presents an adjustment to equity value in a numerical example

[515] This might be a topic of particular relevance for distressed firms with high NOLs relative to their current and foreseeable future earnings, where Gilson et al. (2000, pp. 57–58) find NOL contributions to value of up to 55%

[516] Preferred stocks' equity-like aspects regarding specific tax treatment (e.g. no deduction of dividends from corporate tax—unlike interest) as well as on lack of maturity date and no entitlement to receive a regular dividend payment—as long as equity holders don't receive one (Ross et al., 2005, pp. 392–393; Kieso et al., 2013, pp. 835–836), are of lesser relevance from a multiple valuation perspective

[517] Under both U.S. GAAP and IFRS

market-to-book value multiples.[518]

When it comes to preferred stock of European companies, the situation is somewhat different: Instruments like German *"Vorzugsaktien"* (Matschke & Brösel, 2013, p. 97) bear much closer resemblance to a second class of ordinary shares: They are stock-exchange traded, in many instances with higher liquidity than their ordinary share counterparts, dividends will vary only by a very minor amount to those of ordinary shares; the main economic difference is the lack of/substantially lower voting power compared to ordinary shares.[519] Accordingly, those types of preferred shares should be treated as equity and will usually be reflected in market capitalization.[520]

5.4.4.2 Convertible debt

Convertible debt is a hybrid form of financing, starting its life as debt, which, subject to certain conditions, can be converted into equity. The value of the instrument, which can economically be considered a combination of a bond and a warrant, will depend on the overall enterprise value in a non-linear fashion: for low equity values (warrant out of the money) it will trade consistent with a debt instrument, for high equity values (warrant in the money), it will trade as equity (Fabozzi, 2004, p. 404).[521] [522]

The accounting treatment of convertible debt differs between the major standards. Under U.S. GAAP, convertibles are accounted for like debt without conversion option, under IFRS, both the debt-like liability and the equity component[523] are recorded (Kieso et al., 2013, p. 885; Henry & Gordon, 2009b, p. 520). This suggests that in particular for firms reporting under U.S. GAAP, an adjustment to reflect the divergence between the book value and the economic value of convertibles regarding their conversion feature might be appropriate in determining

[518] According to statistics presented by Robinson et al. (2009b, pp. 204–205), in the United States, preferred stock is a minor balance sheet item anyways, accounting for nil percent of total balance sheet values in many industries and less than 1% for all industries (median values for the S&P500)

[519] Historically, preferred shares have been issued to allow families to retain voting control in publicly companies, while providing investors with exposure to public companies much like ordinary shares in situations where this objective could not have been achieved by issuing a second class of ordinary shares given regulatory environment

[520] This is consistent with the implicit view of Drukarczyk and Schüler (2007, p. 274) on the consideration of preferred shares as part of equity during weighted average cost of capital computation

[521] Also consider the instructive chart presented by Spremann and Gantenbein, 2005, p. 121 on this aspect

[522] Convertible bonds have been studied extensively empirically. According to Stein (1992) convertibles are issued in lieu of straight equity to mitigate some of the negative aspects of equity issuance and further evidence on the leverage-reducing effect of convertible issuances expressed by volatility reductions is provided by Deglmann (2006)

[523] Residual between fair value of the convertible (i.e. the price at which the convertible sold) and the debt-like liability determined via a discounted-cash-flow approach, with no re-measurement taking place for subsequent movements in convertible market value

enterprise value:[524] Koller et al. (2010, pp. 286–287) suggest three alternatives: *market value approach*, where the current trading value of the convertibles are utilized; a *Black–Scholes valuation* model;[525] a *conversion-today approach*, which disregards any potential upside from out-of-money convertibles moving into the money until maturity.[526] Since convertible bonds for publicly traded companies are commonly traded instruments, it appears that in the context of a multiple valuation, the first approach might be most appropriate.

5.4.5 Hybrid items II: ESOPs and other potential future stock dilution

5.4.5.1 Employee share option programs

In efforts to incentivize employees, many public companies are providing equity-based compensation schemes,[527] commonly through participation in employee share option program (ESOP) schemes, in which employees are granted the option[528] to purchase shares at a predetermined share price some time in future under the expectation that the share price by that time will be higher than the predetermined exercise share price.[529] The question then arises if such programs require any adjustments to multiples and if so how can those best be accomplished, the more as there is widespread acceptance that ESOPs do affect enterprise value to equity value bridges (among many: Koller et al., 2010, pp. 288–290; Rosenbaum and Pearl, 2009, pp. 28,32): Under the assumption that (a) investors will consider the potentially dilutive effect of ESOPs in the measured price such as market capitalization and (b) ESOPs will vary in nature and quantum between companies forming a peer group and therefore normalization for them will be beneficial to valuation accuracy, there is a convincing adjustment logic and some of the practitioner guides on multiple calculation have picked up on this aspect (compare e.g.

[524] Whilst convertibles under IFRS "start off" with a market value accounted for as the combined debt liability and equity component, the lack of revaluation leads to an eventual value disparity, hence a valuation discrepancy between market value and book value gradually emerges, which should be corrected for

[525] Which is also advocated for when it comes to convertible valuation in more focused literature regarding convertibles and warrants such as Hull (2003, pp. 652–653, 622) or even more sophisticated models such as binomial lattice models utilized for ESOPs (Damodaran, 2005b, p. 30; see Damodaran (2012a, p. 104) for an explanation from Black–Scholes to binomial models). There is, however, empirical evidence that the choice of valuation models has limited impact on valuation outcomes (Ammann & Seiz, 2004)

[526] Which the other two approaches do reflect. According to this approach, only convertibles in the money at valuation date will require an adjustment relative to book value

[527] Historically those programs were particularly popular among U.S. companies (Damodaran, 2005b, p. 3) but following changes in regulation more recently also in European markets such as Germany (Krolle, 2005a, p. 135)

[528] But not the obligation

[529] ESOPs offer a number of attractions, including alignment of shareholder and employee objectives, compensation opportunities despite low cash balances for young high-growth companies, retention of staff through connection of ESOPs to a future vesting period post granting of the options and favorable accounting and tax treatment (Damodaran, 2005b, pp. 3–4)

Krolle, 2005a; Damodaran, 2005b, pp. 34–36).[530]

Conceptually, dilution is a hybrid claim affecting the price reference, and consequently the adjustment should start there in the first place. A number of adjustment methodologies have been suggested (Koller et al., 2010, p. 289; Rosenbaum & Pearl, 2009, pp. 28–29; Damodaran, 2005b, pp. 21–34; Krolle, 2005a, pp. 151–164):

- *Reported dilution:* This approach entails consideration of the fully diluted number of shares as reported by the company: Under both IFRS and U.S. GAAP, companies are required to report basic and fully diluted EPS (Robinson, van Greuning, Henry, & Broidhahn, 2009c, pp. 149–151). This allows to imply a dilution ratio which can be used to modify other metrics calculated on basic share count such as to notably compute a modified market capitalization including dilution.[531] The limitations of the method are that (a) it might at times require detailed research to identify the dilutive effect of ESOPs in an isolated manner since other aspects—notably convertible debt or warrants—may also cause dilution, and (b) the dilution calculations presented by the companies are based on retrospective share prices rather than the current share price at valuation dates. The considerable advantage of this concept, which ultimately can result in "dilution factors" defined as basic divided by diluted earnings per share is that it can be applied using information readily available in financial databases.[532] Notably, a careful and time-intensive review of financial statement footnotes for each peer company can be avoided

- *Treasury Stock Method:* Dilution calculations required by accounting standards will be based on the "Treasury Stock Method," which assumes that the company utilizes any option proceeds to buy back shares at current share price to then issue new shares for the exceeding balance. With the information provided in the notes to the financial statements, it is possible to re-calculate the diluted number of shares reflecting the share price at valuation date, either considering only options, which are exercisable or all outstanding options even if not vested yet, with the latter being the more conservative

[530] Note that the discussion usually centers on the "negative" aspects of dilution at the expense of shareholders, not potentially positive effects on financial results, which has been studied extensively over the last 20 or so years and continues to be subject to empirical analyses, compare among many others S. Chang and Mayers (1992) X. Chang, Fu, Low, and Zhang (2015) and K. Y. Kim and Patel (2017) but none the less remains challenging to uniformly quantify

[531] Sometimes referred to as "equity value" (Rosenbaum & Pearl, 2009, p. 28; Damodaran, 2012a, p. 219)

[532] For this reason, dilution factors are the approach of choice in the empirical part of this dissertation. I require dilution factors to be 1 at the minimum (i.e. no negative dilution) and set the dilution factor to 1 if it cannot be computed due to lack of data availability

approach (Rosenbaum & Pearl, 2009, p. 28). While academics and textbooks do not favor the concept since it disregards the time value (Koller et al., 2010, p. 289) and treats vesting periods in an ambiguous manner (Damodaran, 2005b, p. 35), the Treasury Stock Method is popular among practitioners, since it is seen as a more precise approach to the "reported dilution" method but at the same time does not require input variables for comprehensive option valuation mechanisms. It is necessary to consult the individual peer company financial statement notes for its application, which might be tedious for multiple valuation

- *Option valuation models:* Similarly to the valuation of the warrant feature of convertible debt,[533] a more sophisticated and theoretically preferable approach is to utilize option pricing theory—i.e. Black–Scholes models or binomial models—to determine the market value of ESOPs (Damodaran, 2005b, pp. 29–32). Financial statement notes will provide the overall value of ESOPs utilizing such methods, including input variables utilized for the calculation (Koller et al., 2010, p. 289). However, as is the case with "reported dilution," peer-by-peer re-calculations will be necessary to reflect the share price at current valuation date

The above choices highlight two dimensions of accuracy relevant to multiple valuation, method—where option valuation models are theoretically preferable over the Treasury Stock Method—and timeliness—where a specifically computed value corresponding to the valuation date share price is preferable over historical "boiler plate" valuations provided in the notes to the financial statements.

Considering dilution through ESOPs is furthermore a topic applicable to both enterprise value and equity value multiples (Krolle, 2005a, pp. 164, 170).[534] Krolle (2005a, pp. 143–147) furthermore discusses whether the above adjustment to the price reference should also prompt a consistency adjustment to the valuation driver: If the price reference is normalized, so should be the corresponding expense line item; depending on the industry, ESOPs do have a material earnings effect (Damodaran, 2005b, pp. 18–20) and typically result in a non-cash cost line item recognized in the net income calculation relating to employee expenses.[535] [536]

[533] See Subsection 5.4.4.2, p. 155

[534] since it is not a consistency adjustment

[535] For U.S. GAAP this was introduced in 2004 through a revision of SFAS 123, 123R, (Subramanyam & Wild, 2009, p. 359) following similar rules in IFRS 2 (Poitras, 2007); see Christian and Lüdenbach (2013, pp. 381–382) for more details on expense accounting under IFRS; historically, it had been optional to include ESOP expenses into net income

[536] If one was to compare a company running ESOPs with an identical company who does not, assuming ESOPs—as in the case of pensions (Compare Footnote 500, p. 151)—are 100% cash wage substitutions,

5.4.5.2 Non-ESOP options and warrants

Options and warrants issued separately from ESOPs can be considered consistently with ESOPs as described above. The fact that the counterpart is an investor and not an employee of the company should economically not matter (Massari et al., 2016, p. 339), even if commercial terms for ESOPs and other types of options might differ and hence specific option valuation methodologies also incorporating vesting periods might be more appropriate for the former types (Ammann & Seiz, 2005).[537]

5.5 Business model comparability adjustments

5.5.1 Leases

The differentiation between operating and capital leases from a multiple valuation perspective Leasing concepts—in essence arrangements to buy or rent assets over time (Henry & Gordon, 2009b, p. 527)—have increasingly developed into an important alternative to outright asset purchases.[538] Depending on the nature of the leasing contract, leases can be classified as either *capital leases*[539]—which are closer to purchases over time—or *operating leases*—which bear more resemblance to rentals—and certain criteria determine, which classification applies to any specific leasing contract.[540] At the writing of this dissertation, following long debates among the standard setters, operating lease accounting rules are changing, with new standards under both IFRS[541] and U.S. GAAP[542] coming into force from 2019 onwards

one could argue that the option issue expense might be a reasonably good proxy for wages and salaries paid otherwise, so no adjustment would be required. Any more precise adjustment might be nontrivial to undertake consistently in practice and its costs for the preparer of a multiple valuation might be considerable. Concerns have been raised that the economic effects of ESOPs, in particular P&L impact of value shifts due to share price movements cannot be fully understood on the basis of reporting standards in any event (Krolle, 2005a, p. 151)

[537] This is notably disregarding any positive impact of ESOPs on company value through a presumably more motivated workforce, which appears nontrivial to quantify

[538] According to the SEC, 77% of U.S. public companies have operating leases with undisclosed future cash obligations amounting to $1.25 trillion (Koller et al., 2010, p. 575); the ratio of leased in total assets in the U.S. is approximately 30 %, while for Germany product leasing quotas have historically been approximately 25% (Drukarczyk & Schüler, 2007, p. 305)

[539] also at times referred to as “financial leases”

[540] See Henry and Gordon (2009b, p. 528), Christian and Lüdenbach (2013, pp. 128–131) and Kieso et al. (2013, pp. 1274–1283) among many others for as discussion of those criteria under U.S. GAAP and IFRS, which show general similarity, however, differ in details

[541] IFRS 19

[542] ASU 2016-02 or ASC 842

(PricewaterhouseCoopers, 2017, pp. 1–10; PricewaterhouseCoopers, 2016, p. 2).[543] Also to allow for longer-term benchmarking and the consideration of historical empirical samples, it is instructive to provide an overview of the historical and anticipated future situation of lease accounting from the perspective of multiple adjustments and computations.

The situation up until the end of 2018 While capital leases are generally regarded as unproblematic from a multiple valuation perspective[544] since they are accounted for as if the asset would have been owned by the company—i.e. as an asset and a corresponding debt item (lease payable)—there have historically been considerable discussions around operating leases: While, for valuation purposes, they should be economically considered traditional assets (with corresponding debt) (Schmitt, 2005a, p. 104), operating leases are amongst the two "most common forms" of off-balance sheet debt (Koller et al., 2010, p. 575), since there are in essence no traces of assets or lease liabilities in the balance sheet (Henry & Gordon, 2009b, p. 528). This leads to biased results for metrics such as return on invested capital (Koller et al., 2010, p. 575) and the question arises whether adjustments to multiples are on order.[545] Indeed, an adjustment should be undertaken, as firms relying in operating leases will have distortedly low enterprise value numbers—given artificially low debt[546]—and, equally, low EBIT and EBITDA numbers given the lease expenses include an interest component (Koller et al., 2010, p. 325). The objective of the adjustment is to treat operating leases as if they were capital leases, which then allows for a close comparison to a situation in which the assets had been purchased outright (Schmitt, 2005a, p. 104). This can be achieved by (a) capitalizing the value of operating lease-assets on the balance sheet and (b) removing any costs in the P&L relating to interest expenses as far as a valuation driver pre interest expenses such as EBIT or EBITDA is concerned.[547]

The value of the operating lease-assets is not typically reported by lessee firms; instead, it requires estimation, for which Koller et al. (2010, p. 583) present a number of approaches,

[543] The new standards will be applicable to the entire lease portfolio, i.e. even on leases agreed prior to the standards becoming effective (PricewaterhouseCoopers, 2016, p. 13)—there is, however, grandfathering for the determination of a contract contains a lease element at all (Deloitte, 2016, p. 3) and retroactive balance sheet restatements are optional (Deloitte, 2016, p. 9)

[544] Due to the fact that capital (or financial) lease accounting broadly mirrors outright ownership; Arzac (2008, p. 67) highlights minor additional insurance and maintenance charges, but one could argue that some of those charges may arise for outrightly owned assets, as well

[545] For the purposes of this dissertation, the focus is on the lessee rather than the lessor, since lessors are in most instances specialist finance companies, to which industry-specific multiples and other valuation concepts apply; see Subsection 5.5.3.2 (p. 163)

[546] I.e. relative to asset purchases

[547] As Damodaran (2006, p. 86) puts it "[an] adjustment for financing expenses that accountants treat as operating expenses"

with a preference for determining the value on the basis of estimates for the asset life in years, the rental expense and the cost of debt.[548] [549] A popular alternative is a similar calculation but on the basis of the present value of lease commitments (Damodaran, 2006, p. 87; Moody's Investor Service, 2016, p. 10; Standard & Poor's Ratings Services, 2013, p. 24).[550] It appears the latter alternative is preferable, as companies will often lease specific asset types but not others, resulting in challenging asset life estimates. Moody's Investor Service (2016, pp. 10–11; 2018, pp. 11–13) utilizes in parallel a parsimonious method, applying an industry-specific multiple of 3–6x to the annual lease expense.[551]

The operating lease interest component, which is not typically reported in financial statements, can be determined through multiplying the cost of debt estimate with the value estimate, potentially capping it at the lease expense (Moody's Investor Service, 2016, p. 11), whilst the residual of the lease expense can be assumed to be depreciation.[552] This allows for computation of an adjusted EBIT and EBITDA as multiple valuation drivers.[553] As Koller et al. (2010, p. 579) point out, operating leases affect invested capital—requiring multiples based on invested capital to be adjusted by adding operating lease asset values. Somewhat consistently with this view, Moody's Investor Service (2016, p. 11) reclassifies the depreciation expense from operating cash flow to capital expenditures for rating purposes.

Schmitt (2005a, p. 108) argues that earnings-based equity value multiples do not require any adjustment for operating leases. While such adjustments would practically indeed be rather uncommon, there is a potential theoretical case to make that equity value does depend on

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[548]The equation suggested by (Koller et al., 2010, p. 583) is as follows

$$Operating\ lease\ asset\ value_{i,t-1} = \frac{Lease\ expense_{i,t}}{r_i^d + \frac{1}{Asset\ life_i}} \tag{5.1}$$

where asset life according to Koller et al. (2010, p. 583) and Lim, Mann, and Mihov (2003) can be determined on the basis of property, plant and equipment divided by PP&E depreciation

[549]This approach is conceptually similar to Schmitt (2005a, p. 106)

[550]There is some discussion as to the right discount rate with Koller et al. (2010, p. 583) arguing for utilizing the yield of a AA-rated instrument given the secured nature of the debt, Moody's Investor Service (2016, p. 24), Schmitt (2005a, p. 106) and Damodaran (2006, p. 87) using an interest rate consistent with the overall rating or risk profile and Standard & Poor's Ratings Services (2013, p. 24) using a constant 7% in all cases

[551]The larger of the multiple and discounted future value approach is then chosen, with a cap at 10x annual lease expense. Compare Moody's Investor Service (2018, pp. 24–25) for capitalization multiples

[552]This approach has superseded more simplistic assumptions based on apportioning formulas, where 1/3 of lease expenses were considered interest and the remainder depreciation (Moody's Investor Service, 2012, p. 3)

[553]According to this approach, for EBITDA, there is in essence a full adjustment of the lease expense, which disregards any maintenance costs related to the leased asset. Following Schmitt (2005a, p. 105) this is an acceptable simplification since the lease adjustment is subject to numerous simplifications and estimates anyhow. The EBITDA obtained in this manner is sometimes referred to as EBITDA**R**, i.e. EBITDA before rent expenses (Koller et al., 2010, pp. 180–181)

the use of operating leases given tax shields (compared to equity financing) and monitoring benefits (compared to debt financing) (Koller et al., 2010, p. 582)—none the less a meaningful adjustment of equity value multiples seems challenging in practice.

A brief preview on the situation from 2019 onwards Starting in 2019, revised accounting standards on operating leases will come into effect. Whilst they are expected to cause substantial impact on financial statement line items, reporting systems and potentially even corporate decision making (PricewaterhouseCoopers, 2016, p. 2), the revisions will lead to a treatment of operating leases much closer to capital leases. In fact, the distinction between the two lease types becomes irrelevant from a lessee perspective, with leases requiring to be activated on the balance sheet as a "right of use asset" (Deloitte, 2016, p. 3).[554] For the purpose of multiple computation, the new rules should therefore mean a simplification in that no adjustments might be required going forward (Moody's Investor Service, 2018, pp. 9–11). As Koller et al. (2010, p. 582) remark, at least theoretically, equity valuation should be independent of operating lease *accounting*.

5.5.2 Other non-operating assets

Damodaran (2005a, pp. 49–50) and Koller et al. (2010, p. 281) discuss a number of other non-operating assets, most notably unused real estate. However, as Damodaran (2005a, p. 50) admits, there are considerable measurement challenges, in particular if no internal company information is available, hence any adjustments will face practical challenges around quantification.[555]

5.5.3 Conglomerates and financing companies

5.5.3.1 Business units

As set out in Subsection 6.2 (p. 185), peer group multiples are commonly calculated on the basis of industry affiliation given there is an assumption that companies operating in comparable industries will have similar business models and hence should be comparable valuation-wise.

554 With the exception of short-term leases for less than 12 months and lower-value assets, under IFRS with initial value of less than $5,000 (PricewaterhouseCoopers, 2016, p. 2), under U.S. GAAP according to a "reasonable capitalization policy" set by each firm (Deloitte, 2016, p. 109). The impact can hence be expected to be greatest for companies leasing valuable assets such as e.g. airline companies but might be much less impactful on administration-heavy firms leasing office and IT equipment

555 Other non-operating assets are often times only considered from a financial asset perspective (Seppelfricke, 2014, p. 158) as covered separately in the preceding sections

In reality, many companies will have different strategies around business units—ranging from focused single-product/single market players to widely diversified conglomerates— but also around aspects of the value chain they focus on and consequently means to operating or outsourcing those value chain elements. In many instances, a single business unit—but not the whole firm—would make a "great comp" for multiple valuation, so the question arises, whether—by means of adjustment—such business unit can be included in the peer set. One potential approach could be the use of *sum-of-the-parts valuation approaches* (Koller et al., 2010, pp. 304–306; Arzac, 2008, pp. 324–332). However, since price references are only available for the whole conglomerate, such valuation will be heavily based on estimates around business unit value: in fact it is common to derive such business unit value estimates on the basis of peer multiple valuations, leading to circularities. So reliance on adjustments, which isolate certain business units sum of the parts valuations as inputs to multiple valuations will usually be challenging.

5.5.3.2 Financing subsidiaries

A more realistic approach compared to eliminating business units for multiple valuation might me to exclude certain—size-wise subordinated but none the less relevant—business units, which are specific to some but not all peers in the sector, or which by virtue of their nature require different valuation concepts or multiple valuation drivers. This is the case for *financing subsidiaries* (Koller et al., 2010, pp. 278–280), through which some firms provide longer-term financing of their products to their customer base. Those entities might also act as lessors in leasing contracts.[556] Koller et al. (2010, pp. 278–280) provide some guidance to address financing subsidiaries in fundamental valuations, in essence through a separate valuation of the operating/manufacturing and financing entities. In the context of multiple valuations, this would introduce considerable complexity through reliance of the price reference for the operating company—to be used as peer—on a valuation for the financing company—to be disregarded, i.e. subtracted from consolidated value. Therefore, the most appropriate way to reflect financing subsidiaries in multiple valuation might be to consider them through the concept of "consistent inconsistency"[557] under the assumption that there are elements of industry commonality or—if too substantial—disregard firms with such entities in peer group formation.

[556] See Subsection 5.5.1 (p. 159) for further details on lease accounting and multiple valuation consequences, however, mainly from a lessee perspective

[557] Compare Subsection 5.1.3.2, p. 135

5.5.4 Receivables policies and working capital fluctuations

5.5.4.1 Receivable securization

Firms may elect to sell on receivables to specialist receivable collection companies at a *discount* to their fair value, but with the benefit of *accelerated cash inflows*. Since net financial debt reflects cash, such companies would have lower net debt balances and higher working capital (Koller et al., 2010, pp. 585–586). Therefore, a careful multiple calculation could consider securitized receiveables via a re-classification of the cash received into accounts receivable.[558] An adjustment might not be required if all firms under investigation are involved to a similar extent in receivable securitization, however, according to the principle of "consistent inconsistency."[559]

5.5.4.2 Working capital fluctuations

In M&A transactions it is common for the target company to be delivered to the buyer with a level of working capital consistent with *medium-term average levels* (Ernst & Young, 2012, p. 3; Miller, 2008, p. 212), which might be determined by comparing working capital levels at the change of control with historical averages for the firm or—possibly less frequently—historical industry averages (Roberts, 2009, pp. 314–315). An adjustment to purchase price is made to cover the difference.[560]

A similar concept can be applied to a carefully constructed multiple analysis: Assuming investors track working capital levels of a company, the price reference would positively reflect extraordinarily high and negatively reflect extraordinarily low levels of working capital; Unless there are specific reasons such as extraordinary growth, materially changing business performance or a new working capital strategy, investors would anticipate those levels to eventually revert to longer-term means. Therefore, an argument can be made to adjust working capital to reflect longer-term averages of the firm under consideration: high working capital today can be thought of as cash inflow tomorrow and excessively low working capital today as a cash need tomorrow. Hence the adjustment—which should only relate to the excess amount, not overall working capital levels—can be classified as net debt adjustment. While in the

[558] The reclassification amount might need to be estimated through industry average account receivable benchmarking, e.g. via the days of sales outstanding metric

[559] Compare Subsection 5.1.3.2, p. 135

[560] This counterbalances any potential incentives for the seller to hand over the business with artificially low levels of working capital, which would require the purchaser to immediately build inventory levels or pay off suppliers on the day the firm changes hands at additional expense

practice of trading multiples somewhat overlooked so far,[561] I assert there is no theoretical reason not to undertake the adjustment, as long as it is understood if there are working capital timing effects (warranting the adjustment) or a permanent re-alignment of working capital needs (no adjustment applicable).

5.5.5 Extraordinary items

5.5.5.1 Some general considerations on extraordinary items

As already discussed in the context of shortcomings of price/earnings multiples over enterprise value multiples,[562] *extraordinary items* and aspects of earnings management constitute a potential source of bias for multiple valuation as they distort the relevance of the commonly one-period valuation driver[563] for ad-infinitum valuations. While it is worth noting that the relative impact of such items on earnings is higher than it is on items higher up in the income statement and there will be additional sources for management discretion further down the income statement, extraordinary items and aspects of earnings management should be adjusted for all valuation drivers to the extent meaningfully possible. While some extraordinary items (such as provisions) are explicitly reflected and quantified in the financial statements as stipulated by the respective accounting standards, this might not be the case for some other non-recurring items (Pratt, 2005, p. 81). Their assessment will require some investigative analysis as to the background and true one-off nature of the items; furthermore, the use of forward-looking valuation drivers should at least avoid inclusion of yet unknown one-off items, consistent with information available to the market at the time.[564]

5.5.5.2 Provisions

Creutzmann and Schmitt (2005, pp. 181–197) discuss the consistent consideration of one-off effects or non-recurring items, with a focus on provisions in the context of multiple computation, arguing that an adjustment for such provisions should be considered as it is priced into the price reference (2005, p. 183). While Creutzmann and Schmitt (2005) do not elaborate in

[561] Also consider the otherwise very comprehensive list of enterprise value to equity value adjustments presented by Koller et al. (2010, p. 274), which notably lacks the excessive working capital adjustment
[562] See above, Subsection 2.4.2.1, p. 56
[563] Or one point in time valuation driver in the context of book value multiples
[564] Bhattacharya, Black, Christensen, and Larson (2003) discusses in greater detail the relationship between GAAP earnings, pro forma earnings reported by management as non-GAAP measures and equity research forecasts, which are relevant as far as forward valuation drivers are concerned. They find that pro forma earnings are significantly larger than both analyst consensus and GAAP numbers (2003, pp. 288–289). This indicates that analyst consensus may include some but not all of the management-proposed normalizations

greater detail on different types of provisions and the need for respective adjustment, such discussion is available from Koller et al. (2010, pp. 285, 568-573): Accordingly, for fundamental valuation concepts, adjustments should be made for long-term operating provisions such as plant decommissions[565] and *non-operating provisions* such as restructuring charges, however, not for ongoing *operating provisions* such as recurring warranty provisions, nor for *income-smoothing provisions*. From a multiple valuation perspective, one can argue that ongoing operating provisions are likely applicable in a similar manner to all firms operating in a sector, hence under the concept of "consistent inconsistency,"[566] no adjustment may be necessary.[567] Income-smoothing provisions are conceptually relevant to multiples as the ambition is to find a valuation driver, which well represents the long-term future economic situation of the firm. Hence, the preferred approach might be not to conduct any adjustment to the valuation driver if the valuation practitioner agrees with management on the nature and quantums of such provisions.[568]

For company-specific provisions not falling into the operational or income-smoothing classifications, adjustments should be considered: As pointed out by Creutzmann and Schmitt (2005, p. 188), the adjustment relates to the price reference for enterprise value multiples, as one could argue market participants price in provisions as a debt-like item.[569] If the provision is adjusted for in price reference, any additions to this provision should be consistently adjusted for in the valuation driver if they relate to the time period of the valuation driver. This can be achieved through adding back the respective provision.

In the case of equity value multiples, the logic for an adjustment starts from the period-recognized provision affecting earnings: Since a longer-term earnings figure might serve as a superior representation of economic realities, extraordinary provision recognitions for a period should be adjusted for,[570] as otherwise a one-off effect would perpetuate itself in value. Creutzmann and Schmitt (2005, p. 186) advocate to also adjust the price reference by the same amount, in essence resulting in a reclassification of an unwanted and inappropriate perpetual impact to a one-off value impact the recognized provision really is; or, in terms of the multiple:

[565] Ideally to be considered at their DCF value

[566] Compare Subsection 5.1.3.2 (p. 135); a further argument can be made if there is a consistent ratio between level of provision on the balance sheet and new provisions incurred under the likely assumption those provisions are valued at the same implied multiple as the firm as a whole

[567] Note it might not always be straightforward to identify ordinary and extraordinary provisions: While provisions for ordinary amounts of warranty claims would not be adjustable, extraordinary warranty claims such as in the example provided by Creutzmann and Schmitt (2005, pp. 183,187) may still prompt an adjustment

[568] Since income smoothing provisions have no valuation impact (Koller et al., 2010, p. 568)

[569] This follows the logic that a firm which has a tax-deductible provision on the balance sheet will trade at a lower market capitalization by the post-tax amount, which can be calculated as tax rate times pre-tax amount

[570] Such adjustment should relate to the after-tax impact of the recognized provision for consistency with earnings

a reclassification of the same amount from denominator to numerator.

For the purposes of a valuation concept with a strong cost-benefit balance and a trade-off more towards simplicity rather than sophistication, one could argue that provision adjustments might play a subordinate role all together unless there are major amounts.[571]

5.5.5.3 Other extraordinary items

Some business events may result in extraordinary impacts on financial statements in an unrelated manner to provisions.[572] [573] Examples are diverse and may include *temporary* de-listings by a retail customer of consumer goods brands, temporary issues with a supplier resulting in non-delivery of raw materials, the weather, substantial exchange rate fluctuations and other occurrences of chance. A firm may furthermore argue to normalize certain *one-off impacts*, including restructuring charges or business write-downs. Since the objective of the valuation driver in a multiple valuation is the representativeness of the driver usually relating to a single period for an ad-infinitum valuation, there is a strong case to make to adjust valuation drivers for such one-off impacts or utilize the company-reported "non-GAAP" metrics. Any adjustment should, however, follow close scrutiny to understand the one-off nature of its underlying impact on the financial statements. Utilization of forward-looking valuation drivers should exclude ex-ante unknown one-off items and thus mitigate the need for adjustments to a certain extent.[574]

5.5.5.4 Earnings management

Companies might be engaged in a variety of earnings management aspects, i.e. the "window-dressing [of] financial statements" (Subramanyam & Wild, 2009, p. 108) through cosmetic or real actions[575] in order to affect key P&L items such as operating profit or net income;

[571] This is particularly the case as far as forward-looking valuation drivers are considered, which should not show any unexpected and unpredictable provisions anyhow and given limitations of financial databases to return specific types of provisions separately allowing a classification along the lines proposed in this Subsection

[572] At least under accounting standards such as IFRS, under which income smoothing provisions are less common (Koller et al., 2010, p. 285)

[573] Also consider the discussion of extraordinary items in the context of shortcomings of price/earnings multiples vs. other multiple types, Subsection 2.4.2.1, p. 58

[574] Massari et al. (2016, p. 335) points out that the reason to adjust for extraordinary items in multiple valuation is obvious, however, there might be informational challenges as the details to conduct adjustments or to fully understand the adjustments proposed in the financial statements will not always be disclosed in the reported financials

[575] Cosmetic earnings management relates to accruals but is cash-neutral, real earnings management relates to actions which affect the cash flow of the firm (Subramanyam & Wild, 2009, p. 108). For multiple valuation, both aspects are problematic: To the extent investors see through cosmetic earnings management, it still affects peer valuation accuracy. Real earnings management can introduce multiple valuation errors in particular if

the objectives can vary, including an ambition to increase, decrease or smoothen financial statement line items and empirical literature is extensive.[576] From a perspective of multiple valuation, not all earnings management aspects can be conclusively discussed here and the costs for adjusting some of the aspects attributed to earnings management may outstrip their benefits for valuation accuracy. It is, however, important to track in particular multiple valuation outliers for an understanding if earnings management might be a driver behind any values which appear biased.

5.5.6 Accounting standard comparability

In addition to elements of accounting discretion exercised by individual firms' management teams, there is a more fundamental aspect around the *accounting standards* utilized. An analysis conducted by the U.S. SEC[577] in 2011 finds 7 differences for the calculation of earnings per share alone between U.S. GAAP and IFRS. However, empirical evidence indicates that this aspect might today be less relevant than in the past: analyzing valuation accuracy of popular multiples over time, both Young and Zeng (2015)[578] and Land and Lang (2002) find increasing mandatory introduction of one set of standards across wider geographies[579] but also convergence efforts between leading standards [580] have had positive consequences on the precision of multiple-based valuation concepts. Young and Zeng (2015, p. 2599) highlight the benefits of accounting comparability are twofold: First, they provide comfort in selecting comparable firms from a larger set of peers and, second, it reduces the cost of financial analysis, since the amount of convergence adjustments to be undertaken can be minimized.[581]

only some peer companies engage in it. Numerous studies on earnings management have been conducted, compare among others Eisele (2012), who finds that firms meeting research consensus are awarded a return premium, indicating that management teams might strive to achieve that through various strategies

[576] Compare e.g. C. Liu, Yip Yuen, Yao, and Chan (2014) for an empirical study comparing earnings management between U.S. GAAP and IFRS companies (similar for earnings management through accruals but earnings management with R&D expenses is higher under IFRS) as well as further references on previous empirical analyses

[577] United States Securities and Exchange Commission (2011, pp. 13–14)

[578] Albeit for the case of price to book multiples

[579] such as IFRS in the European Union

[580] i.e. between U.S. GAAP and IFRS

[581] Consistently, Bae, Tan, and Welker (2008) furthermore point out that accounting differences between countries result in economic costs for foreign equity research analysts covering the firm, which might result in suboptimal coverage by the analyst community and consequently lower quality analyses and consensus financial forecasts

5.6 Type-specific adjustments to address conceptual shortcomings

5.6.1 Leverage-adjusted P/E multiple

As previously discussed,[582] one of the major drawbacks of price/earnings multiples is the fact that they are financial leverage-agnostic: A price/earnings multiple-based valuation implicitly relies on a comparison of price/earnings multiples for companies with very different relative levels of net debt, whilst a strong argument can be made that companies with higher leverage should have higher required equity returns and hence lower price/earnings multiples.

This has led to considerations on whether price/earnings multiples *can be adjusted to reflect differing leverage levels*: Penman (2013, pp. 465–467) connects the "levered" i.e. standard price/earnings multiple $\hat{\mu}_{i,0}^{PE;FW}$ to an "unlevered" i.e. financial leveraged-neutralized multiple, which according to his definition,[583] is a taxed EBIT or NOPAT multiple.[584] Acknowledging that Penman (2013, p. 466) utilizes after-tax net borrowing costs and net financial expenses, it is possible to state his Equation 14.10 linking the levered and unlevered[585] multiples, respectively, as:

$$\hat{\mu}_{i,0}^{PE;FW} = \frac{1}{(1-\tau_{i,1})} \cdot \hat{\mu}_{i,0}^{uPE;FW} + \frac{(1-\tau_{i,1}) \cdot INT_{i,1}}{ERN_{i,1}} \cdot \left(\frac{1}{(1-\tau_{i,1})} \cdot \hat{\mu}_{i,0}^{uPE;FW} - \frac{1}{(1-\tau_{i,1}) \cdot r_{i,1}^{d}} \right) \quad (5.2)$$

$INT_{i,t}$ denotes the pre-tax interest expense and $r_{i,t}^{d}$ the cost of debt or, by approximation, interest rate paid by firm i. $t = 1$ indicates that next-period metrics are applicable. As pointed out by Penman (2013, p. 466), the term in main parenthesis of Equation 5.2 can be thought of as the inverse of the post-tax EBIT multiple—i.e. EBIT yield—compared to the inverse of the post-tax debt financing costs—a sort of debt financing multiple: The higher the enterprise value/EBIT multiple compared to the financing cost multiple, the higher should the levered price/earnings multiple be relative to the enterprise value/EBIT multiple. Figure 5.1 (p. 170)

[582] Compare Subsection 2.4.2.1 (p. 55)

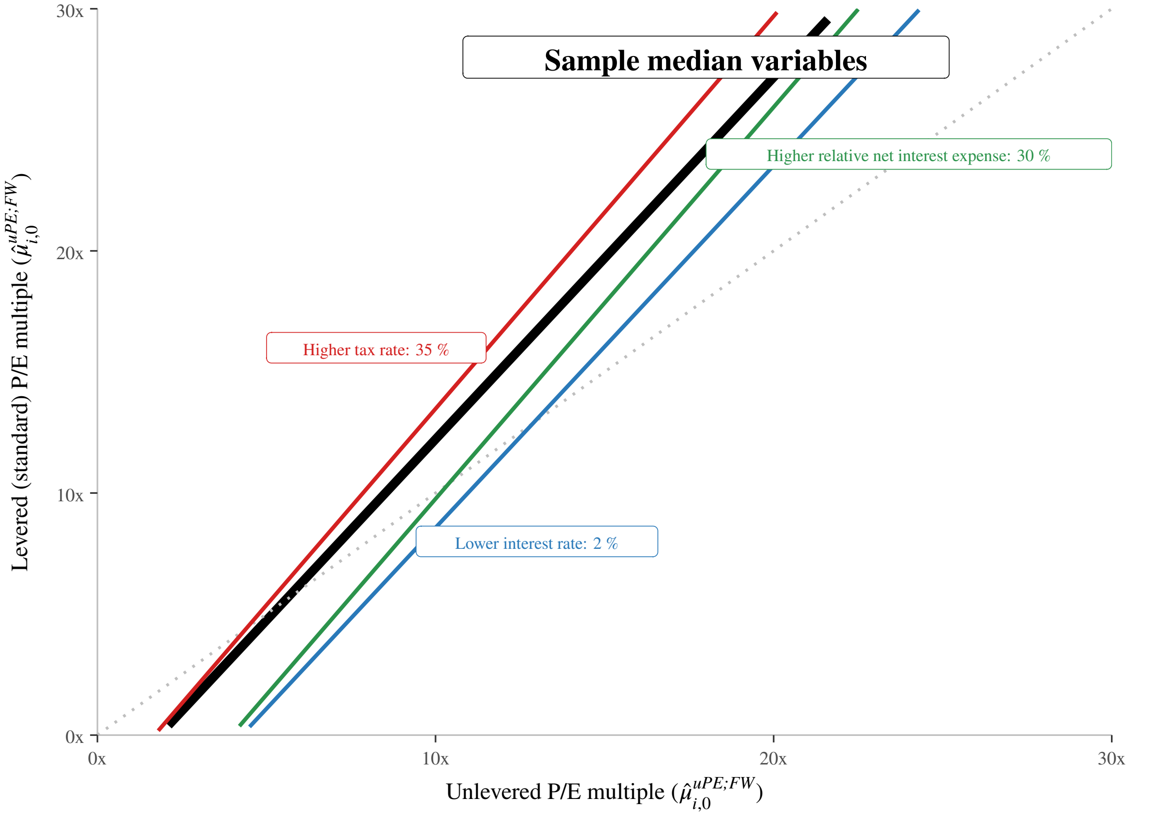
[583] See Penman (2013, p. 303): "Operating income is sometimes referred to as enterprise income or net operating profit **after tax** (NOPAT)" (emphasis added) and numerous calculation examples

[584] Arzac (2008, pp. 74–76) proposes a somewhat similar approach, in which, a leverage-adjusted price/earnings multiple is calculated on the basis of an unadjusted price/earnings multiple of a peer company in addition to some firm-specific adjustments

[585] However, contrary to the approach of Penman (2013, p. 466) on a pre-tax basis

illustratively demonstrates various sensitivities.

FIGURE 5.1: Illustrative connection between levered (standard) and unlevered P/E multiples



Note: Own illustration of Equation 5.2. The thick black line represents the relationship between the standard (i.e levered) P/E multiple, $\hat{\mu}_{i,0}^{PE;FW}$, and its unlevered counterpart, $\hat{\mu}_{i,0}^{uPE;FW}$, following the approach of Penman (2013, pp. 465-467), however on a pre-tax basis. Other relevant parameters are illustratively assumed to amount to the median values of the empirical sample in this dissertation (Compare Chapter 3 for details): $r_{i,1}^{d} = 4.7\%$; $\tau_{i,1} = 28.8\%$; $\frac{INT_{i,1}}{ERN_{i,1}} = 12.8\%$. The colored lines represent sensitivities on varying one of those parameters each to the values indicated, whilst the other 2 parameters remain as in the base case. At commonly observable levered P/E multiples of >10x, the levered P/E is higher than the unlevered P/E as indicated by the thick black line running above the gray dotted line, which signifies parity; however, scenarios of low interest rates, low tax rates and/or high interest expenses relative to earnings exist, where the opposite is the case. Since $\hat{\mu}_{i,0}^{uPE;FW}$ can be shown to be the same as an enterprise value/EBIT multiple, the price-earnings multiple will under most circumstances be higher than the enterprise value/EBIT multiple

Since Equation 5.2 uses pre-tax inputs, $\hat{\mu}_{i,0}^{uPE;FW}$ can be considered an enterprise value/EBIT multiple. Through simple re-arrangement and acknowledging that $INT_{i,1}/r_{i,1}^{d}$ can be considered the average net debt of the firm, D_i,[586] one obtains for the unlevered price/earnings multiple

[586] In a simplifying manner, this model does not assume debt paydown

$\hat{\mu}_{i,0}^{uPE;FW}$ the following Equation:

$$\hat{\mu}_{i,0}^{uPE;FW} = \frac{\hat{\mu}_{i,0}^{PE;FW} + \frac{D_i}{ERN_{i,1}}}{\frac{1}{1-\tau_{i,1}} + \frac{INT_{i,1}}{ERN_{i,1}}} = \frac{\hat{\mu}_{i,0}^{PE;FW} \cdot ERN_{i,1} + D_i}{\frac{ERN_{i,1}}{1-\tau_{i,1}} + INT_{i,1}} = \frac{V_i^{eq} + D_i}{EBIT_{i,1}} = \hat{\mu}_{i,0}^{EBIT;FW} \tag{5.3}$$

This means that a price/earnings multiple valuation considering different levels of leverage as proposed by Penman (2013) is actually an enterprise value/EBIT multiple valuation and hence one could argue that the way to address the shortcoming of the price/earnings multiple regarding leverage adjustments is by just using a different valuation driver all together; the adjustment therefore does not appear to be a "fix" to a limitation of the price/earnings model but rather overcomes the issue through *an alternative concept*, namely an enterprise value/EBIT multiple.

5.6.2 Tax burden normalization, including in light of financial leverage

5.6.2.1 General considerations

Massari et al. (2016, p. 339) point out that different tax systems will have an impact on valuation, which will, however, be normalized by multiples relying on *pre-tax valuation drivers* such as is typically the case for enterprise value multiples (Peemöller, 2009, p. 576). Consistent with the discussion on extraordinary items,[587] the question whether this normalization is theoretically desirable—or whether different tax rates should actually affect trading multiple valuation—depends on the long-term nature of any tax rate outliers. As demonstrated above,[588] enterprise value multiples will be impacted by tax rates: thus, normalizing for tax rates should theoretically introduce an error to multiple valuation. For as long as tax rates[589] are similar across all peers, there is a case to make for "consistent inconsistency."[590] None the less, an analysis of the long-term nature of tax rate outliers is on order, where the following situations can be differentiated:

- Sustained tax rate differentials of structural nature between peers
- Temporary tax rate fluctuations

[587] See above, Subsections 5.5.5 (p. 165) and 2.4.2.1 (p. 56)
[588] See the tax rate sensitivity in Figure 4.2, p. 110
[589] i.e. tax rates today and any over-time rate progressions
[590] Given that, for multiple valuation, it does not matter to incorrectly normalize for aspects among the peer group, which are similar anyhow. See above Subsection 5.1.3.2 (p. 135) regarding the concept of "consistent inconsistency"

The practical identification of sustained and temporary tax rate impacts requires some case-by-case research in the financial statements of the company under investigation: Notably, the tax reconciliation table in the footnotes to the financial statements can provide some relevant information (Koller et al., 2010, p. 546): Elements like foreign income adjustments point more to sustained, aspects like audit revisions more to temporary tax rate impacts. Items like R&D tax credits are ambivalent and can be argued to be integral and recurring part of a business model or tied to a very specific project as the case may be.

5.6.2.2 Potential adjustments to enterprise value multiples

Structural differences in tax rates among peers In the case of structural differences, the objective is to reverse tax rate normalizations such that peers of different levels of taxation can be compared. While, prima facie, this could be effected through utilizing a taxed EBIT,[591] that approach would disregard the fact that interest is de facto tax deductible.[592] As leverage levels will vary between peer companies, a more sophisticated solution is in any event preferable. The *adjusted present value model* discussed by Koller et al. (2010, pp. 121–126) and Damodaran (2012a, pp. 398–401, 415–419), among many, provides a suitable theoretical background: a separate valuation for a quasi-unlevered firm is modified to reflect the value of tax benefits of debt-related interest expenses. To conceptually align the adjusted present value methodology with multiple valuation it is necessary to start from an unlevered case for multiple valuation, therefore taxed EBIT might be a suitable valuation driver since it reflects the after-tax claims of shareholders of an unlevered company. Subsequently, the value of the debt-related tax shield can be estimated. While Koller et al. (2010, p. 125) argue for a more sophisticated approach relying on projections of future net debt levels, Damodaran (2012a, p. 416) proposes a parsimonious model, in which the present value of tax savings from debt can be derived as debt times the tax rate.[593] Under the assumption that the market capitalization-derived—and hence market-measured—unadjusted enterprise value will reflect the value of the tax shield, the tax shield needs to be *subtracted* from the unadjusted enterprise value to derive a tax-shield adjusted enterprise value comparable to a nil-leverage firm. More formally, a tax burden normalization for an enterprise value/EBIT multiple resulting in a tax-adjusted

[591] As opposed to the standard pre-tax EBIT

[592] A highly leveraged firm would see its valuation driver cut by a much larger quantum than is justified by its actual tax burden, which benefits from a considerable tax shield on interest. In contrast, for a company with low levels of leverage on the contrary, taxed EBIT might be a suitable approximation

[593] This approach assumes that interest payments on debt can be considered a perpetuity

multiple, $\mu_{i,0}^{TA;EBIT;FW}$, can therefore be expressed as[594]

$$\mu_{i,0}^{TA;EBIT;FW} = \frac{V_{i,0}^{Enterprise} - V_{i,0}^{Net\ debt} \cdot \tau_i}{(1-\tau_i) \cdot EBIT_{i,1}} = \frac{P_{i,0}^{Market\ cap} + (1-\tau_i)V_{i,0}^{Net\ debt}}{(1-\tau_i) \cdot EBIT_{i,1}} \tag{5.4}$$

Equation 5.4 denotes a multiple, which considers two aspects at once: *differing tax rates* as well as the *impact of leverage* on the tax burden, i.e. the tax shield in absolute terms, which in itself depends on the tax rate and the quantum of net debt. Thus, the adjustment proposed in Equation 5.4 addresses two conceptual and interrelated shortcomings of unadjusted enterprise value multiples at once: the fact that tax rates may differ and the fact that companies can utilize differing quantums of net debt to benefit from the tax deductibility of interest: If the tax rate was zero for all peer companies, no adjustment for net debt is required. However, if net debt for all firms was zero, an adjustment for differing tax rates among peers may still be warranted. An analogous, yet generally not advocated for argument regarding tax shield-adjusted enterprise value multiples is offered by the seminal considerations of Modigliani and Miller (1958) and Modigliani and Miller (1963), respectively: Whilst the standard enterprise value multiple presumes a no-tax utopia and hence the value of the debt-leveraged firm equals the value of the all-equity-financed firm much like Modigliani and Miller (1958) "I" did, the leverage-adjusted multiple offers a potentially useful extension in the more realistic world where taxes exist and do have an impact on enterprise value much like in Modigliani and Miller (1963) "II."

The proposed combined tax shield on debt and tax rate differential adjustment proposed in Equation 5.4 is somewhat different in nature to the other adjustments proposed in this Chapter as it suggests a more material departure from the core nature of a multiple type rather than a simple comparability or consistency adjustment. In the empirical analysis,[595] it will therefore be treated separately to other more "operational" adjustments.

Temporary tax rate differences Short term tax rate differences—in particular those applying to just the measurement period of the valuation driver—do not warrant any adjustment to enterprise value multiples and normalized valuation drivers such as EBIT should outperform valuation drivers taking into consideration tax rates not representative for the future such as taxed EBIT.

[594]This disregards any additional adjustments described in this Chapter
[595]Compare Subsection 7.4.2.4, p. 284

5.6.2.3 Potential adjustments to equity value multiples

Temporary tax rate differences Massari et al. (2016, pp. 353–355) propose a 3-period model, which compares transitory tax rate differences to the long-term "full" or "theoretical" tax rate. It then calculates the cumulated present value of the discrepancy for the 3 periods in monetary units and subtracts this amount from the price reference. For consistency purposes, net income is re-computed on the basis of the long-term tax rate. This adjustment results in a "more coherent trend" (Massari et al., 2016, p. 354) between enterprise value multiples an the price/earnings multiple modified in this manner. While theoretically appealing, this model somewhat departs from the simple one-period nature of multiples.

Sustained tax rate discrepancies The most common equity value multiple, price/earnings, is calculated on a post-tax basis and hence consistently reflects sustained tax rate differences through lower price references—given equity claims are measured after the tax burden—and through (post-tax) earnings. Hence, adjustments appear unnecessary.

5.7 A summary of adjustments in light of valuation efficiency

5.7.1 Summarizing potential biases of unadjusted multiples

At the risk of being repetitive, it is helpful to summarize briefly the shortcomings of pre-adjustment multiples, also given such overviews are very scarce in literature and summaries in existence such as Chullen et al. (2015, p. 643) and Rosenbaum and Pearl (2009, p. 31) are relatively cursory. Table 5.2 (pp. 176–177) summarizes the biases identified in earlier subsections of this Chapter in a systematic manner for both enterprise value and equity value multiples, considering both multiple elements, the price reference (numerator of the multiple) and the valuation driver (denominator of the multiple), each. For illustration purposes, this comparison relies on prominent examples for equity value- and enterprise value multiples, namely the price/earnings multiple and the enterprise value/EBIT multiple. They apply in similar but not always identical manners to multiples with similar roots such as enterprise value/EBITDA or price/earnings before tax.[596] Overall it appears that "raw" enterprise value

[596]Notably, wherever reference is made to post tax adjustments to earnings for standard price/earnings multiples, pre-tax adjustments should be undertaken for price/earnings before tax multiples. In the case of enterprise value/EBITDA, the operating lease depreciation should be stripped out of the valuation driver, as well

multiples tend to suffer from more biases, in particular when it comes to consistency around group structures. As discussed in Subsection 5.1.4 (p. 136), there might furthermore be a "philosophical" view that price/earnings multiples, which find their theoretical roots in the DDM[597] and hence a very shareholder-centric view, should be more focused on (unadjusted) earnings and price references rather than enterprise value multiples with their origin stemming from the fundamental valuation of operations via a DCF approach.[598] From a practitioners' perspective one could argue an all-or-nothing approach: While (unadjusted) price/earnings multiples can be obtained directly from market data (price) and a single line item in the financial statements (earnings per share), the principle of equivalence[599] requires immediate adjustments to enterprise value calculation—i.e. the addition of net debt. One can speculate that, in the eyes of practitioners, it may then only be natural to further adjust enterprise value multiples while at the same time enjoying the true simplicity of equity value multiples, most notably the price/earnings multiple.

5.7.2 Summarizing theoretical adjustments

Having considered some of the biases of multiples, the obvious next step relates to possible adjustments to multiples in order to improve their theoretical rigor and counterbalance the biases identified. Table 5.3 (pp. 180–182) presents a summary of proposed adjustments. In the spirit of the arguments around adjustments being more relevant to enterprise value multiples, Table 5.3 focuses on enterprise value multiples, for which it compares two potential levels of sophistication: A level referred to strikingly as "*gold standard*," which suggests an approach —on the basis of typically available public information—if costs of conducting the valuation are disregarded. This level of sophistication will typically require intense analysis of the financial statements as well as a strong understanding of how equity research analysts are treating certain aspects in their forecasts.[600] The cost of conducting a comprehensive multiple valuation increases substantially for large peer groups, i.e. it will make a difference to research details in financial statements for a peer group consisting of 2 vs. 20 firms. Therefore, an alternative level is presented, in which costs of the valuation feature and hence a *reasonable approximation* to the gold standard is chosen for adjustments. This reasonable approximation

[597] See above Subsection 4.2.1, p. 91

[598] See above, Subsection 4.3.1, p. 98

[599] See above Subsection 5.3.1, p. 140

[600] Naturally, this aspect of equity research interpretation is important for forward-looking valuation drivers: in many instances, the details required prevent use of aggregated equity research consensus numbers and brokers need to be hand-selected resulting in potential biases through limitations around availability, currency of the reports and disclosed information

TABLE 5.2: Summarizing the biases of valuation drivers and price references

	Equity value multiple (P/E multiple as an example)			Enterprise value multiple (Enterprise value/EBIT multiple as an example)			
Adjustment aspect	P	E	Considerations	EV	EBIT	Considerations	Details
Consistency							
Gross debt	✓	✓	• Consistent under the priniple of equivalence	✓	✓	• Consistent under the priniple of equivalence	↑5.3.1
Cash and cash equivalents	✓	✓	• Consistent under the priniple of equivalence	✓	✓	• Consistent under the priniple of equivalence	↑5.3.2.1
Excess cash	✓	∼	• Price reflects value of cash, earnings reflect interest on cash • However, inverse of cash interest rate may be lower than P/E	∼	✓	• Multiple generally consistent • Operating cash could be considered a working capital item	↑5.3.2.3
Group structures							
Minority interest	✓	✓	• Both reflect proportional economics	✓	×	• Enterprise value reflects proportional economics, EBIT 100% of minority interest economics	↑5.3.3.1
Equity investments	✓	✓	• Both reflect proportional economics	✓	×	• Enterprise value reflects proportional economics, EBIT reflects nill economics of equity investments	↑5.3.3.2
Minority passive investments (MPI)	✓	∼	• Price reflects proportional economics, earnings reflects dividend income only rather than earnings potential of MPI	✓	×	• Enterprise value reflects proportional economics, EBIT reflects nill economics of minority passive investments	↑5.3.3.3
Consolidation timing	✓	×	• Price post deal announcement reflects value gain for shareholders, earnings follow only after consolidation has taken place	∼	✓	• Price post deal announcement reflects value gain; incremental transaction financing debt, assumed debt and EBIT follow only after consolidation occurs	↑5.3.4
Comparability							
Future financial claims							
Pension liabilities (defined benefit)	✓	∼	• Price presumed to reflect benefit obligation shortcomings • Earnings will reflect interest cost, returns on plan assets and service costs, providing a conterbalance (but not perfect match) to funded status	×	∼	• Funded statuses of pension plans not included in net financial debt despite constituting a future financial claim • EBIT inconsistent pre adjustment under U.S. GAAP as interest cost and gains on plan assets included	↑5.4.2
Tax loss carryforwards	✓	×	• Price reflects the value (if perceived usable), no equation in earnings	✓	×	• Enterprise value reflects the value via market capitalization, no equation in EBIT	↑5.4.3
Preferred stock (debt-like)	✓	✓	• Assuming earnings are post preferred stockholder claims	×	✓	• Since preferred stock is reported in balance sheet equity, it is not part of enterprise value unless adjusted for	↑5.4.4.1
Preferred stock (Second share class)	✓	✓	• Consistently reflected through either market capitalization/net income or price/earnings of the more common class of shares	✓	✓	• Reflected in market capitalization	↑5.4.4.1
Convertibles	✓	∼	• Dilutive effect on basic earnings per share of potential share issue not considered, however, ongoing interest payable considered	✓/∼[a]	∼	• Dilutive effect on "EBIT per share" of potential share issue not considered • Full reporting of the convertible book value amount in debt might underrepresent economic value	↑5.4.4.2

Note: Own illustration, to be read in conjunction with following page. ↑ indicates section with details on bias and adjustment, ✓ / ∼ / × indicates no bias/some bias/clear bias

	Equity value multiple (P/E multiple as an example)			Enterprise value multiple (Enterprise value/EBIT multiple as an example)			
Adjustment aspect	P	E	Considerations	EV	EBIT	Consideration	Details
ESOPs[b]	✓	~	• Dilutive effect on basic earnings per share of potential share issue not considered • Cost of granting ESOPs considered in employee expenses	✓	~	• Dilutive effect on "EBIT per share" of potential share issue not considered • Cost of granting ESOPs considered in employee expenses	↑5.4.5
Business model differences							
Operating leases[c]	✓	✓	• Can potentially be considered appropriate assuming the operating lease expense is a reasonable proxy for implied D&A and interest costs of owning the assets outright	×	×	• Off-balance sheet debt, not considered in enterprise value as a debt item • Lease interest component not part of interest expense, resulting in artificially low EBIT[d]	↑5.5.1
Other non-operating assets	~	✓	• Comparability through price reference potentially affected by excessive non-operating assets in a similar manner than for excess cash • Inverse of yield earned on those non-operating assets might be lower than P/E multiple	~	~	• Informational challenge to identify non-operating assets, potentially resulting in below-EBIT profit or per balance sheet analysis on the basis of reported financials	↑5.5.2
Conglomerates and financing companies	~	✓	• Comparability (and hence price reference) affected by business footprint • Price/earnings as decently suitable valuation multiple for financially-oriented companies, however multiples will differ	~	✓	• Comparability (and hence price reference) affected by business footprint	↑5.5.3
Receivables securitization	✓	✓	• Minor impact on earnings from higher cost of securitization	×	✓	• Artificially low working capital not considered in EV calculation, however, higher cash balance is reflected, understating net debt • Minor impact on EBIT from higher securitization cost	↑5.5.4.1
Current operating performance							
Working capital fluctuations	✓	×	• Price presumed to reflect actual working cpatial level, earnings unaffected	✓	×	• Artificially low (or high) working capital considered in EV calculation • EBIT unaffected	↑5.5.4.2
Extraordinary items	✓	×	• Earnings not reflective of long-term potential on which valuation is based	✓	×	• EBIT not reflective of long-term potential on which valuation is based	↑5.5.5
Accounting standard differences	✓	×	• Presumption that prices "see through" valuation differences • Earnings potentially affected	~	×	• Presumption that prices "see through" valuation differences, however, net debt and adjustments might be affected • EBIT potentially affected	↑5.5.6
Conceptual							
Differing leverage levels	×	×	• Consistent as neither price nor earnings normalized but conceptually no consideration of different peer leverage levels	✓	~	• EBIT normalizes for different leverage levels but not for different tax shield impacts on enterprise value connected to leverage	↑5.6.1
Differing tax rates	✓	✓	• Generally consistent • However, potential inconsistency through extraordinary tax expense	✓	×	• While enterprise value—through its base in equity value—reflects differing peer-specific tax burdens, EBIT does not, leading to a potential inconsistency problem	↑5.6.2

[a] Subject to accounting standard [b] Similarly applicable to warrants [c] Situation up to 2018 [d] For EBITDA as valuation driver, D&A is biased to lower end, as well

approach relies on availability of the ingredients necessary to conduct the adjustment in common commercial financial databases:[601] If the valuation practitioner manages to build a "spreadsheet template," which can extract the inputs reliably from such databases, the initial cost of building such template can be expected to swiftly outweigh the benefits of studying large peer sets on the basis of adjusted multiples.[602] From an empirical perspective, the impact and benefits of approximated adjustments can be studied on the basis of large sample sizes. Finally, the proposed "reasonable approximation" adjustments do not consider some of the more esoteric adjustments seldomly observed in practice such as adjustments for different leverage levels and for tax rates.[603]

5.7.3 A logic for identifying multiple adjustments beyond the framework

Whilst Tables 5.2 and 5.3 cover numerous of the most common biases and potential adjustments, respectively, they are not exhaustive. Therefore, it is instructive to develop a logic to establish, if an adjustment for other potential cases is appropriate. Figure 5.2 (p. 179) provides 4 potential adjustment cases in an abstract manner, also referencing the distinction between consistency and comparability adjustments made at the outset of this Chapter.[604]

[601] Such as the ones offered by FactSet Research Systems Inc., Thomson Reuters, Bloomberg L.P. or S&P CapitalIQ

[602] The role of the valuation practitioner and the purpose of the valuation should also not be disregarded in this context: Quill (2016, p. 297) presents a useful schematic which differentiates between low and high levels of transaction frequency and transaction volume and one could argue that high transaction frequencies at low transaction volumes correspond well to automated templates, while a lower frequency but higher volumes (and values) might be better served by a more diligent peer-firm by peer-firm data collection

[603] I will, however, report empirical results for some of such adjustments separately to investigate their practical relevance, see Subsection 7.4.2.4 (p. 284)

[604] Compare Subsection 5.1.1, p. 129

FIGURE 5.2: Determining potential case-by-case adjustments beyond the adjustment framework

(1) **Comparability I: Net debt-like value-impacting elements**

- Items resembeling current or eventual debt/liabilites or cash/benefits, no matter if permanent or temporary in nature
- Contingent liabilities/claims, no matter if in a technical accounting or solely economic sense, as long as it is believed they are considered by investors
- Deviations in the interpretation/valuation of basic net debt elements between book values and investor valuation approaches
- Potential value creation through financing structure (tax shields—blurred line to conceptual adjustments)
- Uncertain aspects potentially weighted by investor-perceived likelihood of materialization

$$\mu_i = \frac{P_i \cdot NOSH_i + D_i}{VD_i}$$

(2) **Comparability II: Accretion/dilution**

- Compensation-free dilution to current shareholders at future points in time
- Potentially weighted by likelihood of occurence (option pricing models)
- Accretion/dilution from non-market price share buybacks

(3) **Consistency**

- Assets, which create returns or cause costs not reflected in the valuation driver
- P&L level consistency: Valuation driver sits “too low”/“too high” in the P&L to correspond to enterprise value definition

(4) **Comparability III: Extraordinary items**

- Aspects, which affect the valuation driver during the chosen time horizon[a]
- One-off impacts to financials

- If all peer firms are affected to a similar extent, the concept of consistent inconsistency (see Subsection 5.1.3.2, p. 135) might be employed
- Under the assumption that semi-strong market efficiency applies,[b] only aspects presumed to be known to and priced in by the market are to be reflected for pricing multiple computation
- Any computation of (private) equity value for the company under investigation can naturally reflect aspects known to the valuation practitioner

Note: Own illustration applicable to enterprise value multiples. μ_i denotes the pricing multiple of any random firm i; P_i denotes the price per share for firm i; $NOSH_i$ denotes the shares outstanding of firm; VD_i denotes the valuation driver to be utilized in the desired enterprise value multiple; [a] Or point in time for stock multiples as the case may be [b] Compare Subsection 2.1.5.2 (p. 28) for a discussion of market efficiency in the context of multiples

TABLE 5.3: Summarizing proposed adjustment strategies in multiple valuation

	Enterprise value multiples				Equity value multiples	
	Sophisticated adjustments—"Gold standard"		Reasonable approximation[g]			
Adjustment aspect	Enterprise value	EBIT	Enterprise value	EBIT	Considerations	Details
Consistency						
Gross debt	• Add market value of gross debt	—	• Add book value of gross debt	—	—	↑5.3.1
Cash and cash equivalents	• Subtract cash and cash equivalents	—	• Subtract book value of C&CE	—	—	↑5.3.2.1
Excess cash	—	• Subtract spread of interest earned on cash vs. the interest paid on debt times gross cash	—	—	• Subtract cash from equity value and interest, post tax, from earnings	↑5.3.2.3
Group structures						
Minority interest	• Add properly estimated market values of minority interest	—	• Add book values or simple market value estimates[a]	—	—	↑5.3.3.1
Equity investments	• Subtract equity investments at estimated market values	—	• Subtract book values or simple market value estimates[a]	—	—	↑5.3.3.2
Minority passive investments (MPI)	• Subtract properly estimated market values[b] of minority passive investments	—	• Subtract book values or simple market value estimates[b]	—	• Gross-up of dividend contributions of MPI to reflect net income[c]	↑5.3.3.3
Consolidation timing	• Add to net debt the transaction enterprise value of the target[d]	• "Pro-forma" as if target had been consolidated ever since	—[m]	—	• Pro forma earnings and any capital increases	↑5.3.4
Comparability						
Future financial claims						
Pension liabilities (defined benefit)	• Add the funded status of defined benefit plans as debt-like item	• Add pension expense net of current and amortization of prior service costs[e]	• Add the funded status of defined benefit plans as debt-like item	—	—[h]	↑5.4.2
Tax loss carryforwards	• Subtract as a cash like item to the extent further analysis suggests the firm can make use of the loss carryforward	—	• Subtract as a cash like item	—	• Subtract from equity value; no adjustment to earings required	↑5.4.3
Preferred stock (debt-like)	• Add market value to enterprise value	—	• Add book value to enterprise value[f]	—	• No adjustment required to the extent earnings post earnings to preferred shareholders	↑5.4.4.1
Preferred stock (Second share class)	—	—	—	—	—	↑5.4.4.1

Note: Own illustration, to be read in conjunction with following 2 pages; for footnotes see page 182

	Enterprise value multiples				Equity value multiples	
	Sophisticated adjustments—“Gold standard”		Reasonable approximation[g]			
Adjustment aspect	Enterprise value	EBIT	Enterprise value	EBIT	Considerations	Details
Convertibles	• Add market value of the convertible to enterprise value[f], avoiding double-counting	—	—	—	• Utilize diluted earnings as opposed to basic earnings, however, avoid double-counting	↑5.4.4.2
ESOPs[k]	• Modify equity value to reflect share dilution using treasury stock method or option valuation models	—	• Use dilution factors which can be implied from a comparison of basic to diluted shares outstanding	—	• Utilize diluted earnings per share as opposed to basic earnings per share	↑5.4.5
Business model differences						
Operating leases[l]	• Add the estimated value of lease assets to enterprise value	• Add back the estimated interest component of lease expenses	• Add the estimated value of lease assets to enterprise value	• Add back the estimated interest component of lease expenses	—	↑5.5.1
Other non-operating assets	• Subtract the market value of non-operating assets from enterprise value	• Subtract the contribution of the non-operating assets to EBIT	—	—	• As for enterprise value multiples, however, consider earnings impact post tax	↑5.5.2
Conglomerates and financing companies	• Back-out estimated value of non-core businesses	• Back-out EBIT of non-core businesses	—[m]	—	• Back-out earnings and value contribution of non-core businesses	↑5.5.3
Receivables securitization	• Add to enterprise value the amount of receivables securitized[j]	—	—	—	—	↑5.5.4.1
Current operating performance						
Working capital fluctuations	• Add difference between average working capital and actual working capital[j]	—	—	—	• As for enterprise value	↑5.5.4.2
Extraordinary items	—	• Utilize normalized EBIT derived from detailed financial statement analysis	—	• Forward metrics will likely be normalized for at least some extraordinary items	• Utilize normalized or adjusted earnings metrics	↑5.5.5
Accounting standard differences	• Case-by-case dependent	• Case-by-case dependent	—	—	—	↑5.5.6

Note: Own illustration, to be read in conjunction with preceding and following page; for footnotes see page 182

	Enterprise value multiples				Equity value multiples	
	Sophisticated adjustments—"Gold standard"		Reasonable approximation[g]			
Adjustment aspect	Enterprise value	EBIT	Enterprise value	EBIT	Considerations	Details
Conceptual						
Differing leverage levels	Subtract value of tax shield resulting from leverage (applies to both rows)	Taxed EBIT enables consistency with tax shield -adjusted (i.e. unlevered) enterprise value (applies to both rows)	—	—	• Consider leverage adjustment, however, this means conducting an EV/EBIT valuation	↑5.6.1
Differing tax rates			—	—	• Add cumulated net present value of extraordinary tax burdens to price reference • Re-computation of earnings with normalized tax rate	↑5.6.2

Note: Own illustration, to be read in conjunction with the preceeding 2 pages; [a] Simple market value estimates can be based on the market/book value multiple of the parent company under investigation [b] Book value might be a reasonable proxy in the case of Minority passive investments (MPI) [c] e.g. through considering the payout ratio of the parent, however, dididend policies may differ materially [d] Through addition of target enterprise value, both assumed target debt and newly issued transaction debt can be reflected. Assuming acquirer equity issued at market price, it will equally be fairly reflected [e] For firms reporting under U.S. GAAP [f] Market value might be readily available in financial databases, however, may require research for separate "ticker," inconvenient for larger peer groups [g] Considering data availability in common financial databases, i.e. avoiding detailed financial statements research [h] For substanital funded status deficit and a perceived mismatch of the deficit on earnings through interest cost, an adjustment might be considered [j] Effectively reducing corresponding net cash position [k] Similarly applicable to warrants [l] Situation up to 2018 before new operating lease accounting rules come into force [m] Consider "dropping" the peer company if impact perceived material

CHAPTER 6

From pricing multiples to multiple valuations

"The price system works so well, so efficiently, that we are not aware of it most of the time."
—MILTON FRIEDMAN[605]

6.1 An introduction to multiple aggregation and aspects of precision

Whilst previous Chapters covered aspects relevant to the computation of individual multiples, namely the theoretical corporate finance background to intrinsic multiples in Chapter 4 and adjustment strategies for pricing multiples in Chapter 5, this Chapter is concerned with three important aspects regarding *valuation* multiples and hence valuation using multiples: *peer selection*, *multiple aggregation* and multiple valuation *accuracy measurement*. Those three elements can be considered to form a funnel: First, a method needs to be devised to decide, which (of all public) companies should be considered a peer of the firm under investigation.

[605]Compare Friedman and Friedman (1979, p. 14); Milton Friedman, an influential U.S. economist and the 1976 Nobel laureate, who also popularized libertarian ideas to a wider public. This Chapter is concerned with aggregation of multiples into valuations and the computation of multiple imprecisions. It therefore lays the ground to assess, if what Milton Friedman said about the price system is true for multiples, too

Second, the respective peer pricing multiples need to be aggregated into a single valuation multiple. And finally, this single valuation multiple needs to be applied to the company under investigation, which, from an analytical perspective of assessing multiple valuation accuracy, poses the question around precision of the valuation outcome relative to market price. Whilst the general sequence of multiple valuation outlined in Subsection 1.2.2 (p. 7) suggests peer selection should come before pricing multiple calculation, there are none the less benefits to discuss it in the context of multiple aggregation. Therefore, this Chapter, in a hybrid fashion, covers both peer selection and provides some details on the fifth and last step of multiple valuation described in Table 1.2 (p. 10), operationalizing the "valuation multiple" detailed in Subsection 2.1.4 (p. 26).

Peer selection is in practice usually based on identical or at least similar *industry affiliation* as the company for which the multiple valuation is to be prepared: It can be argued that this industry affiliation serves as a proxy for qualitative and quantitative similarity, which, motivated by an extended version of the Law of One Price[606] sets the basis for peer pricing multiple calculation with value relevance for the company under investigation.

Assuming a single multiple type valuation is to be conducted the initial result will be a vector of peer pricing multiples, on the basis of which a valuation multiple is to be found using *"aggregation."*[607] In the context of questions around aggregation it is important to understand the practitioners' perspective in oder to determine some of the relevant questions to ask from a theoretical perspective. At first glance, the practitioners' approach to aggregation appears rather straightforward. Much like the illustrative trading multiple output tables presented in textbooks,[608] practitioners appear to rely on common measures of central tendency such as arithmetic mean or median without much further reflection. Therefore, from a theoretical perspective, it is instructive to develop a better understanding of common and recommended measures of central tendency as well as explore potential alternatives. Moreover, there is reason to believe that valuation practitioners apply certain levels of judgment when determining a valuation multiple on the basis of a set of pricing multiples[609] and may solve for ranges as

[606]Compare Subsection 2.1.5.4, p. 33

[607]While aggregation is a common term of this step of multiple valuation, it is at times also referred to as "compression" (Sommer & Wöhrmann, 2011; Sommer et al., 2014, p. 38) or "averaging" (Dittmann & Maug, 2008, p. 6). Also compare the definition of valuation multiples in Subsection 2.1.4 (p. 26). Note that, whilst practically uncommon, intrinsic multiples could also serve as a basis for multiple aggregation, compare Figure 2.1 (p. 36) for valuation error measurement points

[608]Compare e.g. Hasler (2011, p. 288), Rosenbaum and Pearl (2009, p. 15), Koller et al. (2010, p. 314), Arzac (2008, p. 69) and Löhnert and Böckmann (2009, p. 562)

[609]Compare e.g. Schönefelder (2007, p. 109), who presents anecdotal evidence for the case of fairness opinions

opposed to precise central tendency calculations.[610]

A valuation multiple—or multiple range as the case may be—determined through aggregation can subsequently be utilized to compute a value for the company under investigation.[611] From a research perspective, the question then arises, how precise such a multiple-based valuation is; a number of precision concepts have been developed in prior empirical studies, which compare multiple valuation outcomes to measured market prices.[612]

6.2 The industry approach as suitable peer and multiple type selection concept

6.2.1 Practical pragmatism of the industry approach in peer selection

There has been some discussion that a useful approach to identifying suitable comparable companies consists in considering firms operating in the *same industry* as the company under investigation.[613] This practitioner approach, which can be transparently observed in fairness opinion settings (Schönefelder, 2007, p. 104) and is described in some detail by Rosenbaum and Pearl (2009, p. 20) has found its way into numerous textbooks explaining—however, while not holding back with critique—how multiple valuations are conducted, including Penman (2013, pp. 76–78), Löhnert and Böckmann (2009, p. 578), Koller et al. (2010, p. 326) and Wagner (2005, p. 14). The justification for industry peer selection is in part intuitive, in part driven by potential familiarity with the sector in a concrete valuation context and anchored in the observation that firms within a specific industry show a smaller dispersion of multiples compared to a comparison of companies across industries:[614]

- Competitors can prima facie be good comparables given it is likely that many of the qualitative aspects mentioned in Subsection 2.1.5.3 (p. 32) concerning business model

[610] See the discussion by Schönefelder (2007, pp. 109, 174) again for the situation regarding fairness opinions. In other valuation contexts such as initial public offerings, valuations are presented as ranges, providing further circumstantial evidence for the importance of multiple ranges (M. Kim & Ritter, 1999)

[611] Through multiplication of the valuation multiple with the respective value driver of the company under investigation, compare Equation 2.5 (p. 26)

[612] This discussion in Subsection 6.4 (p. 222), which also elaborates on potential reasons for multiple imprecisions, is more academic in nature since it implements an accuracy measurement not typically undertaken by practitioners but a crucial foundation for the empirical part of this dissertation

[613] Also compare Subsection 2.1.5.3 (p. 32)

[614] Consider e.g. the illustrative chart presented by M. Kim and Ritter (1999, p. 419) for a visual representation of this aspect

and risk are comparable[615]

- If the multiple valuation is conducted in a consistent manner, e.g. by following the 5 steps outlined in Table 1.2 (p. 10), preparers of valuation will have uncovered the names of competitors as part of acquainting themselves with the industry and in their assessment also understood peculiarities around sector business models, so industry peer formation appears to be an obvious choice
- Equity research team coverage at brokerage firms is in many instances organized by industry[616]
- If multiple valuations prepared by professionals are presented to their respective addressees, e.g. corporate clients in an investment banking context or investors for the purpose of fairness opinions, those addressees will be operationally familiar with the respective competitive environment of a sector[617]
- The choice of industry sector as key determinant of comparables does not necessarily mean additional aspects cannot be considered in an incremental manner[618]

In contrast, a number of arguments have been brought forward to suggest that comparable selection utilizing industry as a criterion is suffering from drawbacks:

- Within-industry differences: "Companies, even in the same industry, can have drastically different expected growth rates, returns on invested capital and capital structures" (Koller et al., 2005, p. 371).[619] Kelleners (2004, p. 178) highlights that the best-in-class player

[615]This is widely argued in literature as the main rationale for the industry approach, compare among many(Löhnert & Böckmann, 2009, p. 578; Esty, 2000, p. 26; Asche & Misund, 2016, p. 2; Rosenbaum & Pearl, 2009, p. 15). There is furthermore empirical evidence that peers align aspects of their financial policy among each other (Leary & Roberts, 2014), which suggests that similarity is not only a consequence of external factors impacting firms but also a feature, which is pro-actively sought by industry constituents

[616]Considering companies in an industry where research analysts have built knowledge appears the straightforward choice and sets a precedent for others parties involved in company valuation. Demirakos, Strong, and Walker (2010, p. 59) find that equity research target price forecast accurateness is positively correlated with the number of available industry peers to consider, suggesting industry peer consideration might be beneficial for research analyst valuation precision

[617]This of course is a practical argument of defensibility of valuation results rather than a theoretically convincing reason: Company boards and management teams can be expected to know about their main competitors and their choice as peers may appear intuitive and instructive in a decision making process, whilst their omission might result in question marks of the underlying rationale; in particular if they have undertaken benchmarking exercises in the context of value-based management (Koller et al., 2010, p. 17)

[618]Löhnert and Böckmann (2009, p. 584) and Massari et al. (2016, p. 326) present illustrative regression charts also popular among practitioners, which compare growth and profitability on the x-axis to multiples of one industry on the y-axis suggesting that financial input variables can play an incremental role in multiple aggregation

[619]Similar arguments are made by Damodaran (2012a, p. 481), "different business mixes and risk and growth profiles"

of every industry might benefit from technological superiority or economies of scale compared to other peer group constituents[620]

- There is little theoretical justification for limiting comparable companies to same/similar-industry peers; theory suggests similarities regarding "cash-flow characteristics, growth rates and investment risks" (Hasler, 2011, p. 292) should instead be the determining factor (Damodaran, 2012a, p. 462)[621]
- A consideration of industry comparables might introduce biases given the securities of those peers might be trading at different stock exchanges (Penman, 2013, p. 78); empirical results on this argument are mixed: Bhojraj, Lee, and Ng (2003, p. 6) find that inclusion of international peers is generally beneficial, however, the results of Dittmann and Weiner (2005) suggest that, while cross-geography selection supports valuation accurateness in a Continental European context, UK and US firms might be better valued on the basis of their local comparables only[622]
- A lack of peer group companies for a specific industry might lead practitioners to "cast the net wider" and include companies as peers, which are as close as possible to a specific firm under investigation but de facto have little commonalities with that firm[623]

6.2.2 Empirical support of the industry approach on peer selection

Industry peer selection has also been studied empirically. In his much cited article, Alford finds that industry membership is an "effective criterion" (1992, p. 96) for selecting comparables, with gradually improve valuation precision as finer and finer selection criteria on industry affiliation are applied.[624] His results on industry-based peer selection are consistent with the findings of Schreiner (2007, p. 112), who shows gradual improvement of valuation accuracy

620 Also compare Appendix Table A.1 (p. A12), which illustratively documents variations of intrinsic input variables between and within industries

621 This argument can also be seen in the context of fundamental valuations such as e.g. the DCF method, which—while considering qualitative aspects for projection preparation—do not typically rely on the industry as such but aim to base the valuation on cash flows; however, DCF valuation outcomes do rely on weighted cost of capital and hence are affected by the equity beta, for which it has been suggested to utilize industry-specific input variables (Koller et al., 2010, pp. 254–257) given similar "operating risks" should result in similar "operating betas"

622 Some of my personal anecdotal experience suggests that, among equity research analysts it is common to consider comparable industry peers across Europe and to a certain but more limited extent North America. Peer selection among North American research analysts is generally more on North America

623 Addressees of valuations may ask for multiple valuations and will potentially not accept the lack of suitable peers as an answer. Further complexities might arise for conglomerates—both as peers and firms under investigation (Kelleners, 2004, p. 188). While for firms under investigation, multiple-based sum-of-the-parts valuations are common practice and useful, conglomerates are in many instances not suitable as industry-derived peers, see Koller et al. (2010, p. 306) for a sum of the parts valuation approach

624 However, only up to a certain point, i.e. no improvement beyond 3 SIC digits as selection criterion

up to 3 digits of ICB industry classification. J. Liu et al. empirically confirm the argument for industry-based peer selection in general (2002, p. 163); however, the detailed outcome is more nuanced when controlling for the size of the error: "the frequency of small (medium) pricing errors increases (decreases), when comparable firms are selected from the same industry. (The frequency of large valuation error remains relatively unchanged)" (2002, p. 156). Empirical results are somewhat unequivocal. Herrmann and Richter (2003) find that a peer selection on control factors such as growth perform better than industry peer selection approaches and Bhojraj and Lee (2002) demonstrated that inclusion of firm-specific characteristics can improve valuation outcomes. Kelleners (2004, pp. 279, 285) finds that peer matching on the basis of theoretically expected valuation drivers, notably growth and risk, outperforms peer selection based on industry affiliation.

On balance, the above mentioned empirical results provide none the less sufficient evidence to consider the practitioners‘ approach of selecting comparable companies on the basis of industry affiliation a respectable concept, as players in the same industry will normally have comparable business models and operating risks.[625] It will thus form the baseline approach for the empirical study in Chapter 7 (p. 239), implemented through selecting peers on the basis of the same 3-digit ICB code, i.e. by "sector" as commonly undertaken in prior studies;[626] an out-of-sample approach is applied to ensure the firm under investigation is not considered its own peer.[627]

6.2.3 Benefits of incremental restrictions on peer group formation

Pure reliance on industry affiliation—in particular when conducted in a more or less automated fashion on the basis of industry classification codes[628]—might not always be appropriate given there is indeed some indication on the basis of numerous potentially relevant metrics that

[625] This approach is also motivated as, throughout this dissertation, presumed practitioner approaches are given preference over theoretical alternatives in an effort to support practitioners with incremental multiple valuation improvement rather than suggesting revolutionary concepts with little practical acceptability

[626] Compare e.g. Schreiner (2007, p. 112) and Berndt, Deglmann, and Vollmar (2014, p. 11) for the same approach. The practice to form peer groups via industry classification systems is highly common in archival studies on multiples, compare Alford (1992, p. 106), Cooper and Cordeiro (2008, p. 8), Henschke and Homburg (2009, p. 4), Young and Zeng (2015, p. 12), among others

[627] Compare Subsection 72 (p. 72) for an overview on the ICB classification system and Table 3.1 (pp. 78–79) for details on the size of samples in each multiple valuation; given an out-of-sample approach is taken, i.e. the peer company cannot be a comp to itself, numbers in Table 3.1 need to be adjusted by −1 to get to respective sample size; compare Subsection 232 (p. 232)

[628] such as SIC or ICB schemes

companies within a given industry will still differ from each other.[629] [630] Some of the empirical studies, which have tried to reflect operational differences by considering financial metrics among comparables, obtained conflicting results:

- A combination of comparable selection on the basis of industry and nature of the firms[631] *does not improve* multiple valuation precision: Alford (1992, p. 96) finds that if industry-matched comparables are further refined through additionally imposing restrictions of similar growth and risk profiles to the company under investigation, valuation accurateness does not improve. Equally, the multiple valuation method with the best performance on error metrics discussed by Herrmann and Richter (2003, p. 211) appears to be one which is solely based on "intrinsic" likeliness of peers rather than industry affiliation, albeit a combination of industry and fundamental aspects comes relatively close[632]
- There is *improvement potential* on multiple valuation quality from considering further company differences in addition to industry affiliation: While not their main subject of interest, Boatsman and Baskin (1981, p. 46) provide some initial evidence on the benefit of including long-term historical earnings growth rate in addition to industry affiliation for the accuracy of price/earnings multiples. More recent studies relying on regression methods to identify a predetermined subset of (equally weighted) industry peers, include Bhojraj and Lee (2002) with "warranted multiples" as well as Bhojraj et al. (2003) with an international extension of the "warranted multiple" approach.[633] Alternative concepts such as Cheng and McNamara (2000, pp. 358–362) have demonstrated that peer exclusion on the basis of return on equity dissimilarities outperforms a non-exclusionary approach on the basis of industry affiliation, yet again giving equal weight to all peer firms considered. Other studies such as C. Liu and Ziebart (1994)[634] and Zarowin (1990)

[629] The question whether forecasts are primarily derived from industry affiliation or are company-specific is not novel. As early as Cragg and Malkiel (1968, p. 72) e.g. broker-forecast growth rates are decomposed into relative to industry average growth and growth between industries

[630] Figure A.1 (p. A12) visually depicts a summary statistics on the dispersion of illustrative metrics for the empirical sample utilized (Compare Chapter 3, p. 69 for details): It documents that variability both between and within industries exists

[631] Expressed through financial metrics such as growth

[632] The approach chosen by Alford (1992) is similar to Herrmann and Richter (2003) in that both separate comparables from non-comparables through somewhat arbitrary cut-offs, the former considering a fixed number of six (Alford, 1992, p. 99), the latter arguing for a 30–50% range in the fundamental peer metric relative to the company under investigation (Herrmann & Richter, 2003, p. 208)

[633] On the basis of some of the fundamental valuation inputs discussed in Subsections 4.2.2 and 4.3.3 (pp. 94 and 109, respectively), the warranted multiple approach proposed by Bhojraj and Lee (2002) recommends choosing those companies with the closest warranted multiple as a peer for the company under investigation

[634] Reported in M. Kim and Ritter (1999, p. 416)

have followed regression approaches to demonstrated that price/earnings multiples are impacted by differences in long-term earnings growth, size and dividend payout ratio, whilst less dependent on other aspects such as risk, short-term growth and accounting methodologies

- Henschke (2009, pp. 11, 74–77, 85) follows a more sophisticated approach by determining a "signed" and, more crucially for peer group selection, "absolute peer score" on the basis of a pairwise comparison of the firm under investigation and each of its peer firms: The peer score is calculated by, first, determining the slopes of a multivariate regression of an expected valuation bias computed for the peer group on the basis of operational dissimilarities between the peer group and the firm under investigation. In a second step, those slope estimators are applied to the pairwise differences between each peer firm and the company under investigation to determine the peer score. The 10 peers with the lowest peer score are then selected as peers to determine the valuation multiple as their median. Alternatively and as a result of peer group size restrictions, Henschke (2009, p. 11) also proposes an adjustment to the valuation multiple on the basis of the signed peer score.[635] Similarly, Esty (2000) references his findings of improved multiple valuation with elements of the Gordon growth formula[636] and the benefits of adjusting for differences of those elements for multiple valuation accuracy[637] [638]
- Dittmann and Weiner (2005) address another interesting aspect of peer selection, which relates to the relevance of the *location of comparables*,[639] in other words: is it preferable to choose peers which have the same or a similar origin, or should a global peer group be considered? The results of Dittmann and Weiner (2005, p. 11) might be interpreted to suggest a preference for country-peer selection in larger and more diverse stock markets such as the United States and the United Kingdom but for smaller markets a more

[635] While an elegant approach to operationalize peer sameness, which results in substantially improved empirical valuation outcomes, both approaches are not based on the intuition of similar peers being awarded a higher weight than their dissimilar counterparts

[636] Gordon and Shapiro (1956, p. 107)

[637] A number of other studies appear to confirm the benefits of using industry comparables as a starting point and then refine the peer group further. See e.g. Asche and Misund (2016) for another approach using an econometric model in combination with Chow test for the oil industry and Cooper and Cordeiro (2008), who are balancing the number of peers relative to growth differences and find that it is better to use a small number of comparables with similar growth profiles

[638] This hybrid approach of considering both industry affiliation and financial input factors will be studied at greater detail in Subsection 7.8 (p. 310) under the concept of peer weights

[639] Unfortunately, Dittmann and Weiner (2005) appear to not discuss in detail how location is determined, since it could be either headquarter location, location of the primary stock exchange or even location of the largest part of production assets

international peer selection might be appropriate[640]

The above concepts have in common that they rely on sub-setting industry peers identified on the basis of further criteria or that they rely on a modification of valuation multiples obtained, e.g. on the basis of regression approaches. The much more intuitive approach of considering industry peers with higher similarity to a larger degree and sector comparables with lower similarity to a lesser degree has so far not been implemented in empirical studies. Such a novel *peer weighting concept* will be followed in the empirical part of this dissertation and contrasted against the baseline equal-weight median approach.[641]

6.2.4 On the ideal number of comparables

Another aspect of practical relevance concerns the determination of an *appropriate number of peers*. If the valuation multiple is considered to be represented best by the population (of all utilized and not utilized) peers and estimated by the sample peers, basic statistical deliberations suggest a higher number of peers is preferable to a lower number, since larger sample sizes allow for better estimates of the distribution parameters expressed by narrower confidence intervals or lower valuation errors compared to smaller sample sizes (among many: Ott and Longnecker, 2010, pp. 230–231). At the same time, it is reasonable to assume that (a) the higher number of peers the more likely it is that similarity between peers and the company under investigation on the margin decreases—with it so does the quality of the aggregation, resulting in a *"dilemma"* of a smaller, very similar peer group vs. a larger but less comparable set of peers (Meitner, 2006, pp. 70–71). This is further amplified by the fact that each additional inclusion of a peer firm carries a cost of preparing a carefully computed multiple, i.e. a usual sample size trade-off (Ott & Longnecker, 2010, p. 230).

It is therefore instructive to consider practitioner approaches and empirical findings on the appropriate number of comparables: While the sample tables of trading comparable outputs illustratively presented by Hasler (2011, p. 288), Rosenbaum and Pearl (2009, p. 15), Koller et al. (2010, p. 314), Arzac (2008, p. 69), M. Kim and Ritter (1999, p. 420) and Löhnert and Böckmann (2009, p. 562) display between 5 and 15 companies, there appears to be no

[640] There are, however, some markets with conflicting results: i.e. Germany and France as comparably large markets benefit from international peer selection, while some smaller markets such as Denmark and Greece appear to benefit from local peer selection. Results may partly be explainable by diverging accounting standards

[641] Compare Hypothesis 3c (p. 128), Subsection 6.3.2.3 (p. 204) regarding some background on weighted central tendency measures and Subsection 7.8 (p. 310) regarding the concrete approach undertaken and results

in-depth discussion on how this number has been chosen.[642] On the basis of conversations with valuation practitioners, Schreiner (2007, p. 73) references a peer group size of 4–8 comparables as ideal and chooses a minimum requirement of 7 industry constituents for his empirical study (2007, p. 95). Pereiro (2002, p. 267) mentions 6–10 comparables as a suitable number, suggesting that beyond 10 peers, the least suitable names should be dropped. Pratt (2008, p. 274) references US court cases, in which 10–16 peer firms had been utilized. Cooper and Cordeiro (2008) present some empirical work, which suggests that there is little benefit from extending the peer group beyond 10 comparables and, while there is an improvement in valuation accuracy of going from 5–10 comparables, the impact is overall small.

The number of available suitable comparables can expected to *vary by industry*.[643] The question arises how to deal with situations where there are just not enough comparables. Prior empirical research has dealt with this restriction in one of two manners: First, *exclusion* of sample companies for which not enough peers are available—starting from Boatsman and Baskin (1981, p. 45), who requires 4 peers at the minimum and others,[644] who set the limit at 5 peers—and, second, an approach to *"cast the net wider"* when it comes to industry finesse by using a higher level industry-code restriction (Kaplan & Ruback, 1995, pp. 1067–1068).[645] [646]

To summarize, while there is no objectively correct answer as to how many comparables are appropriate, the above quoted numbers are helpful in benchmarking any multiple analysis relative to common practice. Naturally the number of peers should also depend on the availability of firms perceived alike to the company under investigation and this number will vary on a case-by-case basis.[649]

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[642] Asquith et al. (2005) and Schönefelder (2007) report in detail on the valuation methodologies used by equity research analysts and fairness opinion providers, respectively, with multiples featuring very prominently, but unfortunately neither reports how many comparables form the basis of such multiple valuations. I recall from prior research on fairness opinions (Berndt, Deglmann, & Schulz, 2014) but did not report either that the above number of comparables is broadly consistent with market practice for fairness opinions in Switzerland

[643] For the empirical sample utilized in this dissertation, where peer groups are constructed on the basis of industry classification groups, the number of comparables varies between 0 and $\max(n_{j,t})$ =56 with a median of $\tilde{n}_{j,t}$ =23, as can be derived from Table 3.1 (pp. 78–79)

[644] E.g. Meitner (2006, p. 190), J. Liu et al. (2002)

[645] Kaplan and Ruback (1995, p. 1068) rely on 4-digit SIC codes to form their industry peer groups, relaxing this to 3 digits and even 2 digits, to ensure a minimum of 5 comparables are available

[646] Without further justification a number of regression-based studies limit the upper number of comparables, too: M. Kim and Ritter (1999, p. 418) limits the peers to a maximum of 5 based on past sales as a selection criterion by size. Bhojraj and Lee (2002, p. 433) uses no more than 4 peers for the harmonic peer mean calculation as input variable to some regression analyses, however, then appears to rely on the six closest peers when choosing warranted multiples (2002, p. 437). An alternative to this despite the work of Cooper and Cordeiro (2008) none the less somewhat arbitrary limit is reliance on relative deviation[647] or a predetermined deviation percentile[648] for fundamental input variables between peers and the company under investigation

[649] Since the empirical part of the dissertation relies on indiscriminate comparable selection based on industry affiliation,[650] the discussion around the number of peers does not result in any additional restrictions applied

6.2.5 Industry-specific valuation drivers and multiple types

As has been discussed in general considerations around valuation driver selection,[651] there is also a potential industry component to *valuation driver selection*. This is theoretically motivated by an argument, according to which valuation drivers—and hence multiple types—should be chosen as the best one-period/one-metric proxy for the future cash generation potential of a firm and that this optimal choice could well be a function of different operational and strategic properties of the company, which—much like forming a peer group—can be approximated by industry affiliation. It is consistent with common practitioner remarks such as "industry X trades on multiple type Y"[652] as well as suggestions in text books to apply dedicated multiple types to certain industries (Mondello, 2017, p. 437; Hasler, 2011, p. 286)[653] or companies with specific characteristics (Damodaran, 2012a, p. 500); it also appears to have found its manifestation in fairness opinions, which tend to rely on different multiple types depending on the industry considered (Schönefelder, 2007, p. 106). In its more extreme forms, e.g. the connotation that financial companies are valued differently to all other industries, has on the one hand led to such companies being excluded for broader industry analyses across a variety of corporate finance areas;[654] on the other hand, some studies such as Nissim (2013) are specifically devoted to certain sectors.

The aspect of industry-specific valuation drivers has also been studied empirically. While not running sophisticated comparison analyses of different multiple types, early studies such as LeClair (1990, p. 40) find that the quality of price/earnings valuations varies substantially for different industry sectors, with between just 5.3% of valuations with less than 10% error in the basic materials sector, compared to a much higher 46.7% of valuations with less than 10% errors in food retail. In a more direct comparison of different multiple types, Baker and Ruback (1999, p. 30) provide a detailed comparison of which multiple type out of enterprise value/EBIT, EBITDA and net sales works best in which industry, documenting a strong performance of EBITDA in electrical/electronics and natural resources, whilst EBIT performs better for health care, auto parts and machinery producers, among others. The conceptual drawback of most studies, which present industry-specific multiples—such as Rossi and Forte

to peer group formation

[651] See above, Subsection 2.4.1, p. 52

[652] Whilst this statement is not frequently made as directly, any cross-industry equity report suggests this is the case as it will apply different multiple types to different industries, compare among many Jeffries (2019) and Credit Suisse (2019)

[653] Also compare Drukarczyk and Ernst (2010), who structure their valuation textbook by different industries

[654] Compare Subsection 3.4.2 (p. 74) for an overview of prior studies which exclude financial companies such as banks for their sample

(2016, pp. 70–83), Harbula (2009) and Schreiner (2007), who all identify some valuation drivers and multiple types, which work particularly well in some industries and some,[655] which perform badly across—is that it is challenging to connect the empirical findings consistently to a compelling theoretical explanation. Whilst Schreiner (2007) interprets his results of price/earnings coming in among the top 4 of the multiple types studied as reconfirmation of the strong performance of price/earnings in the pooled sample,[656] Rossi and Forte (2016, p. 78) speculate that their findings suggest that price/earnings works well where analysts perform a good "job" in forecasting earnings, whilst book value multiples achieve good results in sectors with high "invisible investments," such as professional services and utilities (2016, p. 83), which they interpret as a confirmation of the findings of Penman (2013). Still, no conclusive theory on industry-specific multiples has been developed yet and the data presented is usually analyzed only descriptively rather than with more sophisticated statistical methods and, to add to the complexity, some studies furthermore suffer from a conflation of different aspects such as valuation driver type and timing,[657] suggesting some additional empirical research might be adequate.

My investigation will focus on the following hypothesis, which is motivated by the existing theoretical findings:

Hypothesis 5a *Industry-specific multiple types offer an opportunity to increase valuation accuracy compared to utilizing one single multiple type for valuations across all industries*

Hypothesis 5a will be assessed in the context of Hypothesis 7 (p. 220) on combined multiple type approaches; however, the single best industry multiple type will also be determined and tested against the baseline of the best performing multiple type across all industries.

6.2.6 Adding granularity: the extension to firm-specific multiple type selection

Of lesser practical relevance, yet none the less theoretically instructive is the question if it is possible to add further granularity to multiple type selection by choosing multiple types

[655] Usually (but not always, such as in the hotel & leisure and consumer sectors according to Rossi and Forte (2016, p. 78) and in the chemicals and computer hardware sectors according to Baker and Ruback (1999, p. 30)) enterprise value/net sales produces the highest errorsJ. Liu et al. (2002, pp. 162, 167-170)

[656] This interpretation is consistent with the argument by J. Liu et al. (2002, pp. 162, 167–170) of strong forward-earnings performance—in 77 of 81 industries studied, a two-year forward earnings as valuation driver performs best in J. Liu et al.'s sample

[657] Compare e.g. Schreiner (2007, p. 115) and to some extent J. Liu et al. (2002, pp. 167–170)

depending upon firm-specific characteristics. For example, one could theorize that firms with high return on equity will trade more in line with price/earnings—with earnings acting as a proxy for future cash flow projections—whilst firms with low return on equity will eventually require a reorganization and could therefore rather trade on a market/book multiple—with book values acting as proxy for the optionality around the reorganization—as proposed by Meitner (2006, p. 125).[658] As an alternative to industry-specific multiple types and the baseline of one multiple type applied to all valuations conducted, I will, however, follow a more exploratory-led rationale considering the following two approaches to firm-specific multiple types:

- *Time consistency of well-performing multiple types:* It is reasonable to assume that multiple types, which have historically performed well regarding the valuation of a specific company might be able to do so in future, too. Therefore, one might expect that there is some firm-specific consistency of multiple type success over time. Naturally, application of this concept will in practice be limited to (historically) publicly traded firms, for which the suitable multiple type can be determined during a "training period." For currently still traded firms, multiple valuation following this approach can provide indications of mis-pricing. In a more general setting involving closely held private companies, practical limitations are more material since trading data will not be available
- *Minimization of intrinsic multiple differences to peer group:* An alternative approach easier to generalize comprises the determination of the best pricing/valuation multiple type by considering the discrepancy between the individual firm's intrinsic multiple and its peer group suggested intrinsic multiple. The rationale for this approach is that small differences between the firm's intrinsic multiple and its peer group intrinsic multiple suggest a multiple type might be suitable for valuing the firm. If a perfect match between pricing multiples and intrinsic multiples existed, the concept should minimize valuation errors; in other words this investigation is another[659] investigation around market efficiency of intrinsic valuations diverging from market-observed valuations

The above considerations are further analyzed on the basis of the following more general hypothesis

[658]Meitner (2006) develops this idea further into a two-factor multiple valuation model

[659]Compared to the more direct comparison of intrinsic multiple valuation outcomes relative to valuation multiple outcomes proposed in Hypothesis 3a (p. 127)

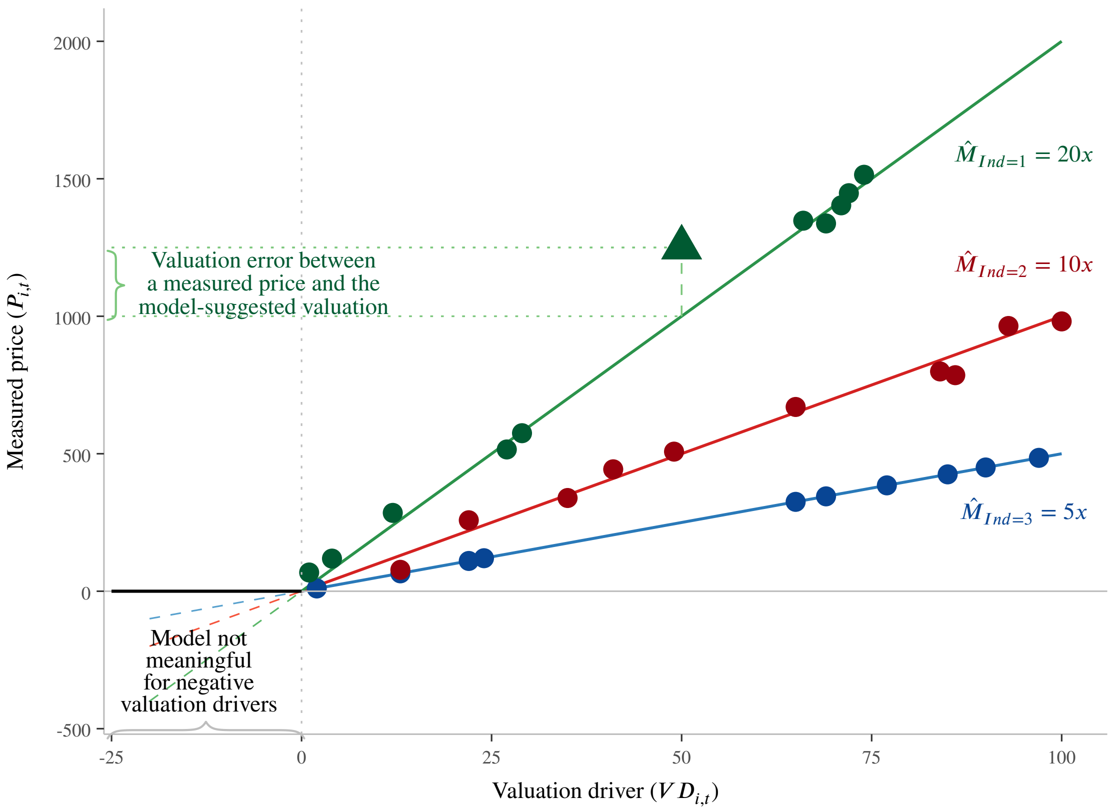
Hypothesis 5b *Best-performing multiple types are firm-specific; strategies to uncover the multiple type, which is best suited for each firm can meaningfully increase valuation accuracy*

As is the case with Hypothesis 5a, Hypothesis 5b will be empirically analyzed in connection with Hypothesis 7 (p. 220) on combination multiple approaches.

6.3 Theoretical and quantitative aggregation and combination aspects

6.3.1 Visualizing multiple valuation in the context of aggregation

FIGURE 6.1: Connecting valuation driver and observed price through multiples



Note: Own illustration. Each color green, red and blue illustratively represents one industry with a resulting multiple valuation of 20x, 10x and 5x, respectively: The multiples can be understood as the slope of the lines which connect valuation driver and price for each industry, assuming proportionality (i.e. no intercept term) as is typically the case in multiple valuations. The dots denote firms in those respective industries. Since in practice no strict linearity can be observed, i.e. the firms will not normally line up on the line representing the multiple like illustratively shown for $\hat{M}_{Ind=3}$, there will be valuation errors, a better understanding of which is crucial in the context of multiple valuation. Such an error is shown for a sample company of Industry 1 (green triangle).

To illustrate aspects of aggregation, it is instructive to first graphically demonstrate and summarize a number of multiple valuation properties. Considering a simple coordinate system with the valuation driver (e.g. earnings) marked on the x-coordinate and the pricing reference (e.g. Market capitalization) on the y-coordinate as represented by Figure 6.1 (p. 196), the following points are worth noting and will be further amplified in the subsequent Subsections:

- As described above,[660] multiple valuations are based on the Law of One Price, which in practice is often based on selecting peers on the basis of industry affiliation. This means there is an implicit assumption that for every industry in k industries, *a specific valuation multiple* $\hat{M}_{Ind=k}$ applies. While the justification of this multiple is in practice often taken as a given and linked to considerations around similar business properties among industry peers, some theoretical considerations above[661] suggest that companies featuring certain financial properties such as incremental investment returns higher than their costs of equity and positive growth within one industry should command higher multiples
- The multiple valuation "model" proposes that the companies, which are valued at the same multiple all sit on a "string of pearls" on the line representing the multiple,[662] i.e. there is "strict linearity."[663] The multiple is conceptually represented by the *slope* of its respective line through the origin. In practice, it will not normally be the case that all pairs of valuation drivers and measured prices line up so conveniently on the respective line—i.e. peers will have somewhat varying multiples. The assumption of the model is then implicitly relaxed to positive and negative deviations from the line suggested by the model *offset each other*.[664] If the deviations remain unexplained it can be perceived as randomness, so any company under investigation should be valued on the basis of its valuation driver as the best estimate for its value, acknowledging that valuation errors will exist.[665] A reduction of such valuation errors is of crucial importance for the portability of multiple valuation approaches from a descriptive nature[666] to a true valuation tool,[667] so it deserves greater attention

660 See Subsection 2.1.5.1, p. 27
661 See Subsection 4.2.1, p. 91
662 Consider the blue line in Figure 6.1
663 Consider among many Schaich, Köhle, Schweitzer, and Wegner (1990, p. 184) for a definition of "strict linearity"
664 Compare the above discussion in Subsection 2.1.5.1 (p. 27) on the relaxation of the Law of One Price as well as Henschke (2009, p. 15)
665 Consider the green triangle in Figure 6.1
666 Consider e.g. the statement "the individual company trades at 10x, sector trades on average at 8x"
667 Consider e.g. the statement "because the sector trades on average at 8x, we can infer that a company under

- It is visually obvious that multiple-based approaches conceptually bear resemblance to a simple *linear regression* approach. The explanatory variable is the valuation driver, the dependent variable is the price. The slope of the regression line through the origin can be considered the multiple. The ambition is to estimate a multiple (i.e. slope) on the basis of the peer group sample, which best fits the true underlying multiple for the respective peer group through minimization of error terms as is customary in a linear regression. In practice there is an assumption of proportionality in the context of multiple valuations, so there will not be an intercept term, i.e. a regression through the origin.[668] While for regressions, the parameter estimation method of ordinary last squares is most popular (Giloni & Padberg, 2002, p. 363), multiple valuation relies on a different more parsimonious concept of central tendency measures including arithmetic mean and median.The slope of the regression line for the k-th industry—and hence its valuation multiple—with I firms at time t would be estimated as

$$\hat{\beta}_{k,t} = \frac{\sum_{i=1}^{I} VD_{i,t} \cdot P_{i,t}}{\sum_{i=1}^{I} VD_{i,t}^{2}} \tag{6.1}$$

under the ordinary least square regression (OLS) concept for a regression through the origin (Rawlings, 1998, p. 21). This compares e.g. to the practically popular arithmetic mean weighting concept, where the valuation multiple would be compared as:

$$\hat{M}_{k,t} = \frac{1}{I} \cdot \sum_{i=1}^{I} \frac{P_{i,t}}{VD_{i,t}} \tag{6.2}$$

It is critical to understand then that a discussion is needed on the "right" aggregation concept—i.e. the algorithm, which best represents the underlying true multiple of the respective peer group—and it appears natural to differentiate the two groups of central tendency measures[669] and regression slopes.[670] While, at a casual glance, those two aggregation algorithm types—standard central tendency concepts (e.g. arithmetic mean) and regressions through the origin—appear quite distinct from each other, I argue and explain in greater detail in the Appendix (p. A13) that they actually can be understood as *different weighted least square models*. The objective of any approach remains the

investigation for which no market price is available or the market price of which should be compared to its underlying value should—with reasonable precision—trade at 8x times, as well"

[668] Even though some theoretical analyses of multiples have allowed for an intercept term, see J. Liu et al. (2002, p. 144)

[669] See below, Subsection 6.3.2, p. 199

[670] See below in the Appendix, p. A13

same though in that the line or slope, which best represents the respective industry multiple on the basis of peer pricing multiples is to be found—i.e. the valuation multiple

- According to a relatively broad consensus in academia,[671] a *non-negativity restriction* should apply. The model of multiple valuations is specified only for non-negative values of the valuation driver: Negative share prices do normally not exist, as shareholders would rather walk away than paying additional considerations in order to dispose of their shares. Consequently, it is argued that negative valuation drivers—such as e.g. a reported loss—are not meaningful as they would suggest a negative valuation. However, more recently, with Sommer et al. (2014), an empirical study has emerged, which questions the value-relevance of negative peer multiples. Furthermore, Schwetzler (2003, p. 89) suggests an alternative aggregation concept, which does allow for negative valuation drivers to be considered in multiple valuation. Therefore, this aspect warrants a more in-depth discussion[672]

6.3.2 Comparing valuation multiple aggregation techniques

6.3.2.1 Standard unweighted central tendency measures

As has been discussed at length by numerous authors previously,[673] a number of common central tendency measures suitable to describe continuous variables—-notably, arithmetic mean, geometric mean, harmonic mean or median—could be considered in the context of multiple aggregation.[674] A focused summary is none the less instructive and provided by the following discussion as well as Table 6.1 (p. 201).[675]

Whilst *arithmetic mean* might be most popular among practitioners (Adrian, 2005a, p. 67), numerous authors have highlighted a strong preference for the *harmonic mean*, which has been motivated by theoretical shortcomings of the arithmetic mean resulting in upward-biased

[671] Including Damodaran (2012a, p. 498), Koller et al. (2010, p. 318), Meitner (2003, p. 108), Mondello (2017, p. 443), Massari et al. (2016, p. 334), Cheng and McNamara (2000, p. 368), among others

[672] See below Subsection 6.3.3.2, p. 210

[673] See references included the footnotes to this Subsection for further details, a good summary on respective formulas with some general discussion is provided by Plenborg and Coppe Pimentel (2016, p. 69), Sommer and Wöhrmann (2011, p. 7), Meitner (2006, pp. 38–41) and to some extent Chullen et al. (2015, pp. 644–645)

[674] While this proposed list and Table 6.1 comprehensively covers the most common metrics used in empirical literature, alternatives such as the ln-mean, where pricing multiples are transformed through taking the natural logarithm, then aggregated and then re-transformed (Herrmann & Richter, 2003, p. 212) are presented by some authors, so the summary should not be seen as exhaustive

[675] For further details Meitner (2006, p. 41) presents an illustrative graphical depiction of the different methods on the basis of a numerical example

estimators[676] given the measurement error is implicitly fully reflected in the valuation driver rather than the price reference (Dittmann & Maug, 2008, pp. 12–13; Beatty et al., 1999, p. 182). For multiples, this can be considered more appropriate as valuation drivers can be measured for peers and the company under investigation, while for price references this is only possible for peers as a valuation is sought for the company under investigation.[677] [678] Furthermore, some empirical precedents[679] point to improved valuation accuracy of harmonic mean over arithmetic mean. A possibly even clearer picture emerges on the strong empirical performance of medians as aggregation metrics: While not in line with J. Liu et al. (2002), three of the more recent studies, which also benefit from additional methodological rigor around adjusted multiples and general multiple computation (Chullen et al., 2015, p. 654; Dittmann & Maug, 2008, p. 2; Herrmann & Richter, 2003, p. 213) ascribe to median a substantially better performance than both arithmetic mean and harmonic mean.[680] Meitner

[676] Mathematically, it is a result of Jensen's Inequality (Dittmann & Maug, 2008, p. 26; Schwetzler, 2003, p. 88) that the harmonic mean always delivers lower valuation multiples than the arithmetic (or geometric) means

[677] Compare for further considerations also Schwetzler (2003, pp. 88–89), who provides an instructive chart, which graphically details the differences between both approaches: resorting to the CAPM, Schwetzler (2003, p. 89) then argues that the preferred interpretation should take place on the equity yield or return (i.e. the inverse of the multiple), as equity returns are weighted in an additive manner, a view also shared by Baker and Ruback (1999, p. 17), who stress the advantageous feature that harmonic means give the same weight to every monetary unit of investment and confirm their preference for the harmonic mean aggregation method through a Gibbs sampling approach; arguing in a similar direction, Adrian (2005a, p. 68) suggests that the harmonic mean is economically more consistent, as its reliance on equity returns considers a case where an equal investment in all peer companies is considered, which then at the end just finds its expression in the inverse of the equity return (i.e. a valuation multiple). A more intuitive argument comes from Schreiner (2007, p. 74), who claims that arithmetic mean is skewed as a consequence of the values it can take from 0 to ∞; however, this is a result of an imposed restriction rather than a property of the arithmetic mean itself

[678] Multiple valuation is also one of the examples given on the Wikipedia website for harmonic mean use cases (Harmonic mean, n.d.)

[679] Probably most in favor of harmonic means relative to both arithmetic mean and median alternatives are J. Liu et al. (2002, p. 137), who find that harmonic means outperform both arithmetic means and, more notably, medians. However, as J. Liu et al. (2002, p. 160) contend, this outperformance decreases as multiple types with higher valuation precision all together are chosen. Other studies confirm the findings of J. Liu et al. (2002) regarding the relative performance of harmonic mean over arithmetic mean but medians appear to emerge as stronger contenders. Compare e.g. Baker and Ruback (1999, p. 29) for a comparison of EBITDA multiple errors, in which harmonic mean and median result in lower error statistics; importantly, Baker and Ruback (1999, pp. 8, 26) also report results suggesting that errors calculated for EBIT and EBITDA multiples using harmonic mean might be normally distributed, despite showing some skewness. The results are consistent with Chullen et al. (2015, p. 654), whose findings suggest that harmonic mean overall outperforms arithmetic mean but both aggregation concepts lack the precision of geometric mean and median. The results of Dittmann and Maug (2008, p. 2) are inconclusive in that they depend on the measurement of the valuation error (see below Subsection 6.4.1 (p. 222) for considerations on valuation error measurement): for percentage errors, harmonic means are least biased, however median and geometric means outperform harmonic means if errors are expressed logarithmically. Inconclusive results between harmonic means and arithmetic means are also reported by Herrmann and Richter (2003, p. 213)

[680] Geometric means are also performing well in empirical analyses (Chullen et al., 2015, p. 654), however, is less obvious to argue for unless used in time series analyses involving multiples (Adrian, 2005a, p. 69) and no conclusive reason is offered by authors advocating for geometric means, one of which could be an anticipated lognormal distribution of multiples (Sommer & Wöhrmann, 2011, p. 7; Dittmann & Maug, 2008,

Table 6.1: A summary of standard unweighted central tendency measures

	Arithmetic mean	Harmonic mean	Geometric mean	Value-weighted mean	Median
Equation	$\hat{M}_{k,t} = \frac{1}{I} \cdot \sum_{i=1}^{I} \frac{P_{i,t}}{VD_{i,t}}$	$\hat{M}_{k,t} = \frac{I}{\sum_{i=1}^{I} \frac{VD_{i,t}}{P_{i,t}}}$	$\hat{M}_{k,t} = \left(\prod_{i=1}^{I} \frac{P_{i,t}}{VD_{i,t}}\right)^{\frac{1}{I}}$	$\hat{M}_{k,t} = \frac{1}{I} \cdot \frac{\sum_{i=1}^{I} P_{i,t}}{\sum_{i=1}^{I} VD_{i,t}}$	$\hat{M}_{k,t} = \begin{cases} \left(\frac{P_t}{VD_t}\right)_{\frac{I+1}{2}} & \text{for odd } I^{a} \\ \frac{1}{2} \cdot \left[\left(\frac{P_t}{VD_t}\right)_{\frac{I}{2}} + \left(\frac{P_t}{VD_t}\right)_{\frac{I}{2}+1}\right] & \text{for even } I \end{cases}$
Equation reference	(6.3)	(6.4)	(6.5)	(6.6)	(6.7)
Attractions	• Popular among practitioners • Straightforward to understand	• Stronger theoretical underpin than arithmetic mean • Empirical evidence pointing to superior performance compared to arithmetic mean	• Strong empirical performance in certain studies • Unbiasedness in combination with log errors	• Possible to consistently consider non-positive multiples or valuation drivers • Some theoretical backing stems from stock index calculation analogy	• Popular among practitioners • Strong empirical performance • Insulates valuation multiple against outliers, no winsorizing of peer pricing multiples required
Drawbacks	• No theoretical backing • Weak empirical performance • Upward bias not consistent with valuation conservatism	• Theoretical superiority possibly not immediately obvious to valuation practitioners	• No obvious reason for use in non-time series multiple valuations	• Implicitly weights larger peer firms stronger than smaller peer firms, which is possibly not desired and challenging to theoretically justify	• Assuming normal distribution of multiples, mean metrics are statistically preferable estimators of mean for the overall population and hence preferable in multiple valuation context
Relative performance in selected empirical studies[b]					
Chullen et al., 2015	×	×	✓		✓
Sommer et al., 2014[c]	×	✓		×	✓✓
Sommer et al., 2011	×	✓✓	~	~	✓
Dittmann et al., 2008[d]	×	✓✓	✓		✓
Henschke, 2009		✓✓			~
Schreiner, 2007					✓✓
Herrmann et al., 2003	×	×			✓✓
J. Liu et al., 2002	~	✓✓			~
Baker et al., 1999	×	✓		~	✓✓
Beatty et al., 1999[e]	×	✓✓		~	✓

Note: Own illustration. ✓✓ / ✓ / ~ / × indicates relative empirical performance of the respective central tendency measure compared to alternative measures: single best / better than other / in-line / worse than others; [a] Median calculation assumes that the I peer pricing multiples are sorted by increasing value; $\frac{I}{2}+1$, $\frac{I+1}{2}$ and $\frac{I}{2}$ represent the indices of those sorted multiples [b] Highly illustrative and non exhaustive [c] Considering only positive valuation drivers for EBITDA multiples [d] Absolute percentage errors for price/earnings multiples [e] Based on pair-wise central limit Z-statistic

(2006, pp. 39–40) highlights that the number of peers commonly utilized results in challenges to verify a normal distribution of multiples: this would result in arithmetic mean metrics being suitable for calculating central tendencies (Sommer & Wöhrmann, 2011, p. 7). Therefore, the median may be the preferential aggregation metric, in particular for narrow peer groups.[681] Also as a consequence of heterogeneous elements in empirical results, Schreiner (2007, p. 76) argues utilizing an equally weighted average of median and harmonic mean as a parsimonious approach to possibly similar considerations by valuation practitioners to reflect both mean and median central tendency metrics for determining value multiples. He then, however, concedes that median outperforms this hybrid approach and reports his empirical results on the basis of median (2007, p. 91).

To summarize, a solid case can be made for the *median* as a suitable unweighted central tendency aggregation method since it connects key attractions such as parsimony, solid empirical performance and theoretical backing:

- Empirically strong results relative to alternative central tendency aggregation concepts as summarized in Table 6.1 (p. 201)
- Straightforward to explain and practitioner familiarity[682]
- Deals well with extreme values, in particular compared to the arithmetic mean also popular among valuation practitioners: From a multiple valuation perspective a concept is preferable, which works well for *all* firms and not just for a majority of firms as such limitations introduce potential elimination biases through the judgment needed to determine what should be considered an extreme value and hence be disregarded[683]
- Avoids at least some selection biases stemming from the decision how—if at all—to include negative valuation drivers or multiples more general[684]

pp. 12–13, 26–27). Even for time series analysis, there have been some discussions around the suitability of the geometric over the arithmetic mean (Abrams, 2010, pp. 223–234)

[681] For larger samples, Dittmann and Maug (2008, pp. 12–13) highlight that the median can theoretically be expected to be close to the arithmetic mean for symmetrical distributions and close to the geometric mean for lognormal distributions

[682] Consider e.g. Schönefelder (2007, p. 109), according to which multiple valuation ranges for fairness opinions are determined by medians (and means), suggesting that appraisers have some familiarity with the median as an aggregation method

[683] This is a counterargument to the point of Henschke (2009, p. 31), who argues that the mean might be suitable since it delivers solid valuation for the majority of firms under investigation. Still, a minority will introduce biases

[684] See below in the Appendix 9 (p. A25) for a more detailed assessment of the issue and what the median can offer to address this issue

- Median is considered a robust estimator for fat-tailed distributions, which are common in finance and accounting research applications (Sudipta Basu & Markov, 2004, p. 200)
- According to some theoretical considerations by Dittmann and Maug (2008, pp. 13–14, 26–28) an approach, which resonates well with multiple valuation precision expressed through log errors, as it is unbiased in large samples

Therefore, much emphasis will lay on the median as a central tendency measure in the empirical part of this dissertation. None the less, I will provide some general results also for the theoretically most compelling alternative central tendency measure for multiple valuation, harmonic mean.

Hypothesis 6a *Median is a suitable aggregation concept in the context of trading multiple valuation*

6.3.2.2 Returning to the role of regressions in multiple aggregation

As indicated in Table 6.1, the comparison of standard unweighted central tendency measures has received widespread attention and, in the context of empirically investigating Hypothesis 6a, will therefore be more replicative in nature. However, studies jointly considering regression approaches are more scarce. Therefore, returning to the visual impression of multiples as regression slopes introduced in Figure 6.1, I will also contemplate a number of regression concepts in the context of Hypothesis 6a, namely a parsimonious OLS regression through the origin to implement Figure 6.1 in a strict sense of proportionality, a more relaxed OLS regression, which allows for an intercept term[685], a price-deflated regression approach following a similar proposal by Beatty et al. (1999, pp. 183–184), among others, which seeks to address heteroscedasticity issues with standard OLS methodology, as well as a Theil–Sen regression approach[686] as more recently suggested by Ohlson and Kim (2015, p. 411) and Ohlson and Johannesson (2016).[687] In its entirety, a review of the 9 aggregation approaches—of which 5 relating to standard unweighted central tendency measures and 4 relating to regression-based alternatives—should provide a meaningful basis for assessing the suitability of median as an aggregation concept in multiple valuation in the context of Hypothesis 6a.

[685] This is consistent with an implicit assumption that other aspects than the valuation driver may determine price and that it might not be reasonable to assume those factors cancel themselves out perfectly (J. Liu et al., 2002, p. 144)

[686] Compare among many Wilcox (2010, pp. 193–200) for a textbook explanation

[687] A more detailed theoretical discussion of the role of regressions in the context of multiple valuation is available in the Appendix (p. A13)

6.3.2.3 Weighted central tendency measures

Assuming a decent number of comparable companies can be identified, practitioners tend to group peers into different *"tiers"* (Massari et al., 2016, p. 343). This tiering can follow ex ante informational factors such as headquarter location/primary listing stock exchange, size or business profile but can also relate to the degree of similarity, "from closest to peripheral" (Rosenbaum & Pearl, 2009, p. 13).[688] In particular the latter tiering suggests that not all peer firms should have equal influence on the computation of the valuation multiple for the company under investigation. Consequently, practitioners might apply their professional judgment rather than the strict mathematical output of the central tendency measures above and multiple valuations might be anchored around a very select number of comparables, which are perceived to be the best peers (Rosenbaum & Pearl, 2009, p. 49). Some of the discretion applied can be expected to relate to quantitative nature such as growth and profitability, however, qualitative aspects around the business model will regularly also play a certain role.[689] A quantitative equivalent to such judgment comprises the use of *weights* for the above mean concepts.[690] For example, the harmonic mean in Equation 6.4 could be modified to a *weighted harmonic mean* by introducing a vector of weights, $\mathbf{w_t}$, consisting of I elements $w_{i,t}$ such that

$$\hat{M}_{k,t} = \frac{1}{\sum_{i=1}^{I}\left(w_{i,t} \cdot \frac{VD_{i,t}}{P_{i,t}}\right)} \tag{6.8}$$

assuming

$$\sum_{i=1}^{I} w_{i,t} \overset{!}{=} 1 \tag{6.9}$$

An equivalent concept to the weighted harmonic mean is the *weighted median*, in which the position of the median value is determined by adding weights[691] up to a sum of $\frac{1}{2}$: Pricing multiples and their respective weights are first sorted by the size of the multiple. The weighted median equals the position of the corresponding element of pricing multiple $\frac{P_{i,t}}{VD_{i,t}}$, where no additional weight element $w_{i,t}$ can be added to exceed a cumulative weight value of $\frac{1}{2}$, thus

[688] Compare Subsection 2.1.5.3 (p. 32) for other potential tiering factors

[689] Compare e.g. Schönefelder (2007, p. 109) for a critical discussion on these aspects in the context of fairness opinions in addition to the fact that practitioners prefer to express valuation outcomes in ranges rather than point estimates

[690] Compare Equations 6.3 to 6.6 (p. 201)

[691] Which should be consistent with Equation 6.9

satisfying[692]

$$\sum_{i=1}^{j-1} w_{i,t} \leq \frac{1}{2} \quad \text{and} \quad \sum_{i=j+1}^{I} w_{i,t} \leq \frac{1}{2} \tag{6.10}$$

The weighted median is a rather novel approach in corporate finance applications, but it has been used in other economics contexts such as inflation rate analyses.[693] [694] The weighted median approach will be employed to operationalize the peer weighting concept following Hypothesis 3c (p. 128) and argued for in Subsection 6.2.3 (p. 188) as an alternative to existing peer group improvement approaches beyond industry affiliation.[695]

Independently of whether the weighted harmonic mean or the weighted median is utilized, the question arises on how to quantify the weights contained in $\mathbf{w_t}$. From a practitioner's perspective any number of qualitative and quantitative influencing factors can play a role in determining weights, however, from an empirical position, some operationalization needs to take place. I will propose and report results on a possible approach in Subsection 7.8 (p. 310). Despite its surprisingly simple approach and consistency with practitioners' reasoning, the concept of weighting multiples has not seen widespread empirical use.[696]

6.3.3 Pricing multiple distributions and negative multiples more specifically

6.3.3.1 Pricing multiple distributions and confidence intervals

Confidence intervals as theoretical equivalent of practically common multiple ranges
Practitioners have shown a preference of expressing multiple valuations in terms of ranges (Schönefelder, 2007, p. 109) and a statistical operationalization to the concept of ranges consists of *confidence intervals*. In the context of multiple valuation, confidence intervals have so far received little attention, with the notable exception of Kelleners (2004, pp. 159–162).[697] Equally, relative to the importance of multiple aggregation, the discussion around the

692 Similar to median calculation for even number of values a more sophisticated approach of taking the mean of the lower and upper weighted medians may be needed in special cases

693 Compare e.g. Smith (2004), Lange (2010, p. 313) and Cormen, Leiserson, Rivest, and Stein (2009, p. 225)

694 Surprisingly, many of the common statistics textbooks do not cover the weighted median. The most instructive discussion is available from Wikipedia (Weighted Median, n.d.), with further references to computer algorithm and image processing literature, where it is a more established concept

695 Compare above, Subsection 6.2.3 (p. 188) for a more detailed discussion of approaches to peer restrictions over and above industry peer selection

696 There is at least some use of weighting concepts in the context of multiple valuation observable in LeClair (1990, pp. 36, 42), who uses a multi-period historical earnings approach, where earnings are weighted in a decreasing manner depending how far back in the past they are

697 And, for purposes of valuation errors but not multiples themselves, Herrmann and Richter (2003, p. 211)

distribution of multiples has not been a focus in precedent literature[698] and if at all, has been limited more to lower-order statistics such as considerations around mean and variance.[699] The approach of confidence intervals requires, that, first, a distribution of the underlying pricing multiples is inferred, then, second, that certain distribution parameters such as mean and standard deviation are computed and, third, that the confidence interval for the valuation multiple assuming a specific probability is derived. Whilst steps two and three are part of the standard statistical tool set, it is relevant to consider the *underlying distribution* specifically. Kelleners (2004, p. 159) argues that it is appropriate to assume a lognormal distribution for pricing multiples since—assuming the non-negativity restriction applies—their distribution is bound by zero. This presumption deserves some additional consideration, since little empirical analysis or theoretical considerations on this aspect exist[700] and I assert that a case for the consideration of negative pricing multiples can be made:[701] Pricing multiples can be considered *ratios of 2 random variables,* the price reference and the valuation driver. Those variables cannot ex ante be assumed to be independent; on the contrary, the concept of multiples stipulates dependency between the valuation driver and the pricing reference and hence this dependency will need to be dealt with. The distribution of a ratio of random variables depends on the distributions of each of the random variables. Under the assumption that financial metrics used in multiple computation, i.e. the valuation driver and the price reference follow a lognormal distribution,[702] it can be shown that the multiple itself can also be assumed to be *lognormally distributed*.[703]

Based on the central estimate for the j^{th} valuation multiple computed on the basis of I peers,

[698] An exception are Koller et al. (2010, p. 316), who present a histogram for enterprise value/EBITA in the S&P500® but do not discuss their result at any length other than highlighting that multiples that relying on multiples outside the interquartile range of 7–11x enterprise value/EBITDA needs to be well motivated

[699] Compare e.g. the very illustrative Figure 1 by M. Kim and Ritter (1999, p. 418) on the rationale of using comparable company analysis on the basis of industry peer groups; furthermore compare some more substantial work on multiple distributions by Dittmann and Maug (2008)

[700] This is notably in contrast to a number of analyses dating back mostly to the 1970ties to 1990ties around the distribution of financial ratios: Deakin (1976, p. 95) finds that the normality assumption for 10 out of the 11 financial ratios considered in his analysis appears inappropriate. So (1994) argues that a non-normal Paretian distribution performs better than even lognormal distribution assumption for financial ratios; whilst the lognormal distribution addresses skewness, the empirically obtained distributions display fatter tails. Kane and Meade (1998, pp. 59, 61) highlights that alternative approaches to tackle distribution issues for financial ratios have included elimination of negative values and trimming, concluding that a rank approach results in superior explanatory power of stock returns (1998, pp. 59, 70). A more recent analysis by Pazarskis, Alexandrakis, Vogiatzoglou, and Drogalas (2018, p. 427) using a bootstrapping approach appears to confirm prior findings on the non-normality of ratios and, consequently, Pazarskis et al. (2018, p. 426) argue that t-tests to study interference among financial ratios need to be undertaken with caution

[701] Compare below, Subsection 6.3.3.2, p. 210

[702] Compare Footnote 700

[703] A proof is offered in the Appendix (p. A13)

$\bar{M}_j$, the resulting confidence interval—or multiple valuation range—can then be shown to be given by[704]

$$e^{\ln(\bar{M}_j) \pm Z_{(1-\frac{\alpha}{2})} \frac{SD_{\ln(M_j)}}{\sqrt{I}}} \tag{6.11}$$

This result carries an important theoretical implication, namely that—as any numerical example will demonstrate[705]—the confidence interval is *asymmetrical*. As a consequence of a log-normal distribution, its lower boundary is closer to the central estimate than the upper boundary. Practitioners wishing to rely on ranges of multiples can mirror the asymmetric distribution by choosing a shorter distance between the lower range and the midpoint and a longer distance between the upper range and the midpoint.[706]

On the distribution of multiples more specifically To approach an initial understanding of the empirical distribution of multiples, Figure 6.2 presents distribution plots for the sample utilized in this dissertation of price/earnings. It is based on the pooled sample of all pricing multiples.[707] Panel A of Figure 6.2 depicts density plots for untransformed metrics. Consistent with the previous discussion, the distributions indicated by the solid colored lines are non-symmetrical and visually appear to follow a *lognormal distribution* as indicated by the dashed lines,[708] which appear to mostly overlap with the observed distribution, in particular for the price reference (here: market capitalization—blue line) and the valuation driver (here: net income—green line), however, to a somewhat lesser extent for the multiple (here: price/earnings—red line). Panel B of Figure 6.2 allows for a closer comparison on the basis of log-transforming both the observed density and the theoretical distribution estimated (resulting in a normal distribution). This uncovers some persisting *right-skewness* of both the natural logarithms of market capitalization and net income. However, the natural logarithm or price/earnings appears more symmetrical in its distribution, which indicates that skewness is offset. None the less, price/earnings still does not follow the theoretically expected logarithmic

[704] Compare the Appendix (p. A22)

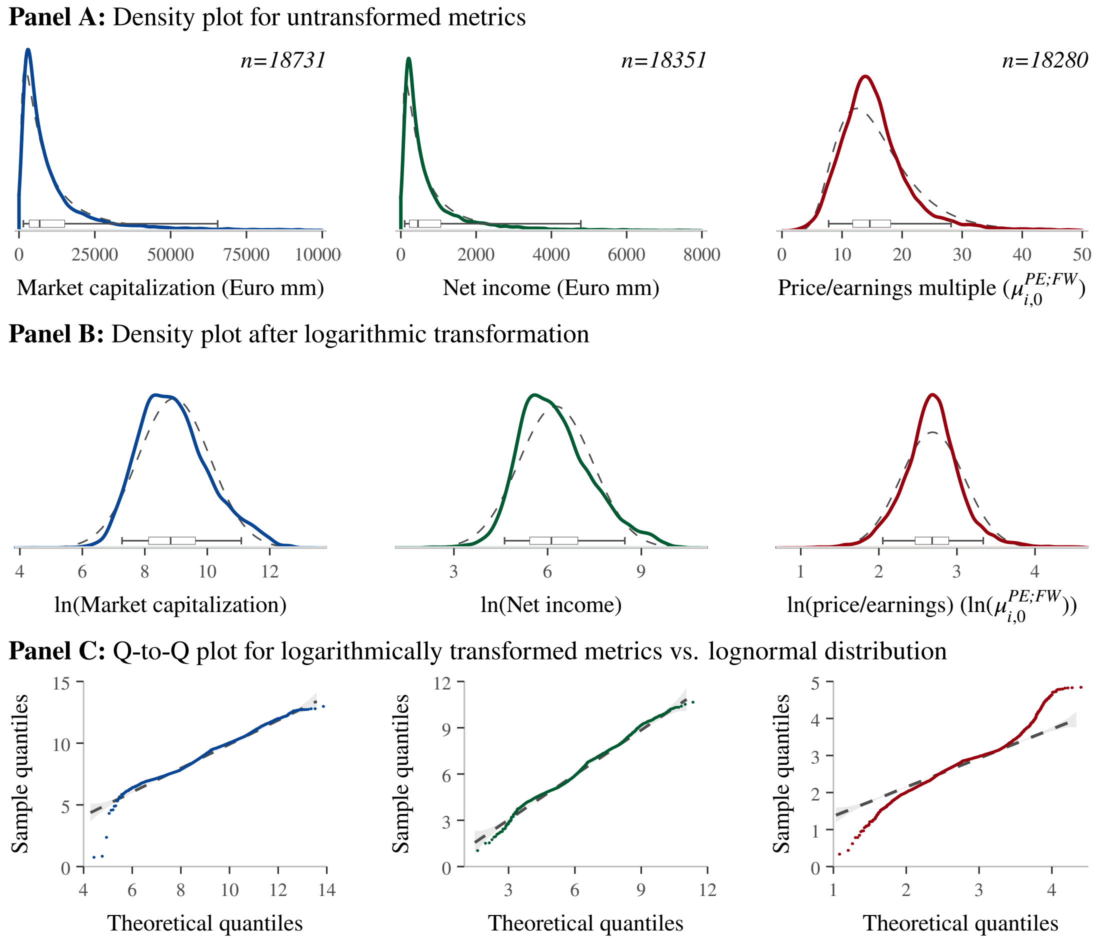
[705] Compare e.g. Kelleners (2004, p. 161)

[706] e.g. if a range around a mid point multiple of 10x is desired, 8.5x–12.5x might be more appropriate than the symmetrical range of 8x–12x

[707] The benefit of analyzing the overall sample across all industries lies in a larger sample size relative to an assessment of industry and or date specific data, where peer group sizes and thus sample groups range from $\min(n_{j,t})$ =0 to $\max(n_{j,t})$ =57 with a median of $\tilde{n}_{j,t}$ =24. There is a case to make to approach the overall distribution using cluster analysis, notably Fixed Mixture Model approaches, relying on sector as a classification criterion (McLachlan & Peel, 2002). This is the more the case as there have been ongoing discussions whether skewness observed in a specific sample can be explained by a 2-component mixture model or is just a consequence of a homogeneous non-normal density function (Tarpey, Yun, & Petkova, 2008). I have therefore also considered but do not separately report randomly picked date-aggregated industry-specific density functions, which, however, graphically display very similar distribution patterns to the overall sample

[708] Estimating using a simple maximum likelihood approach on the basis of μ and σ^2

FIGURE 6.2: The distribution of the P/E multiple and its constituents—sample observations



Note: Solid colored lines relate to the pooled empirical sample utilized in this dissertation, see Chapter 3 (p. 69) for further details on the sample. Dashed lines in the background of density plots relate to density functions of the lognormal and normal distributions estimated using maximum likelihood methods on the basis of sample distribution parameters. Boxplots at the bottom of the density plot drawing areas relate to the distribution of the respective variable in the sample: IQR (box) and 5%/95% quantiles ("whiskers") for respective sensitized variable. Dashed lines in the background of Q-to-Q plots would indicate perfect match of sample distribution and lognormal distribution. Gray-shaded area around dashed line indicates approximate confidence interval range for an $\alpha = .05$ confidence level. Multiples shown relate to empirically measured pricing multiples prior to any valuation model application or determination of valuation model.

distribution, showing heavier tails on both sides and a leptokurtic distribution. Panel C of Figure 6.2 shows Q-to-Q plots, which are customarily used to visually inspect if a sample distribution follows a distribution argued for theoretically (Ott & Longnecker, 2010, p. 196; Hogg, McKean, & Craig, 2005, p. 244)—in this case a lognormal distribution: The higher the likeliness between the observed and the assumed distribution, the more will the points sit on the black dashed line. Whilst for both net income and market capitalization, the Q-to-Q plot appears to overlap graphically reasonably well with the dashed line,[709] the Q-to-Q plot for the price/earnings multiple reconfirms the *heavy-tailed nature* of the pricing multiple sample distribution already observed in Panel B of Figure 6.2, since lower (higher) values sit below (above) the dashed reference line.[710] The findings are directionally consistent with Dittmann and Maug (2008, p. 39), who find a similar lighter-tailed shapes.

To summarize, it has been argued that under the assumption that both components of a multiple are lognormally distributed, the multiple should be lognormally distributed. Formal distribution tests fail to confirm such lognormal distributions, though. I assert that this might have to do with sample size. A visual inspection of the data including Q-to-Q plots suggests that a lognormal distribution is certainly a superior and within limits *useful approximation* for multiples and their components than the standard normal distribution. Log-transformation of the multiple distribution appears to address skewness well, however, fat-tailed properties remain.

[709]Insofar as it is invisible given it is covered by dots of the plot

[710]Whilst Q-to-Q plots are a visually appealing tool to analyze statistical inference, more formal tests exist, which allow the rejection of the hypothesis that a sample distribution follows a hypothetically assumed distribution. For the context of multiples, tests utilized in studies on the distribution of financial metrics can be considered of particular relevance, and some studies have used the Jarque–Bera test (Pazarskis et al., 2018, p. 427). I have conducted but do not report in detail a test of the null hypothesis that the price/earnings multiple is lognormally distributed using a Kolomogorov–Smirnov test. This is motivated by the Q-to-Q plot for the price/earnings multiple in Panel C of Figure 6.2, which suggests a heavy-tailed distribution, for which there is some concern around utilizing the Jarque–Bera test (Thadewald & Büning, 2004). This null hypothesis is to be rejected though with a *p*-value of less than 0.01, which I, however, also ascribe to the large sample size (compare Dittmann and Maug (2008) with a similar argument): As can be seen in the Panel C of Figure 6.2, the confidence interval highlighted by a gray shaded area is relatively narrow for large sample sizes and takes an only slightly wider form for low and high quantiles each. More fundamentally, however, Panel B of Figure 6.2 suggests that whilst the log-transformed price/earnings multiple is distributed broadly symmetrical around its sample distribution mean, it indeed displays a lighter tailed shape than the theoretical lognormal distribution of equal mean and variance. It therefore can be argued that the lognormal distribution assumption is empirically not verifiable for the sample in this dissertation and other distributions should be considered regarding the price/earnings multiple; I did prepare but do not report also Q-to-Q plots on the basis of the Pareto distribution, since there is some evidence from prior studies on the distribution of financial metrics that the Pareto distribution might be an appropriate way to approximate financial metrics (So, 1994). However, the Q-to-Q plot suggests a lack of fit in a very obvious manner

6.3.3.2 Negative valuation drivers and pricing multiples

Non-negativity of multiples has long been accepted as a restriction to multiple valuation.[711] Negative pricing multiples[712] usually occur in the context of *negative valuation drivers*.[713]

The question arises how to deal with negative valuation drivers of peer companies in computation of a valuation multiple and a number of potential alternatives come to mind: ignoring the issue all together, i.e. aggregate to a valuation multiple including the negative pricing multiples,[714] exclude negative pricing multiples,[715] replace negative pricing multiples with another value such as zero[716] or employ specific aggregation concepts such as notably the median.

Empirical studies on the subject of negative multiples are still scarce; only Sommer et al. (2014) and Meitner (2006) have specifically considered this aspect. In a comparison of harmonic means and value-weighted means including and excluding negative multiples, Sommer et al. conclude that, overall, the exclusion approach performs better (2014, p. 49). Their summarizing statement, however, relies on a relatively better performance of other aggregation methods (such as median) rather than an improvement or worsening of the respective specific aggregation method.[717] Meitner (2006, p. 167) studies the value relevance of valuation drivers and finds that coefficients of determination generally improve for common valuation drivers such as net income, book value of equity, net sales, EBITDA and EBIT if negative valuation driver elements are excluded from the regression.[718]

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[711] See Footnote 671 above for selected references

[712] The practically common situation, of negative multiples studied here occurs if a number of pricing multiples in the peer group for a firm under investigation are negative. This is distinct from a situation, where the valuation driver for the company under investigation itself is negative and where alternative valuation drivers need to be explored

[713] While for equity value multiples, this will normally be a restriction relevant to the valuation driver since the minimal value for the price reference is zero, for enterprise value multiples the price reference can in extreme cases turn negative, as well: If deductions from in the equity value to enterprise value bridge outweigh the sum of equity value and additions of the bridge. None the less even in the cases of enterprise value multiples, the "culprit" will regularly also be the valuation driver, which is why this Subsection focuses on valuation drivers

[714] To the extent the aggregation concept supports this, which is e.g. not the case with geometric mean

[715] Which implicitly assumes they don't carry value relevance, which if an incorrect assertion, might lead to upward biased multiples

[716] Which carries arbitrariness

[717] For that, their reported data suggests the picture is somewhat less uniform but still directionally points to better performance of the elimination method: e.g. valuation error metrics seem to improve for value-weighted means of EBIT as valuation driver but worsen for harmonic mean of EBIT as valuation driver (Sommer et al., 2014, p. 41) and worsen for both aggregation methods (Sommer et al., 2014, p. 39) if net income is chosen as valuation driver if negative multiples are considered. Unfortunately, Sommer et al. (2014) do not test the benefits of including the ranks of negative multiples into median determination

[718] Coefficients of determination appear to be higher though for more esoteric valuation drivers such as free cash flow to equity and cash flow from operations. However, those valuation drivers have overall lower coefficients

The Appendix (p. A23) provides are more detailed discussion arguing that any infrequent existence[719] of negative multiples in a peer set can be dealt with effectively through utilizing *median* as an aggregation method as all mean-based alternatives carry a considerable risk to introduce biases. If the argument is followed that negative peer multiples provide relevant insight for the underlying valuation multiple, no elimination should take place: the information content of negative multiples will then be reflected in the resulting valuation multiple through impacting the ranking of (positive) peer multiples, which serve to quantify the median.[720] If, on the other hand, the position is taken that negative peer multiple do not carry any relevant information for the valuation multiple, they should be considered non-meaningful and disregarded all together in the analysis. This alternative line of argumentation also enables the concurrent use of other aggregation methods: if a view is taken that negative multiple carry no relevance for the valuation multiple, setting them to "non meaningful" and computing mean metrics is appropriate. Empirical analysis on which of the above lines of arguments is superior from a multiple valuation precision perspective is non-existent and hence warrants investigation, which will be provided in Subsection 7.3 (p. 268) on the basis of the following hypothesis:

Hypothesis 6b *Negative multiples carry value-relevant information; their inclusion using appropriate aggregation concepts such as median is beneficial*

I motivate this Hypothesis by the fact that median offers the opportunity to reflect negative multiples through their low ranks towards the bottom end of the pricing multiple distribution. Exclusion of negative multiples results in higher medians. Firms with peer groups of many negative multiples can be argued should trade lower than firms, which do not have any negative multiple peers, which can be reflected through consideration of the ranks of negative multiples in a peer group.

of determination than the more common drivers

[719] If the frequency of negative peer multiples exceeds a certain number of occurrences and substantial amount of negative peer multiples exist, it might be preferable to utilize a different valuation driver all together: A negative valuation multiple would be inconsistent with a positive valuation driver of the company under investigation as it implies a negative price reference

[720] More precisely, they can be expected to reduce the valuation multiple as ranks of positive multiples shift lower compared to the exclusion of negative multiples

6.3.4 Pluralistic alternatives to single multiple type valuations

6.3.4.1 Considerable practical relevance of combined multiples and combined valuation concepts

A popular practitioner technique in the context of multiple aggregation is to refer to *several types of multiples concurrently*. Schönefelder (2007, p. 105) finds for the case of U.S. fairness opinions the combination of enterprise value/EBITDA and price/earnings multiples to be common, Matschke and Brösel (2013, p. 822) present questionnaire study results suggesting a combination of sales- and profit-oriented multiples may practically be common. Conceptually, the concurrent use of different multiple types follows a wider positive perception around a *pluralistic approach to valuation concepts*, where fundamental valuation methodologies are combined with relative approaches such as multiples, among other concepts (Gantenbein & Gehrig, 2007; Matschke & Brösel, 2013, p. 821). In practice, this will often result in a *"football field"* valuation output, summarizing the valuation ranges of different approaches with a view to center on the ultimately recommended valuation outcome (Rosenbaum & Pearl, 2009, p. 236),[721] or to cross-check any lead valuation approach through other concepts (Welfonder & Bensch, 2017, p. 178).[722] Such a hybrid concept is also consistent with juridical approaches to valuation, including under the "Delaware Block Method" (Yee, 2004a, p. 24) and have been developed into more formal models, including a "scoring approach" by Engelhardt and Bönner (2017).[723]

From the above it is obvious that 3 levels of combinations can be identified: First, the trading multiple valuation itself, i.e., different trading multiple type combinations, second, among different multiple valuations, i.e. integrated concepts of transaction and trading multiple valuations and, third, multiple valuations and other valuation classes all together such as notably fundamental valuations.

6.3.4.2 Combined multiples: aggregation of several trading multiple types

Previous approaches with challenges to operationalize weights While still considered somewhat of a "niche" area of multiple valuation (Rossi & Forte, 2016, p. 38), a number of

[721] Berndt, Deglmann, and Schulz (2014, p. 27) provide some data on the overlap of different valuation methodologies in the case of Swiss fairness opinions. For a wide selection of football field valuations compare many of the publicly available fairness opinions for the Swiss market provided on http://takeover.ch/transactions/search/

[722] The use of multiples as a confirmatory rather than a driving valuation is advocated for by some of the fundamental valuation-heavy textbooks, including Koller et al. (2010, p. 313) as well as Arzac (2008, p. 66)

[723] Which has rightly been criticized by Follert and Schild (2018, p. 51) for a lack of theoretical justifiability of the weights proposed for the different methods

authors have considered combined multiples in their empirical analyses: Cheng and McNamara, who equally-weigh price/earnings and price/book multiples (2000, p. 368), find that such combination outperforms both individual price/earnings and price/book multiples, which they interpret as separate value relevance of either multiple. The combination approach can be two-fold: first with regards to considering one single valuation driver over several time periods—i.e. turning a single-time period method[724] into a multi-time period approach[725]—or considering some type of blended approach, which relies on several single multiples or valuation drivers measured at one point in time. The "composite approach" of Yoo (2006), which somewhat conflates both valuation driver measurement time periods and the combination of multiples, yields improved valuation outcomes for multiple combinations based on historical valuation drivers; however, forecast valuation drivers of simple multiples[726] lead to valuation outcomes, which cannot be further improved through inclusion of multiples computed based on additional historical valuation drivers, which Yoo (2006, p. 120) interprets as forecast valuation drivers including all value-relevant information not only of their own historical but also other valuation drivers.[727] Focusing on different combination methods for price/earnings with price/book multiples, Beatty et al. (1999) compare the commonly used simple equally-weighted averages to averages of inverse multiples and deflated regression analyses with flexible weights and find that the latter two concepts outperform the simple averages. Schreiner (2007, pp. 118–119) investigates optimal weights differing from 0.5, which he finds through minimizing valuation errors for a combination of price/book and previously determined best-performing industry-specific multiple types. Accordingly, the benefits of combined multiples appear to differ between industries—e.g. in telecommunications, the single multiple of price/future earnings appears to minimize valuation errors, whilst e.g. in the Oil & Gas industry an approximately 50% to 50% weight of price/future earnings and price/book displays strong performance. Schreiner (2007, p. 121) then moves on to analyzing the benefits of valuation accuracy; e.g. for the Oil & Gas industry, he finds that the combined multiple approach improves valuation errors by c. 20 percentage points.

The above illustrative combination concepts provide in many instances evidence for information content of additional multiple types (relative to single multiple type analyses) and

[724] Or as the case may be for stock multiples, point-in-time method

[725] Also compare the remarks regarding valuation driver timing in Subsection 2.3.2.2 (p. 42)

[726] in this case: forecasted earnings

[727] The study of Yoo (2006) is methodologically differentiated from other studies in that its approach provides a more sophisticated method to the most burning aspect of combined multiple valuation: the weighting of the individual simple multiples. Yoo (2006) estimates those weights using a price-deflated out-of-sample regression following the concept of J. Liu et al. (2002) rather than applying arbitrary weights

hence for the benefits of combined multiples. The concept followed by J. Liu et al. (2002) and others, who, with their $P*$-multiples, use single multiples, which are dependent on several valuation drivers such as a formulaic relationship of earnings and book value. Another related but ultimately different concept are multiple regression approaches, where valuations are determined by numerous input variables, e.g. some of the Theil–Sen regression models proposed by Ohlson and Kim (2015, p. 423). Furthermore, Penman (1998, pp. 294, 311) proposes an integrated approach, where the weights represent both the multiple of the respective valuation driver[728] and the degree of influence it should have on the valuation outcome in a single number.

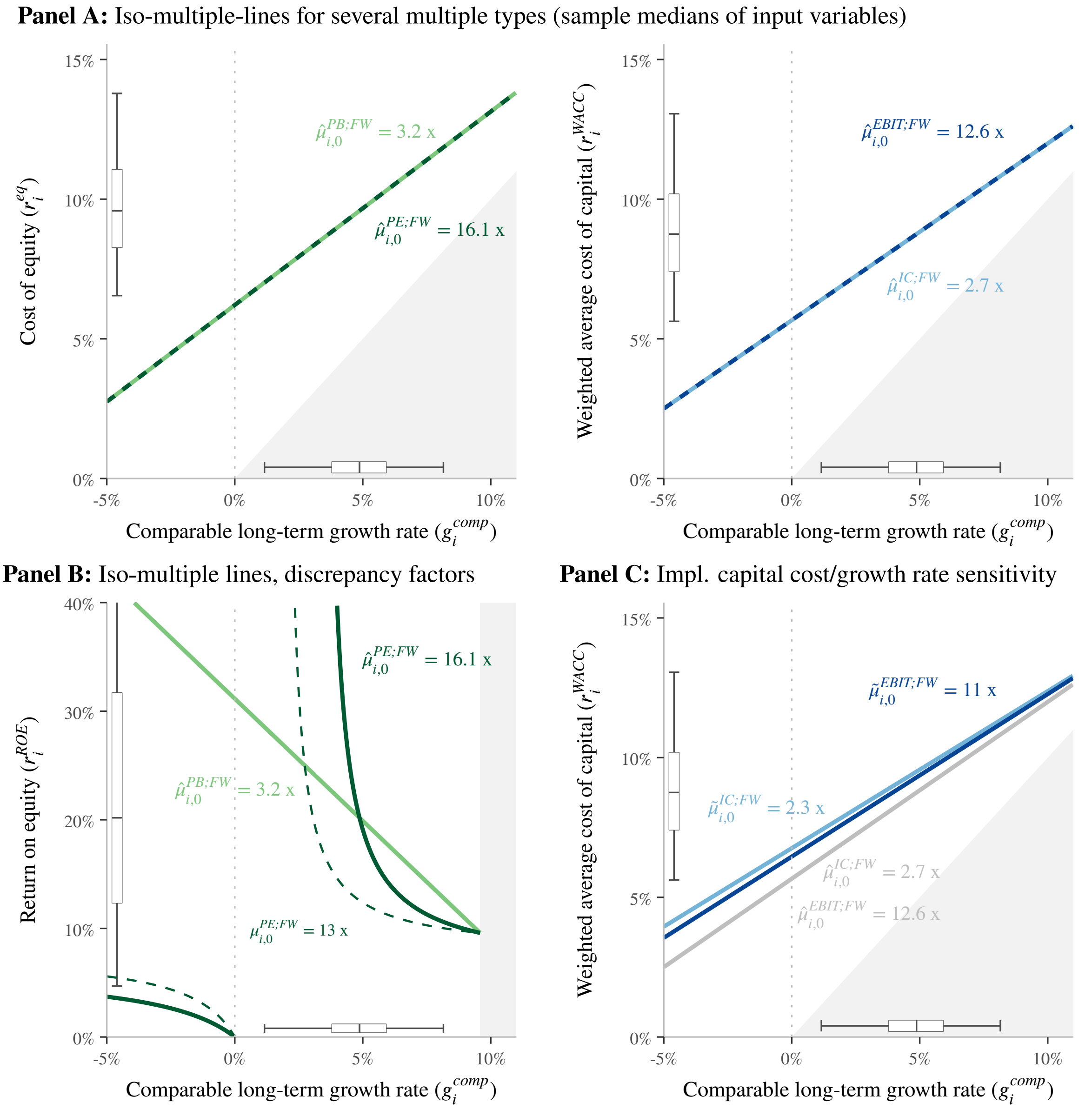
From a practitioner perspective, the drawback is that the *resulting weights are less straightforward* to interpret compared to prior valuations given the amount of information they contain. In a more recent study on returns of portfolios with differing inverse price/earnings and price/-book value multiples using a jointly sorted approach and hence extracting valuation-relevant information for both multiples, Penman (2013, pp. 1036–1040) deduces that inverse price/-book can serve as proxy for the risk of buying earnings growth. This concept is repeated in a similar study by Penman and Reggiani (2014), which advocates that a screening for "value stocks" as improperly measured by high inverse price/earnings and high inverse price/book multiples—or low price/earnings and low price/book multiples—might mislead investors into buying high-risk growth, since high-risk growth might result in low price/earnings multiples.

Iso-multiple lines to visualize incremental value-relevant information of combined multiples The potential benefits of combined multiples can also be visualized through revisiting the concept of *iso-multiple lines* proposed in Figure 4.3 (p. 115). As the charts in Panel A of Figure 6.3 (p. 215) illustratively demonstrate, theoretical multiple valuation suggests that any implied multiple derived consistently from the identified input variables of the chosen model[729] results in the same valuation outcome as input variables are sensitized, i.e. the iso-multiple lines overlap for the same valuation factor combinations. Naturally, the different multiple types will take different values (i.e., $\tilde{\mu}_{i,0}^{EBIT;FW}$ =12.6x and $\tilde{\mu}_{i,0}^{IC;FW} = 2.7$x) in the left hand chart of Panel A, but the shapes of the iso-multiple lines match each other perfectly. Since one multiple type can be readily derived from the other through algebraic rearrangement and the use of discrepancy factors as described in Subsection 4.4.2 (p. 118 ff.), all multiple types within the same model are interconnected. Thus, Panel A suggests that, if different

[728]Notably: Book value and earnings

[729]I.e., the DCF model for enterprise value multiples and the DDM for equity value multiples

FIGURE 6.3: Iso-multiple lines for several multiple types, sensitizing for pairs of selected inputs



Note: Iso-multiple lines based on Equations 4.23 for enterprise value/EBIT (dark blue), 4.54 for enterprise value/invested capital (light blue), 4.12 for price/earnings (dark green) and 4.52 for price/book (light green) through sensitizing the variables indicated on the x- and y-axes, and keeping all other variables at sample median levels. Compare Figure 4.3 for median input factors used and other details, return of equity of $\tilde{r}^{ROE} = 20.2\%$. The iso-multiple lines in Panel A each overlap as indicated through dashes. Panel B, in contrary, shows a case where a discrepancy input factor (r_i^{ROE}) used to derive $\hat{\mu}_{i,0}^{PB;FW}$ from $\hat{\mu}_{i,0}^{PE;FW}$ (compare Equation 4.52) is utilized. Panel C represents the median pricing multiples observed in the sample, solving for model-suggested cost of capital and growth.

types of multiples such as the enterprise value/EBIT and enterprise value/invested capital multiple are calculated on the basis of the same input variables, iso-multiple lines overlap.

This indicates that theoretically *nothing could be gained* from a combined multiple approach, as every single multiple would contain all relevant pricing information. There are 3 further considerations of relevance though:

- *Discrepancy factors to derive one multiple from the other include the sensitized input variable:* The above holds true for certain input variable sensitivities only. As is shown in Panel B of Figure 6.3, the iso-multiple lines for a combined sensitivity of the return on equity and the growth rate sensitivity do not overlap fully. I ascribe this behavior to the fact that at least one of the input variables, in the example shown the return on equity, is part of the discrepancy factor used to derive one multiple—in this instance price/book—from the other—i.e. price/earnings:[730] in such cases, the incremental mathematical expression of the discrepancy factor will affect the sensitivity and pairs of input variable combinations will result in differently shaped iso-multiple lines. It is in those situations, where combined multiples offer a potential valuation benefit as they allow *triangulation of valuations* as opposed to just locating them somewhere along the joint iso-multiple line. Of particular interest are the intersections of the multiple-type specific iso-multiple lines: Only at those—in Panel B: two—input variable combination points do the price/earnings and price/book multiples of $\hat{\mu}_{i,0}^{PE;FW}$ =16.1x and $\hat{\mu}_{i,0}^{PB;FW}$ = 3.2x, respectively, correspond to each other. One multiple type determines all the pairs of input variables along its iso-multiple line but it is the second multiple type introduced through a combined multiple valuation, which pins those infinitely many points on the line down to two possible locations, of which one input variable combination—$\tilde{r}^{ROE}$ = 20.2% / $\tilde{g}^{comp}$ = 4.9%—is practically most relevant, since the other sits just at the limit of the model restriction.[731] A further possible interpretation relates to the relative location of the iso-multiple lines: As can be seen from Panel B, firms with low long-term growth rates and high return on equity can be expected to trade relatively low on price/earnings multiples compared to their price/book multiples. Conversely, companies featuring high long-term growth rates and low returns on equity can be expected to display relatively high price/earnings multiples[732] Lastly, the described

[730] Compare Equation 4.52, p. 121

[731] Grey shaded area: model not defined as $g_i^{comp} > r_i^{ROE}$, compare Subsection 4.2.2 (p. 95)

[732] Panel B shows a dashed iso-multiple line illustratively set a at price/earnings multiple of 13x versus the intrinsic multiple calculated on sample median variables of $\hat{\mu}_{i,0}^{PE;FW}$ =16.1x. Assuming the light green line representing the price/book multiple is the "baseline," it is obvious that, under constant price/book multiple, the price/earnings multiple moves to increasingly lower values as the intersection of the price/earnings and price/book multiples moves up towards the top left hand area of the chart. Similarly, the price/earnings multiple increases as the intersection of price/earnings and price/book multiples move towards the bottom

effects suggests that the combination of some multiple types might resonate best with the expected divergence of certain input variables: i.e. if peers and the company under investigation differ only in variables, which are not part of the discrepancy factor, the additional effort of using combined multiples might not be warranted; in contrast, to the extend there are differences with regards to input variables featured in discrepancy factor, triangulation benefits of combined multiples can be expected to exist

- *Alternative intrinsic multiple models:* Figure 6.3 traces its roots back to one type of model each for equity value (DDM) and enterprise value (DCF model). Different multiple types within those 2 main classes are then derived using discrepancy factors. Alternative derivation models to justify multiples as valuation approaches do exist, most notably Ohlson (1995, pp. 667, 669),[733] whose RIV concept relies on both earnings and book value.[734] As Meitner (2006, p. 123) points out, Ohlson (1995) furthermore does not offer a concrete recommendation for the weighting earnings relative to book value[735]

- *Empirically observed model error terms:* It can be reasonably expected that the models proposed in Chapter 4 will not perfectly align across different multiple type outputs and hence differences between multiples resulting from implicit differences in how input variables actually translate into valuation drivers will result.[736] This is illustratively

right of the chart

[733] And in a conceptually consistent manner also by further developments of the Ohlson (1995) model such as the Feltham and Ohlson (1995) model, which addresses accounting conservatism through allowing positive long-term residual income streams and the Courteau et al. (2006) model, which addresses negative biases found in empirical studies of the Ohlson (1995) and Feltham and Ohlson (1995) models

[734] This logic is consequently also employed by Penman (2013, pp. 1025–1026), who—following earlier literature as referenced—develop it further into a multiple-inverse combined model considering both earnings and book value and subsequently present empirical evidence which suggests that book value indeed contains additional value information not captured by earnings e.g. for "value investor" strategies. In contrast, Ohlson and Johannesson (2016, pp. 86–87) provides recent empirical evidence that book value per share is "virtually irrelevant" to value. There is a theoretical argument at times mentioned that the RIV approach can be readily derived from the DDM assuming the clean-surplus assumption holds (Schönefelder, 2007, p. 53). None the less, given the Ohlson (1995) separates book value from (residual) earnings, it is at the Ohlson (1995) model's core that both book value and (residual) earnings bear valuation relevance

[735] Meitner (2006, pp. 125–135) therefore proposes a combined model, which jointly considers, as a function of return on equity, a book value of equity-based reorganization valuation—for companies, whose returns on equity do not exceed their cost of equity and hence a future reorganization is economically more viable—and an earnings/RIV-based recursion valuation—for companies, whose returns on equity are higher than their cost of equity. The result is a non-linear estimator for the price-book ratio as a function of return on equity: Low returns on equity stipulate a price/book value of equity multiple close to 1, whilst high returns on equity result to higher value for price/book value of equity, with the slope of the relationship tracing its roots back to a RIV model, which also considers earnings

[736] The price references will likely be the same, e.g. in Figure 6.3 in the left hand side charts enterprise value and in the right hand side charts equity value

documented in Panel C of Figure 6.3, where the multiples are set to their median observed sample values: a misfit between the measured pricing multiple types can be observed;[737] this appears visually as relatively minor for the pairs of price/earnings and price book value as well as enterprise value/EBIT and enterprise value/invested capital, also given median values have been chosen each. Discrepancies can be expected to be more substantial on a per-company basis. In such cases it appears indeed relevant to consider several types of multiples in a combined multiple approach in efforts to determine the true empirically underlying model as closely as possible

To summarize, a number of theoretical and empirical motivations exist to consider combined multiples, even at the expense of increased valuation efforts. Solid concepts to implement multiple weighting, however, are still scarce.

6.3.4.3 Valuation beyond trading multiples: Aggregation between valuation approaches

As discussed previously,[738] multiples are one valuation concept among many and it is practically common to base valuations on concurrent concepts.[739] From the perspective of trading multiple valuation, which is the focus of this dissertation, this aggregation can relate, first, to *other multiple concepts*, notably transaction multiples, and, second, even expand to *other valuation concepts* such as fundamental valuations (including DCF analyses) all together. This additional effort would be warranted if meaningful incremental valuation precision could be achieved, or, in other words, if each additional valuation would help uncover additional value-relevant information. This might be in particular the case if conceptually different valuation types are combined, such as fundamental/intrinsic valuations and comparable company/multiple valuations, given the additional and complementary value-relevant information they each might bring—namely a theoretical value vs. market-observed prices.[740]

[737] There appears to be also a divergence between the measured median multiples for the sample and the model-suggested multiples determined through median input variables (gray lines in the charts of Panel C of Figure 6.3)

[738] See above, Subsections 6.3.4.1 (p. 212) and 1.1 (p. 1)

[739] See e.g. Deloof et al. (2009) for a detailed discussion in the context of initial public offer valuation: Out of 49 IPOs studied, Deloof et al. (2009, p. 141) finds that banks use DCF analysis in all cases and that multiples are used in more than 80% of cases, with the price/earnings multiple being most popular. Directionally similar statistics are available by Schönefelder (2007, p. 77), who find that in 154 out of 205 U.S. fairness opinions considered (or 75% of cases) trading multiples are actively used, whilst 93% of U.S. fairness opinions considered use the DCF approach

[740] Compare above discussion on market efficiency and the Law of One Price, Subsection 2.1.5.2 (p. 28) and the discussion by Meitner (2006, p. 70)

A number of empirical studies have analyzed this aspect from two perspectives: empirical valuation precision and occurrence in practitioner valuations, with some studies covering both topics. On valuation precision, Kaplan and Ruback (1995, p. 1071) report for their sample of 51 leverage-related transactions a particular precision of industry-beta based fundamental valuation and comparable industry transaction approaches, measured both in terms of valuation error statistics and within valuation range percentiles. Trading multiple methods perform worst among the six concepts studied. The sample of 63 companies emerging from insolvency utilized by Gilson et al. (2000, p. 59) appears to confirm those findings: DCF valuation appears to result in more favorable valuation error statistics compared to trading multiple concepts at all 4 discrete points in time of a 6 month trading period window studied.[741] Both of the above studies have the shortcoming that they are based on very specific situations of corporate actions, namely leverage transactions and bankruptcy,[742] thus it is uncertain if their results can be generalized to more common applications such as the analysis of ordinary traded firms as is the ambition of trading multiple valuation. In fact, studying the trading multiple valuations presented in Swiss fairness opinions, Berndt, Deglmann, and Schulz (2014, pp. 22, 28) argue that, trading multiples prepared by fairness opinion providers reflect well unaffected market prices, whilst fundamental valuations appear to result in higher valuation levels.[743] [744] On the basis of a comprehensive capital market sample, Henschke (2009, p. 145) compares a number of different trading multiple-based and fundamental valuation concepts and concludes that trading multiple approaches outperform intrinsic valuations, which he however ascribes to a relatively weak performance of the Gordon growth formula: Best-performing valuations are the ones where a fundamental valuation concept for the explicit forecast period of cash flows is combined with an exit multiple-based approach, a quasi-hybrid concept between fundamental valuation and trading multiples. Using a broad industry sample, Asquith et al. (2005, pp. 278–280) find that the proportion of reports reaching equity research target prices

[741] It is worth highlighting that median valuation errors are found to be unbiased, however, absolute errors in excess of 35% for both approaches cast some doubt on the practical relevance of the methodology used for the specific case of companies emerging out of bankruptcy (Gilson et al., 2000, p. 79). Indeed the "Fresh start" valuations, which focus on post-bankruptcy balance sheets, appear to be performing best in the study of Gilson et al. (2000)

[742] In addition to relying on comparably small sample sizes

[743] The full realization of which, as Berndt, Deglmann, and Schulz (2014, p. 21) argue, will usually require a takeover offer

[744] This study has relevance as it relies on reasonably sophisticated and reviewed trading multiple valuations actually conducted by valuation practitioners for the purposes of fairness opinions, benefiting from peer selection on both quantitative and qualitative aspects offered by valuation experts and thus avoiding biases potentially introduced from "automated" peer selection on the basis of industry classification. At the same time fairness opinion multiples might, however, suffer from "rubber stamping" biases of fairness opinion providers in light of their client relationships

is not significantly impacted by the choice of valuation model: i.e. reliance on either DCF or stock or flow multiple valuations does not improve or reduce the likelihood of target prices being achieved at all or being achieved in a more timely fashion.

When it comes to the frequency of concurrent valuation methodology usage in practitioner valuation settings, prior studies have analyzed valuation methodologies relied upon by professionals in the context of fairness opinions (Berndt, Deglmann, & Schulz, 2014; Schönefelder, 2007), IPO valuations (Cassia et al., 2004) and equity research reports (Asquith et al., 2005, pp. 278–280; Fernández, 2001, p. 2) and uniformly find that pluralistic approaches are very common, led by high popularity of multiple-based concepts. This aspect is confirmed by survey studies such as Mondello (2017, p. 541) and Matschke and Brösel (2013, p. 824).[745] A survey study conducted among public German firms by Welfonder and Bensch (2017, p. 178) finds that more than 80% of responders use more than one valuation methodology.

6.3.4.4 Hypothesis formulation and operationalization of combined multiple and aggregated valuation type approaches

The above deliberations suggest that combined multiple concepts and hybrid approaches considering both multiple and alternative valuations might yield superior valuation outcomes. This results in the following hypothesis:

Hypothesis 7 *Valuation precision can be improved through the combination of several multiple types and the concurrent consideration of different general valuation approaches*

A challenge inherent to Hypothesis 7 is its operationalization. As will be discussed in greater details in Subsection 7.9 (p. 314), a heuristic needs to be devised which allows for the joint consideration of different multiple types when establishing valuation errors: the concept of deriving *weights* by which individual multiple types should impact a multiple valuation based on a ranking of their accuracy.[746] Furthermore, a conceptually compelling logic is required to simulate potential practitioner approaches and I propose the following three weighting frameworks:

- *Estimate of weights based on the relative performance of different multiple types during a specific historical time period:* This approach assumes that firm-specific multiple

[745] Although, here, DCF valuations seem to have an edge over multiple-based methods in both value determinations (i.e. valuations) and counterpart price negotiations

[746] Compare Subsection 7.8 (p. 310) for a discussion of this approach in the context of weighting different peers in computing valuation multiples (of one type)

types, which performed well historically can reasonably be expected to do so in future. In order to test the concept empirically, the sample will be cut into two subsamples comprising of 11 half years each, the earlier time frame ranging from January 2005 to January 2010, which serves as the estimation time frame as well as the later time frame ranging from July 2010 to July 2015, which serves as the time frame to test the performance of the multiple type weights estimated during the earlier time period. Multiple type weights are determined by producing a ranking of all multiple types for which data is available in descending order by valuation accuracy. Those multiple types with high (low) accuracy during the estimation time frame will then be weighted relatively stronger (lighter) during the testing time frame. The approach would be convincing if its overall valuation error distribution outperforms the baseline valuation concept, for which the best performing individual multiple type will be utilized; it is limited in its practical use to publicly listed firms since the weights are estimated on a per-firm basis

- *Estimate of weights based on industry affiliation:* Subsection 6.2.5 (p. 193) discussed precedent findings on the benefits of industry-specific multiples and Hypothesis 5a was formulated, which argues that industry-specific multiple types might offer improved valuation outcomes. It is therefore conceivable that industry affiliation offers a reasonable discrimination factor for multiple type weights: for each industry,[747] a ranking by best performing multiple type is undertaken. This ranking is then applied to respective industry constituents and it is established, if the valuation accuracy of such approach is lower than for the baseline single multiple type. This concept offers an advantage over the time period approach in that it can be extrapolated to non-publicly traded companies on the basis of their industry affiliation

- *Estimate of weights based on intrinsic multiple differences:* This concept assumes that similarity of an individual company's intrinsic multiple as determined on the basis of the theory developed in Chapter 4 (p. 89) to its median peer group intrinsic multiple translates into similarity of the individual company's pricing multiple relative to its peer-group driven valuation multiple. In other words the multiple type to choose is the one with the intrinsically lowest valuation difference to the peer group. Once again, the different intrinsic multiple types are ranked by their relative accuracy and the weights

[747] As determined by its 3 digit ICB code

applied to the valuation multiple types computed for every firm. The resulting level of valuation accuracy can be compared to the baseline simple multiple approach

6.4 Assessing multiple valuation precision

6.4.1 Approaches to measure multiple valuation accuracy

6.4.1.1 The two (plus one) conceptual dimensions of valuation errors

Accuracy measurement of multiple valuation is more of a topic of academic rather than practical interest since, from a practitioner perspective, multiple valuation outcomes "are what they are," while from a a theoretical perspective, conclusions on accuracy should be drawn. Errors in the context of multiple valuations are typically measured through a comparison of the valuation outcome suggested by the valuation multiple and the price observed on the market: notably, a large (small) error indicates a large (small) deviation between prices and valuations and, consequently, a low (high) accuracy of valuation precision. To operationalize error measures for statistical analysis, it is instructive to differentiate them along two dimensions: The *function* used to standardize or scale the errors—commonly a relative/percentage error or alternatively a logarithmic concept—and whether absolute valuation precision—commonly defined as multiple *accuracy*—is to be investigated or *biases*—i.e. a differing treatment of over- and undervaluations—are considered. Both dimensions and their respective computation formulas are summarized in Table 6.2 (p. 223), with the error always being denoted as $u_{j,t}$ in addition to respective indexes for the dimensions.

Whilst Table 6.2 outlines the key dimensions of measuring valuation precision, it is common to describe the distributions obtained through common descriptive parameters such as mean, median,[748] variance and the percentages of observations among all observations with errors below a pre-defined threshold of e.g. 15%.[749] This can be seen as an additional dimension of valuation error measurement. Arguably the most common metric in precedent empirical literature and thus a reasonable parameter to compare studies with each other at high level is the mean.[750]

The following Subsections will describe each dimension in greater detail.

[748] Importantly, the median of the error distribution is not be be confused with the median as a concept of aggregation of pricing multiples into one valuation multiple
[749] Commonly denoted as "fractions" of errors below the threshold, compare Table 7.2 (p. 245)
[750] Consequently, this metric is shown in Panel A of Figure 6.6 on precedent studies

TABLE 6.2: Two dimensions of valuation error measurement

Valuation error scaling	Bias	Accuracy
Percentage error	$u_{j,t}^{b,pct} = \frac{\hat{P}_{j,t}-P_{j,t}}{P_{j,t}}$ (6.12)	$u_{j,t}^{a,pct} = \left\|u_{j,t}^{b,pct}\right\| = \left\|\frac{\hat{P}_{j,t}-P_{j,t}}{P_{j,t}}\right\|$ (6.13)
Log error	$u_{j,t}^{b,log} = \ln\left(\frac{\hat{P}_{j,t}}{P_{j,t}}\right) = \ln(\hat{P}_{j,t}) - \ln(P_{j,t})$ (6.14)	$u_{j,t}^{a,log} = \left\|\ln(\hat{P}_{j,t}) - \ln(P_{j,t})\right\|$ (6.15)
Squared error	—	$u_{j,t}^{a,squ} = \left(\frac{\hat{P}_{j,t}-P_{j,t}}{P_{j,t}}\right)^2$ (6.16)
Error expressed in "turns" of multiple	$u_{j,t}^{b,turns} = \hat{M}_{j,t} - \mu_{j,t}$ (6.17)	$u_{j,t}^{a,turns} = \left\|\hat{M}_{j,t} - \mu_{j,t}\right\|$ (6.18)

Note: Own illustration. Equation references indicated in lines immediately following the respective equations

6.4.1.2 Log and percentage functions as the most common measures of scaling valuation errors

Percentage and log errors most common To the extent valuations and market prices are compared, the resulting respective discrepancies in monetary terms need to be scaled in order to address different sizes (Cheng & McNamara, 2000, p. 352):[751] As is obvious, only valuation errors expressed in some form of relative terms to prices can be used as meaningful metrics to common statistical methods assessing valuation accuracy in an aggregated manner. Regarding the function used to scale valuation errors, two measures of relative precision have been particularly popular in prior research: *percentage errors* and *log errors*.[752] [753] Dittmann and Maug (2008, pp. 1–2) review prior literature and find that 9 out of 14 studies on multiple valuation accuracy considered rely on percentage errors, with the balance of 5 studies utilizing log errors. More recent studies including Sommer et al. (2014, p. 34) have reported valuation errors under both approaches, whilst others have discussed both concepts to eventually settle for one such as Chullen et al. (2015, p. 653), who rely on log errors. Somewhat less commonly

[751] This commonly accepted approach is sometimes referred to as "deflation" (compare among many: Courteau et al., 2006, p. 566
[752] Consider Equations 6.12 to 6.15 for percentage and log errors each in Table 6.2
[753] Early proponents of percentage errors include Boatsman and Baskin (1981), whilst Kaplan and Ruback (1995) where among the first to employ log errors; log errors are at times referred to as "log-scaled errors" (Chullen et al., 2015, p. 646)

used are squared errors (Sommer & Wöhrmann, 2011, p. 11; Henschke, 2009, p. 30; Dechow et al., 1999, pp. 21, 23; Kaplan & Ruback, 1995, p. 1071).[754] Most of the studies tend to rely on the standard formulas presented in Table 6.2 (Henschke, 2009, p. 30), however, some have diverged.[755]

Preference for log errors Sommer et al. (2014, p. 34) explains the difference between percentage and log errors as follows: percentage errors result in an equal valuation error for two companies, which are over- and under-predicted by the same *amount*, whilst the logarithmic error is identical for companies which are over- oder under-predicted by an equal *percentage*. Whilst Dittmann and Maug (2008, p. 6) argue that, from a first order Taylor expansion, it follows the differences should be small for smaller errors, they admit that for larger errors the discrepancies between both concepts are material and consequently the question arises, which relative precision measure should be given preference. It has been argued by Sommer et al. (2014, p. 34), Sommer and Wöhrmann (2011, p. 11), Dittmann and Maug (2008, p. 2) and Cheng and McNamara (2000, p. 352) that the most suitable error scaling concept ultimately depends on the utility function of the practitioner conducting the valuation;[756] therefore, the discussion is one to clarify implications of the different options rather than to determine the most appropriate one (Dittmann & Maug, 2008) and Sommer and Wöhrmann (2011, p. 13) offer an instructive plot comparing different error functions. None the less it appears that *the log error approach* might offer many preferable properties in light of statistical tests, including the theoretical property that the median is an unbiased central tendency measure when coupled log errors for large samples (Dittmann & Maug, 2008, p. 14). It also offers the attractive property of *symmetry* over percentage errors as the latter can at the minimum take values of –100%, whilst their maximum values are infinite (Dittmann & Maug, 2008, p. 9; Sommer & Wöhrmann, 2011, p. 13).[757]

[754] Compare Equation 6.16 in Table 6.2

[755] E.g. Penman and Sougiannis (1998, p. 357) and J. Liu et al. (2002, p. 143) subtract the model-suggested price (i.e. valuation outcome) from the market-observed or measured price, whilst the opposite approach is more common, presumably since the error is expressed relative to measured price and hence the sign of the error might be more intuitive to interpret; for accuracy the distinction is of course irrelevant. Cheng and McNamara (2000, p. 353) proposes two modifications: First, to express the error relative to the valuation outcome (which is, however, empirically found to be more skewed than the generally accepted alternative) and, second, to transform the error value to range between 0 and 1, with the objective to reduce outliers for statistical tests

[756] This is probably most obvious if squared errors are compared to percentage errors: If squared errors are compared to percentage error accuracy, it is immediately obvious that outliers (i.e. high absolute errors in excess of 100%) weigh more profoundly on any distribution statistics prepared, whilst smaller errors (less than 100%) weigh lower under the squared error method than they do under the percentage error method. This is graphically demonstrated by Sommer and Wöhrmann (2011, p. 13)

[757] Also see below, Subsection 6.4.1.4 (p. 227) and compare J. Liu et al. (2002, p. 153), whose errors are bound at the higher limit by 100% as a result of subtracting multiple-determined price from market-observed price

Errors expressed in "turns" Valuation multiples offer one further property, which so far has been widely overlooked in theoretical literature when it comes to scaled error calculation: The fact that they are standardized for the respective valuation driver.[758] Practitioners have long used this aspect when discussing multiples in statements such as "firm A trades at a 2-turn multiple discount to firm B on the price/earnings multiple."[759] It can therefore be instructive to also analyze multiple precision in terms of "turns" of multiple. This can be achieved by calculating valuation errors as the discrepancy between the pricing *multiple* and the valuation *multiple*, $u^{b,turns}$,[760] which, if standardized with the pricing multiple, would result in the same error ($u^{b,pct}$) as the respective scaled valuation error on the basis of value and price (Cheng & McNamara, 2000, p. 352, Eq. (7); Dittmann & Maug, 2008, p. 6, Eq. (6) and (7)):

$$u_{j,t}^{b,pct} = \frac{\hat{P}_{j,t} - P_{j,t}}{P_{j,t}} = \frac{\frac{\hat{P}_{j,t}}{VD_{j,t}} - \frac{P_{j,t}}{VD_{j,t}}}{\frac{P_{j,t}}{VD_{j,t}}} = \frac{\hat{M}_{j,t} - \mu_{j,t}}{\mu_{j,t}} \Leftrightarrow u_{j,t}^{b,turns} = \hat{M}_{j,t} - \mu_{j,t} \tag{6.19}$$

Naturally, this approach finds its limits insofar as 2 different multiple types are considered, since a "2-turn" or 2x discrepancy on enterprise value/net sales is a materially wider range than for price/earnings multiples, which tend to have substantially higher values.[761] It is none the less beneficial to analyze valuation precision in line with potential practitioner interpretation.

Transformation of enterprise multiple valuations to equity value Another important point applicable in particular to comparisons of equity value and enterprise value multiples and respective valuations is the necessity for *level playing field* in error measurement between those two classes: For comparability, both classes are either deflated by the equity value or by the enterprise value as the respective price reference. Since in many instances equity valuation is the desired focus of multiple valuation results, one could argue that *equity value deflation* is the preferable approach. Consequently, in order to enable fair comparisons between enterprise value- and equity value multiples as part of the deflation procedure, enterprise value multiple outcomes will need to go through a transformation, where for the company under investigation the initial result of enterprise valuation is to be reconciled and expressed in terms of equity

as opposed to vice versa. Consequently, their empirically obtained errors are left-skewed as graphically demonstrated in their Panel A of Figure 1 (J. Liu et al., 2002, p. 157)

758 Compare the definition of pricing multiples, Subsection 2.1.2, p. 20

759 Compare among many J. P. Morgan (2018, pp. 11, 93, 98), mentioning relative valuation premia, discounts and movements in "turns" three times for different sectors

760 As opposed to price and multiple-derived valuation

761 e.g. for the sample utilized in this theses, the overall price/earnings median is $\hat{\mu}_{i,0}^{PE;FW}$ =16.1x vs. $\hat{\mu}_{i,0}^{Sales;FW}$ =1.7x for enterprise value/net sales

value:

$$u_{j,t}^{b,pct} = \frac{\hat{M}_{j,t}^{Ent} - \mu_{j,t}^{Ent}}{\mu_{j,t}^{Ent}} = \frac{\hat{P}_{j,t}^{Ent} - P_{j,t}^{Ent}}{P_{j,t}^{Ent}} \neq \frac{\hat{P}_{j,t}^{Eq} - P_{j,t}^{Eq}}{P_{j,t}^{Eq}} \tag{6.20}$$

since $P_{j,t}^{Eq} \neq P_{j,t}^{Ent}$. Therefore, the preferable approach enabling comparisons between enterprise value and equity value results is to *transform* all valuations obtained on the basis of enterprise value multiples to correspond to equity value, thus:

$$u_{j,t}^{b,pct} = \frac{\left(\hat{P}_{j,t}^{Ent} - A_{j,t}^{Ent;\,Eq}\right) - P_{j,t}^{Eq}}{P_{j,t}^{Eq}} \tag{6.21}$$

and

$$u_{j,t}^{b,log} = \ln\left(\frac{\hat{P}_{j,t}^{Ent} - A_{j,t}^{Ent;\,Eq}}{P_{j,t}^{Eq}}\right) = \ln\left(\hat{P}_{j,t}^{Ent} - A_{j,t}^{Ent;\,Eq}\right) - \ln\left(P_{j,t}^{Eq}\right) \tag{6.22}$$

for percentage and log errors (bias), respectively, where $A_{j,t}^{Ent;\,Eq}$ denotes enterprise value to equity value adjustments such as most notably the net debt of the company under investigation but also other adjustments as described in Chapter 5. This approach is consistent with some[762] but apparently not all[763] previous studies. In any event, I will follow it in the empirical part of this dissertation to ensure error comparability of different multiple types and avoid undue accuracy biases to the benefit of enterprise value multiples.

6.4.1.3 Bias and accuracy

A second dimension in the classification of multiple valuation precision relates to considering the sign of errors: The primary calculation outcome under both the percentage and the log method will be a *signed error*: thus it is indicated whether the multiple valuation model proposes an over- or under-prediction. This information can be helpful for specific valuation settings, e.g. where, motivated by *conservatism*, a maximum value is sought or in the context of fairness opinions, where the preparer might be more focused on *confirming* a commercially agreed price is—depending on the nature of the opinion—higher or lower than the value determined in the opinion.[764] Signed valuation errors are commonly referred to as *"bias"*

[762] Compare e.g. (J. Liu et al., 2002, p. 142)

[763] Compare e.g. Schreiner (2007, pp. 102–103)

[764] This aspect is not to be confused with potential principal-agency conflicts in the context of fairness opinions discussed by Schönefelder (2007, p. 27): If a fairness opinion primarily prepared to the benefit of selling shareholders (or the Board of the target company) comes to the conclusion that the price the buyer is willing to offer is higher than the intrinsic value, selling shareholders should accept the offer. The multiple valuation in those cases just needs to demonstrate that the offer is indeed higher: a "not higher than"-statement is the most important aspects, whilst the lower boundary is of little relevance

(Chullen et al., 2015, p. 646; Sommer et al., 2014, p. 34; Henschke, 2009, p. 30; Bhojraj & Lee, 2002, p. 428; Francis et al., 2000, p. 47). On the contrary in most empirical studies concerned with multiple precision, over-predictions are "just as bad as" under-predictions. In those instances, it is common to utilize the absolute value of the bias, referred to as *"accuracy,"* which avoids that over- and under-predictions are netted off during statistical aggregation (Henschke, 2009, p. 30; Francis et al., 2000, p. 47) and Francis et al. (2000, p. 47) argue that this symmetrical treatment of over- and under-predictions is closer to investor preferences for individual stocks than bias, which, they believe may have more relevance for the market as a whole. On the other hand, bias might display more suitable characteristics in the context of regression analyses on valuation errors.

To summarize, whilst bias can have some practical implications in multiple valuation quality assessment, the key point from an investor utility function perspective can likely interpreted to be *accuracy*, which will therefore be the focus of the empirical analysis with the exception of some regression analyses on valuation errors, which will rely on bias.

6.4.1.4 The distribution of valuation errors and consequences for statistical testing

As briefly discussed in Subsection 6.4.1.1 (p. 222), any combination of accuracy or bias and log or percentage error will produce one data point of valuation accuracy each for every corresponding valuation multiple, i.e. firm under consideration in the case of simple multiples.[765] In order to describe the resulting distribution of errors, the empirical literature commonly relies on typical descriptive parameters such as mean, median, variance and the percentages of observations among all observations with errors below a pre-defined threshold. A number of studies such as Cooper and Cordeiro (2008, p. 29), J. Liu et al. (2007, p. 65), J. Liu et al. (2002, p. 157) and Baker and Ruback (1999, p. 23) also present figures, which allow at least a visual assessment of valuation error distribution beyond descriptive parameters. Those figures usually focus on *bias* as opposed to accuracy, since bias follows a two-tailed distribution and are visually more straightforward to interpret.

In a more comprehensive analysis of different bias distributions by aggregation approach, Dittmann and Maug (2008, pp. 10, 38) demonstrate that, for their sample, percentage errors appear to be positively skewed, whilst log errors appear to be more symmetrical, and—on the basis of confirming theoretical deliberations—also argue that log errors in combination with

[765] Note this Subsection is predominantly concerned with the distribution of valuation errors (bias and accuracy), not with the distribution of multiples, which is discussed in greater detail in Subsection 6.3.3.1 (p. 205) and visually plotted for the pooled sample in Figure 6.2 (p. 208)

geometric mean or median for large samples produce unbiased results (2008, pp. 13–14).[766] Thus, from a perspective of distribution symmetry of valuation biases, preference should be given to logarithmic errors over percentage errors and the empirical part of this dissertation will consequently follow that concept. Under the assumption of normality, for studying the bias of different multiple valuation concepts, the *t*-test might be an acceptable concept and it indeed has been applied in some of the studies on multiples, which rely on bias such as Alford (1992, p. 102) or relative improvement metrics of interquartile ranges of biases (J. Liu et al., 2007, p. 60; J. Liu et al., 2002, p. 148).[767]

Since accuracy plays an even more critical role in assessing overall multiple valuation quality,[768] it is instructive to also consider its distribution characteristics. The obvious drawback of the accuracy measure is that it cannot ex-ante be assumed to be distributed normally given its *single-tailed nature* in which negative bias values are "folded onto" positive bias values by means of transformation through taking absolute values. Under the assumption that bias follows a normal distribution, accuracy could then be argued to follow a half-normal distribution[769] and respective tests could be applied. However, more common—if not too common—in multiple valuation error analysis is the utilization of *non-parametric tests,* notably Wilcoxon tests (Herrmann & Richter, 2003; Courteau et al., 2006; Sommer & Wöhrmann, 2011; Berndt, Deglmann, & Vollmar, 2014; Sommer et al., 2014).[770] [771] Wilcoxon tests will also be utilized in the empirical part of this dissertation.

6.4.1.5 A graphical representation of valuation precision metrics

To summarize the discussion of valuation precision measurement, it is instructive to investigate in an exploratory manner the distribution of conceptual dimensions of valuation precision based on an example, the price/earnings multiple. Figure 6.4 (p. 229) presents an illustrative overview, utilizing the pooled sample of this dissertation.[772]

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[766] See above Subsection 6.4.1.2 (p. 223) for the intuitive argument of minimum-bound percentage error distributions

[767] Both J. Liu et al. (2007) and J. Liu et al. (2002) rely on a bootstrapping approach and do not report their results in detail

[768] See above, Subsection 6.4.1.3, p. 226

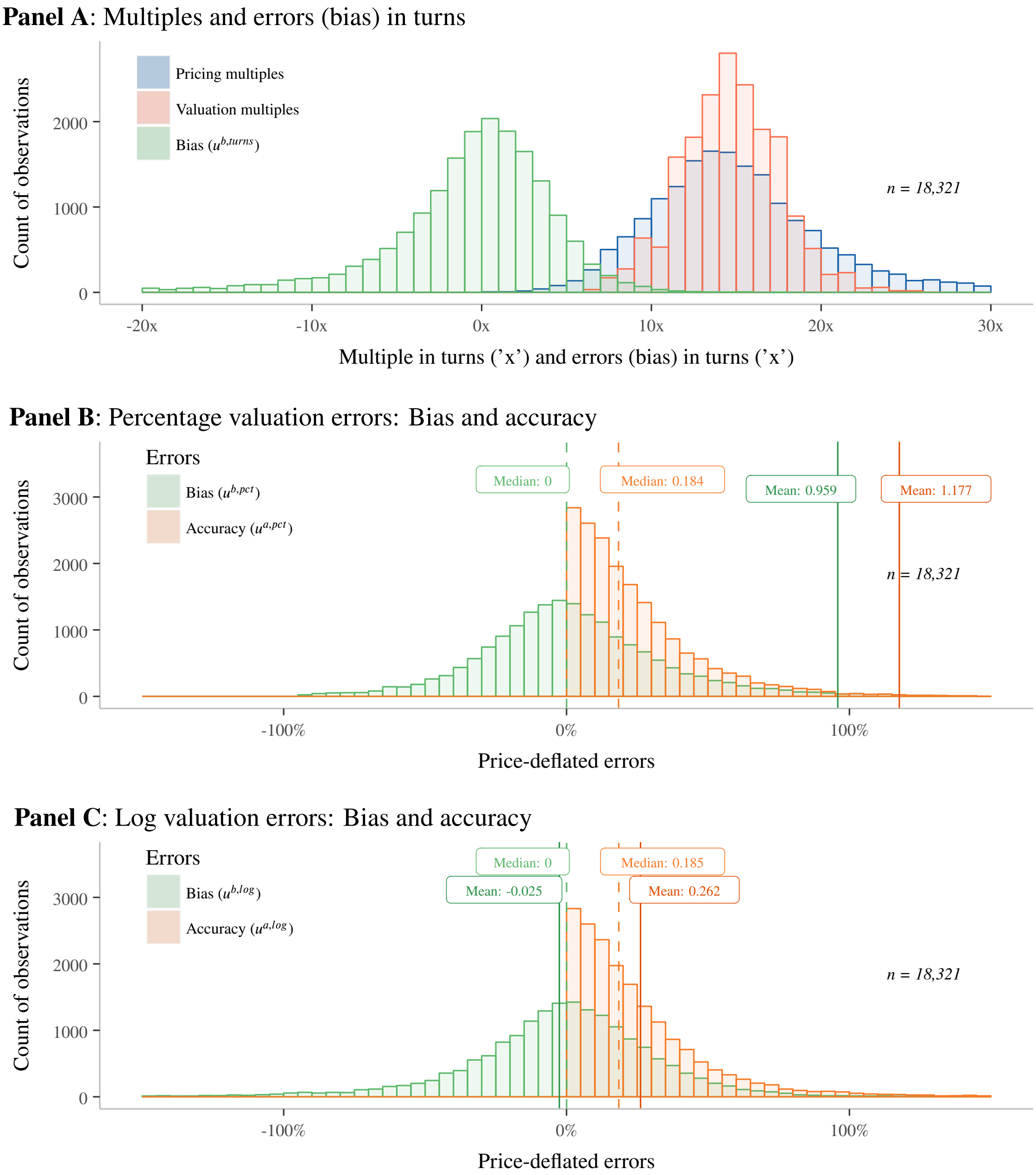
[769] Compare for some of the properties of the half-normal distribution Tsagris, Beneki, and Hassani (2014)

[770] Also compare Nissim (2013) who uses *t*-statistics on the pairwise differences of multiple valuation approaches as expressed by the proportion of valuations under a specific (absolute) error threshold

[771] Given Wilcoxon tests are non-parametric, I do not devote more room to the discussion of absolute valuation error distributions; notably, I do not deem it necessary to run statistical tests on the nature of the distribution

[772] See Chapter 3 (p. 69) for details on the sample. Valuation multiples aggregated on the basis of the industry approach utilized throughout this dissertation (described in greater detail in Subsection 7.2.2, p. 242) and using median as aggregation concept

FIGURE 6.4: A visualization of error metrics—example for price/earnings multiple



Note: Figure illustratively depicts histograms for the distribution of various error metrics of the price/earnings multiple. Panel A represents the pricing and peer-calculated and median aggregated valuation P/E multiples for the pooled sample used in this dissertation (see Chapter 3, p. 69 for details) and also indicates absolute errors as measured by "turns" of multiple (bias only, accuracy withheld). Panels B and C show the percentage and log valuation errors (deflated by price), each expressed by both bias (signed error) and accuracy (absolute error). Dashed lines represent the medians of the respective distributions, solid lines the means, each colored by the respective error metric (bias vs. accuracy)

In some respect, Figure 6.4 confirms the arguments made earlier in that accuracy is obviously not symmetrically distributed and hence the traditional parametric tests will not be suitable, with non-parametric tests appearing more appropriate. However, in contrast to the plots presented by Dittmann and Maug (2008, p. 38), percentage biases shown in Panel B of Figure 6.4 at least visually do not appear skewed in an obvious manner. I ascribe this to a generally solid peer selection process with overall low valuation errors. As a consequence, very few valuation biases run into the lower (i.e. –100%) error limit and the relatively close dispersion of most biases around 0% further supports symmetry, which is also documented by a relatively small difference between mean and median percentage. Panel C of Figure 6.4 indicates the log-scale errors, which are theoretically preferable over percentage errors and visually appear symmetrically distributed around 0%. A closer investigation of the underlying distributions of biases in Panel B and C which I have conducted on the basis of Q-to-Q plots but do not report graphically suggests that both biases are distributed relatively symmetrically with little skewness, however do display heavy tails and are leptokurtic. Such investigation also reveals that percentage errors might be less suited to deal with extreme outliers and winsorizing or other techniques of outlier treatment might be adequate, whilst for log valuation biases such approaches can potentially be kept to a minimum.

6.4.2 Empirical approach to operationalize multiple valuation studies

6.4.2.1 A comparison of common practice and empirical approaches

While there is no strictly and equivocally advocated standard, empirical approaches to multiple valuation accuracy tend to resemble each other in that their ambition is to mirror the practitioner's approach outlined in Table 1.2 (p. 10). However, the more analytical nature of empirical studies requires a more formal approach, avoiding any judgment which may be involved by practitioners. It is therefore instructive to briefly contrast common practitioner and empirical approaches on the basis of the 5 steps of multiple valuation presented in Table 1.2:

1. *Analyze the company under investigation and its industry:* Whilst of great practical importance in the process of determining the right general set of comparables from a practitioner perspective, this aspect has seen less attention in previous large sample trading multiple studies. Most empirical studies will cover companies from all sectors represented in their sample with the objective to maximize sample sizes and ensure generalization.[773] Results will usually be presented across the sectors. In some instance,

[773]With the potential exclusion of some sectors such as the finance sector (Sommer & Wöhrmann, 2011)

industry-specific multiple types have been studied though, but usually even then no detailed assessment of the industry investigated is conducted

2. *Choose comparable firms:* Practitioners will typically choose peers on the basis of industry affiliation combined with judgment on closest comparables picked on the basis of a combination of quantitative and qualitative aspects. Starting with Boatsman and Baskin (1981), peer formation in empirical studies is implemented by reliance on industry codes such as SIC or ICB, with varying degrees of finesse (Alford, 1992). Every peer company considered will usually be contributing equally to the valuation multiple. Some studies (Herrmann & Richter, 2003; Bhojraj & Lee, 2002) also present and test alternative or incremental peer selection approaches, notably by proximity to fundamental valuation factors

3. *Select suitable type(s) of multiple(s):* The multiple type(s) considered by practitioners will be subjective and not typically anchored in theory. They might be linked to industries under investigation. Similarly, most studies do not justify their multiple type choice at length but tend to rely on commonly observed multiple types and even benchmark the quality of a number of different multiple types (Rossi & Forte, 2016; Schreiner, 2007; J. Liu et al., 2002)

4. *Calculate the individual peer pricing multiples:* Also given the large number of sample companies considered, empirical studies do not usually adjust multiples during pricing multiple computation, with the exception of specific recent studies on the benefits of doing so (Chullen et al., 2015; Berndt, Deglmann, & Vollmar, 2014) and despite this being recommended in textbook literature (Koller et al., 2010, pp. 323–325). Relatively little is known on how practitioners approach adjustments, but Berndt, Froese, et al. (2014) suggest that at least some adjustments are usually undertaken by preparers of fairness opinions. Whilst empirical evidence has been strong on the benefits of forward- vs. historical valuation drivers (Deloof et al., 2009; J. Liu et al., 2002; Lie & Lie, 2002) and there is consistency with practitioner approaches, some older (Baker & Ruback, 1999; Beatty et al., 1999), more comprehensive (J. Liu et al., 2007) or more local market (Chullen et al., 2015) studies have relied on historical valuation drivers

5. *Determine a valuation multiple and the valuation for the investigated firm:* Whilst practitioners appear to deduct a valuation multiple through judgment from the distribution of pricing multiples, medians and arithmetic means are common aggregation concepts

(Schönefelder, 2007, p. 109). Even though median appears a suitable theoretical aggregation approach, empirical studies have considered numerous alternative approaches such as harmonic, geometric and value-weighted mean.[774] Practitioners will also usually argue on the basis of ranges, whilst empirical studies tend to draw conclusions using point estimates

The above review demonstrates that empirical studies differ from practitioner focus areas with regards numerous factors such as peer selection (mechanical based on industry codes vs. judgment-based), peer aggregation (more sophisticated concepts vs. simple approaches, including ranges), pricing multiple computation (relatively simple for large samples vs. at least some adjustments undertaken) and focus (ability to generalize vs. concrete company-specific valuation outcome), although there is an ambition by studies to mimic common practices. The reasons for the diverging approaches include data availability, large sample-operationalization and the avoidance of judgment as well as the objective of empirical studies to propose innovative approaches with error-reducing properties. The differences need to be contemplated when drawing conclusions on reality from empirical samples and I will follow in the empirical part of this dissertation a combination of precedent empirical approaches, practitioner common practices and innovative, not overly technical concepts with the objective to maximize valuation accuracy.

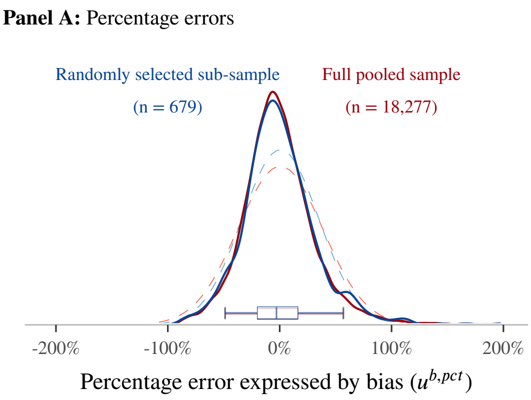
6.4.2.2 The question mark around a true out-of-sample approach

An important yet broadly undiscussed particularity of empirical approaches relates to the nature of the "out-of-sample" approach: Studies commonly compute valuation multiples of the respective peer groups for each company under investigation out-of-sample (Schreiner, 2007, p. 126; Yoo, 2006, p. 128; Beatty et al., 1999, p. 187),[775] i.e the company under investigation is not considered its own peer and consequently there are as many peer groups as there are observations of companies—each varied by at least the respective company under investigation—for which a multiple valuation is computed. However, one could argue that the overall distribution of biases and accuracy metrics do not represent a "true" out of sample approach, since other companies under investigation draw their peers from all firms, including the ones, which also are firms under investigation in the same sample and have been peers to

[774] Compare Table 6.1 (p. 201) for an extensive discussion

[775] Note the quoted references are some of the ones which discuss this aspect explicitly; it is likely that others (but not all studies) may also use out-of-sample techniques but do not deem it necessary to discuss this aspect specifically. The out-of-sample approach is at times also referred to as a "holdout"-procedure (Courteau, Kao, O'Keefe, & Richardson, 2003, p. 3; Chullen et al., 2015, p. 646)

FIGURE 6.5: Comparing distribution characteristics of a subsample vs. the full sample



Note: Own illustration. Shown are the density functions of P/E multiple valuation errors (bias) for the full pooled sample (i.e data consistent with the one used in Figure 6.4, p. 229) in red and for a randomly selected sub-sample in blue. The randomly selected subsample has been chosen by randomly picking 1 company under investigation per industry per measurement date and avoids peers are used several times and firms under investigation are peers of other firms under investigation. Should the chosen random observation be N/A, it will not be replaced. The dashed lines indicate the theoretical normal distributions for the same sample mean and variance and suggest the error metrics shown are reasonably symmetrical but display leptokurtic characteristics. The colored boxplots near the x-axes indicate IQR (box) and 5%/95% quantiles ("whiskers").

other companies under investigation. Thus, the fact that bias mean metrics shown in Figure 6.4 (p. 229) are close to zero might not necessarily be a statistical coincidence but can be shown to be a mathematical consequence of the approach since every firm is a comparable and a firm under investigation at the same time; hence errors might have a tendency to cancel themselves out.[776] Furthermore, there might be statistical implications from utilizing peers as comparables repeatedly several valuations. It is therefore instructive to consider some distribution metrics of a randomly drawn sample, which consists of 1 representative of each industry at each measurement point in time and Figure 6.5 (p. 233) presents the results of this analysis for the illustratively chosen price/earnings multiple. The randomly drawn sample visually shows a strikingly similar distribution to the full pooled sample for both percentage and log errors: The boxplots are virtually identical and with the exception of minor discrepancies in extreme quantiles so are the density functions. I hence conclude that it should be possible to rely on the full sample and a random sample selection to avoid repeated use of peers might not be necessary.[777]

[776] The slight divergence from zero being attributed to rounding. Bias medians and means close to zero are a common occurrence in many previous multiple valuation studies, compare e.g. Baker and Ruback (1999), Beatty et al. (1999) and J. Liu et al. (2002), all with maximum mean bias in the order of 1%–2%

[777] The random drawing approach for firms under investigation has also not received many followers in prior literature as far as I am aware of. This excludes studies in which the sample is segmented on the basis of

6.4.3 Reviewing prior empirical studies on multiple valuation accuracy

While prior literature has been concerned with a number of aspects surrounding multiple valuation, it is valuation accuracy which is at the core of the body of empirical work to date. Some form of valuation error concept is an element, which unifies prior studies and, commonly, the valuation error baseline is compared to some specific study aspect in order to determine benefits of this aspect for multiple valuation accuracy. While a number of studies have already been referenced in the context of discussing theoretical aspects of multiple valuation above, it is therefore none the less instructive to provide a summary of prior studies, grouped by main study subject, even at the risk of being repetitive. Figure 6.6 (p. 235) presents an aggregated graphical overview based on a review of 34 empirical studies,[778] which is further amplified in Appendix Table A.5 on pp. A28–A35.

The following points are worth noting:

- *Continued popularity of multiple-accuracy studies since the 1990ties:* Following Boatsman and Baskin (1981) published in the early 1980ties, the question of multiple valuation precision and—consequently—valuation error measurement has seen continued popularity until today since the 1990ties with on average 1.3 studies published each year since
- *Multiple valuation errors appear mostly in the order of 30–40%* Whilst valuation error definitions, computation methods and reporting approaches vary, for 23 studies it is possible to determine a reasonably similarly defined price/earnings multiple average absolute valuation error, as indicated by the position of each "dot" in Panel A of Figure 6.6 on the *y*-coordinate. The arithmetic mean absolute error across all studies considered amounts to 38.3%, with a median of 33%. Whilst mean absolute valuation errors go to up to 127%, a number of studies have seen valuation errors in the 20–30% range, with the lowest mean error amounting to 20% (Courteau et al., 2006)[779]

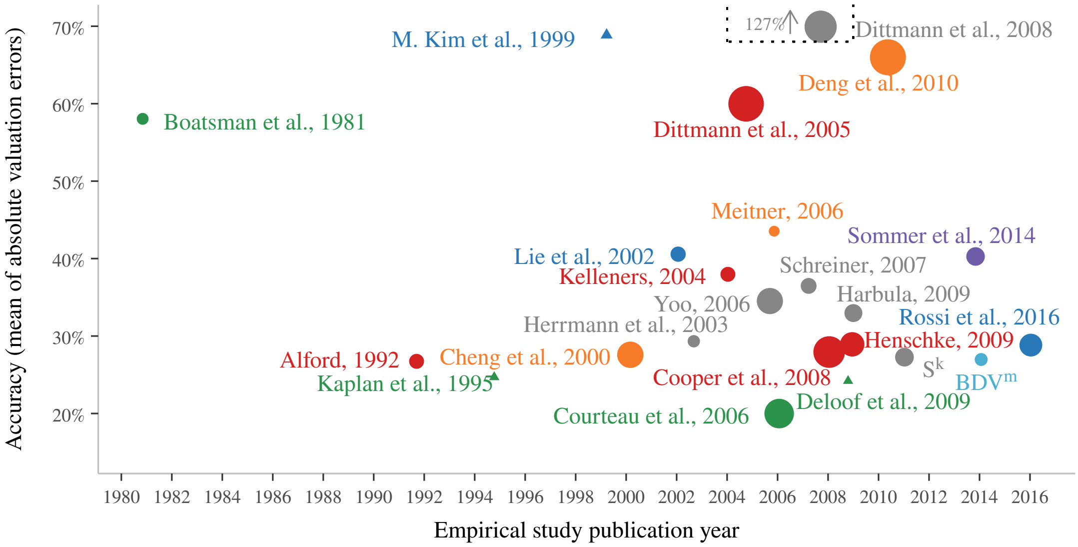
certain conditions or characteristics such as the approach of Sommer et al. (2014, p. 33), who uses distinct groups of target and peer firms on the basis of valuation driver negativity

[778] The review of literature is focused on general trading multiple studies of broader markets and disregards studies on local markets (e.g. Minjina (2009) for the Romanian market and Nel, Bruwer, and Le Roux (2013) for the South African market) and specific industries (e.g. Asche and Misund (2016) for Oil and Gas companies), unless they provide substantial incremental contribution to the body of literature. It only considers widely available analyses, notably disregarding studies referred to at times in literature, which are not readily accessible such as Choudhary (as cited in Meitner, 2006) or Liu and Ziebart (as cited in M. Kim and Ritter, 1999)

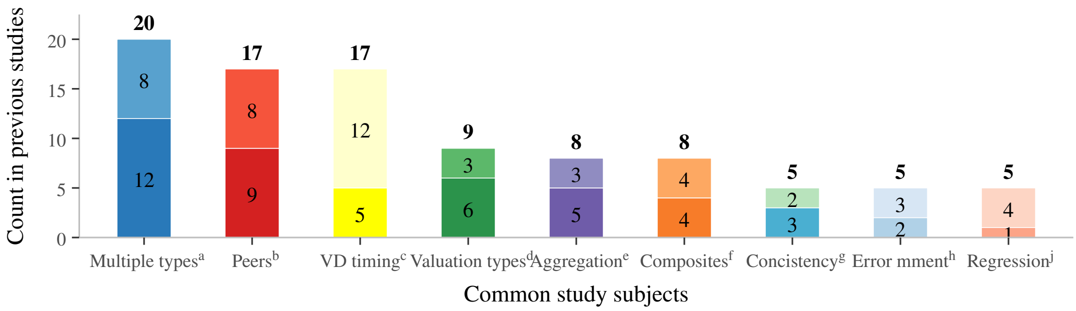
[779] For comparability reasons, all metrics relate to standard reported values prior to any of the suggested improvements to multiple valuation as the case may be

FIGURE 6.6: A visual summary of precedent empirical studies on multiple valuation accuracy

Panel A: Valuation errors over time: focus topics, sample sizes and biases



Panel B: Precedent empirical study focus areas in 34 studies reviewed: focus vs. peripheral topics



Note: Own illustration, highly indicative. Colors in both panels indicate areas of the respective study per indicative assessment: [a] Valuation accuracy of different multiple or valuation driver types;
[b] Considerations on peer group formation, specifically departure from the standard approach to select peers by industry classification; [c] Historical and future-oriented measurement of the valuation driver; [d] Comparison of multiple valuation to other concepts (e.g., fundamental valuations); [e] Discussion of potential aggregation techniques of pricing multiples into valuation multiples; [f] Approaches on the benefits of combined or composite multiple valuation (rather than reliance on individual multiples); [g] Benefits of consistency adjustments to multiples to better mirror economic reality;
[h] Measurement of valuation errors to determine valuation accuracy;
[j] Further regression analysis with the valuation error as dependent variable. [k] denotes Sommer and Wöhrmann (2011), [m] denotes Berndt, Deglmann, and Vollmar (2014). Panel A: Mean absolute error chosen as metric since most commonly reported (in 23 out of 34 studies reviewed); calculation principles not always identical, hence results are directional only. Size of shapes indicates sample sizes. Triangular shapes indicate special situations (e.g. IPOs), which may result in potential biases. Grey colored studies cover several concepts concurrently. Panel B: Intense colored lower area of stacked bar chart relates to focus topics, pale top area of staked bar chart relates to peripheral topics

- *Precedent samples:* Cross-sectional samples (firm-years or firm-months) are frequent, with sample sizes ranging from below 100 for situation-specific studies to commonly significantly below 100,000 observations (median of 9,794 observations) as illustratively indicated by the size of the "dots" in Panel A of Figure 6.6.[780] In the 1990ties, a couple of multiple-related studies were published on specific situations, including Kaplan and Ruback (1995) on leveraged buyouts and M. Kim and Ritter (1999) on IPOs, which are conceptually relevant; however, their results might not allow generalization of findings for broader trading comparable analyses. Studies in which such bias might exist are denoted with a triangular symbol in Panel A of Figure 6.6. More recently, the majority of studies relies on broader index samples with no obvious generalization issues. Furthermore the U.S. focus of earlier studies has somewhat normalized to international samples, although empirical evidence on non-U.S. markets is still materially lower than for the U.S. No clear error trends regarding increasing sample sizes emerge from Figure 6.6

- *Focus on one of 9 core research subjects:* It is furthermore instructive to offer an illustrative classification of research subjects. Studies commonly focus on one or several of those 9 topics and will usually also touch upon other subjects briefly. Panel A of Figure 6.6 provides an indicative overview, with one color each corresponding to one of 9 core research subjects. Studies marked in gray consider several topics at approximately equal detail.[781] Panel B of Figure 6.6 summarizes both key focus topics[782] and peripheral aspects.[783] Accordingly, focus on different multiple types, peer selection and different valuation types are most common core topics. Valuation driver timing has also received considerable attention, but more so as peripheral topic. Also as a consequence of emergence of multi-topic studies, it is challenging to derive visually obvious trends in focus topics; recent empirical evidence has been produced on most of them, suggesting that findings are still not commonly accepted, nor conclusive

Figure 6.6 is instructive to contextualize empirical results of this dissertation from a number of perspectives

- Valuation error metrics obtained for the sample can be considered in context to error

[780] One notable outlier, J. Liu et al. (2007) has 1.8mm observations, however does not report comparable error metrics. This drives up the average to 64,125 observations

[781] The assignment of studies to the 9 core identified research subjects is highly illustrative and subject to considerable judgment, with study authors potentially disagreeing. It should only be seen as an indicative overview

[782] Intense color at the bottom of the stacked bars; ; illustrative classification

[783] Pale color at the top of the stacked bars; illustrative classification

levels obtained by previous studies shown in Panel A.[784]

- An indication that the sample size used in this dissertation is sufficient compared to precedent studies[785]
- A reconfirmation that the dissertation covers a wide area of critically important trading multiple valuation aspects if its scope is compared to Panel B

Chapter 6 concludes the theoretical part of this dissertation, having focused on multiple aggregation, where median is argued to be a useful approach and the precision measurement of multiples, predominately via absolute log errors. A review of empirical studies concerned with prior multiple valuation reveals 9 core focus subjects. Together with Chapters 4 on pricing multiple roots in corporate finance and 5 on economically sensible adjustments to multiples, Chapter 6 paves the way towards empirical assessment, its discussion and implications the following final part of the dissertation.

[784] Results presented later in Table 7.2 (p. 245) point to 26.2% mean error for price/earnings, i.e. a strong but not unusually low general level of valuation accuracy, with mean precedent errors of 38.3%, with a median of 33%

[785] Sample size of 19,139 (compare Table 3.1, pp. 78–79) vs. a precedent study median of 9,794

THIRD PART

RESULTS, IMPLICATIONS, PROSPECTS

Synopsis Chapter 7 presents the empirical results of this dissertation in respect to the 17 Hypotheses formulated throughout the introductory and theoretical parts. From a replication perspective, levels of multiple valuation accuracy obtained compare well to precedent studies, which I ascribe to judicious sample selection. Accounting-focused multiple types are found to outperform cash flow-focused alternatives (Figure 7.2) and flow multiples outperform stock multiples (Figure 7.3); the picture for enterprise value (vs. equity value) multiples is inconclusive given the strong performance of price/earnings in particular (Figure 7.4), which I assert might be caused by a "feedback loop" corridor between price/earnings multiples and market prices (Figure 7.13). Multiple types with obvious theoretical drawbacks display underperformance (Figure 7.5). There is low value relevance of considering negative valuation drivers (Figure 7.1) and the quality of enterprise value multiples benefits from the adjustments argued for in Chapter 5. Future-oriented valuation drivers outperform historical drivers, with a 12–24 month forward-looking horizon performing best (Table 7.10). Critically, I find that fundamental valuations implemented through intrinsic multiples underperform multiple valuations (Figure 7.9), which I argue can in part be explained by the former displaying a systematic over-valuation of c. 15–20%, however, a residual underperformance aspect remains, even if a discount is indiscriminately applied to all intrinsic multiple valuation outcomes (Figure 7.11). Errors of multiple valuations can be explained to some extent by differing intrinsic input variables between peer companies and the individual company under investigation (Tables 7.12 and 7.13), and the proposed approach to weight peers by peer similarity affords meaningful error reductions. On the basis of the empirical results Chapter 8 discusses stakeholder implications and prospective research areas. Chapter 9 concludes with a summary of this dissertation—particular its empirical findings—in brief statements.

Background literature On multiple types: Prior empirical findings on aspects of multiple performance including J. Liu et al. (2002), Schreiner (2007), Henschke (2009) and Rossi and Forte (2016). Peer group improvement approaches such as Herrmann and Richter (2003) and Kelleners (2004). Studies on the connection of multiple valuation and the CAPM such as Sanjoy Basu (1977) and on relative performance of different valuation types such as Berndt, Deglmann, and Schulz (2014)

CHAPTER 7

Empirical investigation and results assessment

"When the going gets tough,
the tough get empirical"
—JON CARROLL[786]

7.1 Introduction and "baseline" assumptions

The objective of the empirical investigation is to provide further evidence on a number of *potentially contentious choices* faced by the valuation practitioner in the context of multiple valuation. Those issues have been selected on the basis of their presumed general relevance to multiple valuation and also reflect remaining research gaps. Naturally, not every potential aspect of multiple valuation can be comprehensively studied in the context of a dissertation[787] and consequently, with respect to some topics such as industry peer formation, I follow the established market practice or prior empirical findings.

Table 7.1 (p. 240) provides an instructive overview of some of the approaches applied throughout this Chapter in addition to further references on their respective theoretical discussion. With respect to a number of decision-relevant aspects, Table 7.1 details a *"baseline"* assumption or approach. This baseline is then compared to alternative concepts in a one-by-one

[786] A a journalist and former columnist of the San Francisco Chronicle
[787] Also compare the scope defined at the onset of this dissertation in Table 1.3 (p. 12)

TABLE 7.1: Empirical baseline and alternative approaches

		Potential alternative assumption/approach		Compare Subsection	
Key elements	Baseline assumption/approach	Considered	Not considered	Theoretical	Empirical
Peer group formation					
Company under investigation	• Exclude from peer group (“out of sample”) but repeated use in other peer groups	• Strict one-time use	• Peer selection without replacement	↑6.4.2.2	↑ Fig. 6.5
Industry peer formation	• Determination of peer group by industry as specified by identical 3-digit ICB code between company under investigation and the potential peer	—	• Cross-industry peers • Variation of industry finesse	↑6.2	—
Measurement point in time	• Same measurement point in time reflecting market-based multiple valuation nature	• Analysis of over-time valuation accuracy	• Through the cycle multiple analysis	↑3.5	↑ Tab. 7.5
High multiple outlier cut-off	• Imposed; consistent with practitioner approach of setting multiples “not meaningful”	—	• Winsorizing or trimming	↑3.4.2	—
Negative multiple elimination	• Exclusion of negative multiples as non-meaningful in line with practitioner approaches	• Consider negative multiples for median aggregation	• Negative multiples mean aggregation	↑6.3.3.2	↑7.3
M&A bias	• In-sample retention of firms with M&A activity announced around measurement point in time	• Removal of firms with recent M&A activity	• Pro-forma adjustments of multiples	↑2.3.2.2	↑7.5
Pricing multiple computation					
Multiple type	• Focus on most common types of flow multiples: EV/EBIT, EV/EBITDA, P/E	• Consider relative performance of alternative multiples	• Esoteric multiple types	↑2.4.1	↑7.2.3
Adjustment to multiples	• Fully adjust multiples to best reflect economic realities	• Assess benefits through comparison of adjusted and unadjusted multiples	• “Gold standard” adjustments	↑5	↑7.4
Valuation driver timing horizon	• Next twelve months from the measurement point in time	• Consider other time horizons, in particular in light of potential M&A bias	• Multi-period valuation drivers	↑2.3.2.2	↑7.5
Aggregation to valuation multiple					
Standard aggregation method	• Median of peer pricing multiples	• 4 alternative central tendency and 4 regression approaches	• LAD models	↑6.3.2	↑7.2.3
Varying peer weight concepts	• Standard unweighted central tendency measures: median	• Weighting of peers by similarity of their fundamental factors	—	↑6.3.2	↑7.8
Multiple type weighting	• Individual multiple	• Combination of several multiple types	—	↑6.3.4	↑7.9
Multiple valuation error assessment					
Determination of errors	• Accuracy (log valuation error) of *equity* valuation	—	—	↑6.4.1	throughout
Comparision of errors	• Comparison of error distributions of alternative multiple valuations, including Wilcoxon tests	—	—	—	throughout
Explanation of errors	• Regression analyses with valuation error as dependent variable to fundamental input factors	—	—	—	↑7.7
Alternatives to multiples	• Comparison of multiple and fundamental valuations	—	—	—	↑7.6

setting.[788] The central measurement metric to establish improving or worsening multiple valuation performance will be accuracy as defined by the *absolute log valuation* error;[789] as the lowest part of Table 7.1 on "multiple valuation error assessment" details, further analysis will be conducted on the basis of this error metric as appropriate. Finally, Table 7.1 also highlights some common alternative approaches, which are outside the scope of the empirical analysis.[790]

The remainder of this Chapter is structured as follows: First, in Subsections 7.2 to 7.5, I will analyze aspects with relevance to valuation accuracy predominately for the individual multiple, notably (a) best-performing multiple types and aggregation concepts, (b) the benefits of adjusting multiples, (c) the time period chosen for valuation drivers of flow multiples and (d) the benefits of including negative valuation drivers when aggregating pricing multiples into a valuation multiple through median. Second, in Subsections 7.6 and 7.7, I will investigate the relevance of fundamental valuation input variables through a comparison of multiple valuations to intrinsic valuations and through further analysis of valuation errors as dependent variable of fundamental valuation input variables. Finally, in Subsections 7.8 to 7.9, I will assess opportunities to further improve multiple valuation accuracy beyond the standard approaches through (a) an weighting concept for peers, (b) industry-specific multiple types and (c) combined multiples.

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[788] Whilst very common among previous multiple studies, which investigate numerous aspects of multiple valuation empirically, the baseline approach has a material drawback in that the different topics cannot be automatically be assumed to be independent. Notably, there might be some *interaction*, e.g. the choice of time horizon of the valuation driver may affect the performance of multiple types based on the specific valuation drivers differently. In other words the selection of individually most accurate approaches might not be the overall most accurate model. To address this issue, Sommer and Wöhrmann (2011) propose a repeat-measure ANOVA design. Even though Sommer and Wöhrmann (2011) find interaction between valuation drivers and aggregation concepts, the ANOVA approach carries considerable additional complexity, which is why I follow the traditional approach, of studying selected aspects individually relative to the respective baseline

[789] See above, Subsection 6.4.1.1 (p. 222) and Table 6.2 (p. 223) for additional details on valuation error assessment

[790] Those exclusions are motivated by the amount of existing studies which have analyzed them as well as a perceived lower practical relevance

7.2 Multiple type and and aggregation accuracy (Hypotheses 2a–2e, 6a)

7.2.1 High relevance of empirical evidence on valuation driver accuracy

As argued in Subsection 2.4.1 (p. 52), suitable valuation drivers of multiples are those, which are good proxies of the future economic cash generation potential of the firm under investigation. Under the assumption that the Law of One Price applies,[791] accurate valuation drivers and multiple types[792] result in low valuation errors if appropriate peers are chosen and their pricing multiples are aggregated in a suitable fashion. In Subsection 2.4.5 (p. 64), it was argued that, with the exception of some obviously flawed valuation drivers, it is a challenge to determine the most suitable valuation driver ex ante and that, ultimately, empirical evidence was crucial. Subsection 2.4.5 did, however, formulate a couple hypotheses, according to which valuation drivers and consequently multiple types do result in multiple valuations of varying quality, as well as that accounting-based valuation drivers, flow multiples and multiples normalizing capital structures would outperform cash-based valuation drivers, stock multiples and multiples impacted by capital structure differences, respectively. Previous evidence discussed in Subsection 2.4.3 (p. 61) is inconclusive, which also fosters presentation of additional empirical results. The assessment of valuation driver accuracy is also instructive for a general comparison of valuation errors with results in previous studies on the subject matter: The detailed assessment of prior studies on multiple accuracy presented in Figure 6.6 (p. 235) suggests that the performance of different multiple types has been the most popular field of study; hence, presentation of results on valuation driver performance as the first area of empirical evidence also replicates prior findings and contextualizes subsequent results presented in this Chapter.

7.2.2 Methodology: baseline of the "horse race" approach

As established in Subsection 1.3 (p. 14), the methodology to assess performance of different valuation drivers conceptually follows the widely applied general framework of pricing multiple computation, selection of an aggregation method and derivation of the valuation

[791] See Subsection 2.1.5.1, p. 27

[792] Since each valuation driver defines a different multiple type, the terms valuation driver and multiple type can be utilized pretty much interchangeably: A given valuation driver will, as a consequence of the principle of equivalence (Compare Subsection 5.3.1, p. 140), drive the choice of a consistent pricing reference

multiple for each sample company, computation of valuation errors through comparison of multiple valuation-suggested valuation with actual price as well as, ultimately, assessment and comparison of valuation errors for the different multiple types—the "horse race" approach. On a more detailed level and as suggested by Table 7.1 (p. 240), certain choices will need to be made in order to present condensed results in a meaningful manner. Namely, the empirical assessment proceeds as follows:

- Selection of common valuation drivers based on two restrictions, *the most practically common multiple types* and *a broad cross-section of different classes* of multiples under each general concept or Hypothesis studied—e.g. numerous common enterprise and equity value multiples, numerous common stock and flow multiples and numerous common forward valuation diver and historical valuation driver multiples[793]

- *Computation of pricing multiples* for the multiple types as shown and all firm-half year observations of the sample, using *next twelve month* recalendarized forecasts as valuation driver measurement horizon for flow multiples and latest available historical financials for stock multiples. Enterprise value computation aspects such as e.g. elements affecting net debt are taken from the last available historical annual, semi-annual or quarterly balance sheet. Market price references such as market capitalization are computed on the pricing date, i.e. the last trading day of January and July, respectively. Any currency conversions are undertaken at the *prevailing spot rate* at the time of the pricing date into Euros. The basis of calculation are multiples, which follow the *principle of equivalence*[794] but do not benefit from any of the additional adjustments proposed in Chapter 5.[795] Some aggregated descriptive statistics for price/earnings and enterprise value/EBIT multiples are available from Tables 3.5 (p. 84) and A.2 (p. A8), respectively

- *Aggregation of pricing multiples* into valuation multiples for the respective companies under investigation, i.e. all firm half-year observations: This step primarily relies on the *median* of peer pricing multiples,[796] where peers are defined as firms *with the same 3-digit ICB industry classification code* as the respective company under investigation.[797]

[793]Compare Subsection 2.4.4 (p. 63) for additional considerations on the selection of valuation drivers and consequently multiple types in this dissertation
[794]Compare Subsection 5.3.1, p. 140
[795]Those will, however, be analyzed in Subsection 7.4 (p. 270)
[796]Compare Subsection 6.3.2 (p. 199) and, more specifically, Table 6.1 (p. 201) for a comparison of aggregation methodologies
[797]Compare Subsection 6.2.2 (p. 187); to obtain a sense for the number of peers to each firm-half year observation, compare Table 3.1 (pp. 78–79). Since those statistics include the firms under investigation, the number of

Aggregation is conducted for all multiple types concurrently

- Computation of valuation errors for each multiple type, predominately relying on accuracy as expressed by *absolute log errors*[798]

- Comparison of valuation errors between the different multiple types, in a concurrent side-by-side and pairwise manner. Whilst the concurrent comparison of valuation errors by multiple type is more descriptive in nature, the *pairwise comparison* of two multiple types each with each other allows for some statistical testing as on the differences of the respective errors. For this purpose and following the discussion regarding the distribution of valuation errors in Subsection 6.4.1.4 (p. 227), *Wilcoxon sign-rank tests* will be utilized, which allow for the pairwise comparison of empirical distributions without assuming any underlying distribution type[799]

7.2.3 General assessment of multiple type valuation accuracy

7.2.3.1 Introduction

Summary results for valuation drivers and aggregation concepts Results for accuracy of different multiple types are presented along a couple of dimensions: First, Table 7.2 (p. 245) references a descriptive comparison of distribution statistics of valuation accuracy by multiple type as expressed by absolute log errors. Both harmonic means and medians of the peer pricing multiples computed for all sample observations are utilized as aggregation methodologies. Table 7.2 is instructive for a preliminary quantitative assessment of a number of the Hypotheses formulated around valuation driver accuracy in Subsection 2.4.5 (p. 64) in addition to some other quantitative insights:[800]

- *Generally varying levels of accuracy between multiple types:* Hypothesis 2a stated that, as a result of their differing valuation drivers, different multiple types would display diverging levels of valuation accuracy. Even without formal tests, there is ostensible support for this Hypothesis, which persists under both aggregation methodologies: Key

peers can be obtained by subtracting 1 from the numbers presented in the Table. The number of peers might be negatively affected by data availability, in particular for more esoteric multiple types

798 Compare Subsection 6.4.1.1 (p. 222) and, more specifically, Table 6.2 (p. 223) for a discussion of valuation error measurement in th context of multiple valuation

799 The Holm-Bonferroni method will be applied to address aspects of repeated testing in a conservative manner, compare Subsection 7.2.3.3 (p. 251)

800 For sake of completeness I also report in Appendix Table A.3 (p. A10) Spearman and Pearson correlations of absolute valuation multiple errors (accuracy) for different multiple types and relative to pricing multiples as well as financial and operating ratios

TABLE 7.2: Distribution statistics of log-scaled valuation errors (accuracy) by multiple type

		Distribution statistics of valuation errors							Fractions of errors[a]			Obs.[g]
		Mean[b]	Median	SD[c]	5%	25%	75%	95%	< 10%	< 25%	< 40%	n
Panel A: Peer median aggregation												
Enterprise value multiples[d]	EV/Net sales	59.3%	45.2%	53.0%	3.9%	20.9%	83.2%	159.8%	12.4%	29.5%	45.3%	17,772
	EV/EBITDA	31.7%	23.1%	33.5%	2.2%	10.6%	41.5%	89.2%	23.6%	53.4%	73.4%	18,267
	EV/EBIT	30.2%	20.7%	35.1%	1.9%	9.6%	39.2%	86.3%	26.1%	57.2%	75.7%	17,588
	EV/(EBITDA-Capex[e])	38.2%	24.8%	45.2%	2.3%	11.3%	47.7%	119.9%	22.4%	50.3%	68.7%	16,357
	EV/taxed EBIT	31.1%	21.7%	34.8%	1.9%	9.7%	40.8%	89.1%	25.5%	55.7%	74.2%	17,564
	EV/(taxed EBIT+D&A[f]-Capex[e])	41.3%	27.5%	48.2%	2.4%	12.5%	51.9%	128.3%	20.3%	46.2%	64.8%	15,183
Equity value multiples[d]	Price/Earnings	26.2%	18.5%	30.5%	1.5%	8.3%	34.0%	74.1%	29.6%	62.6%	80.8%	18,321
	Price/Earnings before tax	27.8%	20.0%	31.4%	1.8%	9.2%	36.5%	77.9%	27.1%	59.3%	78.5%	18,329
	Price/Earnings growth	48.2%	31.8%	54.1%	2.6%	14.0%	62.5%	149.3%	18.0%	41.6%	58.7%	16,308
	Price/Dividends	42.5%	32.2%	38.2%	2.9%	14.8%	59.0%	118.9%	17.2%	40.3%	59.0%	15,386
Stock multiples[d]	EV/total Assets	47.3%	38.4%	39.1%	3.5%	18.2%	66.0%	122.6%	13.7%	33.7%	51.9%	18,661
	EV/Invested Capital	70.1%	54.3%	66.7%	4.4%	24.7%	93.9%	188.6%	11.1%	25.3%	38.2%	16,311
	Price/Book value of equity	59.0%	43.3%	60.6%	3.8%	21.1%	79.2%	161.3%	12.8%	29.5%	46.8%	16,964
Panel B: Peer harmonic mean aggregation												
Enterprise value multiples[h]	EV/Net sales	64.2%	50.7%	58.3%	4.4%	23.2%	87.8%	170.4%	11.1%	26.8%	41.1%	17,500
	EV/EBITDA	32.7%	24.3%	33.5%	2.0%	11.1%	43.4%	89.8%	22.6%	51.1%	71.5%	18,229
	EV/EBIT	30.7%	21.2%	35.6%	2.0%	9.7%	39.7%	88.8%	25.7%	56.9%	75.3%	17,574
	EV/(EBITDA-Capex[e])	38.4%	25.0%	46.4%	2.1%	11.3%	47.1%	121.4%	22.0%	49.9%	69.1%	16,331
	EV/taxed EBIT	32.2%	22.0%	37.4%	2.0%	10.3%	41.6%	92.0%	24.3%	54.9%	73.5%	17,553
	EV/(taxed EBIT+D&A[f]-Capex[e])	41.1%	27.2%	48.4%	2.4%	12.2%	51.4%	128.7%	20.9%	46.9%	65.5%	15,129
Equity value multiples[h]	Price/Earnings	30.6%	18.9%	52.1%	1.7%	8.7%	34.7%	83.0%	28.6%	61.7%	79.9%	18,321
	Price/Earnings before tax	32.1%	20.5%	52.3%	1.9%	9.6%	37.2%	84.0%	26.1%	58.1%	77.6%	18,329
	Price/Earnings growth	55.7%	35.3%	72.1%	3.0%	15.6%	69.0%	169.7%	16.3%	38.0%	55.1%	16,250
	Price/Dividends	44.8%	31.4%	50.9%	2.9%	14.7%	59.1%	126.0%	17.5%	41.3%	59.6%	15,386
Stock multiples[h]	EV/total Assets	48.2%	38.9%	40.2%	3.8%	18.8%	66.9%	124.6%	13.3%	33.2%	51.2%	18,655
	EV/Invested Capital	72.9%	54.9%	70.4%	5.4%	26.4%	95.3%	198.2%	9.4%	23.7%	37.5%	15,860
	Price/Book value of equity	78.2%	48.9%	96.4%	3.6%	21.5%	92.4%	281.9%	13.0%	28.4%	42.6%	16,964

Note: Valuation drivers measured on the basis of recalendarization to next twelve months per measurement date; all errors express as errors of equity value, adjusting errors of enterprise value-based multiples for better comparison with price-based multiple errors [a] Denotes percentage of log-scaled valuation errors which fall below the indicated fraction threshold relative to all log-scaled valuation errors for the respective multiple type [b] Arithmetic mean [c] Sample standard deviation [d] Valuation multiples derived through computation of the median of the peer pricing multiples for each observation [e] Capital expenditure abbreviated as Capex [f] Depreciation and amortization, abbreviated as D&A [g] Number of observations with available data per type of multiple [h] Valuation multiples derived through computation of the harmonic mean of the peer pricing multiples for each observation distribution metrics for some multiple types, notably price/earnings, price/earnings before tax, enterprise value/(taxed) EBIT and enterprise value/EBITDA show higher valuation accuracy compared to multiples such as price/book and enterprise value/net sales as expressed by numerous key parameters of the resulting valuation error distributions such as median, mean and standard deviation. A nonparametric Quade-test[801] confirms the suspicion by rejecting the null hypothesis, that the medians of each multiple type presented in Table 7.2 are equal[803]

- *Median outperforms harmonic mean as aggregation method:* Hypothesis 6a (p. 203) stated that median would be a suitable aggregation method relative to harmonic mean. Utilizing the median of the peer multiples as displayed in Panel A of Table 7.2 rather than their harmonic mean as shown in Panel B of Table 7.2 appears to result in lower valuation errors and consequently higher accuracy. Expressed by the mean of valuation error distributions, this is the case for all multiple types suggested; expressed by median, it applies for all but one of the multiple types,[804] which is also confirmed by considering the proportion of valuation errors below a threshold of e.g. 25% and by a generally lower standard deviation of absolute valuation errors. Both a Wilcoxon sign-rank test and—conducted for completeness— a paired t-test for a randomly chosen multiple type rejects the null hypothesis that there is no difference between the distributions at a level of significance of 0.001,[805] even though median valuations outperform in just 51.9% of cases. It is reasonable to assume that harmonic mean in particular might be more influenced by outliers, in particular asymmetric outliers. Consequently, any decision of setting pricing multiple outliers as "not meaningful" and therefore removing them from the universe of potential peers might become relevant.[806] Since such exclusions

[801] The (somewhat lesser-known) Quade-test is the primary test of choice here since it is a generalized Wilcoxon sign-rank test for more than one pair (García, Fernández, Luengo, & Herrera, 2010; Bortz, Lienert, & Boehnke, 2008, pp. 272–274) in the case of paired samples. It is furthermore argued that Wilcoxon sign-rank tests can be suitable post-hoc tests to investigate pairwise distribution differences(Mangiafico, 2016, p. 274). Some Wilcoxon sign-rank tests will be conducted later in this Chapter, compare Subsections 2b (p. 65) and following. The close relationship between the Quade- and the Wilcoxon sign-rank test makes the Quade-test a preferable alternative to the similar Friedman test, which is a generalization of a paired sign test. Another nonparametric and very commonly used test, the Kruskal-Wallis test, is of lesser relevance here since the sample is paired, i.e. data for the different multiple types is available for identical firm-year combinations. None the less, a Kruskal-Wallis test was performed with directionally consistent results of KW=2.02787×10^4, Holm-Bonferroni-adjusted[802] $p \ll 0.0001$. Compare among many Ott and Longnecker (2010, pp. 478–481) regarding further details on this test

[803] Test statistics for the Quade-test are Q=2.8, Holm-Bonferroni-adjusted $p \ll 0.0001$

[804] The notable outlier being price/dividends

[805] The statistics for the Wilcoxon sign-rank test and the paired t-test are W=8.85e+07 (Holm-Bonferroni-adjusted $p \ll 0.0001$) and t=13.938 (Holm-Bonferroni-adjusted $p \ll 0.0001$), respectively

[806] Compare Subsection 3.4.2 (p. 74) for the treatment of outliers in this sample

are somewhat arbitrary, the higher degree of resilience of median relative to the actual values outliers take suggests a possible approach might be to operate with median as aggregation concept and eliminate only a small number of obviously irrelevant pricing multiples[807]

- *Median significantly outperforms 7 out of 8 alternative aggregation concepts:* For the price/earnings multiple,[808] Table 7.3 (p. 248) indicates that median as an aggregation concept produces trading multiple valuations of higher accuracy compared to *all* alternative aggregation concepts;[809] results are statistically significant for 7 out of 8 alternatives, with the notable exception being the Theil–Sen regression also utilized by Ohlson and Kim (2015). This provides further support regarding Hypothesis 6a, according to which median appears a useful aggregation concept[810]

- *Errors found in empirical sample compare well to prior multiple accuracy studies:* Table 7.2 provides an interesting opportunity to compare the precision obtained by the sample utilized in this dissertation to prior studies as discussed in Subsection 6.4.3 (p. 234) and more specifically in Figure 6.6 (p. 235). Figure 6.6, which, on the *y*-axis of the chart in Panel A denotes mean absolute valuation errors of previous studies on multiple accuracy where available, suggests that mean valuation errors in the sample utilized in this dissertation are with median and arithmetic mean of 18.5% and 26.2% for price/earnings, respectively, at the lower end of previously observed errors, which, on average, amounted to 38.3%.[811] This study therefore replicates at baseline prior findings, which carries importance for the generalization of some of the more distinctive results

Error measurement concepts In Subsection 6.4.1.1 (p. 222) and Table 6.2 (p. 223) specifically, a number of different measurement concepts for valuation errors have been proposed and it was argued that *absolute log error* might be most appropriate. Whilst this metric will

[807] For the discussion around negative multiples and valuation drivers specifically compare below, Subsection 7.3 (p. 268)

[808] Which has been illustratively selected on the basis of its overall strong performance reported in Table 7.2. Other multiple types were reviewed, too, but are not tabulated. Results are directionally consistent

[809] Compare Subsection 6.3.2 (p. 199) for theoretical consideration on the selection of those alternatives

[810] Should a more sophisticated regression-based approach be preferred, the Theil–Sen regression as recently used by Ohlson and Kim (2015, p. 411) and Ohlson and Johannesson (2016) appears most appropriate

[811] Whilst the results are not exceptionally low compared to prior studies, where a number of samples displayed errors of between 20–30%, they do rank in the lower spectrum of prior valuation error results, which I attribute to a judicious sample selection of larger peers with good liquidity and equity research coverage, careful sample assessment and appropriate selection of some multiple valuation baseline aspects presented in Table 7.1 (p. 240), such as next twelve month valuation drivers and peer selection by 3-digit ICB industry code

TABLE 7.3: Accuracy of P/E multiple valuation for various aggregation methods

	Distribution statistics of valuation errors							Fractions of errors[f]			Relative performance of median[g]		
	Mean[d]	Median	SD[e]	5%	25%	75%	95%	< 10%	< 25%	< 40%	Prop. winning[h]	PW error diff.[j]	Sig.[k]
Panel A: Standard unweighted central tendency measures													
Median	26.2%	18.5%	30.5%	1.5%	8.3%	34.0%	74.1%	29.6%	62.6%	80.8%			
Harmonic mean	30.6%	18.9%	52.1%	1.7%	8.7%	34.7%	83.0%	28.6%	61.7%	79.9%	52.1%	0.275%-pts	***
Arithmetic mean	28.7%	21.2%	30.7%	2.0%	9.6%	38.5%	78.6%	26.0%	57.0%	76.6%	56.2%	1.551%-pts	***
Geometric mean	26.6%	19.1%	30.3%	1.7%	8.8%	34.6%	73.9%	28.3%	61.4%	80.3%	52.2%	0.262%-pts	***
Value-weighted mean	28.6%	20.1%	31.9%	1.7%	9.1%	37.6%	83.0%	27.2%	58.5%	77.4%	55.9%	1.211%-pts	***
Panel B: Regression-based concepts													
OLS without intercept[a]	28.7%	20.2%	32.4%	1.8%	9.1%	37.3%	83.1%	27.2%	58.5%	77.6%	56.8%	1.829%-pts	***
OLS with intercept[b]	31.1%	21.4%	35.0%	1.8%	9.4%	40.8%	91.7%	26.5%	56.1%	74.3%	55.6%	1.501%-pts	***
Price-deflated OLS without intercept[c]	107.6%	92.8%	79.9%	8.7%	44.7%	153.3%	259.1%	5.8%	14.1%	22.4%	87.6%	68.995%-pts	***
Theil-Sen regression	26.3%	18.6%	30.5%	1.6%	8.4%	34.7%	75.4%	29.4%	61.9%	80.2%	50.7%	0.094%-pts	n.s.

Note: Table displays absolute log-scale valuation errors of P/E trading multiple valuations for different aggregation methods as specified in the respective row; valuation drivers measured on the basis of recalendarization to next twelve months per measurement date as per standard methodology; sample size ranges from 18188 to 18324, depending on aggregation methodology; [a] Ordinary least square ("OLS")-regression through the origin (i.e. no intercept) conceptually following Figure 6.1 of the form $P_{i,t} = M_{k,t} \cdot VD_{i,t} + \varepsilon_{i,t}$ (compare Equation C.1) [b] Standard OLS regression with intercept ($\beta_{k,t}$) of the form $P_{i,t} = \beta_{k,t} + M_{k,t} \cdot VD_{i,t} + \varepsilon_{i,t}$ [c] Price-deflated OLS regression through the origin of the form $1 = M_{k,t} \cdot \frac{VD_{i,t}}{P_{i,t}} + \frac{\varepsilon_{i,t}}{P_{i,t}}$, compare Equation C.6 [d] Arithmetic mean [e] Sample standard deviation [f] Denotes percentage of log-scaled valuation errors, which fall below the indicated fraction threshold relative to all log-scaled valuation errors for the respective multiple type [g] Compares the performance of median as aggregation method to the alternative presented in the respective row [h] Indicates the proportion of median aggregations emerging as winner over the respective alternative [j] Indicates the median of the pairwise error differences between median and the respective alternative, compare Equation 7.1 [k] Holm-Bonferroni-adjusted (compare Subsection 7.2.3.3) Wilcoxon sign-rank test results in common asterisk notation (***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$)

TABLE 7.4: Medians of selected valuation error metrics by type of multiple

		Multiples[a]		Turns error[b]		Percentage error[c]		Log error[g]		Observations[l]
		Observed[h]	Peer-calculated[k]	Bias	Accuracy[j]	Bias	Accuracy[j]	Bias	Accuracy[j]	n
Enterprise value multiples[d]	EV/Net sales	1.7 x	1.9 x	0 x	0.64 x	-0.06%	43.56%	1.6 %	**45.21%**	17,772
	EV/EBITDA	8.2 x	8.3 x	0 x	1.57 x	-0.05%	22.87%	0.17 %	**23.11%**	18,267
	EV/EBIT	11.5x	11.6x	0.01 x	2 x	0.05 %	20.96%	0.49 %	**20.69%**	17,588
	EV/(EBITDA-Capex[e])	12.4x	12.3x	0 x	2.64 x	0.01 %	25.52%	1.18 %	**24.79%**	16,357
	EV/taxed EBIT	16 x	16.1x	0 x	2.88 x	-0.01%	21.75%	0.39 %	**21.67%**	17,564
	EV/(taxed EBIT+D&A[f]-Capex[e])	17.1x	17.2x	-0.01x	4.09 x	-0.04%	28.35%	1.21 %	**27.48%**	15,183
Equity value multiples	Price/Earnings	14.6x	14.6x	0 x	2.6 x	0.01 %	18.39%	0.01 %	**18.47%**	18,321
	Price/Earnings before tax	10.6x	10.5x	0 x	2.04 x	0.02 %	19.94%	0.02 %	**19.95%**	18,329
	Price/Earnings growth	1.4 x	1.4 x	0 x	0.47 x	-6.2 %	33.9 %	-2.84%	**31.76%**	16,308
	Price/Dividends	36.8x	38.8x	-0.01x	11.36x	-0.04%	32.28%	-0.04%	**32.18%**	15,386
Stock multiples	EV/total Assets	1.3 x	1.3 x	0 x	0.39 x	-0.02%	37.08%	0.07 %	**38.36%**	18,661
	EV/Invested Capital	2.8 x	3 x	0 x	1.24 x	0.32 %	53.09%	2.23 %	**54.27%**	16,311
	Price/Book value of equity	2.9 x	3.1 x	0 x	1.15 x	0.17 %	41.49%	0.17 %	**43.29%**	16,964

Note: Valuation drivers measured on the basis of recalendarization to next twelve months per measurement date, all errors expressed as errors of equity value, adjusting errors of enterprise value-based multiples for better comparison with equity value multiple errors [a] Median observed and peer-calculated valuation multiples by sample company observation; not an error metric, for reference [b] Median of errors between peer-calculated and observed multiples for each sample company observation; expressed in turns of multiples, i.e. calculated by subtracting the peer-calculated from the observed multiple for each of the sample company observations; expressed as signed error (bias) and absolute error (accuracy), each [c] Median of errors between peer-calculated and observed multiples for each sample company observation; expressed in percent of observed multiples, i.e. calculated by dividing the errors expressed in turns of multiples by the observed multiple for each of the sample company observations; expressed as signed error (bias) and absolute error (accuracy), each [d] Multiples unadjusted [e] Capital expenditure abbreviated as Capex [f] Depreciation and amortization, abbreviated as D&A [g] Median of errors between peer-calculated and observed multiples for each sample company observation; calculated as log error based on observed multiples, as described in Subsection 6.4.1.1; expressed as signed error (bias) and absolute error (accuracy), each. **Bold** emphasis added to indicated main error metric utilized in the context of other analytics [h] Observed pricing multiple for the respective sample company [j] Absolute valuation error [k] Valuation multiple calculated for the respective sample company on the basis of its peers [l] Number of observations with available data per type of multiple, relating to log-scaled valuation error (accuracy) metric, number of observations for other error metrics does not differ substantially be used going forward, Table 7.4 (p. 249) presents results for the numerous alternative error concepts, which do offer some relevant interpretation opportunities:

- The main alternative to log error measurement, *percentage errors*, appear to result in broadly similar median valuation errors for all multiple types. Thus, whilst no benefits of absolute log errors over absolute percentage errors can be inferred from Table 7.4 given its focus on median only, the theoretical benefits of absolute log errors around symmetry properties argued for in Subsection 6.4.1.2 (p. 223) suggest they should be given preference
- *Median biases* for all error metrics and multiple types appear to be *close to zero*. It has been argued in Subsection 6.4.2.2 (p. 232) that this could have to do with the "out of sample" nature of multiple valuation, however, the approach to avoid peer group and company under investigation overlap presented in Figure 6.5 (p. 233) suggest that this might be an inherent rather than a methodological feature of multiple error measurement
- Absolute valuation errors expressed by *"turns"* can be helpful in assessing the practically popular determination of valuation ranges. E.g. a 2x median valuation error as observed for enterprise value/EBIT per Table 7.4 suggests that 50% of observations have an error of less than 2 "turns" (and 50% of more than 2 "turns"). In layman terms, one could thus argue that expressing a valuation range in form of a 2x range could be correct in 50% of cases.[812] According to this logic, the comparison of absolute errors in turns enable to set broadly consistent ranges across the practically relevant question of concurrent multiple valuation with different multiple types such as in a "football field," where practitioners might include both enterprise value/EBIT(DA) and price/earnings multiples: Given a range of 2x for enterprise value/EBIT, a consistent range for price/earnings should be 2.6x, or 134.3% of the enterprise value/EBIT range

7.2.3.2 Descriptive statistics on cross-sectional error metrics

From a descriptive perspective and while I do not formulate any specific hypotheses on the topic, it is instructive to present some cross-sectional error metrics to investigate how errors vary over time and between different industries. This fosters a superior understanding of the distribution characteristics of valuation errors and their *time-* and *industry stability*. Since

[812] Also consider the more detailed discussion on valuation ranges and confidence intervals in Subsection 6.3.3.1 (p. 205)

the presentation is descriptive in nature, I focus exclusively on one multiple type, which, according to Table 7.2 (p. 245), appears to provide strong valuation accuracy and is at the same time very common: the *price/earnings* multiple.[813]

Table 7.5 (p. 252) presents the results, which are color-coded to illustratively indicate deviation from the overall sample median price/earnings valuation error of 18.5%. As expected, there is some variability within the cross-sectional data, both as far as measurement points in time and industry affiliation is concerned. *Industry affiliation* appears to have *a more profound impact*, with over-time valuation errors ranging from 8.4% to 30.4%, or 45.4% to 164.8% of median error. This poses a question further investigated later in this dissertation around potential benefits of industry-specific multiples.[814] *Variability of errors over time appears lower*, ranging from 14.3% to 23.5%, or 77.3% to 127.5% of the overall sample median error. Prima facie, this suggests that the quality of multiple valuations does not vary as substantially over time and thus multiples appear a suitable concept throughout the economic cycle. Furthermore, Table 7.5 provides some insights in the valuation performance of the U.S and European subsamples, respectively.[815] It appears that the price/earnings multiple performs somewhat better in a U.S. context than in a European context but differences do not appear to be too material.

7.2.3.3 The pairwise comparison and statistical inferences of multiple types

Two methodological challenges Hypotheses 2b to 2e refer to the relative performance of different groups of families of multiple types rather than individual types of multiples. Consequently, a test of relative performance faces two challenges:

- *Issues of testing:* Traditional Wilcoxon signed-rank or paired t-tests are suitable for a comparison of two different multiple types with each other (i.e. its respective alternatives) but not groups of multiple types. Whilst the Kruskal-Wallis test or one-way repeated measure ANOVA concepts could be utilized to compare three or more multiple types at the same time (Ott & Longnecker, 2010, pp. 451–489), this still does not solve the actual question of comparing two groups or families of multiple types. In order to address this aspect I utilize a 2-stage approach, namely the pairwise comparison of the

[813] I have also studied other multiple types, including enterprise value/EBIT and the results are conceptually similar. Results are available upon request

[814] See Subsection 7.9.2.2, p. 321

[815] In those lines (and across all data presented in this dissertation) I form global peer groups, i.e. a European company might be valued by U.S. and European companies. The lines relate to valuation error assessment for European and U.S. companies, respectively

TABLE 7.5: Median absolute log valuation errors by date and industry affiliation

ICB classification[a]		Median sector P/E absolute log valuation error by measurment date[b]								
Code	Descr.	Jan-05	Jul-05	Jan-06	Jul-06	Jan-07	Jul-07	Jan-08	Jul-08	Jan-09
053	Oil & Gas Producers	23.6%	20.6%	29.9%	21.4%	22.8%	21.7%	31.6%	24.1%	26.9%
057	Oil Equipment, Services & Distr.	15.2%	8.0%	6.7%	5.8%	15.2%	9.1%	11.4%	18.4%	22.7%
058	Alternative Energy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25.4%
135	Chemicals	13.6%	14.1%	11.5%	20.9%	24.3%	10.4%	30.1%	25.0%	35.5%
173	Forestry & Paper	13.3%	18.9%	15.1%	14.4%	11.8%	13.8%	10.6%	10.0%	24.9%
175	Industrial Metals & Mining	35.8%	47.6%	24.0%	18.7%	12.5%	15.9%	29.5%	25.8%	23.7%
177	Mining	8.9%	25.5%	31.9%	21.7%	26.9%	22.3%	15.8%	17.7%	63.5%
235	Construction & Materials	8.5%	9.8%	11.2%	16.8%	15.2%	13.0%	19.6%	21.2%	28.9%
271	Aerospace & Defense	12.9%	12.1%	5.9%	10.8%	8.8%	8.4%	9.1%	16.3%	16.1%
272	General Industrials	18.0%	17.2%	18.9%	14.7%	14.4%	14.6%	8.8%	17.9%	31.8%
273	Electronic & Electrical Equipment	19.7%	14.8%	8.7%	13.0%	13.9%	16.9%	22.7%	25.7%	23.1%
275	Industrial Engineering	23.1%	13.2%	16.9%	16.3%	12.5%	12.8%	21.4%	22.2%	21.5%
277	Industrial Transportation	20.7%	23.9%	17.9%	23.3%	26.3%	32.0%	19.0%	20.0%	28.7%
279	Support Services	21.4%	23.5%	17.9%	20.3%	16.7%	20.0%	24.9%	25.8%	21.8%
335	Automobiles & Parts	14.6%	18.8%	16.4%	12.0%	7.4%	12.5%	19.1%	29.0%	38.8%
353	Beverages	17.9%	10.3%	18.1%	10.9%	9.4%	13.2%	11.2%	8.8%	22.7%
357	Food Producers	10.9%	12.0%	7.3%	10.7%	9.9%	7.1%	15.2%	13.4%	12.3%
372	Household Goods & Home Constr.	55.4%	40.5%	29.7%	29.1%	35.5%	29.2%	20.2%	17.1%	44.3%
374	Leisure Goods	12.8%	23.1%	28.4%	15.2%	8.4%	43.5%	21.9%	29.2%	35.0%
376	Personal Goods	14.8%	12.4%	12.1%	14.4%	12.4%	10.7%	20.6%	14.7%	24.3%
378	Tobacco	7.2%	13.0%	4.5%	5.3%	11.0%	2.3%	7.7%	13.2%	12.3%
453	Health Care Equipment & Services	22.7%	19.8%	15.5%	10.2%	14.3%	13.2%	13.5%	10.5%	10.4%
457	Pharmaceuticals & Biotechnology	17.3%	16.7%	15.0%	12.8%	15.8%	27.1%	26.2%	27.1%	29.0%
533	Food & Drug Retailers	12.4%	20.7%	23.4%	12.1%	17.9%	12.6%	13.4%	13.4%	15.5%
537	General Retailers	19.2%	23.0%	16.9%	11.0%	12.0%	15.4%	16.6%	18.8%	22.0%
555	Media	21.5%	15.4%	15.0%	16.4%	12.8%	11.2%	22.9%	37.0%	31.3%
575	Travel & Leisure	20.7%	25.6%	22.5%	21.5%	19.7%	20.6%	25.5%	34.2%	33.9%
653	Fixed Line Telecommunications	17.7%	12.1%	19.9%	21.0%	19.4%	16.1%	13.7%	9.6%	14.4%
657	Mobile Telecommunications	28.5%	14.1%	19.7%	21.0%	9.1%	12.3%	13.1%	20.5%	25.2%
753	Electricity	6.8%	7.4%	7.5%	9.5%	8.2%	7.8%	11.8%	11.6%	16.7%
757	Gas, Water & Multiutilities	24.6%	12.5%	10.2%	12.8%	11.2%	12.8%	10.7%	8.1%	10.6%
953	Software & Computer Services	20.9%	28.9%	31.4%	25.2%	21.0%	21.1%	14.9%	21.9%	24.8%
957	Technology Hardware & Equipment	19.2%	19.9%	17.0%	15.3%	15.9%	16.4%	18.5%	17.9%	41.7%
Median across industries		**18.2%**	**17.3%**	**15.9%**	**15.7%**	**14.9%**	**14.3%**	**18.7%**	**19.7%**	**23.5%**
o.w.: STOXX® Europe 600		18.6%	17.0%	15.0%	16.3%	16.2%	16.1%	21.4%	22.3%	24.8%
o.w.: S&P 500®		17.2%	18.2%	17.0%	15.0%	12.6%	12.6%	15.3%	16.6%	22.1%

Note: Table should be read in conjunction with the facing table on the following page. Color coding refers to relative difference between overall sample median P/E absolute valuation error shown at the intersection of total median column/row (highlighted in bold): red (green) represents a higher (lower) valuation error than overall median. Intensity of color indicates relative quantum of difference. [a] Industry Classification Benchmark by "Sector," which relates to the first 3 digits of the respective ICB codes and includes all respective "Subsectors," which are defined by the full 4 digit ICB taxonomy [b] The measurement date is the last trading day of the month and year specified in the column heading. The valuation driver is recalendarized to a rolling next twelve month level [c] Sample as detailed in Table 3.1, excluding companies classified by ICB in the industry "Financials" (ICB code 8xx) [d] "Total" refers to median over time, also including corresponding line item of the table on previous page in the conjunction with which it should be read [e] Please refer to previous page for row labels (i.e. industries)

Median sector P/E absolute log valuation error by measurment date[b](continued)[e]													
Jul-09	Jan-10	Jul-10	Jan-11	Jul-11	Jan-12	Jul-12	Jan-13	Jul-13	Jan-14	Jul-14	Jan-15	Jul-15	Total[d]
35.0%	34.5%	38.5%	31.5%	35.6%	30.6%	31.6%	29.1%	30.7%	26.5%	30.5%	43.0%	51.5%	**30.4%**
25.1%	23.4%	21.9%	14.6%	15.6%	15.3%	11.4%	9.3%	8.6%	17.4%	17.8%	32.3%	27.5%	**15.9%**
45.6%	14.2%	23.9%	22.7%	46.7%	40.8%	N/A	N/A	N/A	N/A	N/A	21.1%	41.0%	**29.4%**
18.4%	14.8%	14.5%	16.1%	24.1%	19.6%	17.7%	17.1%	17.7%	17.8%	13.8%	15.4%	18.3%	**18.1%**
48.4%	19.7%	42.9%	22.3%	31.9%	25.7%	32.7%	24.4%	34.5%	34.5%	25.6%	19.1%	27.4%	**23.6%**
49.3%	26.5%	24.6%	17.5%	18.8%	23.2%	34.1%	18.0%	27.4%	37.0%	17.6%	22.4%	40.2%	**24.7%**
29.7%	20.3%	36.4%	20.8%	31.0%	22.6%	27.2%	29.7%	23.3%	20.7%	36.9%	39.3%	24.8%	**28.6%**
22.4%	13.5%	19.0%	16.9%	16.2%	21.8%	21.3%	33.0%	28.1%	26.7%	20.6%	23.2%	23.7%	**19.6%**
17.6%	19.6%	26.7%	25.2%	19.2%	22.2%	18.1%	16.7%	12.5%	8.7%	6.3%	5.9%	10.7%	**13.1%**
25.0%	21.2%	10.0%	9.5%	12.8%	9.6%	5.2%	11.3%	10.7%	6.7%	9.5%	11.9%	14.1%	**12.8%**
17.9%	12.0%	7.1%	7.7%	7.5%	10.8%	19.7%	9.9%	14.2%	10.0%	9.2%	19.3%	14.6%	**13.9%**
20.6%	12.9%	7.9%	9.8%	16.1%	18.0%	17.3%	15.1%	15.0%	13.7%	12.9%	16.2%	19.4%	**16.4%**
30.1%	22.4%	19.2%	21.7%	18.0%	18.4%	20.7%	16.5%	17.7%	14.8%	13.8%	15.3%	15.2%	**19.6%**
26.6%	13.9%	23.4%	20.9%	23.5%	23.4%	26.7%	16.9%	15.3%	14.8%	14.2%	16.9%	14.5%	**19.2%**
45.7%	19.3%	21.6%	28.1%	17.9%	25.1%	28.4%	20.3%	20.0%	23.1%	21.8%	14.2%	16.7%	**19.5%**
12.8%	16.6%	9.3%	15.0%	15.1%	17.1%	24.0%	13.6%	16.2%	14.1%	13.6%	11.3%	11.0%	**13.8%**
9.9%	12.4%	10.6%	12.6%	11.7%	12.6%	17.5%	12.6%	10.2%	16.4%	15.7%	13.7%	10.7%	**12.1%**
14.9%	18.5%	10.7%	15.3%	15.3%	19.4%	22.9%	21.4%	12.4%	23.6%	27.7%	31.2%	29.2%	**25.1%**
46.2%	21.6%	10.9%	29.8%	10.6%	11.9%	16.1%	17.4%	2.9%	13.5%	14.8%	20.8%	24.5%	**20.9%**
11.0%	17.6%	15.7%	16.8%	17.6%	18.3%	18.5%	12.3%	14.7%	11.1%	21.4%	21.3%	11.4%	**15.4%**
22.9%	10.2%	4.5%	12.3%	6.5%	7.4%	8.4%	9.0%	7.0%	5.5%	4.0%	5.5%	8.5%	**8.4%**
11.3%	19.6%	16.8%	11.9%	15.9%	16.1%	19.3%	13.6%	13.3%	12.6%	14.3%	14.6%	12.2%	**13.9%**
31.0%	17.2%	23.6%	24.6%	17.4%	27.1%	21.8%	31.0%	25.4%	25.6%	24.5%	22.6%	27.2%	**23.4%**
21.4%	14.8%	11.0%	11.9%	18.0%	14.5%	19.6%	21.4%	15.5%	14.1%	14.7%	11.9%	15.0%	**15.8%**
13.1%	17.9%	14.8%	24.8%	23.9%	21.7%	21.9%	21.6%	14.5%	15.6%	15.2%	16.6%	16.2%	**17.1%**
23.8%	21.8%	19.8%	16.8%	21.0%	17.8%	24.3%	13.8%	17.9%	18.2%	20.5%	23.1%	24.3%	**20.0%**
33.3%	33.1%	28.9%	30.1%	31.5%	35.4%	34.3%	24.9%	19.6%	22.6%	26.8%	26.1%	24.6%	**26.5%**
3.9%	11.4%	23.0%	12.7%	10.1%	24.2%	24.7%	20.0%	22.5%	29.7%	23.2%	13.1%	17.2%	**17.0%**
14.3%	9.5%	17.2%	22.5%	14.9%	20.8%	13.5%	25.8%	29.8%	38.5%	31.1%	37.5%	31.2%	**20.7%**
9.7%	10.7%	12.4%	9.7%	10.0%	12.7%	18.7%	8.6%	10.7%	9.7%	10.1%	10.8%	12.2%	**10.5%**
11.4%	14.3%	16.8%	17.1%	21.6%	25.0%	30.6%	21.8%	22.6%	18.2%	23.3%	17.7%	22.9%	**16.9%**
21.3%	19.3%	31.2%	25.1%	29.0%	34.5%	40.7%	30.9%	32.0%	28.9%	28.8%	33.7%	30.1%	**26.5%**
35.1%	21.1%	19.8%	16.1%	20.6%	27.6%	28.0%	25.1%	24.1%	27.5%	20.2%	18.7%	20.2%	**21.3%**
21.8%	**18.0%**	**19.0%**	**17.8%**	**18.8%**	**20.9%**	**22.7%**	**18.8%**	**18.4%**	**18.1%**	**18.1%**	**18.5%**	**18.8%**	18.5%
23.7%	18.4%	19.9%	18.2%	20.2%	21.2%	24.0%	19.2%	19.0%	18.4%	19.8%	19.3%	19.2%	**19.4%**
18.4%	17.4%	18.3%	17.6%	17.3%	19.9%	20.6%	18.3%	17.8%	17.7%	15.8%	17.3%	18.3%	**17.2%**

Note: Table should be read in conjunction with facing table on the previous page and footnotes apply accordingly best (worst) performing multiple type from the family the hypotheses state should under (out)-perform, respectively; the rationale being if the best-performing multiple type in one family underperforms the worst performing multiple of another, it should be an appropriate conclusion that the group of the former underperforms the family of the latter more generally. Since I conduct several tests in sequence, i.e. I first determine the most suitable multiple type within groups to subsequently compare the most suitable types among groups, a potential multiple comparison problem may arise. To alleviate this issue, I conduct Holm-Bonferroni corrections for all p-values reported in this dissertation.[816] An extension of the Bonferroni method,[817] the Holm-Bonferroni method offers a more powerful way to control the family-wise error rate in statistical testing[818]

- *Issue of choosing appropriate representatives for each group of multiple types considered:* Naturally, the generalization of individual multiple type results for their respective families implicitly assumes that the proposed individual multiple types are appropriate representatives of their families. Whilst I am confident that the multiple types I have chosen are commonly used multiple types by practitioners, results should none the less be read with this caveat in mind

Proportion of winners and pairwise error differences In a first step, it is instructive to provide some statistics of a pairwise "horse race" of multiple types, where valuation accuracy between two multiple types is compared for each sample company. This comparison can be shown as a *proportion* of one of the multiple types considered causing a lower valuation error than the other multiple type in all valuations: e.g. a ratio of 100% would signify the respective multiple type "wins" for all sample companies over the other multiple type of the pairwise comparison. A ratio substantially different of 50% would indicate that one multiple type provides higher valuation accuracy than the other. Since 13 multiple types are under investigation, a total of 156 horse races can be run,[819] half of which—or 78—contain relevant

[816] Compare Holm (1979)

[817] Compare among many Ott and Longnecker (2010, p. 462) and Mittelhammer, Judge, and Miller (2000, p. 73) on the Bonferroni method specifically and a discussion of multiple comparison issues in statistical testing

[818] Compare among many Stevens, Masud, and Suyundikov (2017) for a comparison of multiple testing adjustment methods

[819] $13 \cdot 13 = 169$; $169 - 13 = 156$, with 13 relating to obviously irrelevant comparisons of the same multiple type

information regarding valuation precision.[820] Further to proportions of "winners" among each pair of multiple types compared, a second metric is provided, which indicates relative multiple type performance: The median of *pairwise differences*, $\widetilde{\Delta}_{Pair}$, with

$$\Delta^{\mu1;\mu2}_{Pair_{j,t}} = u^{a,log,\mu1}_{j,t} - u^{a,log,\mu2}_{j,t} \tag{7.1}$$

denoting the pairwise difference between the absolute log-scale valuation errors $u^{a,log}_{j,t}$ of multiple types $\mu1$ and $\mu2$ for the jth valuation at measurement point in time t. Whilst the distributions of $\Delta^{\mu1;\mu2}_{Pair}$ for respective pairs of multiples will be shown as boxplots in some of the Figures later in this dissertation,[821] the median of $\Delta^{\mu1;\mu2}_{Pair_{j,t}}$, $\widetilde{\Delta}^{\mu1;\mu2}_{Pair}$ can be considered a core relative assessment metric; it can be interpreted as the outperformance in percentage points of multiple type $\mu2$ over multiple type $\mu1$: according to this interpretation, a large positive (negative) value for $\widetilde{\Delta}^{\mu1;\mu2}_{Pair}$ indicates that $\mu2$ outperforms (underperforms) $\mu1$, a small value indicates that performance is comparable. Thus $\widetilde{\Delta}_{Pair}$ can be understood as an *effect size* proxy of moving from one multiple type to another.

Summary of pairwise comparison results Figure 7.1 (p. 256) sets out the results of the pairwise comparison for the sample utilized in this dissertation. In Panel A, the row-column intersections determine the *proportion* of the respective multiple types listed in the column winning over the respective multiple types in the row. If this ratio is larger (smaller) than 50%, the intersection is colored in green (red) and the label indicates the respective ratio. Columns are sorted in ascending order by multiple types with lower valuation precision to multiple types with higher valuation precision and row sorting follows column sorting.[822] Panel B of Figure 7.1 denotes the median of *pairwise error differences*, $\widetilde{\Delta}_{Pair}$, as measured in percentage points. Its results are broadly consistent with Panel A in that multiple types which win many of the pairwise comparisons tend to show large pairwise median error differences. The concept behind Figure 7.1 furthermore provides the basis for the assessment of Hypotheses 2b to 2e, which will be discussed in the following Subsections.

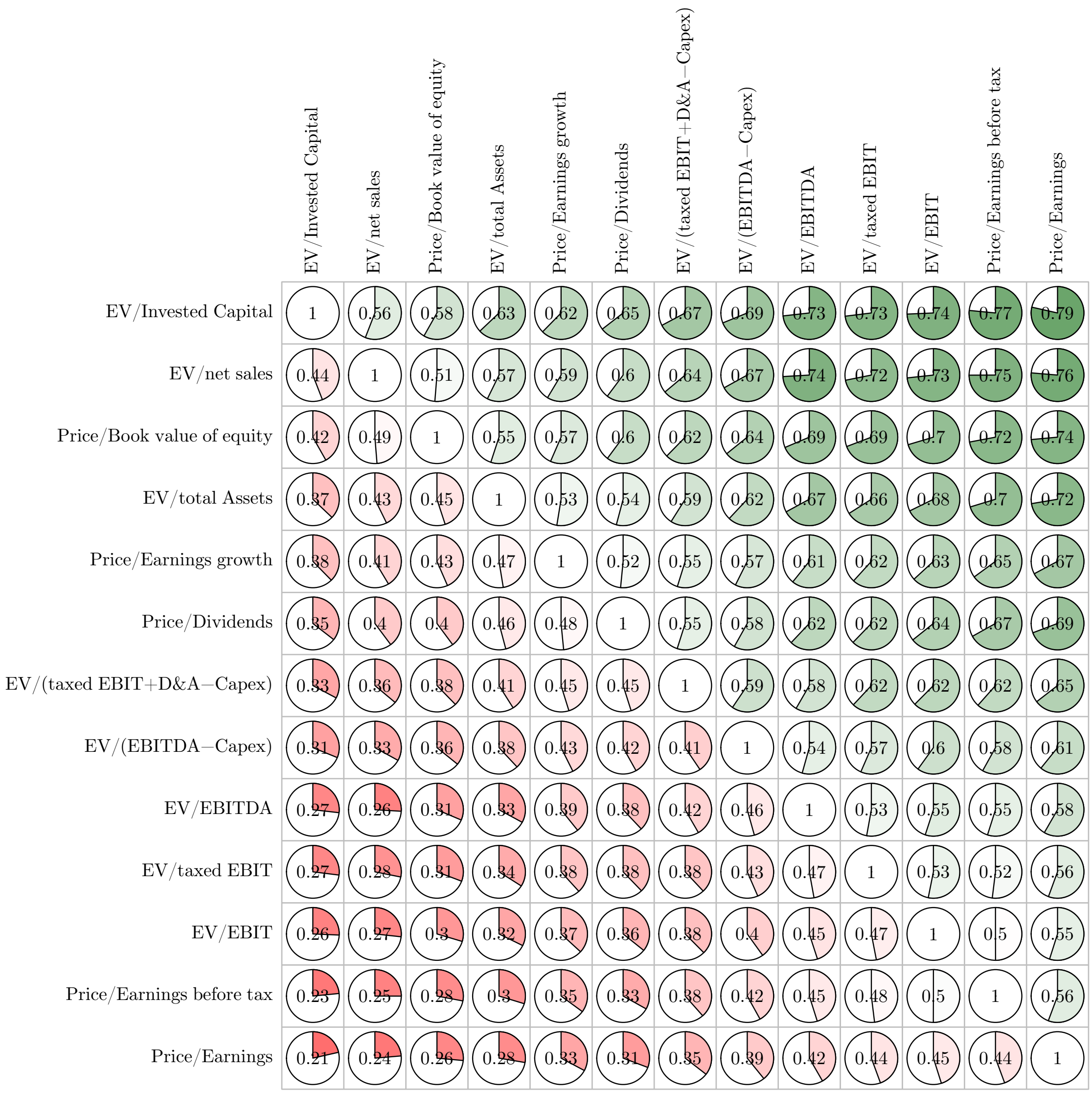
[820] Since a high (low) percentage of "wins" for one multiple type automatically suggests a low (high) percentage for the other multiple type

[821] Compare e.g. Figures 7.2 (p. 260) to 7.5 (p. 267)

[822] In order to avoid statistical challenges with multiple comparison issues, no pairwise tests are conducted by default. Multiple comparison issues relate to an increasing chance of an unlikely event occurring if several tests are conducted, resulting in higher likelihood of Type 1 errors. There are a number of concepts to counteract this effect and the Holm-Bonferroni method will be applied as required where p-values are reported, compare Subsection 7.2.3.3 (p. 254)

FIGURE 7.1: Pair-wise comparison of valuation errors by type of multiple

Panel A: Proportion of winning valuations by multiple type



Note: Figure depicts the proportion of valuations using the multiple type specified in the respective column outperforming valuations specified in the respective row, e.g.: in 76.3% of observations, price/earnings multiples produce lower valuation errors than enterprise value/sales multiples; conversely, in 23.7% of observations, enterprise value/sales multiples produce lower valuation errors than price/earnings multiples. Pair-wise comparison conducted for observations where both types of valuation multiples involved can be calculated in a meaningful manner; valuation multiple obtained through aggregation by median of pricing multiples, prior to any adjustments. Valuation drivers relate to next twelve months underlying financials. Columns sorted for illustrative purposes in ascending order by what appear to be types of multiples performing well compared to all other types using the "first principal order" criterion. Color gradient visualizes relatively strong performance of multiple type in column (dark green), balanced performance (white), relatively strong performance of multiple type in row (dark red)

Panel B: Medians of pairwise error differences ($\widetilde{\Delta}_{Pair}$; in percentage points)

	EV/Invested Capital	EV/net sales	Price/Book value of equity	EV/total Assets	Price/Earnings growth	Price/Dividends	EV/(taxed EBIT+D&A−Capex)	EV/(EBITDA−Capex)	EV/EBITDA	EV/taxed EBIT	EV/EBIT	Price/Earnings before tax	Price/Earnings
EV/Invested Capital	0	7.2	5.97	13.83	16.83	17.18	21.54	23.63	26.68	27.29	27.91	30.46	32.13
EV/net sales		0	1.37	6.35	9.3	11.6	13.29	16.26	19.95	20.63	21.79	22.9	24.14
Price/Book value of equity			0	4.56	7.53	9.93	12.67	15.14	18.13	18.5	19.51	20.09	21.74
EV/total Assets				0	2.42	4.11	8.27	10.08	12.79	13.47	14.3	15.66	17.15
Price/Earnings growth					0	1.43	3.99	5.77	8.21	9.21	9.79	10.55	11.97
Price/Dividends						0	3.94	6.34	9.12	8.95	10.01	11.61	12.7
EV/(taxed EBIT+D&A−Capex)							0	3.26	4.24	4.49	5.65	6.36	7.09
EV/(EBITDA−Capex)								0	1.83	2.8	3.02	3.47	4.93
EV/EBITDA									0	1.19	1.71	1.91	3.22
EV/taxed EBIT										0	0.8	0.79	2.03
EV/EBIT											0	−0.02	1.62
Price/Earnings before tax												0	1.42
Price/Earnings													0

Note: Figure depicts the median of pairwise error differences in percentage points between the multiple type specified in the column vs. the multiple type specified in the row, e.g. enterprise value/invested capital results in valuation errors (absolute log errors) of 26.7% percentage points higher than enterprise value/EBITDA as indicated by the median of all valuation errors measured. The data is directionally consistent with computing the differences between medians of multiple types presented in Table 7.2 (p. 245) but will differ given the median of observation differences does generally not equal the difference of observation medians. Blue shaded coloring added to visualize larger (intense blue) vs. smaller (pale blue) differences. Respective other notes of Panel A on the previous facing page apply

7.2.4 Multiple type families I: cash flow vs. accounting multiples

Hypothesis 2b (p. 65) postulated that valuation drivers trying to mimic single-period *cash flows* do not necessarily outperform more cash flow-remote *accounting-based* valuation drivers; on the contrary, the accrual nature of accounting-based drivers can be expected to play to their benefit. The investigation of Hypothesis 2b requires a—necessarily somewhat arbitrary—allocation of multiple types to either group. I will rely on a comparison of the following multiple types:

- *Cash flow-like valuation drivers:* enterprise value/(EBITDA-Capex), since the related metric (EBITDA-Capex)/EBITDA is at times referred to as "Cash Conversion" and considered a cash-flow-like improvement over enterprise value/EBITDA, enterprise value/(taxed EBIT+D&A-Capex), a more refined valuation driver approximating free cash flow computation in DCF valuations,[823] and price/dividends; Whilst the former 2 multiple types are representatives of a cash flow to the firm approach, the latter can be classified as a cash flow to shareholders concept

- *Accounting-based valuation drivers:* price/earnings and enterprise value/EBIT, with EBIT being a reasonably close proxy to operating income. It is worth to note that both multiple types may carry some elements of non-GAAP normalizations rather than being pure-form accounting figures since they are taken from equity research estimates

- *Not considered in this comparison:* All other valuation drivers, given (a) their differing characteristics as balance sheet/stock multiples (enterprise value/total assets, price/-book value of equity), (b) their hybrid nature (enterprise value/EBITDA, enterprise value/taxed EBIT) or their arguably imperfect (enterprise value/net sales) or generally differing (price/earnings growth) characteristics[824]

As discussed in Subsection 7.2.3.3 (p. 251), the next step entails identification of the best-performing multiple type each for the cash flow-like and accounting-based valuation drivers, respectively. Fortunately, it turns out that this assessment is straightforward on the basis of Panel A in Table 7.2 (p. 245), since enterprise value/(EBITDA-Capex) outperforms both enterprise value/(taxed EBIT+D&A-Capex) and price/dividends when it comes to lower mean

[823] It does, however, lack net working capital movements

[824] It is worth to note that some proponents of the enterprise value/EBITDA multiple claim it is actually a "cash earnings measure" such as e.g. the Financial Times in a recent LEX column article (BP: well to do, 2018)

and median errors and higher fractions of errors below the 10%, 25% and 40% thresholds.[825] [826] I therefore select the *best* performing multiple type, enterprise value/(EBITDA-Capex) as the representative for cash flow-like multiples. For accounting-based multiples, price/earnings outperforms enterprise value/EBIT. I hence proceed with selecting enterprise value/EBIT since my approach postulates picking the *worst*-performing multiple type of the family of types presumed to win.

Figure 7.2 (p. 260) provides a side-by-side comparison of the cash flow-focused and accounting-based multiple types and the proportions of their relative out- or underperformance if run against each other. The worst-performing accounting-based multiple type, enterprise value/EBIT, outperforms the best performing cash flow-focused multiple type, enterprise value/(EBITDA-Capex) in 59.9% of instances, which is supported by the rejection of the null hypothesis of a Wilcoxon sign-rank test according to which enterprise value/(EBITDA-Capex) would perform no different to enterprise value/EBIT in the underlying distribution (W=4.407e+07 and Holm-Bonferroni-adjusted $p \ll 0.0001$) at a level of significance of 0.001. This represents in my view useful evidence on the *value-relevance of accounting-based metrics* and suggests that accounting-based valuation drivers are better single-period proxies of the overall future economic cash generation potential than cash flow-mimicking valuation drivers. I assert that one reason for the strong performance of accounting-based valuation drivers is their more normalized nature as a consequence of general accrual principles and accounting policy allowances for such normalizations, whilst cash flow-focused drivers suffer from higher year-on-year volatility.

7.2.5 Multiple type families II: flow vs. stock multiples

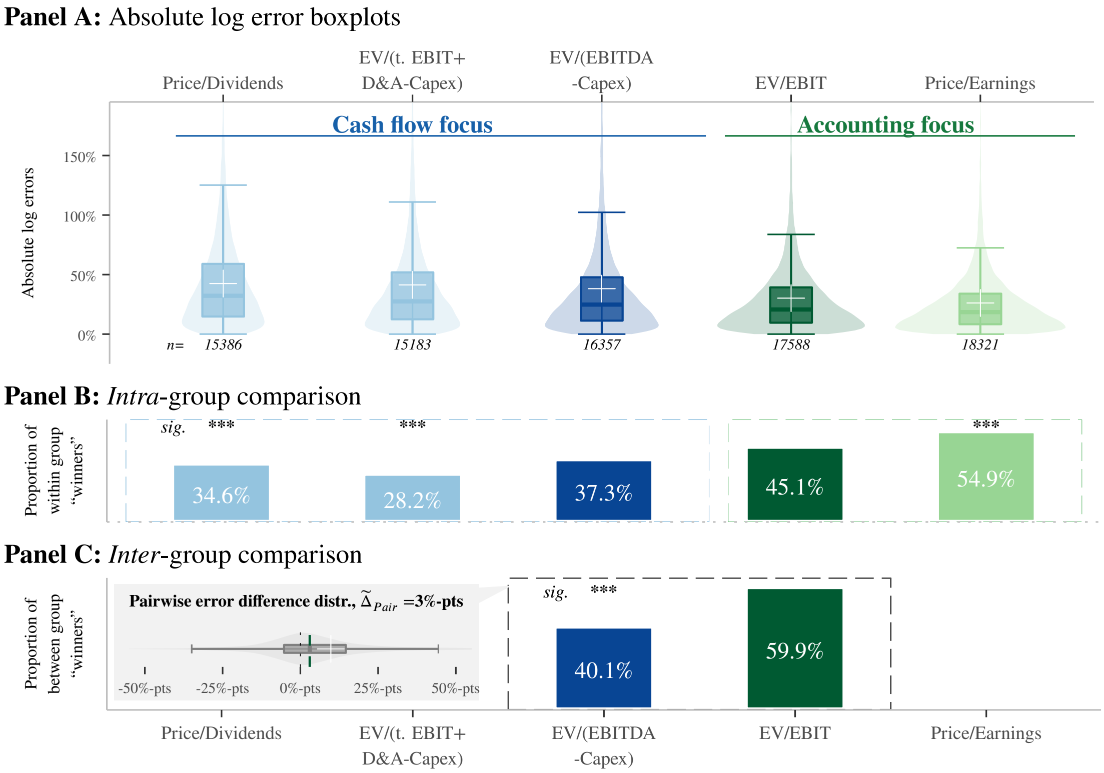
Hypothesis 2c (p. 66) postulated that, given the nature of the former as superior proxies of future economic cash generation, *flow* multiples are expected to outperform *stock* multiples.[827] Consistent with my methodological approach in this Subsection, I first define the representatives of each group and then compare the best-performing stock multiple with the worst performing flow multiple. Evidence of the worst performing flow multiple outperforming

[825] It is worth to note that price/dividends performs somewhat better at dispersion measured by standard deviation, however is substantially worse across all other metrics

[826] The fact that this assessment does not change if harmonic mean is used as aggregation principle as shown in Panel B of Table 7.2 provides further reassurance

[827] Stock multiples are sometimes referred to as balance sheet multiples since their valuation driver chiefly relies on line items of the balance sheet

FIGURE 7.2: A comparison of cash flow-based and accounting-focused multiple types



Note: Panel A provides boxplots (standard 1.5 IQR whiskers, outliers not depicted, background violin charts providing an indication on dispersion) for absolute log valuation errors (accuracy) of all unadjusted multiple types considered for the comparison, with valuation drivers measured over the next twelve months; pair-wise comparison for hypothesis assessment relates to the best (worst) multiple type for cash flow and accounting-related types, respectively. Exact numeric data available from Table 7.2 (p. 245). White crosses depict arithmetic mean of errors. Panel B provides the proportion of *intra*-group valuation outperformance for each respective group by respective multiple type in order to solidify selection of the best-performing (in the case of cash flow) and worst-performing (in the case of accounting) multiple types. Panel C subjects the pair of best and worst performing multiples in their respective groups to an *inter*-group comparison. A Wilcoxon sign-rank test rejects the null hypothesis that the underlying distribution of enterprise value/(EBITDA-Capex) valuation errors shows as favorable parameters as enterprise value/EBIT (W=4.407e+07, $p \ll 0.0001$) at a 0.001 level of significance. Holm-Bonferroni-adjusted results for p-values of pairwise Wilcoxon sign-rank tests between the indicated and the winning multiple types as the case may be are depicted by common asterisk notation (***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$). Gray inlay boxplot chart in Panel C details the distribution of pairwise error differences between enterprise value/(EBITDA-Capex) and enterprise value/EBIT , computed by subtracting the respective enterprise value/(EBITDA-Capex) from the paired enterprise value/EBIT errors. $\widetilde{\Delta}_{Pair}$ denotes the median of those error differences in percentage points. A value substantially different from 0%-pts indicates outperformance of the respective multiple type and the median value allows for the assessment of the directional effect and conditions at times applied to the Wilcoxon sign-rank test such as a symmetrical distribution of $\widetilde{\Delta}_{Pair}$. t-tests were conducted as an alternative (but are not reported); they confirm the directional shifts as indicated by $\widetilde{\Delta}_{Pair}$.

the best performing stock multiple will be interpreted as pointing towards an overall stronger performance of flow multiples and vice versa.

- *Stock or balance sheet multiples:* The selection of multiple types offered in Table 7.2 (p. 245) provides for three common balance sheet or stock multiples, enterprise value/total assets, enterprise value/invested capital[828] and price/book value of equity. All three are consequently chosen as representatives of stock multiples

- *Flow multiples:* Arguably with the exception of the somewhat special case of price/earnings growth,[829] all other 9 multiples presented in Table 7.2 are flow multiples. In the spirit of the classification of Massari et al. (2016, p. 30) between direct and indirect multiples, I eliminate enterprise value/net sales from the list of flow multiples. This allows for a concurrent analysis of the flow/stock multiple and the direct/indirect multiple question, since all multiple types among flow multiples are direct and all multiple types among stock multiples are indirect.[830] Furthermore, enterprise value/net sales suffers from a number of additional drawbacks uncommon among other flow multiple types as described in greater detail in Subsection 2.4.2.2 (p. 60), which suggests it might bias results if it would be considered. Therefore, the list of flow multiples will entail the following 8 multiple types: enterprise value/EBITDA, enterprise value/EBIT, enterprise value/(EBITDA-Capex), enterprise value/taxed EBIT, enterprise value/(taxed EBIT + D&A - Capex), price/earnings, price/earnings before tax and price/dividends

Figure 7.3 (p. 262) summarizes the results of the analysis: The best performing stock multiple type appears to be enterprise value/total assets;[831] the worst-performing flow multiple considered is price/dividends.[832] A comparison of enterprise value/total assets with price dividends leads to a "win" for price/dividends as measured by lower absolute log valuation error in 54.1% of cases, indicating a statistically highly significant rejection of the null hypothesis that enterprise value/total assets would perform similar to price/dividends in a Wilcoxon

[828]Compare Subsection 4.3.1 (p. 98) for a discussion on how invested capital is defined

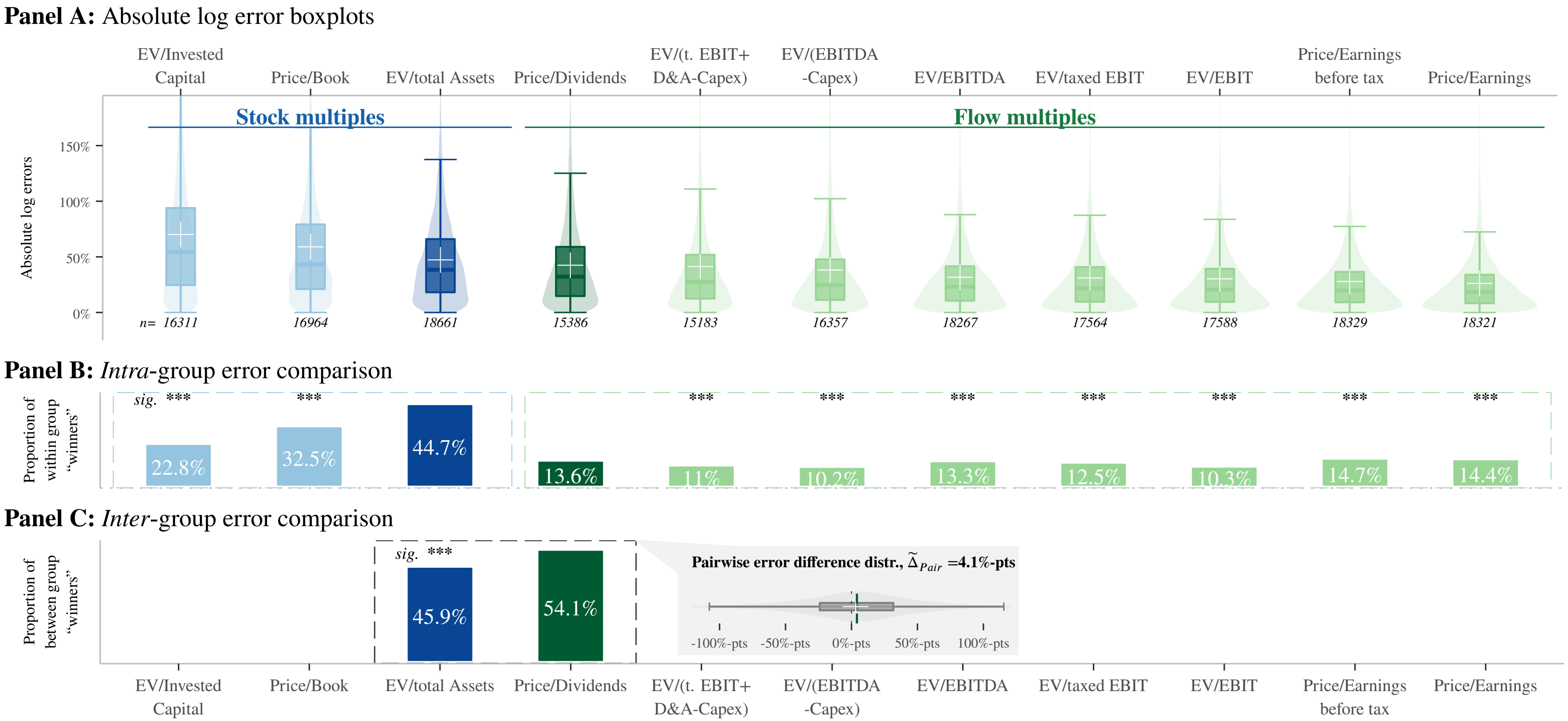
[829]One could argue that even price/earnings growth has important elements of a flow multiple since it relies on earnings; however, earnings is normalized for growth, which differentiates this multiple type from all others. I hence exclude it from this comparison, although results would not be impacted if it would remain part of it

[830]I do focus, however, on the distinction flow vs. stock multiples since it is more common in precedent literature, compare among many Hasler (2011, p. 284) and Henschke (2009, p. 17)

[831]Which wins 44.7% of intra-group error comparisons and has a significantly lower error distribution in a pairwise comparison against the other two stock multiples considered

[832]Whilst price/dividends wins a higher proportion of valuations in an 8-way comparison among all flow multiple types than other multiple types such as enterprise value/(EBITDA-Capex), it looses all 7 pairwise comparisons against other flow multiples (data highly significant) and hence is argued to be overall the weakest flow multiple type and hence the representative of flow multiples in this comparison. Figure 7.1 (p. 256) indicates that other weak intra-group performers within flow multiples appear to show a stronger performance vs. enterprise value/total assets than price/dividends

FIGURE 7.3: A comparison of stock and flow multiple types



Note: This figure mirrors the presentation in Figure 7.2 (p. 260), all remarks apply to it mutatis mutandis and should be considered in connection with this Figure. The comparison in this Figure 7.3, however, relates to enterprise value/total assets as the best-performing stock multiple type and price/dividend as the worst-performing flow multiple type. A Wilcoxon sign-rank test rejects the null hypothesis that the underlying distribution of enterprise value/total assets valuation errors shows the same distribution parameters than price/-dividend errors (W=5.324e+07, Holm-Bonferroni-adjusted $p \ll 0.0001$) at a 0.001 level of significance and the pairwise error difference distribution indicates effect directionality towards lower valuation errors of price/dividends sign-rank test.[833] Pairwise error differences have a median value of 4.1%-pts to the benefit of price/dividends: i.e. utilization of the worst flow multiple (price/dividends) compared to the best stock multiple (enterprise value/total assets) reduces valuation errors by a median value of 4.1%-pts.

The above results provide in my view strong evidence to support Hypothesis 2c in that *flow multiples are generally preferable over stock multiples*. I argue that this is a result of flow multiples being a better representative of the future economic cash generation potential of a firm than stock multiples, and that this could be driven by the nature of the former of being a more direct way to interpret future cash flows, in particular in the context of normal "going concern" valuation settings, where ongoing future operations rather than monetization of book values are to be expected. This argument is somewhat consistent with the results of the multifactor model of Meitner (2006, p. 135), which differentiates between recursion value and reorganization value under the assumption of most companies falling into the reorganization value category.[834]

7.2.6 Multiple type families III: capital structure discrepancies

Hypothesis 2d (p. 66) argues that multiples normalizing for or considering *different capital structures* should outperform multiples, which do not account for such differences. This Hypothesis can be studied from 2 perspectives: first, the choice of multiple types, which automatically correct for leverage aspects and, second, whether adjustments to multiples which do not reflect differing levels of financial leverage are appropriate. Since this Subsection focuses on multiple types, I will approach the Hypothesis using the former perspective.[835]

As with the general approach followed on horse races of different groups of multiples, it is in a first instance necessary to define which multiples fall under which group. This distinction will primarily rely on equity value vs. enterprise value multiples, following the discussion in Subsection 2.3.2.6 (p. 49):

- *Equity value multiples* include all multiples, which have price or equity value as their valuation reference

[833] Level of significance of 0.001; W=5.324e+07, Holm-Bonferroni-adjusted $p \ll 0.0001$

[834] It is worth noting that the analysis presented in this Subsection does preclude any potential benefits of a combined multiple approach, which takes into consideration both flow and stock multiples, referring to the Ohlson (1990, 1995) models; compare Subsection 4.5 (p. 120) for a more detailed discussion

[835] Leverage/tax shield adjustments are considered in Subsection 7.4.2.4 (p. 284)

- *Enterprise value multiples*, conversely, include all multiple types, which rely on enterprise value for price reference
- *Excluded multiple types* are ones which have arguably imperfect (enterprise value/net sales) or generally differing (price/earnings growth) characteristics[836]

Figure 7.4 (p. 265) summarizes the results of the comparison. As is obvious from the boxplots in Panel A and contrary to the investigations for Hypotheses 2c and 2b, the strict requirement of a consistent outperformance of *all* (i.e. even the worst) multiple types of one group over the best multiple type of the other group cannot be upheld: Even the best multiple type of the theoretically superior group, enterprise value/EBIT, underperforms the best multiple type of the theoretically inferior group, price/earnings.[837] Equally, however, some multiple types of the anticipated weaker group appear to underperform some enterprise value multiple types; therefore, there appears to be no support for an argument according to which equity value multiples *in general* outperform enterprise value multiples either.[838] To summarize, on the basis of an "obvious" enterprise value/equity value multiple type comparison, I can find no support for Hypothesis 2d, according to which multiple types considering financial leverage are superior. The strong performance of price/earnings is consistent with the findings of J. Liu et al. (2002, p. 152) but in contrast to other previous studies, which find outperformance of enterprise value multiple types such as Lie and Lie (2002, p. 48). Consequently, the subject matter remains inconclusive. One argument for the strong performance of price/earnings multiples specifically could be that this multiple type might be of such tremendous importance to investors that public market valuations reflect it and I will elaborate on this argument further in the context of discussing a potential feedback loop.[839]

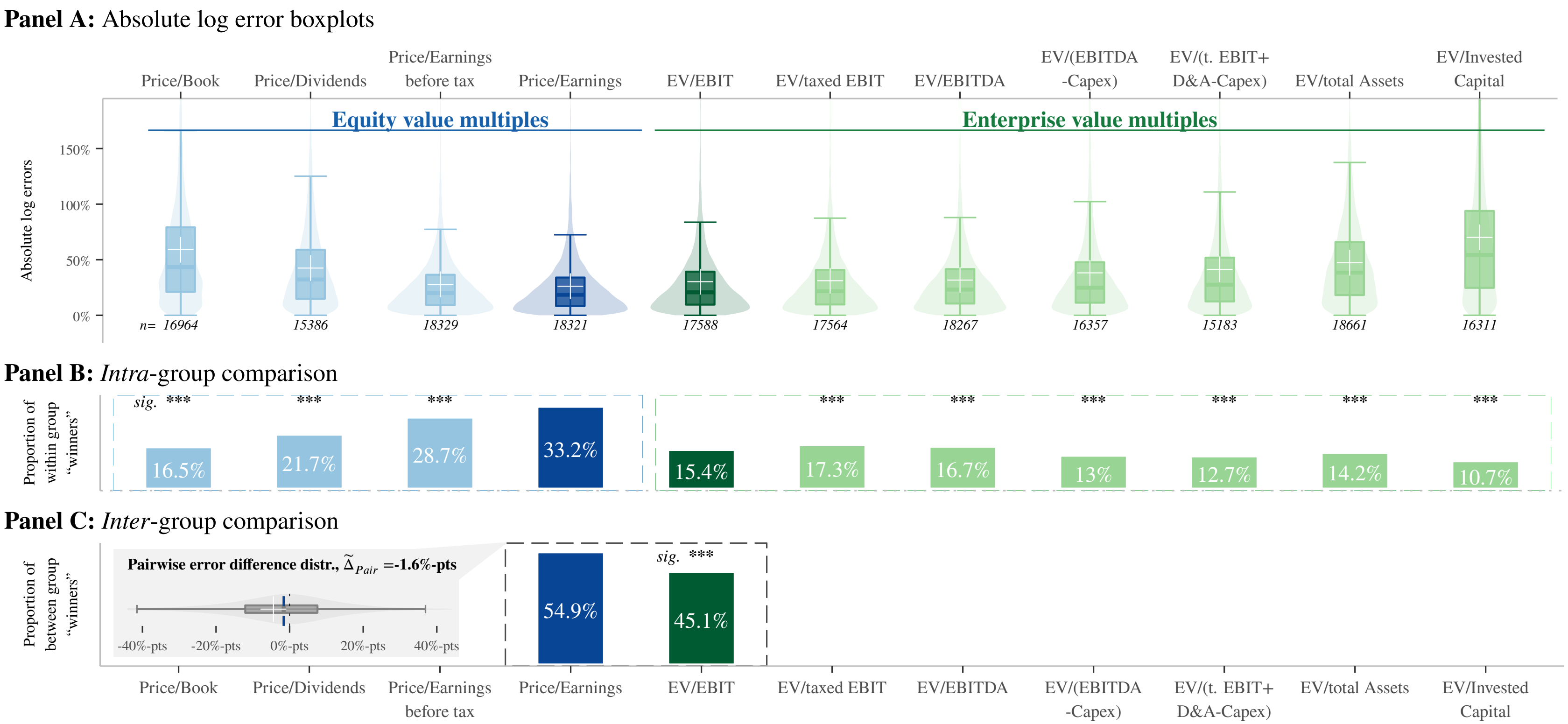
[836]They will be studied separately in Subsection 7.2.7 (p. 266)

[837]The null hypothesis of a Wilcoxon sign rank test that enterprise value/EBIT error distribution is equal to price/earnings error distribution is rejected at a significance level of 0.001, W=6.489e+07 and Holm-Bonferroni-adjusted $p \ll 0.0001$ and the pairwise differences obtained confirm directional consistency with the hypothesis, albeit indicating a much smaller distribution shift than for other comparisons in this Subsection

[838]This this was not my hypothesis, I report this argument for illustrative purposes only and without formal testing. It is worth noting that, whilst no evidence is found that enterprise value/EBIT would outperform price/earnings from a flow multiple perspective, descriptive data suggests that, among stock multiples, the most precise enterprise value multiple (enterprise value/total assets) might outperform the best (and only) equity value stock multiple, price/book value of equity as indicated by Figure 7.1 (p. 256). Therefore, illustratively, one could argue that when it comes to flow multiples, the best equity value multiple (price/earnings) could be the best choice, when it comes to stock multiples, enterprise value/total assets should be the preferred multiple type Since this was not part of my hypothesis I do not conduct any formal tests and discuss those results on an indicative basis only for the benefit of researchers looking for analytical opportunities

[839]Compare Subsection 7.10, p. 324

FIGURE 7.4: A comparison of equity value and enterprise value multiple types



Note: This figure mirrors the presentation in Figure 7.2 (p. 260) and all remarks apply to it mutatis mutandis and should be considered in connection with this Figure. Since the empirical picture between the performance of enterprise value vs. equity value multiples is less clear (notably the worst enterprise value multiple selected does not outperform the best equity value multiple selected and equally the worst equity value multiple does not outperform the best enterprise value multiple, which is immediately obvious from the boxplots presented in Panel A), a comparison between the best multiple types of each group is run: enterprise value/EBIT and price/earnings. Descriptive parameters suggest that price/earnings might outperform enterprise value EBIT. A Wilcoxon sign-rank test rejects a consistent null hypothesis that the underlying distribution of enterprise value/EBIT valuation errors shows the same distribution than price/earnings errors (W=6.489e+07, Holm-Bonferroni-adjusted $p \ll 0.0001$) at a 0.001 level of significance and an analysis of the pairwise error distribution differences indicates that P/E appears to perform more favorably than EV/EBIT, albeit the effect being smaller than for some of the other comparisons in this Subsection

7.2.7 Signal-to-noise aspects of specific multiple types

Hypothesis 2e suggests that multiple types, which consider value-relevant information should perform better than multiples which do not (valuation quality benefit of *incorporating value-relevant signals*). Equally, multiple types, which consider information in a non value-relevant manner should underperform multiple types, which do not (valuation quality benefit of *ignoring value-irrelevant* or *-inconsistent noise*). It is a challenge to study this Hypothesis with the existing framework of group comparisons since the distinction between noise and a value-relevant signal goes to the heart of choosing the most appropriate valuation driver. I therefore slightly modify the methodology by providing evidence for one arguably typical pairwise comparison each:

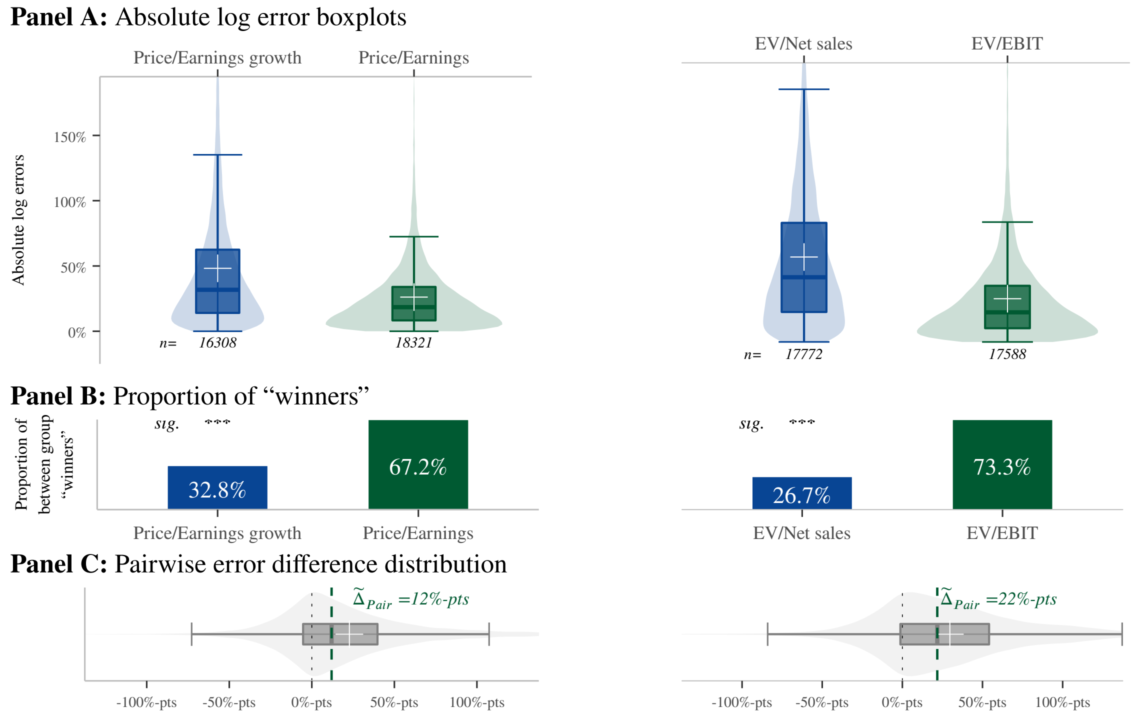
- *Benefits of incorporating value-relevant signals:* For this comparison, I choose a pairwise analysis of enterprise value/net sales vs. enterprise value/EBIT. I argue that evidence pointing to stronger performance of enterprise value/EBIT would indicate that a key value-relevant aspect, the cost line items between net sales and EBIT, indeed has positive impact on multiple valuation accuracy[840]
- *Benefits of disregarding signals with potentially misleading valuation impact:* In Subsection 4.6 (p. 122) it was argued that price/earnings growth multiples are a practitioner-advocated concept with potential for misleading outcomes since it treats value-creative and value-destructive growth in a similar manner; the latter is inconsistent with theory since value-destructive growth should have negative impact on valuation and consequently multiples. I therefore compare the price/earnings growth multiple as a proponent of a multiple introducing unwarranted noise to the comparably "clean" price/earnings multiple

Even though this approach chooses typical and I believe highly important examples for value-relevant signals and value-irrelevant noise, the ability to generalize results will be limited; however, it none the less provides instructive first evidence on the subject matter in general and more specifically additional empirical results on the expected relative underperformance of enterprise value/net sales and price/earnings growth, respectively.

Figure 7.5 (p. 267) summarizes the results of the two pairwise comparisons. As expected, the null hypotheses that price/earnings growth and enterprise value/net sales would perform

[840] The drawbacks of enterprise value/net sales as a multiple have been discussed more extensively in Subsection 2.4.2.2 (p. 60)

Figure 7.5: A comparison of sales and PEG multiples to respective alternative approaches



Note: This figure mirrors the presentation in Figure 7.2 (p. 260), all remarks apply to it mutatis mutandis and should be considered in connection with this Figure. The comparison in this Figure 7.2, however, relates to two multiple types each, which is why no intra-group comparisons are necessary to determine within-group winners. A Wilcoxon sign-rank test rejects the null hypothesis that the underlying distribution of price/earnings growth valuation errors shows the same parameters than price/earnings errors (W=3.297e+07, Holm-Bonferroni-adjusted $p \ll 0.0001$) at a 0.001 level of significance (comparison on the left hand side). A Wilcoxon sign-rank test furthermore rejects the null hypothesis that the underlying distribution of enterprise value/net sales valuation errors shows the same parameters than enterprise value/EBIT errors (W=2.627e+07, Holm-Bonferroni-adjusted $p \ll 0.0001$) at a 0.001 level of significance (comparison on the right hand side) and pairwise error differences are directionally consistent with the Hypothesis as formulated

in line with their more theoretically appropriate counterparts are rejected each on the basis of a Wilcoxon sign rank test at 0.001 levels of significance.[841] The assessment of pairwise error difference distribution reveals the most material distribution shifts in excess of 20%-pts obtained in this Subsection. I interpret those results as a general support for the Hypothesis that it is beneficial *to consider theoretical value signals* and *disregard noise* as well as more specifically for the empirical confirmation of the theoretically advocated underperformance of price/earnings growth and enterprise value/net sales multiples.

[841] W=2.627e+07 and Holm-Bonferroni-adjusted $p \ll 0.0001$ for the comparison of enterprise value/net sales vs. enterprise value/EBIT and W=3.297e+07 and Holm-Bonferroni-adjusted $p \ll 0.0001$ for the comparison of price/earnings growth vs. price/earnings

7.3 Information relevance of negative multiples as stipulated by Hypothesis 6b

In Subsection 6.3.3.2 (p. 210) it was argued that negative pricing multiples[842] could potentially carry value-relevant information for the valuation multiple under investigation. Hence, as specified in Hypothesis 6b (p. 211), it might be preferable to consider the affected peer companies as comparables. However, whilst mean-based valuation concepts suffer some shortcomings for doing so as also detailed in a numerical example in Table A.4 (p. A23) *median aggregation* offers the opportunity to avoid those drawbacks.

In order to investigate this further, a pairwise comparison of valuation multiple errors based on valuation multiples considering vs. valuation multiples not considering negative pricing multiples—each using the relatively unbiased approach of median aggregation—is conducted. Figure 7.6 (p. 269) depicts the results of the analysis. The following methodological aspects apply:

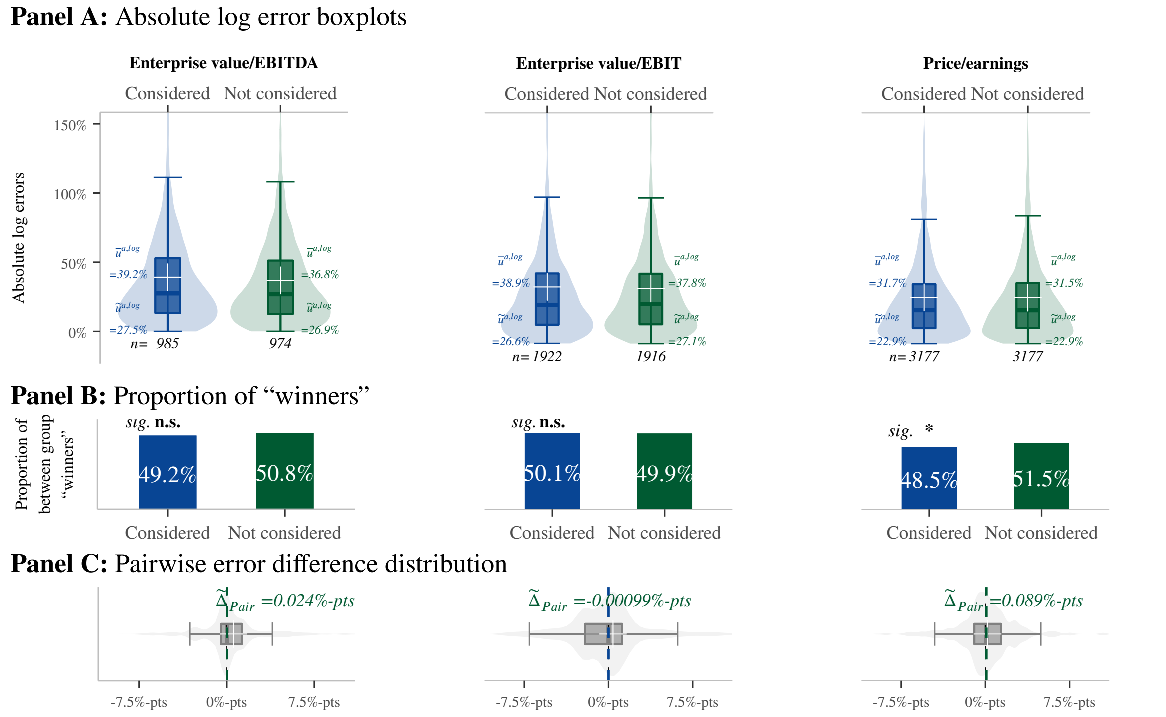
- To determine effects more appropriately, only valuation multiple observations comprising *at least one negative peer pricing multiple* are included in the comparison. Effects were also studied for the full sample, are available from the author upon request and are directionally consistent, however, as expected, show even smaller pairwise differences on average[843]
- From a presentational style, focus is laid on three multiple types, which are perceived to be most popular among practitioners: price/earnings, enterprise value/EBIT and enterprise value/EBITDA[844]
- The approach to investigate Hypothesis 6b broadly follows in methodology and results presentation the analysis conducted in the preceding Subsection in that it relies on a visual inspection of side-by-side distribution parameters, followed by a pairwise "horse-race" to determine the proportion of winning multiples defined as the valuation multiple with the lower absolute log pricing error. This is concluded by Wilcoxon sign-rank tests to determine statistical significance and a review of the pairwise error difference distribution to determine direction of the effect and its size

[842]Usually caused by negative valuation drivers

[843]The Wilcoxon sign-rank test statistics equal each other since its test statistic discards pairs with no differences such as is the case with peer groups which do not contain any negative multiple

[844]The multiple types chosen have also been shown to achieve strong empirical results relative to others in Subsection 7.2 (p. 242)

FIGURE 7.6: A comparison of multiple valuation accuracy if negative multiples are considered



Note: Only considers (positive) valuation multiples, which rely on at least one negative pricing multiple. Aggregation into the valuation multiple via median pricing multiples, considering (not considering) negative pricing multiples in the left/blue (right/green) respective parts of the charts. Consideration of negative multiples under median aggregation takes place via additional low ranks, resulting in lower valuation multiples than if negative multiples are not considered. Two of the three Wilcoxon sign-rank tests (enterprise value/EBITDA, enterprise value/EBIT) fail to reject the null hypothesis, according to which there would be no distribution shift between inclusion and exclusion of negative pricing multiples t a 0.05 level of significance (W=2.127e+05 at a Holm-Bonferroni-adjusted p=0.151,W=9.859e+05 at a Holm-Bonferroni-adjusted p=0.1505), whilst there is weak significance that inclusion of negative multiples might be beneficial for price/earnings (W=2.353e+06 at a Holm-Bonferroni-adjusted p=0.03532). Effect sizes are small throughout, especially considering that only a subsample of firms with peers featuring negative multiples are considered. This figure mirrors the presentation in Figure 7.2 (p. 260), all remarks apply to it mutatis mutandis and should be considered in connection with this Figure

- As throughout most of the empirical section of this dissertation, aggregation relies on utilizing the median of pricing multiples to determine the valuation multiple. Therefore, the *values* of negative multiples are not considered but their *ranks* are. Valuations,[845] which comprise negative multiples should be lower than comparable valuations, which do not comprise negative multiples. Median is chosen as an aggregation method as it can be shown to avoid biases introduced by mean-based aggregation concepts[846]

[845]But of course not necessarily valuation *errors*
[846]Compare Table A.4, p. A23

Figure 7.6 reveals that inclusion of negative pricing multiples in valuation multiple aggregation via median produces mixed outcomes. Proportions of wining multiples are close to 50% each for the different multiple types studied and the median of pairwise error differences does not exceed 0.01%-pts in any of the comparisons. For price/earnings, inclusion is weakly significant, whilst differences between including and disregarding negative peer pricing multiples is not significant for other multiple types. Therefore, whilst some support for Hypothesis 6b has been identified for price/earnings multiples, *benefits of including negative multiples are small*.[847] [848]

The above discussion is relevant in the context of existing empirical literature. Whilst Sommer et al. (2014, p. 23) argue that inclusion of negative multiples is detrimental to valuation accuracy, I find that there is little impact, suggesting it can be left to the valuation practitioner to decide his or her preferred approach, for as long as the *median concept* is chosen as aggregation principle over alternative approaches such as harmonic or geometric means as studied by Sommer et al. (2014).

For the remainder of this dissertation, I follow the arguably more practitioner-accepted approach of *excluding* negative pricing multiples from valuation multiple computation, since this might also be a more appropriate baseline compared to precedent empirical studies, which have eliminated negative multiples on the basis of a self-imposed non-negativity restriction.[849]

7.4 Adjusting multiples to improve accuracy (Hypotheses 4a and 4b)

7.4.1 Background and methodology

Chapter 5 (p. 129) discussed in greater detail potential *adjustments* to multiples for consistency, comparability and from a conceptual perspective in order to reflect a number of *economic aspects* and avoid potential valuation biases with an objective to maximize multiple valuation

[847] It appears furthermore challenging to conclusively argue for the differing results for price/earnings vs. the other multiple types

[848] The proportion of negative pricing multiples as a percentage of total peers in price/earnings valuation multiple aggregation ranges from 1.9% to 25%, with a median of 3.7%. Since this proportion is therefore relatively low and there is some risk of a positive effect of negative multiple inclusion being lost in overall noise, it is instructive to calculate the correlation coefficient for the proportion of negative multiples and the pairwise error difference distribution to assess whether a large proportion of negative multiples would be in some kind of statistical relationship. For the price/earnings multiple, the Pearson correlation coefficient however amounts to just 4.5%, which I interpret as a confirmation that the impact of including negative multiples overall is small, as even larger numbers of negative multiples in a peer group display little correlation with pairwise error differences between inclusion and non-inclusion

[849] Compare e.g. Meitner (2003, p. 108)

accuracy. On page 133, Hypothesis 4a was formulated, which proposes that the valuation quality provided by adjusted multiples should outperform their unadjusted counterparts. Similarly, a more restrictive Hypothesis 4b was proposed, according to which each additional adjustment can be expected to provide incremental valuation precision. This Subsection provides some empirical results to investigate Hypotheses 4a and 4b.

From a methodological perspective, previous studies, notably Chullen et al. (2015) and Berndt, Deglmann, and Vollmar (2014) are utilized as a basis to expand upon, which ensures comparability: Respective valuation errors are computed for unadjusted and adjusted multiples, each. Subsequently, a comparison of dispersion metrics of the respective valuation error distributions takes place. In order to enable presentation of condensed results, certain approaches to multiple valuation as presented in Table 7.1 (p. 240) as "baseline" are accepted as a given.[850] The empirical assessment proceeds in a manner quite similar to the comparison of multiple types presented in Subsection 7.2 (p. 242). However, this comparison focuses on adjusted vs. unadjusted multiples for selected valuation drivers:

- Computation of *adjusted* and *unadjusted* pricing multiples for the multiple types as shown and all firm-half year observations of the sample, using next twelve month recalendarized forecasts as valuation driver measurement horizon for flow multiples. Adjusted multiples follow adjustments proposed as *"reasonable approximations"* proposed in Table 5.3 (pp. 180–182) and discussed at length in Chapter 5. Reluctantly, I do not apply the "gold standard" levels of adjustments proposed in Table 5.3 since the necessary data to do so is not readily available for download and processing from the financial and market databases I have access to and hand-collection would be excessively burdensome given sample size[851]
- The following further considerations apply relative to the "reasonable approximation" suggestions in Table 5.3: First, suitably clean data points for *tax loss carryforwards* are unavailable from the financial databases utilized. Hence, no adjustment is undertaken for this line item. Second, for group structure adjustments, it was suggested that both book value or simple market value approximations on the basis of parent company price/book value could be undertaken. Some exploratory analysis suggests that reliance on *book values* provides more meaningful results, hence this approach is followed.

[850] This includes reliance on next twelve month valuation drivers, utilization of median as peer aggregation concept and a focus on valuation drivers, which have been shown in previous studies to perform well

[851] The study therefore mirrors an "efficient" practitioner approach, which might well rely on financial data bases, as well, rather than a hand-collected approach considering individual financial statements

Third, whilst a reasonable approximation would in theory be possible, in a first step, no adjustments are undertaken for the "Conceptual" aspects suggested in Table 5.3 given their potentially more esoteric nature; instead, a separate study follows in Subsection 7.4.2.4 (p. 284). Forth, whilst the application of all adjustment types is similar in that, wherever data points are available suggesting that a pricing or valuation multiple requires an adjustment, it is undertaken whilst for firms, which—based on financial databases—appear to not require such adjustment, the respective adjustment is set to zero, the adjustment for M&A firms is different since it comprises elimination of firms affected from the pricing and valuation multiple universe.[852] Since elimination means no pairwise comparison between adjusted an unadjusted multiples can take place[853] the pairwise error comparison and the respective Wilcoxon sign-rank tests will be biased.[854] Some aggregated descriptive statistics regarding adjustments are available from Table 3.2 (p. 80)

- Aggregation of pricing multiples, much like in the analysis of valuation drivers[855] through *median* of peers defined by 3-digit ICB industry classification
- Computation of valuation errors for each, adjusted and unadjusted multiples, as in the case of valuation driver accuracy, predominately relying on accuracy expressed by *absolute log errors*[856]
- Comparison of valuation errors between adjusted and unadjusted multiples, in a *pairwise* and *aggregated* manner. This includes a side-by-side review of valuation error distribution statistics (e.g. mean, median, percentiles) in addition to Wilcoxon non-parametric tests[857]

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[852] M&A firms are defined as those companies which have acquired or disposed of a cumulated transaction enterprise value in excess of 25% of their market capitalization over the 12 months preceding the respective valuation date

[853] The adjusted multiple has no partner, i.e. the same firm-half year observation on an unadjusted basis, since the adjustment is achieved through elimination rather than a proper pro-forma modification to the multiple suggested by the "gold standard"

[854] Whilst I do not report the paired unadjusted error metrics, I have reviewed them and believe the impact of this bias is of conservative nature; i.e. M&A adjustments are—on average—positive for valuation accuracy and hence their omission from a pairwise comparison suggests that the differences between adjusted and unadjusted multiples would be even larger were those adjustments considered. This is also suggested by considering the individual impact of the M&A adjustment in Table 7.7 (p. 276), which, with the exception of EV/Net sales is positive

[855] Compare above, Subsection 7.2, p. 242

[856] Compare Subsection 6.4.1.1 (p. 222) and, more specifically, Table 6.2 (p. 223) for a discussion of valuation error measurement in th context of multiple valuation

[857] Compare Subsection 6.4.1.4, p. 227

- Consideration of all proposed adjustments *at the same time* vs. no adjustments to investigate Hypothesis 4a but also *individual adjustments* "one-by-one" vs. unadjusted multiples for further clarity regarding Hypothesis 4b. Finally, consideration of adjustment combinations with an ambition to determine patterns of adjustment combinations with particularly low valuation errors, acknowledging post-hoc limitations

- Separate consideration of enterprise value multiples and equity value multiples: Adjustment aspects and principles for those different groups of multiple types differ and I argue that adjustments are *predominately a domain of enterprise value multiples*. Focus is hence laid primarily on enterprise value multiples in Subsection 7.4.2 (p. 273) , whilst a brief discussion of adjustments to equity value multiples follows in Subsection 7.4.3 (p. 285)[858]

7.4.2 Meaningful improvement by adjusting enterprise value multiples

Tables 7.6 (p. 274), 7.7 (p. 276), 7.8 (p. 278) and 7.9 (p. 282) present the empirical results of the study on accuracy of adjusted multiples.

7.4.2.1 Concurrent application of all adjustments

First, in Table 7.6, I document a *significantly*[859] *superior* performance of fully adjusted multiples relative to their unadjusted counterparts for *all 6 enterprise value multiple types* studied. Median pairwise error differences ($\widetilde{\Delta}^{Adj;Unadj}_{Pair}$) show improvements of between 0.1%-pts and 0.9%-pts.[860] The differences of medians pre- vs. post adjustment[861] amount to 1.3%-pts in the case of enterprise value/EBIT, for example, consistent with a meaningful improvement of enterprise value/EBIT, bridging the error discrepancy approximately half way to the overall best-performing multiple type identified, price/earnings. The differences of medians are positive for the 5 out 6 enterprise value multiples and negative only for the weak-performing enterprise value/net sales multiple.[862]

[858]Equally, I focus on flow as opposed to stock multiples since evidence has been shown suggesting flow multiples are substantially more accurate in Subsection 7.2.5 (p. 259)

[859]According to Wilcoxon sign-rank tests as reported in the Table

[860]I argue this metric is conservative since it only covers 8 out of the 9 proposed adjustments, whilst the M&A adjustment is not considered, compare the notes to Table 7.6 for a more comprehensive explanation

[861]Which, while an overall inferior metric to the pairwise error differences, also capture the M&A adjustment

[862]I ascribe the directionally opposing between differences of medians and median of differences to the fact that the median of differences relies on a matched sample and to a skewed distribution in the case of enterprise value/net sales

Table 7.6: A comparison of unadjusted and fully adjusted enterprise value flow multiples

	Unadjusted, median errror	Adjusted, median error	Median pairwise error difference ($\widetilde{\Delta}_{Pair}$)	Proporiton of adjusted multiples outperforming unadjusted multiples	Wilcoxon sign-rank statistic	p-value[a]	sig.[b]
EV/Net sales	45.2%	46.0%	-0.064%-pts	50.2%	5.57e+07	0.001105	**
EV/EBITDA	23.1%	22.7%	-0.292%-pts	51.3%	5.68e+07	$\ll$ 0.0001	***
EV/EBIT	20.7%	19.4%	-0.700%-pts	53.0%	4.99e+07	$\ll$ 0.0001	***
EV/(EBITDA-Capex)	24.8%	23.3%	-0.888%-pts	53.9%	4.15e+07	$\ll$ 0.0001	***
EV/taxed EBIT	21.7%	20.8%	-0.545%-pts	52.4%	5.10e+07	$\ll$ 0.0001	***
EV/(taxed EBIT+D&A-Capex)	27.5%	26.7%	-0.787%-pts	52.9%	3.66e+07	$\ll$ 0.0001	***

Note: Table presents a side-by-side comparison of unadjusted and fully adjusted multiples for different enterprise value flow multiples. Unadjusted median errors are consistent with the results reported in Table 7.2 (p. 245). Median errors for adjusted multiples refer to all of the proposed adjustments. Since the M&A adjustment specifically relies on elimination of firms, which have conducted M&A, the unadjusted and adjusted median metrics are not based on paired samples. However, the statistic for pairwise error differences (per definition) is and hence implicitly considers the M&A adjustment for unadjusted firms (since firms affected have no comparison partner, given it was eliminated). This explains directional differences for EV/Net sales between the median of errors (unadjusted multiples with better performance) and the median pairwise error (adjusted multiples with better performance). Coloring indicates light (pale color) and more material (intense color) improvements (green) or negative impacts (red), with the threshold illustratively set at 0.2%-pts.

[a] Holm-Bonferroni-adjusted p-value of the Wilcoxon sign-rank test [b] Common asterisk notation for significance (***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$)

My results are consistent with prior empirical findings on a smaller variety of multiple types studied by Berndt, Deglmann, and Vollmar (2014) and a more local sample considered by Chullen et al. (2015) and provide *convincing support for Hypothesis 4a*. They document that adjustments to enterprise value multiples—on average—increase valuation accuracy, which is in line with intuition in that consideration of value-relevant aspects is beneficial to multiple valuation accuracy as a higher sophistication of the Law of One Price is reached. The observed *effect sizes* are in my judgment sizable enough to warrant those adjustments. Given adjustments based on the "reasonable approximation" approach lead to overall consistent valuation quality improvements, I assert that utilizing the proposed "gold standard" adjustments[863] could result in further valuation accuracy benefits, since they enable consideration of an even more precise economic reality in enterprise value trading multiple valuation.

7.4.2.2 Selective application of individual adjustments

Table 7.7 sets out individual adjustments for the 6 enterprise value multiple types considered in response to Hypothesis 4b, according to which each individual adjustment should yield an improvement in valuation accuracy compared to not undertaking the adjustment. No systematic support is found for this Hypothesis, however, since many adjustments appear to lead to higher valuation errors compared to their omission. Whilst there is some consistency between the different multiple types and their reaction to multiple adjustments, the adjustment for ESOPs results in higher valuation errors compared to the unadjusted multiple for all types.[864] Table 7.7 furthermore suggests individual adjustments are not additive towards the median valuation error metrics observed for fully adjusted multiples; instead there appear to be interaction effects.[865] Therefore, further investigation will be needed to analyze joint effects.

7.4.2.3 Joint application of several adjustments

The previous Subsection revealed that the individual application of adjustments are not "additive"; this suggests that a gradual assessment from "no adjustments" to "all adjustments" in 9 steps may suffer from biases resulting from the arbitrarily defined sequence of those 9

[863] Compare Table 5.3 (pp. 180–182)

[864] Those findings are highly significant according to Wilcoxon sign-rank tests for all multiple types: e.g. for enterprise value/EBIT with W=8.521e+07 and Holm-Bonferroni-adjusted p=$\ll$ 0.0001 at a 0.001 level of significance

[865] A rather parsimonious analysis of adding all individual effects as expressed by the respective differences of median errors to the unadjusted enterprise value/EBIT multiple suggests an "adjusted" multiple estimated error of 20.3% (vs. the actually observed full adjusted enterprise value/EBIT multiple of 19.4%)

TABLE 7.7: Median absolute log valuation errors for individual adjustments to multiples

	Unadjusted	Operating leases	Cash and cash equivalents	Equity investments[a]	Retirement benefit obligations[b]	Other long-term investments	Elimination of M&A firms	Preferred shares	Minority interest[a]	ESOPs	Fully adjusted
EV/Net sales	45.2%	46.2%	44.3%	45.2%	45.3%	44.8%	45.6%	45.2%	44.9%	46.0%	46.0%
EV/EBITDA	23.1%	22.5%	23.0%	23.2%	22.9%	23.3%	22.9%	23.2%	23.0%	23.5%	22.7%
EV/EBIT	20.7%	20.3%	20.4%	20.6%	20.6%	20.7%	20.7%	20.7%	20.7%	20.9%	19.4%
EV/(EBITDA-Capex)	24.8%	25.1%	23.9%	24.2%	24.8%	24.5%	24.8%	24.8%	25.0%	25.1%	23.3%
EV/taxed EBIT	21.7%	21.5%	21.6%	21.7%	21.6%	21.6%	21.6%	21.7%	21.6%	21.9%	20.8%
EV/(taxed EBIT+D&A-Capex)	27.5%	27.8%	26.5%	27.1%	27.4%	27.4%	27.4%	27.5%	27.4%	27.8%	26.7%

Note: Table depicts the resulting median of absolute log valuation errors for *individual* adjustments, i.e. one adjustment at a time, relative to unadjusted multiples. Fully adjusted column for comparison purposes only. With the exception of the M&A adjustment (which relies on eliminations of sample companies which were involved in M&A), no eliminations to the sample take place if any adjustment is not required given not featured by the respective company under investigation or its peers. Coloring indicates light (pale color) and more material (intense color) improvements (green) or negative impacts (red), with the threshold illustratively set at 0.2%-pts. Adjustment columns sorted by individual error reduction impact on enterprise value/EBIT [a] At book value. Tests were also conducted for market values, however results more meaningful if relied on book values, which I ascribe to a poor performance of the parent price/book proxy suggested in Subsection 5.3.3.1 (p. 144). [b] Considers net retirement benefit obligations, post tax, given contributions by the firm to retirement plans are usually tax-deductible adjustment steps. Therefore I analyze the joint application of several (but not all) adjustments by computing valuation errors for all $2^9 = 512$ possible "adjustment switch positions," i.e. the switch for each adjustment set to "on" or "off." This approach follows Chullen et al. (2015, p. 652) in that it maps possible permutations of adjustments. The analysis is then conducted in two ways: First, I investigate resulting highest and lowest valuation errors for particular combinations of adjustment switches, which provides illustrative results. Second, I run a more formal mixed model regression, where the switches act as dummy variables.

Having run all 512 adjustment switch scenarios, it is subsequently possible to sort each of the 512 valuation error distributions by the medians of absolute log valuation errors and to study adjustment patterns of the best and worst performing valuation results. For presentational purposes, I will focus on enterprise value/EBIT[866] and I am particularly interested in the 50 best and 50 worst performing valuations, i.e. a c. 10% low and c. 10% high percentile threshold.

Table 7.8 (p. 278) presents the results. It suggests that, among the c. top 10% of valuations as measured by low median valuation errors, a number of adjustments are always (cash & cash equivalents, operating leases) or most of the time (M&A eliminations, minority interest, retirement benefit obligations and equity investments) applied. Other adjustments, notably for employee stock options feature in less than 20% of the c. top 10% of valuations. A third group (other long-term investments and preferred shares) results in inconclusive outcome in that they apply to around half of valuations. The results are mostly mirrored with the opposite sign and some exceptions such as minority interest for the c. bottom 10% of valuations as expressed by a high median valuation error. The implications of the analysis presented in Table 7.8 are as follows:

- The *fully adjusted scenario performs well*: It ranks 28^{th} out of 512 possibly adjustment permutations, at the 5.5% percentile. One practically relevant interpretation can be to argue *all* adjustments should be conducted given the rank proximity of the fully adjusted to the best performing adjustment combination. Whilst minor error reductions are possible through exclusion of ESOP adjustments compared to applying all adjustments, such suggestion on the basis of my findings would be problematic from a post-hoc perspective. Given one (in 9 proposed) adjustments turns out to consistently worsen

[866] The data has also been studied on the basis of enterprise value/EBITDA and results are directionally consistent. Data available from the author upon request

Table 7.8: "Best" and "worst" EV/EBIT adjustment combinations

Rank	Percentile	Cash and cash equivalents	Operating leases	Elimination of M&A firms	Minority interest	Retirement benefit obligations	Equity investments	Preferred shares	Other long-term investments	ESOPs	Median of valuation errors
1	0.2%	✓	✓	✓	✓	✓	✓	×	✓	×	19.14%
2	0.4%	✓	✓	✓	✓	✓	✓	✓	✓	×	19.14%
3	0.6%	✓	✓	✓	✓	✓	✓	×	×	×	19.16%
4	0.8%	✓	✓	✓	✓	✓	✓	✓	×	×	19.20%
5	1.0%	✓	✓	✓	✓	×	✓	×	✓	×	19.23%
6	1.2%	✓	✓	✓	✓	×	✓	✓	✓	×	19.25%
7	1.4%	✓	✓	✓	✓	✓	×	✓	✓	×	19.27%
8	1.6%	✓	✓	×	✓	✓	✓	✓	×	×	19.28%
9	1.8%	✓	✓	✓	✓	✓	×	×	×	×	19.28%
10	2.0%	✓	✓	×	✓	✓	✓	×	×	×	19.28%
11	2.1%	✓	✓	✓	✓	✓	×	✓	×	×	19.29%
12	2.3%	✓	✓	✓	✓	✓	×	×	✓	×	19.29%
13	2.5%	✓	✓	✓	✓	×	✓	✓	×	×	19.33%
14	2.7%	✓	✓	✓	✓	×	✓	×	×	×	19.33%
15	2.9%	✓	✓	✓	×	✓	✓	×	×	×	19.36%
16	3.1%	✓	✓	✓	✓	✓	✓	✓	×	✓	19.37%
17	3.3%	✓	✓	✓	✓	×	×	×	×	×	19.37%
18	3.5%	✓	✓	✓	✓	×	×	✓	×	×	19.37%
19	3.7%	✓	✓	✓	×	✓	✓	✓	×	×	19.38%
20	3.9%	✓	✓	✓	×	×	✓	✓	✓	×	19.39%
21	4.1%	✓	✓	✓	×	✓	✓	✓	✓	×	19.40%
22	4.3%	✓	✓	✓	×	✓	×	✓	×	×	19.40%
23	4.5%	✓	✓	✓	✓	✓	✓	×	×	✓	19.40%
24	4.7%	✓	✓	✓	×	×	✓	×	✓	×	19.41%
25	4.9%	✓	✓	✓	×	✓	✓	×	✓	×	19.41%
26	5.1%	✓	✓	✓	×	✓	×	×	×	×	19.41%
27	5.3%	✓	✓	×	✓	✓	✓	✓	✓	×	19.42%
28	5.5%	✓	✓	✓	✓	✓	✓	✓	✓	✓	19.42%
29	5.7%	✓	✓	✓	✓	×	×	✓	✓	×	19.42%
30	5.9%	✓	✓	✓	✓	×	×	×	✓	×	19.43%
31	6.1%	✓	✓	×	✓	✓	✓	×	✓	×	19.43%
32	6.2%	✓	✓	×	✓	×	✓	✓	×	×	19.45%
33	6.4%	✓	✓	✓	×	✓	×	✓	✓	×	19.45%
34	6.6%	✓	✓	✓	✓	✓	✓	×	✓	✓	19.46%
35	6.8%	✓	✓	×	✓	✓	×	✓	×	×	19.46%
36	7.0%	✓	✓	×	✓	×	✓	×	×	×	19.49%
37	7.2%	✓	✓	✓	×	×	✓	✓	×	×	19.49%
38	7.4%	✓	✓	×	✓	✓	×	×	×	×	19.49%
39	7.6%	✓	✓	✓	×	✓	×	×	✓	×	19.49%
40	7.8%	✓	✓	×	✓	✓	×	×	✓	×	19.51%
41	8.0%	✓	✓	✓	✓	✓	×	✓	×	✓	19.51%
42	8.2%	✓	✓	✓	×	×	✓	×	×	×	19.52%
43	8.4%	✓	✓	×	✓	✓	×	✓	✓	×	19.52%
44	8.6%	✓	✓	✓	✓	✓	×	×	×	✓	19.52%
45	8.8%	✓	✓	×	✓	✓	✓	✓	×	✓	19.52%
46	9.0%	✓	✓	✓	✓	×	✓	✓	✓	✓	19.52%
47	9.2%	✓	✓	×	✓	✓	✓	×	×	✓	19.53%
48	9.4%	✓	✓	×	✓	×	✓	✓	✓	×	19.53%
49	9.6%	✓	✓	✓	×	×	×	✓	×	×	19.54%
50	9.8%	✓	✓	✓	×	×	×	×	×	×	19.54%
	Freq.	**50**	**50**	**37**	**36**	**32**	**30**	**26**	**22**	**9**	
	Prop.	**100%**	**100%**	**74%**	**72%**	**64%**	**60%**	**52%**	**44%**	**18%**	

Note: Table depicts the resulting median of absolute log valuation errors for indiviual adjustment combinations, sorted by valuation errors: Top 50 lowest (highest) median valuation errors on the left (right) hand side out of 512 possible combinations

Rank	Percentile	Convertibles	Operating leases	Cash and cash equivalents	Equity investments	Retirement benefit obligations	Minority interest	Elimination of M&A firms	Preferred shares	Other long-term investments	Median of valuation errors
458	89.5%	×	×	×	×	×	×	×	×	×	20.69%
	⋮				⋮				⋮		
463	90.4%	×	×	×	×	×	✓	✓	×	×	20.71%
464	90.6%	×	×	×	✓	×	×	✓	×	✓	20.71%
465	90.8%	×	×	×	×	×	×	✓	×	✓	20.71%
466	91.0%	×	×	×	✓	×	✓	✓	✓	×	20.72%
467	91.2%	×	×	×	×	✓	×	×	✓	✓	20.72%
468	91.4%	×	×	×	✓	×	×	×	✓	×	20.72%
469	91.6%	×	×	×	✓	×	×	✓	✓	×	20.73%
470	91.8%	×	×	×	×	×	✓	×	✓	×	20.73%
471	92.0%	×	×	✓	✓	✓	×	×	×	✓	20.73%
472	92.2%	×	×	×	×	✓	×	×	×	✓	20.73%
473	92.4%	×	×	×	×	×	✓	×	×	×	20.73%
474	92.6%	×	×	×	✓	×	×	×	×	×	20.73%
475	92.8%	×	×	✓	✓	✓	×	×	✓	✓	20.73%
476	93.0%	×	×	×	✓	×	×	×	×	✓	20.74%
477	93.2%	×	×	×	✓	×	×	✓	×	×	20.74%
478	93.4%	×	×	×	×	✓	✓	✓	×	✓	20.74%
479	93.6%	×	×	×	×	×	✓	×	✓	✓	20.74%
480	93.8%	×	×	×	×	×	✓	✓	✓	✓	20.75%
481	93.9%	×	×	×	×	×	✓	✓	×	✓	20.75%
482	94.1%	×	×	×	×	✓	✓	✓	×	×	20.75%
483	94.3%	×	×	×	×	✓	✓	×	×	×	20.75%
484	94.5%	×	×	×	×	✓	✓	✓	✓	✓	20.75%
485	94.7%	×	×	×	✓	×	✓	✓	×	×	20.75%
486	94.9%	×	×	×	×	×	✓	×	×	✓	20.76%
487	95.1%	×	×	✓	×	×	×	×	✓	✓	20.77%
488	95.3%	×	×	✓	✓	×	×	×	×	✓	20.77%
489	95.5%	×	×	✓	✓	×	×	×	✓	✓	20.77%
490	95.7%	×	×	×	×	✓	✓	×	✓	×	20.77%
491	95.9%	×	×	×	×	✓	✓	✓	✓	×	20.78%
492	96.1%	×	×	×	×	×	×	×	✓	✓	20.78%
493	96.3%	×	×	✓	×	×	×	×	×	✓	20.78%
494	96.5%	×	×	×	×	×	×	×	×	✓	20.79%
495	96.7%	×	×	×	×	✓	×	✓	×	×	20.80%
496	96.9%	×	×	×	×	✓	×	✓	✓	×	20.81%
497	97.1%	×	×	×	×	✓	×	×	×	×	20.84%
498	97.3%	×	×	×	×	×	×	×	✓	×	20.84%
499	97.5%	×	×	×	×	✓	×	×	✓	×	20.85%
500	97.7%	×	×	×	×	×	×	✓	✓	✓	20.85%
501	97.9%	×	×	×	×	×	✓	×	✓	×	20.86%
502	98.0%	×	×	×	×	×	✓	✓	✓	✓	20.86%
503	98.2%	×	×	×	×	×	×	✓	×	✓	20.86%
504	98.4%	×	×	×	×	×	✓	✓	✓	×	20.87%
505	98.6%	×	×	×	×	×	✓	×	✓	✓	20.87%
506	98.8%	×	×	×	×	×	✓	×	×	×	20.88%
507	99.0%	×	×	×	×	×	✓	×	×	✓	20.88%
508	99.2%	×	×	×	×	×	×	×	×	✓	20.89%
509	99.4%	×	×	×	×	×	✓	✓	×	×	20.89%
510	99.6%	×	×	×	×	×	×	✓	×	×	20.89%
511	99.8%	×	×	×	×	×	✓	✓	×	✓	20.91%
512	100.0%	×	×	×	×	×	×	✓	✓	×	20.91%
	Freq.	**0**	**0**	**6**	**12**	**14**	**23**	**23**	**23**	**25**	
	Prop.	**0%**	**0%**	**12%**	**24%**	**28%**	**46%**	**46%**	**46%**	**50%**	

Note: Table should be read in conjunction with table on the previous page valuation outcomes,[867] *I fail to find formal confirmation of Hypothesis 4b*, which argued that each adjustment on its own needs to display a positive valuation impact; the findings to point, however, to a *strong performance of the combination of all adjustments* rather than one single particular adjustment accounting for all valuation improvement

- As the case of the ESOP adjustment shows, not all proposed adjustments appear to consistently improve valuation accuracy. This might have to do with the "reasonable approximation" approaches I have suggested in Table 5.3 (pp. 180–182), which appear to work well for most adjustments but less so for others, notably ESOPs. Therefore, for ESOPs, more sophisticated adjustments might be necessary to analyze their potential economic impact in the context of multiple valuation. Since there is no convincing argument as to why the economic impact of ESOPs should not be considered, I speculate that the results have to do with the *way* the adjustments are conducted/approximated rather than whether they are conducted at all and further research regarding improved adjustment concepts may be appropriate:
  - Notably, the proposed ESOP adjustment—which relies on computation of a dilution factor on the basis of diluted versus basic earnings per share—considers *any* form of dilution (be it from ESOPs or other potential sources such as e.g. convertible bonds expected to convert) it does carry some obvious shortcomings of double-counting
  - Conceptually, the fact that the proposed ESOP adjustment performs relatively inferior than other more "clear cut" and obviously economically more solid adjustments suggests that adjustment concepts, which try to emulate economic reality in a too distant manner are more generally not advisable
- Consistency adjustments appear to somewhat outperform comparability adjustments. Thus the intrinsic consistency of any individual pricing multiple might play a bigger role for valuation accuracy than the comparability between the different peer company pricing multiples
- Certain adjustment combinations can result in a worse valuation outcomes than not

[867] Whilst the best-ranked valuation also does not include the adjustment for preferred shares, the picture for this adjustment is much less consistent in its directional impact on valuation accuracy compared to ESOPs

considering any adjustments at all: The no-adjustment case[868] ranks at the 458th position, i.e. the 89.5% percentile. From a practitioner perspective, it is therefore important that adjustments are transparently described and part-adjustments are well-reasoned to avoid potential biases

For a more rigorous statistical analysis, I consider a *linear regression approach* based on standard OLS methodology. For computational reasons, I run the model on the basis of the *median* absolute log error results as dependent variable, i.e. the aggregated data points presented in last column of Table 7.8, for all 512 different switch scenarios. The switches are modeled as dummy variables, each. The use of median rather than individual firm/half-year observations provides the central advantage over a pooled regression analysis for all observations that time and company-specific factors are considered a "quasi" fixed effect.[869] The downside is the loss of potentially critical observation-specific variations, which more sophisticated fixed effect regressions or mixed models can take into consideration.[870] Since it is argued that averaging variables in a regression is a legitimate approach (Winter, 2014, p. 5)[871] and for this particular case provides enough flexibility I believe that, on balance, it is the most suitable approach. Table 7.9 (p. 282) presents the results of 9 simple regressions and 3 multiple regressions. The predicted negative impact of adjustment on valuation errors is observed for 7 out of the 9 proposed adjustments and significant according to a *t*-test in 4 out of those 7 cases. The results in Table 7.9 also reconfirm data presented in Tables 7.7 and 7.8 around the relatively weak performance of adjustments concerning ESOPs, whilst other adjustments have a positive or at worst balanced/minor negative effect on valuation precision.

[868] Shown as first line in right hand side Table 7.8 but excluded from summarizing averages at the bottom of the table

[869] An alternative model on the basis of log-transformed median absolute log valuation errors has been considered; results are directionally similar, however, coefficients more challenging to interpret, which is why reporting of the standard method has been given preference

[870] I seriously considered both fixed effect regressions, which are highly common in corporate finance/accounting research literature (compare e.g. Callen and Segal (2005), Bradshaw, Brown, and Huang (2013) or Dittmar and Mahrt-Smith (2007) for regressions relying on fixed effects) and mixed models popular in other disciplines. The issue with both approaches is the tremendous amount of data needed to create to run them on the full sample; it can be estimated at 17588 firm/half-year observations times 512 adjustment switch permutations, i.e. in excess of 9 million line items of data. Common mixed model packages for RStudio such as `lme4` or `nlme` will struggle to assign the required cross matrices on desktop computers. Whilst this limitation could be overcome by sub-sampling or using more powerful hardware including cloud products like Amazon Web Services, mixed model approaches would be more complex to interpret to the casual observer since *p*-values are of different relevance and alternative ways of assessment such as the Likelihood Ratio tests are required. Classical fixed effects models common in corporate finance and accounting research applications furthermore do not deal well with situations in which multiple observations (in my case the adjustment switches) for each pair of fixed effect defined (in my case e.g. company ID and time) are applicable

[871] Also compare the highly accessible tutorial by Winter (2014, p. 5) on mixed models for additional sources regarding this discussion

TABLE 7.9: Regression of adjustment dummy variables on valuation error medians

		Dependent variable: medians of abs. log valuation errors $\widetilde{u}_{j,t}^{a,log}$					
		Simple OLS					
	Pred.	(1)	(2)	(3)	(4)	(5)	(6)
Consistency							
Cash and cash equivalents	–	-0.0042*** (-12.92)					
Equity investments	–		-0.0016** (-4.19)				
Minority interest	–			-0.00084 (-2.24)			
Other long-term investments	–				0.00022 (0.59)		
Elimination of M&A firms	–					-0.0013* (-3.36)	
Comparability							
ESOPs	–						0.0024*** (6.75)
Preferred shares	–						
Retirement benefit obligations	–						
Operating leases	–						
Intercept		0.2041*** (881.36)	0.2027*** (772.96)	0.2024*** (762.42)	0.2018*** (756.95)	0.2026*** (767.80)	0.2007*** (785.40)
Observations		512	512	512	512	512	512
R^2		24.7%	3.3%	1.0%	0.07%	2.2%	8.2%
Adjusted R^2		24.5%	3.1%	0.8%	-0.1%	2.0%	8.0%
F statistic		166.88***	17.52**	5.03	0.35	11.27*	45.51***
df		(1;510)	(1;510)	(1;510)	(1;510)	(1;510)	(1;510)

Note: Table presents the results of 9 simple one independent variable ordinary least square linear regressions (columns denoted (1)–(9)) and 3 multiple ordinary least square linear regressions (columns denoted (10)–(12)). Regressions specified as $\left(\widetilde{u}_{j,t}^{a,log}\right)_k = \beta_0 + \sum_{p=1}^{9} \beta_p DUMMY_{p,k} + \varepsilon_k$, where k is the index for the 512 adjustment permutations and p is the index for the 9 individual adjustment dummy variables, which are coded 0...no adjustment and 1...adjustment, respectively. In regression models (1)–(9), all $DUMMY_{p,k}$ where p does not correspond to the single independent variable under investigation are artificially set to zero. In regression model (10) ((11)), all comparability (consistency) adjustment variables are set to zero (Compare Subsection 5.1.1, p.130). Regression (12) considers all 9 independent variables at once. The dependent variable $\widetilde{u}_{j,t}^{a,log}$ is defined as the medians of log valuation errors for all adjustment permutations for enterprise value/EBIT. For each independent variable, the signed slope, its level of significance (Holm-Bonferroni-adjusted; common codes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$) and the respective t-statistic (in parentheses) is shown

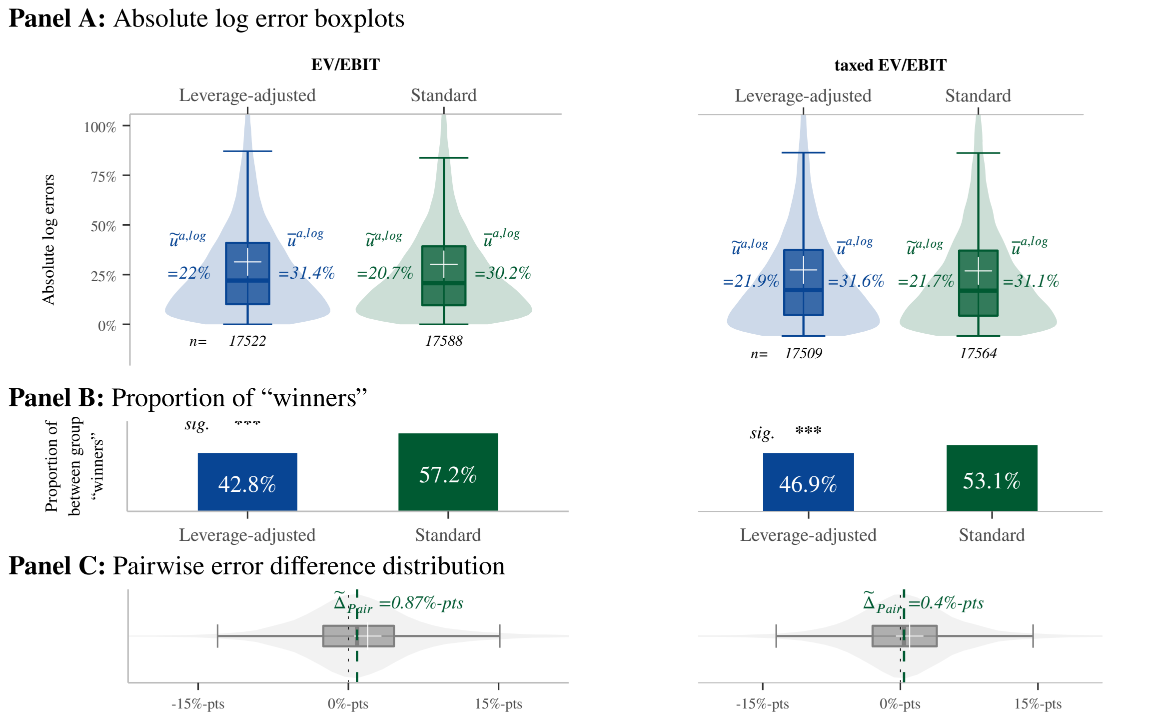
		Dependent variable: medians of abs. log valuation errors $\widetilde{u}_{j,t}^{a,log}$ (cont'd)					
		Simple OLS			Multiple OLS		
	Pred.	(7)	(8)	(9)	(10)	(11)	(12)
Consistency							
Cash and cash equivalents	–				-0.0042***		-0.0042***
					(-13.46)		(-36.07)
Equity investments	–				-0.0016***		-0.0016***
					(-4.94)		(-13.24)
Minority interest	–				-0.00084		-0.00084***
					(-2.68)		(-7.18)
Other long-term investments	–				0.00022		0.00022
					(0.71)		(1.89)
Elimination of M&A firms	–				-0.0013**		-0.0013***
					(-3.99)		(-10.68)
Comparability							
ESOPs	–					0.0024***	0.0024***
						(10.10)	(20.80)
Preferred shares	–	-0.000068				-0.000068	-0.000068
		(-0.18)				(-0.28)	(-0.58)
Retirement benefit obligations	–		-0.0012			-0.0012***	-0.0012***
			(-3.10)			(-4.80)	(-9.88)
Operating leases	–			-0.0060***		-0.0060***	-0.0060***
				(-22.25)		(-24.77)	(-50.99)
Intercept		0.2020***	0.2025***	0.2049***	0.2058***	0.2043***	0.2081***
		(757.26)	(766.40)	(1078.58)	(534.80)	(757.25)	(1122.73)
Observations		512	512	512	512	512	512
R^2		0.006%	1.8%	49.3%	31.2%	59.3%	90.5%
Adjusted R^2		-0.2%	1.7%	49.2%	30.5%	59.0%	90.3%
F statistic		0.032	9.61	495.07***	45.86***	184.72***	530.66***
df		(1;510)	(1;510)	(1;510)	(5;506)	(4;507)	(9;502)

Note: Table to be read in conjunction with the table facing this page

7.4.2.4 No evidence for the relevance of tax shields in trading multiple valuation

Subsection 5.6.2 (p. 171) discussed theoretical attractions of considering *tax shields* in the context of trading multiple valuation by means of a *leverage-adjusted* taxed EBIT multiple.[872] It is therefore instructive to empirically study the performance of such multiple type in order to investigate if valuation improvements over more traditional enterprise value/EBIT or enterprise value/taxed EBIT multiples can be obtained.

FIGURE 7.7: The benefits of leverage adjustments to enterprise value multiples



Note: Comparison of leverage-adjusted and standard EV/EBIT and EV/taxed EBIT multiples (following Equation 5.4). In both cases, the null hypothesis according to which there is no difference between leverage-adjusted and standard multiple types is rejected on the basis of Wilcoxon sign-rank tests (W=6.967e+07 at a Holm-Bonferroni-adjusted $p \ll 0.0001$ and W=6.138e+07 at a Holm-Bonferroni-adjusted $p \ll 0.0001$, respectively for EV/taxed EBIT and EV/EBIT), indicating that standard multiples outperform leverage-adjusted multiples. $\widetilde{u}^{a,log}$ and $\overline{u}^{a,log}$ denote the median and mean, absolute valuation errors, respectively

Figure 7.7 (p. 284) presents the results of this analysis. It suggests that *no improvement* in multiple valuation accuracy can be achieved through consideration of tax shields. To the contrary, "standard" multiple types outperform their leverage-adjusted siblings for both EBIT

[872]Compare Equation 5.4, p. 173

and taxed EBIT as valuation drivers.[873] Results are significant for both multiple types. Valuation preparers concerned with considering tax shields might therefore be better off utilizing multiple types such as price/earnings, which offer some alternative implicit consideration such is the case with price/earnings.[874] The outcome also suggests that if in doubt, such simpler solutions of implicit consideration (price/earnings) might outperform more sophisticated adjustments (leverage adjusted enterprise value/taxed EBIT), consistent with the spirit of multiples as a straightforward valuation concept.

7.4.2.5 A summarizing discussion on adjustment benefits

To summarize, the proposed consistency and comparability adjustments for enterprise value multiples in their entirety allow for improved valuation accuracy for all but one of the multiple types studied, which supports Hypothesis 4a. An assessment of resulting valuation errors for 512 adjustment permutations suggests multiple valuations benefit from the combination of adjustments and of the 9 proposed adjustments, only one is found to consistently result in less valuation accuracy. So while an analysis of individual adjustments does not formally support Hypothesis 4b, a joint analysis of adjustments suggests they each appear to contribute to valuation accuracy. Furthermore, since adjustments are conducted on the basis of a "reasonable approximation," rather than the "gold standard," the approximation for this one adjustment around ESOPs could potentially be flawed, which could deserve further research. Results for more esoteric conceptual adjustments regarding tax and leverage to enterprise value multiples suggest no gains for valuation accuracy.

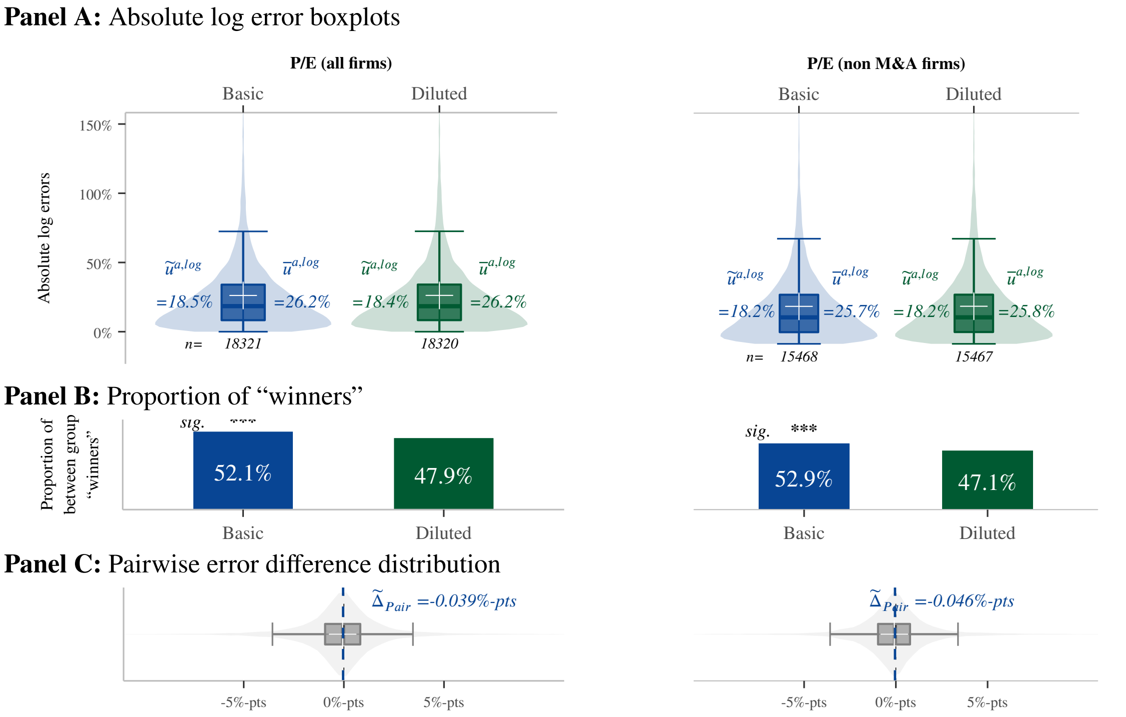
7.4.3 Equity value multiples: high accuracy "out of the box"

As is obvious from Table 5.3 (pp. 180–182), a number of the adjustments applicable to enterprise value multiples are not relevant for equity value multiples. Other potential adjustments to equity value multiples are challenging to reasonably approximate in an empirical study on the basis of a large sample. This suggests that the focus of adjustments for enterprise value multiples should be based on (a) dilution and (b) the impact of M&A consolidation. A closer assessment of the adjustment for dilution is furthermore instructive as it effectively allows for a comparison of a per-share calculated multiple on a diluted vs. basic level, with the latter being consistent with a firm approach comparing market capitalization to net income.

[873] I tested but do not report in detail the "cross-outperformance" of leverage-adjusted taxed EBIT vs. standard EBIT; results are directionally consistent in that the standard form outperforms the leverage-adjusted alternative

[874] Compare Subsection 5.6.2 (p. 171) and Table 5.3 (p. 180–182)

FIGURE 7.8: The benefits of adjustments to equity value multiples



Note: Comparison of the two adjustment levels for equity value multiples: Full sample vs. exclusion of M&A firms and basic vs. diluted shares. In both cases for the full sample and the exclusion of M&A firms subsample, the null hypothesis according to which there is no difference between basic and diluted share error distributions is rejected on the basis of Wilcoxon sign-rank tests (W=8.643e+07 at a Holm-Bonferroni-adjusted $p \ll 0.0001$ and W=6.249e+07 at a Holm-Bonferroni-adjusted $p \ll 0.0001$, respectively). However, effect sizes appear comparably small as indicated by the pairwise error difference distributions and similar levels of median and mean errors for basic and diluted price/earnings. $\widetilde{u}^{a,log}$ and $\overline{u}^{a,log}$ denote the median and mean, absolute valuation errors, respectively

Figure 7.8 (p. 286) summarizes the results for the price/earnings multiple. Since only 2 levels of adjustments are undertaken, a figure format following Figure 7.2, rather than a tabular presentation style, is chosen. Consistent with the results for enterprise value multiples, a focus on non M&A firms provides improved valuation error metrics as expressed by lower median and mean errors.[875]

Key distribution metrics of basic vs. diluted share counts suggest that the effect size is minor. However, the basic share count outperforms the diluted share count in more than 52% of cases and results are significant. Hence the dilution adjustment is not conducive to improved valuation accuracy and market capitalization/net income appears preferable over price/diluted earnings per share as a calculation method for price/earnings, albeit the differences in valuation

[875] Detailed statistics and tests withheld for presentational reasons. Available from the author upon request

accuracy are small.[876] I argue that price/earnings as a multiple is indeed best be considered in its “raw” form, which also gives rise to the Functional Fixation Hypothesis developed by M. Kim and Ritter (1999, p. 423) and Hand (1990) as well as the feedback loop presumption developed in Subsection 7.10 (p. 324).

7.5 Valuation driver timing in response to Hypotheses 1a and 1b

7.5.1 Background and methodology

Hypothesis 1a (p. 45) argues that flow multiple valuation drivers based on time periods moderately ahead of the pricing date should outperform valuation drivers based on historical time periods or time periods materially further ahead.[877] Some empirical findings (Schreiner, 2007, p. 108; Rossi & Forte, 2016, pp. 65–68) point to a gradually increasing valuation accuracy as valuation drivers further out in future are chosen; this motivated Hypothesis 1b (p. 46), according to which biases of valuation drivers through the consolidation impact of M&A could be one explanatory variable. In order to investigate Hypotheses 1a and 1b empirically, I conduct pairwise comparisons. Valuation drivers relating to next twelve months measured from the pricing date are used as a baseline, to which the relative performance of other valuation driver timings are compared.[878] The effect of M&A consolidation is studied by analyzing timing impact for a subsample of companies, which have not conducted material M&A:[879] M&A consolidation could be argued as a key impact on valuation driver timing if this subsample would display different dynamics than the full sample. Results presented will focus on one important enterprise and equity value multiple type, each, enterprise value/EBIT and price/earnings.[880]

[876]This is consistent with the weak performance of the ESOP adjustment in the context of enterprise value multiples

[877]Stock multiples are of lesser relevance here since usually measured on latest available historical balance sheet data

[878]The baseline is motivated by a combination of practical and theoretical considerations further detailed in Subsection 2.3.2.2 (p. 42)

[879]Compare Footnote 852 (p. 272) for a definition

[880]Enterprise value/EBITDA has also been considered for the analysis but results are not reported in spirit of presentational focus; they are directionally consistent with the results for enterprise value/EBIT. The analysis is less relevant for stock multiples since forecasted valuation drivers for stock multiples (invested capital, total assets, book value of equity) are less of a focus in equity research reports and to my knowledge typically no consensus is available from the usual financial databases. Stock multiples are commonly computed on the basis of latest available historical balance sheet data

TABLE 7.10: Multiple error distribution for valuation driver timing scenarios

	Valuation driver timing, each relative to NTM[a]					
	LTM[b]	NTM[a]	NTM+2[c]	NTM[a]	NTM+3[d]	NTM[a]
Panel A: EV/EBIT—full sample						
Median	24.8%	20.4%	19.9%	20.5%	20.1%	20.2%
Mean	35%	29.4%	28.6%	29.5%	28.7%	28.8%
Sample standard deviation	36.5%	33%	33.3%	32.4%	32.4%	30%
Fraction of errors <10%[g]	22.1%	26.3%	27.7%	26.3%	27.4%	26.4%
Fraction of errors <25%[g]	50.2%	57.7%	59.6%	57.4%	58.9%	58%
Proportion winning[e]	39.3%	60.7%	56%	44%	52.8%	47.2%
Pairwise difference/significance[f]	2.88%-pts/***		-0.93%-pts/***		-0.76%-pts/**	
Number of observations	17255		15413		7459	
Panel B: EV/EBIT—excluding M&A companies[e]						
Median	24.6%	20.4%	19.6%	20.6%	20.4%	20.5%
Mean	34.7%	29.2%	28.6%	29.4%	28.6%	28.7%
Sample standard deviation	36.6%	32.1%	33%	31.4%	31.9%	29.1%
Fraction of errors <10%[g]	22.4%	26.2%	27.6%	26%	26.3%	25.4%
Fraction of errors <25%[g]	50.6%	57.8%	59.6%	57.6%	58.9%	58.1%
Proportion winning[e]	39.2%	60.8%	55.4%	44.6%	52.2%	47.8%
Pairwise difference/significance[f]	2.88%-pts/***		-0.84%-pts/***		-0.58%-pts/n.s.	
Number of observations	14591		13040		6312	
Panel C: P/E—full sample						
Median	22.8%	18%	17.2%	18.4%	17.8%	18.4%
Mean	33.2%	24.9%	23.7%	26.1%	23.8%	26.1%
Sample standard deviation	37.2%	28.2%	25.2%	29.5%	24.7%	30%
Fraction of errors <10%[g]	24.1%	30.2%	31.1%	29.6%	30.9%	29.6%
Fraction of errors <25%[g]	53.5%	63.6%	65.5%	62.6%	64.6%	62.8%
Proportion winning[e]	37.3%	62.7%	56.3%	43.7%	52.8%	47.2%
Pairwise difference/significance[f]	3.8%-pts/***		-1%-pts/***		-0.74%-pts/***	
Number of observations	17543		16610		7828	
Panel D: P/E—excluding M&A companies[e]						
Median	22.4%	17.7%	17.1%	18.1%	17.8%	18.2%
Mean	32.5%	24.6%	23.3%	25.6%	23.6%	25.7%
Sample standard deviation	36.5%	28.2%	24.8%	29.1%	24.3%	29.5%
Fraction of errors <10%[g]	24.4%	30.9%	31.7%	30.3%	30.3%	30.1%
Fraction of errors <25%[g]	54.3%	63.8%	65.9%	62.9%	64.1%	62.7%
Proportion winning[e]	37.5%	62.5%	56.1%	43.9%	52.1%	47.9%
Pairwise difference/significance[f]	3.62%-pts/***		-0.89%-pts/***		-0.45%-pts/***	
Number of observations	14855		14011		7828	

Note: Table presents log-scaled valuation errors for matched groups of multiples with varying valuation driver timings. First 5 lines of each panel denote absolute log error distribution metrics, following 2 lines relate to pairwise comparison. Green highlight added to indicate the better relative performance

[a] Valuation drivers recalendarized to next twelve months from the pricing date forward (e.g. relate to January 2007 to January 2008 for a January 2007 pricing date) [b] Recalendarized to last twelve months from the pricing date backwards [c] Recalendarized to next twelve months financials in a year's time (e.g. forecasts for a time period between January 2008 to January 2009 for a January 2007 pricing date) [d] Recalendarized to next twelve months financials in two years' time [e] Subsample excluding companies, which have engaged in material M&A [f] Median of pair wise error difference, $\widetilde{\Delta}_{Pair}$ (see Eq. 7.1); positive (negative) sign indicates outperformance of the NTM (time-varied) valuation driver. Significance based on Holm-Bonferroni-adjusted p-value of pairwise Wilcoxon sign-rank tests [g] Higher values indicate positive impact on accuracy

7.5.2 Two-year forward valuation drivers appear most accurate

Table 7.10 (p. 288) presents empirical findings. Expectedly, last twelve months (LTM)[881] multiples underperform the baseline of next twelve months (NTM)[882] multiples throughout, which is consistent with a forward-oriented nature of valuation also observed in DCF models. In a comparison of different forward multiples, valuation drivers referencing time periods beyond NTM, such as notably NTM+2 and NTM+3, display a strong performance: They highly significantly outperform[883] paired NTM as valuation drivers measured by key distribution parameters of absolute log errors, including median errors, fractions below a specific error threshold and pairwise comparisons. Effect sizes are meaningful, ranging from c. 0.5%-pts to c. 1.0%-pts, as expressed by pairwise valuation error differences. While I do not formally test a comparison between NTM+2[884] and NTM+3,[885] effect sizes are larger for NTM+2 vs. NTM than for NTM+3 vs. NTM, indicating that *NTM+2* might be the empirically preferred forward valuation time period. As indicated by number of observations denoted in the respective comparisons, NTM+2 offers furthermore the advantage versus NTM+3 that a *materially larger peer universe* with sufficient data availability can be considered. A comparison with the number of observations for enterprise value/EBIT and P/E, respectively, in Table 7.4 (p. 249) reveals, however, that the number of available peers drops already somewhat between NTM and NTM+2, so the decision which valuation driving timing to rely upon should also depend on the availability of respective forecasts in the concrete case. Results are stable between P/E and enterprise value/EBIT as indicated by a comparison of Panels A and C of Table 7.10.

The results presented in Panels A and C of Table 7.10 can overall be interpreted as a confirmation of Hypothesis 1a in that valuation drivers with a moderate forward-orientation (NTM+2) display stronger results than multiples, which are backward oriented (LTM) or too far in the future (NTM+3). However, the weak performance of the practically most common

[881] Based on valuation drivers computed on financials relating to a historical last twelve months time period, relative to the pricing date

[882] Valuation drivers recalendarized to next twelve months from the pricing date forward (baseline approach followed in this dissertation, compare Subsection 2.3.2.2, p. 42 for details), relying on equity research consensus forecasts. Note next twelve months (NTM) dataset relies on availability of the respective comparable column (and vice versa), distribution metrics for the paired samples each, shown. The NTM approach is conceptually consistent with the forward financial valuation driver approach abbreviated as "FW" in Chapter 4; however, NTM is preferred as label to distinguish the next twelve months forward period for periods further in the future (e.g. "NTM+2")

[883] According to pairwise Bonferroni-adjusted Wilcoxon sign-rank tests, p values withheld (available from the author), level of significance indicated in Table 7.10 by common significance code asterisk notation (***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$)

[884] Compare notes to Table 7.10 for a definition

[885] In order to avoid statistical post-hoc issues

NTM valuation driver timing vs. NTM+2 is surprising. The results are partly consistent with existing literature such as Schreiner (2007, p. 108) and Rossi and Forte (2016, pp. 65–68) in that they, too, find future valuation drivers outperforming historical valuation drivers; however, their strongest drivers are those furthest out in future, whilst my analysis suggests that NTM+2 could be considered an "optimal" forward-looking time period.[886]

In order to shed further light on the relative performance of valuation driver timings, Hypothesis 1b (p. 46) suggested that M&A consolidation leading to asymmetries between a (delayed) valuation driver recognition and an immediate price reference reflection of such transactions could be a factor why valuation drivers further out display higher accuracy. Whilst an exclusion of "M&A companies" indeed appears to result in generally somewhat lower valuation errors, this effect does not by itself mean that M&A consolidation explains the valuation driver timing patterns found in the context of studying Hypothesis 1a. An indication for the validity of Hypothesis 1b could be a materially better performance of near-term valuation multiples (e.g. NTM) over longer-term valuation multiples (e.g. NTM+2 and NTM+3). A comparison of Panels A and C with Panels B and D of Table 7.10 reveals that this is indeed the case as far as the pairwise differences are concerned: NTM appears to consistently perform relatively stronger (pairwise differences closer to 0) than NTM+2 and NTM+3 in Panels B and D, however, NTM+2 and NTM+3 still outperform NTM. So while there is a minor M&A effect explaining the strong performance of NTM+2, it retains its overall leadership in valuation accuracy for both P/E and enterprise value/EBIT. I therefore argue that NTM+2 in particular might be the *optimal balance* between a representation of the *future economic cash creation potential* of a firm at the *lowest level of noise from forecasting uncertainty* and consequently should be considered as an alternative to the more practically relevant NTM as the appropriate valuation driver timing period.

The remainder of this dissertation will none the less rely on NTM as a valuation driver time period to ensure consistency with earlier empirical data presented in this Subsection, as a result of the arguably higher practical relevance of NTM and given the broader availability of forecasts for NTM as compared to NTM+2.

[886] Compare Subsection 2.3.2.2 (p. 42) for a further discussion on existing literature regarding valuation driver timing

7.6 Intrinsic multiple valuations in response to Hypothesis 3a

7.6.1 Background and methodology

In Hypothesis 3a (p. 127) it was argued on the basis of theoretical preferences in textbook literature and prior empirical findings that it is reasonable to expect that intrinsic valuations outperform multiple valuations. In order to investigate Hypothesis 3a further, I follow the concept of intrinsic multiples discussed greater detail in Chapter 4 (p. 89). For presentational purposes, I focus on the two common and comparably precise multiple types of price/earnings and enterprise value/EBIT. The study goes as follows:

- Computation of *intrinsic multiples* for each firm/half year observation in the sample on the basis of Equations 4.12 (p. 94) and 4.34 (p. 103) for price/earnings and enterprise value/EBIT, respectively. These valuations are *not* peer-based but intrinsically driven valuations, normalized by their respective valuation drivers[887]
- Such computation requires estimation of the relevant input variables to Equations 4.12 and 4.34, respectively, for each company under investigation:[888]
  - The growth rate g_i is estimated on the basis of the *fade factor concept* presented in Subsection 4.3.2 (p. 104), where initial growth forecasts for near-term future time periods are gradually reduced to $\tilde{g}^{TGR}_{Europe}$ =4.1% and $\tilde{g}^{TGR}_{US}$ =4.6%. Once a 10 year growth trajectory has been established on this basis, a comparable growth rate can be computed for each observation, which is a single figure corresponding to the respective 10 year growth rate trajectory suitable for use in Equations 4.12 and 4.34[889]
  - *Weighted average cost of capital* (r_i^{WACC}) and cost of equity (r_i^{eq}) are obtained for each observation from their standard textbook formulas, notably Equation 4.31 (p.

[887]This differentiates the approach presented to previous studies such as e.g. Kelleners (2004), who forms cross-industry peer groups on the basis of intrinsic similarities; intrinsic multiples utilized here are rather convenient implementations of intrinsic valuations, to which the cut-offs applied pricing multiples are imposed for comparability purposes, compare Subsection 3.4.2 (p. 74)

[888]Compare Chapter 4 for additional details on estimates for input variables

[889]Compare Footnote 362 (p. 105) for details

102) for the cost of equity[890] [891]

- *Return on invested capital* r_i^{ROIC} and return on equity r_i^{ROE}, respectively, with return on invested capital computed *including* goodwill and following the approach of Damodaran (2012a, p. 536) and return on equity as earnings divided by book value of equity
- Other input variables such as tax rates obtained from financial databases for each of the sample companies

Table 3.3 (p. 82) provides an overview of distribution metrics of selected input variables to Equations 4.12 and 4.34 used for computation of intrinsic multiples

- Once intrinsic multiples have been computed,[892] it is possible to calculate errors between valuations based on intrinsic multiples and market prices observed in an approach analogous to utilizing valuation multiples for each company under investigation.[893] The resulting valuation errors can then be compared to valuation errors obtained from the valuation multiple approaches for price/earnings and enterprise value/EBIT, respectively, in the usual pairwise "horse race" fashion
- Lower (higher) valuation errors of intrinsic multiples indicate a stronger (weaker) performance of intrinsic valuations relative to valuation multiple approaches. The analysis is anecdotal in a sense that it only allows for a relative quality assessment of the *respective valuation concepts as presented* and any more generalized statements or deductions on the overall performance of intrinsic vs. multiple valuations need to be interpreted accordingly. None the less it adds to the existing body of literature comparing those two valuation approaches
- While intrinsic multiples are computed to remain within the concept presented in Chapter 4, de facto, the analysis compares the underlying intrinsic valuations to market prices.

[890] A slight recursivity problem exists for the weighted average cost of capital given the weights are based on market values which are ex ante unknown in the context of valuation. This is practically solved by using target capital weights; I rely on the actually measured capital weights, assuming any result bias introduced is minuscule

[891] Ingredients to the cost of equity formula are estimated based on market data and include a country risk premium r_{CRP} on the basis of headquarter location added to the equity risk premium as well as a 3 year leveraged equity beta downloaded from Reuters. Both the country risk premium and the cost of debt are estimated based on yields of consistently rated debt securities according to the S&P rating obtained from Reuters for the various points in time

[892] And cut-offs consistent with trading multiple cut-offs as described in Subsection 3.4.2 (p. 74) on outlier treatment are conducted

[893] Naturally, no aggregation is required for intrinsic multiples since for each observation a valuation each is obtained from Equations 4.12 and 4.34

Thus no additional biases or restrictions should arise from relying on intrinsic multiples rather than direct intrinsic valuations[894]

- The somewhat lower sample size for intrinsic multiple valuations can be ascribed to data availability and, to some extent, to outlier elimination described in Footnote 894 (p. 293)
- The comparison of intrinsic multiple valuations and valuation multiples takes place on the basis of unadjusted multiples for comparability purposes with results presented elsewhere in this dissertation (baseline approach). A comparison has also been run on the basis of adjusted multiples with directionally consistent results

7.6.2 Strong performance of valuation multiples vs. intrinsic concepts

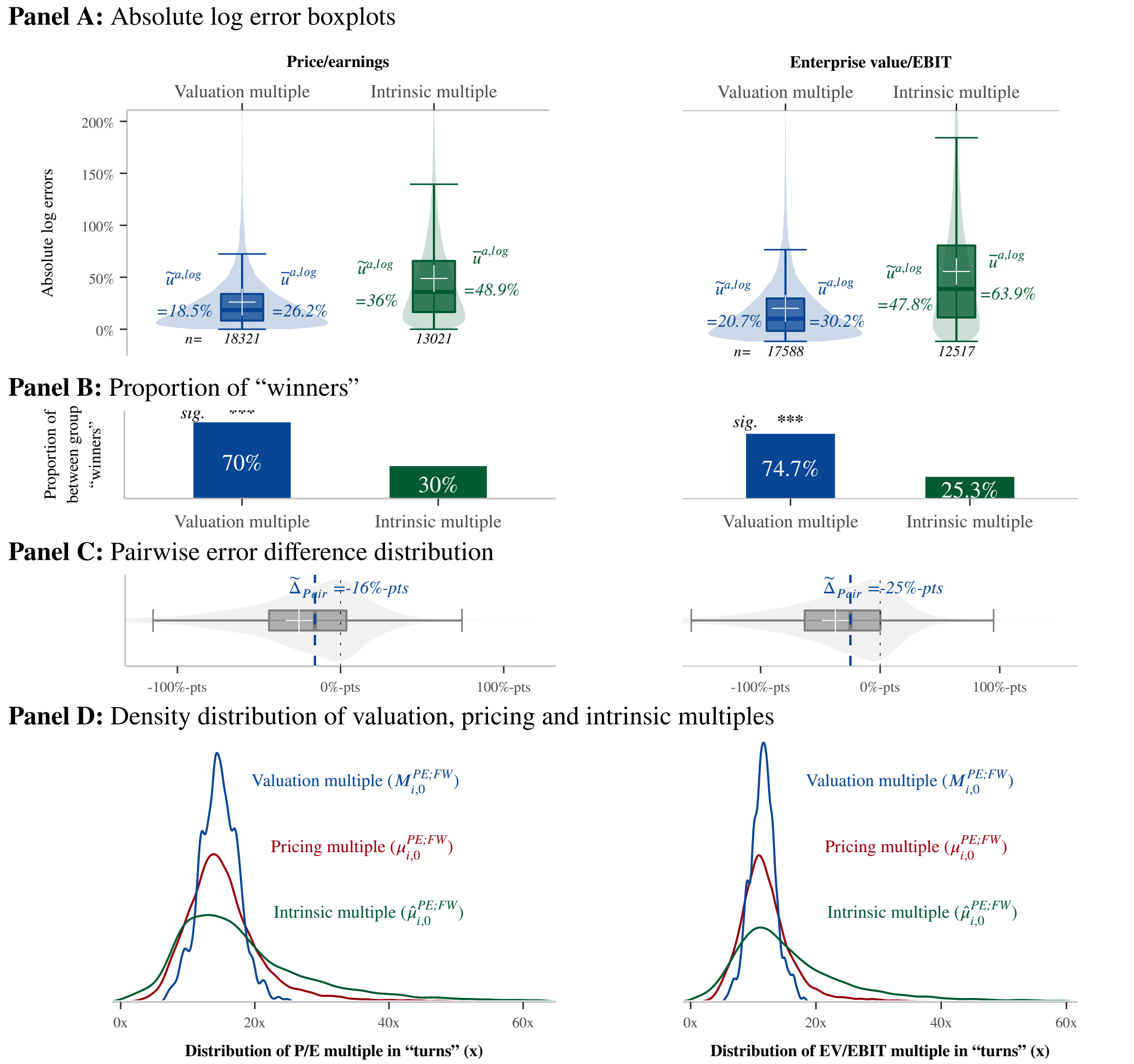
7.6.2.1 Pairwise comparison of intrinsic and valuation multiple results suggests strong performance of the latter

Figure 7.9 (p. 294) summarizes the results in the common combination of error boxplots, proportion of pairwise winners and error difference distributions. Valuation multiples appear to *materially outperform* intrinsic (multiple) valuations, with a consistent picture for both price/earnings and enterprise value/EBIT emerging; this outperformance amounts to 70% or more of pairwise comparisons. Results are significant according to two-tailed Wilcoxon sign rank tests, which do not support the null hypothesis that the underlying error distributions between intrinsic (multiple) valuations and valuation multiples are identical. The effect size of the outperformance is material, with median pairwise error differences to the benefit of valuation multiples of -15.7%-pts and -24.9%-pts, for enterprise value/EBIT and price/earnings, respectively. The evidence presented does not support Hypothesis 3a; on the contrary it suggests a *substantially weaker performance of the chosen intrinsic valuation concepts* relative to the standard multiple valuation approach methodology followed throughout this dissertation.[895]

[894] Intrinsic multiples are convenient as they normalize each valuation by the respective multiple valuation driver (e.g. next twelve months earnings or next twelve months EBIT). However, in determining valuation errors, intrinsic multiples are multiplied by the valuation drivers resulting in intrinsic valuations. Thus, a direct consideration of intrinsic valuations should result in the same results. Consistent with outlier exclusion described in Subsection 3.4.2 (p. 74), I do exclude intrinsic multiples below or above the thresholds specified there, however. Such exclusions would not take place in a direct intrinsic valuation and hence constitute a divergence from the direct approach. I argue that intrinsic multiples do offer the advantage of consistent outlier detection not available in direct intrinsic valuation approaches

[895] This is the case for the relatively weaker performing unadjusted multiple valuation approach and would be even more the case for the stronger adjusted multiple valuation approach or other positive deviations from the

FIGURE 7.9: A comparison between intrinsic- and valuation-multiple based valuations



Note: Comparison of valuations derived from valuation multiples (as conducted elsewhere) and intrinsic multiples relying on Equations 4.12 (p. 94) and 4.34 (p. 103) for price/earnings and enterprise value/EBIT, respectively. In both cases the null hypothesis according to which there is no difference between both methods is rejected on the basis of Wilcoxon sign-rank tests (W=6.733e+07 at a Holm-Bonferroni-adjusted $p \ll$ 0.0001 and W=6.573e+07 at a Holm-Bonferroni-adjusted $p \ll$ 0.0001, respectively). Effect sizes appear relatively substantial as indicated by the pairwise error difference distributions and materially higher levels of median and mean errors for intrinsic multiples. $\widetilde{u}^{a,log}$ and $\overline{u}^{a,log}$ denote the median and mean absolute valuation errors, respectively. Intrinsic multiples can be seen as intrinsic valuation concepts, so this Figure can be interpreted as displaying differences between (simplified) intrinsic and multiple valuations. Panel D displays density charts for the 3 different approaches: Intrinsic multiples distributions positively skewed and display wider dispersions than valuation multiples, which possibly contributes to their relatively weaker performance

It is important to be aware of limitations to generalize the results obtained regarding Hypothesis 3a to a relative assessment on the underperformance of *all* intrinsic valuation approaches

base line approach specified in Table 7.1 (p. 240) relative to multiple valuations or even more generally of the primacy of the Law of One Price over the concept of market efficiency. A potential point of criticism is that Equations 4.12 and 4.34 are overly simplistic versions of what should be more sophisticated fundamental valuation approaches and that this simplification leads to disadvantages for the quality of intrinsic valuations presented. However, it is fair to say that the intrinsic approaches, DDMs in the case of the price/earnings multiple and DCF models in the case of enterprise value/EBIT, are two different concepts with *high practical relevance*.[896] They have furthermore been implemented on the basis of formulas, which have strong support in textbook literature, including Koller et al. (2010) and Damodaran (2006). Moreover, techniques such as "fade factors" have been employed to ensure there are no obvious elements of oversimplification.[897] Finally the substantial and consistent effect sizes for both multiple types studied suggest that intrinsic (multiple) valuation would have "quite a long way to go" until it becomes competitive relative to the valuation multiple approach advocated for throughout this dissertation. Whilst valuation multiple approaches by their nature and through their simplicity presumably benefit from a higher degree of automation necessary for large sample studies, this automation avoids any unwarranted judgment for intrinsic valuations around aspects of cost of capital and terminal growth rates. Lastly, insofar as valuation costs come into play, one could argue that the simplified intrinsic valuation approach utilized is already more complex (and consequently costly) than the valuation multiple approach. Hence, at level playing field from a valuation cost perspective, valuation multiple approaches shine even brighter.

As discussed in the context of formulating Hypothesis 3a,[898] prior empirical literature on the topic is incomplete—given DCF and DDM valuations have not previously been matched up with trading multiples for larger market sample studies—and inconclusive, with somewhat more results pointing to a stronger performance of intrinsic (i.e. RIV) concepts. The results of a *clear and significant outperformance* of *valuation multiples* over *intrinsic* (multiple) *valuations* presented in this Subsection are therefore important additions to the body of empirical valuation literature.

TABLE 7.11: Absolute log valuation errors: Pearson correlation coefficients

		Price/earnings		Enterprise value/EBIT	
		Valuation multiples	Intrinsic multiples	Valuation multiples	Intrinsic multiples
Price/ earnings	Valuation multiples				
	Intrinsic multiples	0.29***			
Enterprise value/ EBIT	Valuation multiples	0.57***	0.17***		
	Intrinsic multiples	0.13***	0.62***	0.21***	

Note: Table depicts the Pearson correlation coefficients for the pairs of errors of valuation and intrinsic multiples as well as of selected multiple types (price/earnings, enterprise value/EBIT). Cross combinations of multiple types and valuation approaches less meaningful to interpret, hence grayed out. Correlations between identical variables withheld. p values of a t-test Holm-Bonferroni-adjusted and depicted with common codes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$

7.6.2.2 Some correlation between intrinsic and valuation multiple errors

In order to further analyze the relationship between intrinsic multiple and valuation multiple errors it is instructive to consider the correlation between those metrics: a high error correlation can be interpreted as the existence of certain firms under which *both* intrinsic and multiple-based valuations struggle or at the same time do well: in this event, little would be gained from a concurrent consideration of both approaches. Conversely, a low correlation would point to the ability of the two concepts to add to valuation precision over and above each other and, consequently, the valuation practitioner could benefit from employing both techniques concurrently or depending on the situation at hand.

Table 7.11 (p. 296) presents the results in form of Pearson correlation coefficients. Correlation coefficients between the absolute log errors of valuation multiples and the intrinsic (multiple) valuations amount to 0.29 for price/earnings and 0.21 for enterprise value/EBIT. Even though correlations between valuation multiple and intrinsic multiple errors are significant, the results suggest none the less that there might be merits to *concurrently consider* the two different valuation concepts proposed given the correlation coefficients differ substantially from 1. Thus, embedding elements of intrinsic multiple approaches can be expected to be beneficial to the accuracy levels of valuation multiple approaches.[899]

[896]Compare Matschke and Brösel (2013, p. 824) and Mondello (2017, p. 541) for survey studies on the importance of DCF models in particular as well as Schönefelder (2007, p. 74) for the case of fairness opinions specifically

[897]The relatively small sensitivity of fade factor variations documented in Figure 4.2 (p. 110) also suggests that fade factors, while being a technically suitable solution to the aspect of connecting shorter term explicit growth rate forecasts and longer-term macroeconomic growth rates, have little influence on intrinsic multiples and therefore it can be argued are not a main influencing factor of relatively weak intrinsic multiple performance

[898]Compare Subsection 4.7, p. 124

[899]An approach to operationalize such a hybrid concept will be presented in Subsection 7.9 (p. 314) under the

Table 7.11 also provides Pearson correlation coefficients between absolute log errors of different multiple types, i.e. price/earnings vs. enterprise value/EBIT. With 0.57 and 0.62 for valuation multiples and intrinsic multiples, respectively, correlations are highly significant. The results also suggest that a concurrent consideration of different multiple types might be beneficial—however, presumably *less so* than in the case of a combined intrinsic and valuation multiple approach given the higher levels of correlation.[900]

7.6.2.3 Strong relative valuation multiple performance is stable over time

An important follow-up question on the results presented in Figure 7.9 relates to whether the relatively inferior performance of intrinsic multiple valuations can be explained in a *systematic manner*. While there might be many reasons well beyond the scope of this dissertation for such systematic biases, I propose that two common aspects deserving further investigation relate to cyclicality and to generally higher—or as the case may be lower—outcomes of intrinsic valuations. Presumption of the former bias relates to proponents of market timing investors, who try to uncover and utilize to their benefit temporary market mis-pricing,[901] whilst the latter is motivated by some research, which points to challenges to justify (systematically lower) observed asset prices through (systematically higher) fundamental valuations.[902]

I will hence first analyze the relative performance of valuation multiple-based vs. intrinsic valuations over time, with a view to determine if certain time periods can be identified, where multiple-based valuations perform strongly or weakly relative to intrinsic valuations. This is also instructive to gain a more precise understanding of the quality of multiple valuations over time.

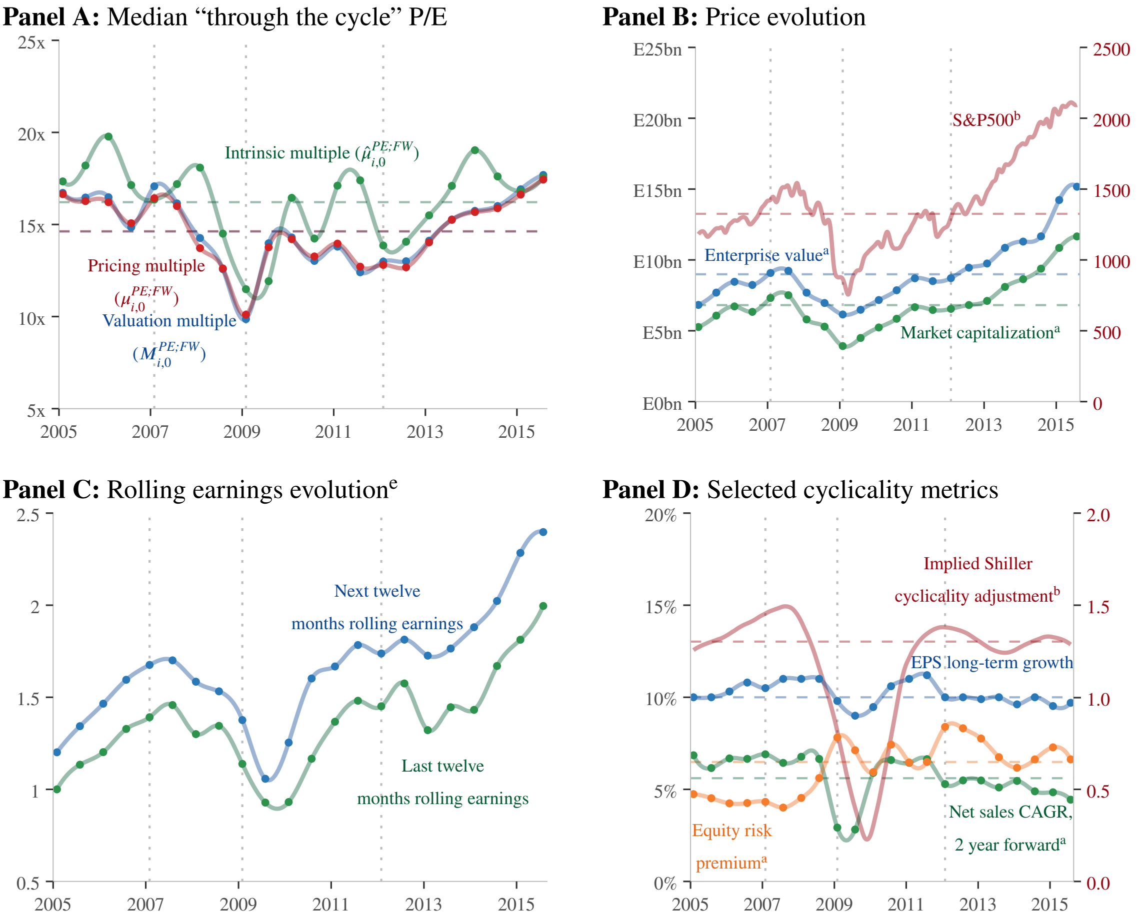
concept of weighted multiples

[900] An approach considering different multiple types will also be presented in Subsection 7.9 (p. 314)

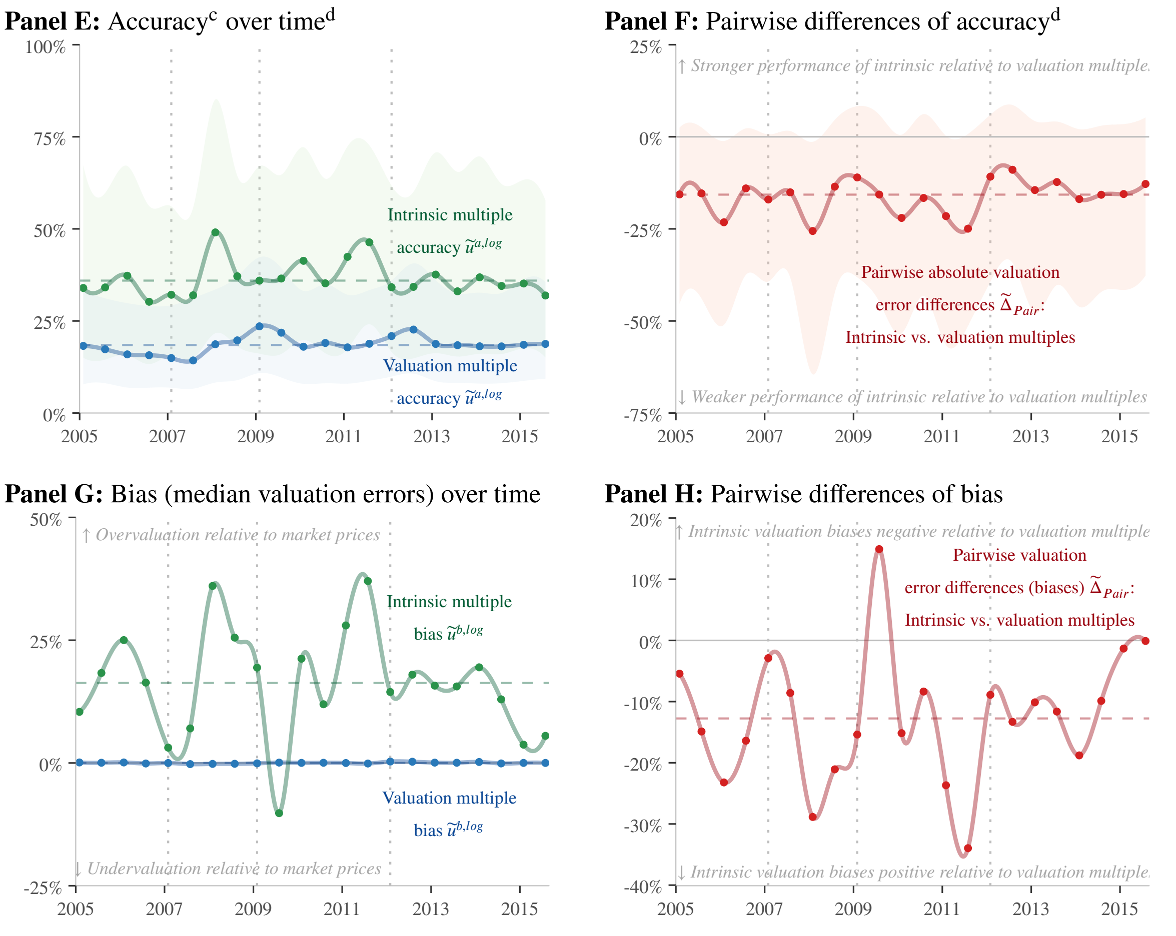
[901] Compare among many discussion by B. Graham: "[...] the endeavor to buy stocks when they are quoted below their fair value and to sell them when they rise above such value" (1949, p. 189) or for more recent considerations around stock market bubbles consistent with this aspect the books of Shiller (2015) titled "Irrational Exuberance" and of Malkiel (2015), "A random walk down Wall Street," both of which have received considerable public attention. Essentially the discussion around market timing is one of market efficiency, compare Subsection 2.2 (p. 35) for further theoretical background

[902] Compare e.g. Berndt, Deglmann, and Schulz (2014) for an analysis of Swiss fairness opinions. Results suggest that, whilst trading multiple valuations presented in fairness opinions are broadly consistent with unaffected market prices, fundamental valuations are more in line with inflated takeover offers, even prior to the consideration of any synergies. One possible interpretation of such mis-pricing relates to the concept of minority discounts, according to which trading valuation may reflect the fact that typically no control changes hands on stock exchange transactions, compare Subsection 2.2 (p.35) for further theoretical background

FIGURE 7.10: Illustrating valuation and intrinsic multiple accuracy over time



Note: Panels A–F display spline-interpolated medians (lines) on the basis of the 22 discrete measurement time periods between January 2005 and July 2015 (dots) of the respective variables; horizontal dashed lines indicate over-time medians of the full underlying dataset (as opposed to medians of over-time medians) where appropriate; [a] left hand side scales apply [b] right hand side scales apply; Implied Shiller cyclicality adjustment computed as CAPE divided by corresponding P/E LTM, effectively a quotient of the LTM earnings and 10 year past inflation-adjusted earnings at respective measurement date, both obtained from Shiller (2018) for comparability purposes and shown on a monthly basis [c] median absolute valuation errors [d] pale-colored "ribbons" show interquartile ranges [e] Rebased to last twelve months rolling earnings (Jan-2005 = 1)



Note: Panels to be read in conjunction with Panels and notes on the facing page

Illustrative interpretation based on Figures presented Figure 7.10 (p. 298) provides a directional analysis in a visual manner for the price/earnings multiple using definitions shown elsewhere:

- As expected, there exists over-time *volatility* in pricing, valuation and intrinsic multiples (Panel A), which can be linked to volatility in prices (Panel B) and volatility in the earnings evolution (Panel C). Valuation multiple biases net off against each other consistently over time as far as median is concerned (Panel G, blue line), which had been observed already for the pooled sample[903] and there is some variation in valuation multiple accuracy over time, ranging from 23.5% to 14.3% (Panel E, blue line)
- Over-time variation of intrinsic multiple accuracy and bias (green lines in Panels E and G, respectively) appears *more pronounced* compared to valuation multiples. Intrinsic multiples tend to be positively biased suggesting *over-valuations* might occur.[904] This aspect requires further assessment given its presumable *systematic* nature[905]
- Across all time periods, valuation multiples appear to outperform intrinsic multiples in about 75% of cases,[906] with median error differences over time amounting to -15.7%-pts, as indicated in Panel F
- Valuation multiples appear to perform less accurate (higher median absolute valuation error in Panel E) at times shortly before receding financial forecasts reach their minima as can be seen when considering the January 2009 and July 2012 data points for multiple valuation and the 6 month lagging local minima for forward earnings forecasts in July 2009 and January 2013, respectively. I speculate that this may have to do with earnings forecasts not having fully caught up yet with price contractions and their hence smaller ability to predict prices at those times
- Intrinsic multiples appear to perform particularly poorly as indicated in Panel E at times when growth trajectory forecasts have not caught up with contracting share prices (as was the case in 2008) or when growth forecasts appear to expand quicker than share prices (as was the case in 2011). Those timing differentials *amplify over-valuations* of the intrinsic approach as shown in Panel G

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[903] Compare Table 7.4 (p. 249)
[904] With the notable exception of the July 2009 measurement point during the financial crisis
[905] Compare below and Figure 7.11 (p. 302) for additional details
[906] As indicated by the 25% quantile of pairwise differences hovering around 0% pairwise differences in Panel F

- A further visual inspection of Panel E suggests that both intrinsic and valuation multiples display a somewhat constant base level of valuation quality over time, which is interrupted by their respective points in times of poor performance described above. In other words the asymmetrical nature of valuation quality over time challenges the identification of times when either valuation approach performs particularly *well*

To summarize, the graphical interpretation of time effects suggests that valuation multiple approaches outperform the proposed intrinsic (multiple) valuations consistently over time. There are (different) times when both valuation multiples and intrinsic multiples perform in a particularly unfavorable manner,[907] which relate to timing differences between stock prices as well as forward earnings and forward growth trajectory, respectively for valuation and intrinsic multiples. This temporary dissonance of underlying fundamental financials or forecasts and market prices is discussed in the context of momentum investment strategies, which rely on systematic temporary mis-pricings resulting from delayed investor reactions.[908]

To provide a more formal statistical analysis, a logit regression with "outperformance of intrinsic valuations over valuation multiples" as dependent variable was conducted, with results reported in the Appendix.[909] Whilst partly significant, effect sizes are relatively small and coefficients of determination rather low, suggesting a more sophisticated approach beyond the scope of this dissertation would be on order.

The question of systematic intrinsic over-valuations As discussed, Panel G of Figure 7.10 suggests that the proposed intrinsic multiple approach might result in *systematic over-valuations*. In order to investigate this proposition further, Figure 7.11 (p. 302) provides a sensitivity of applying different levels of discounts and premia *indiscriminately* to all intrinsic multiple valuations.

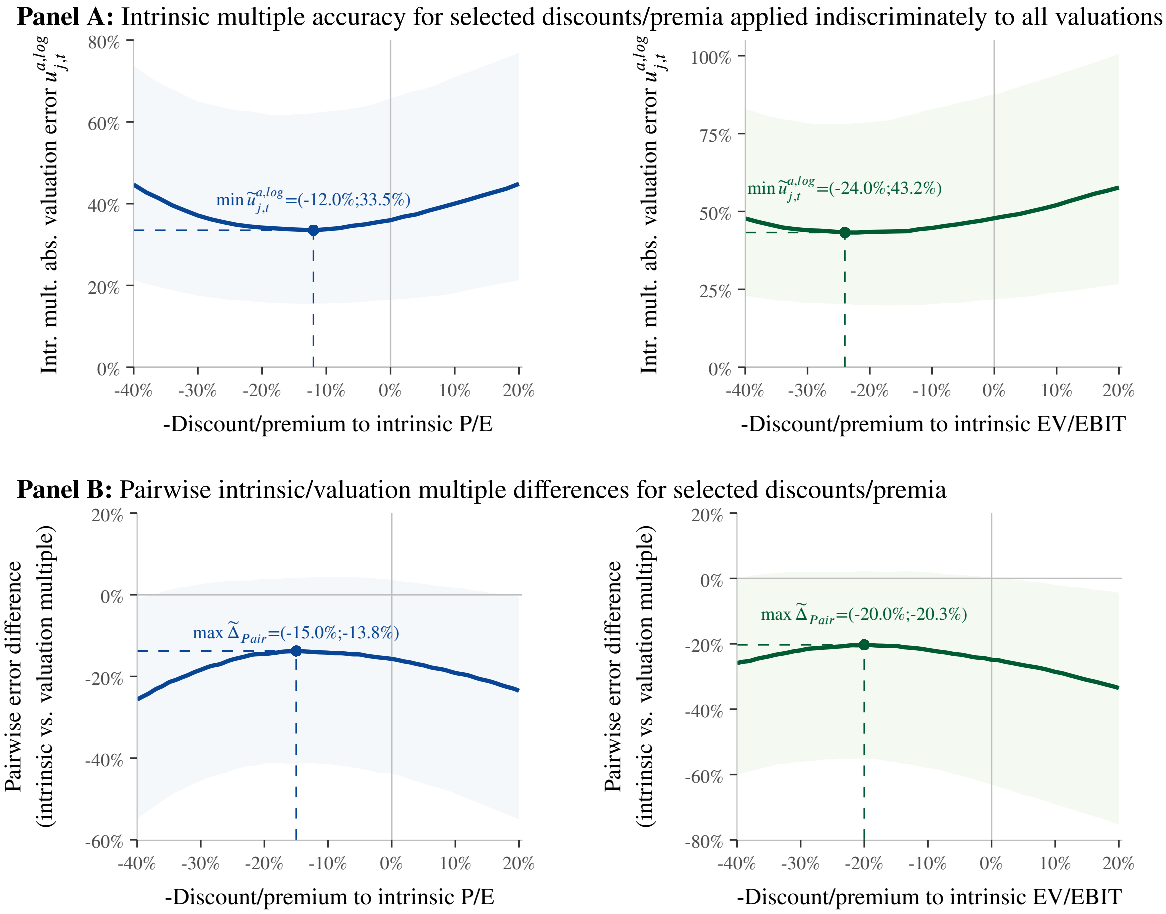
This parsimonious approach of adjusting all intrinsic multiple valuation outcomes by a pre-determined percentage as specified on the x-axes of all charts in Figure 7.11 indicates that a 12.0% discount applied to all intrinsic price/earnings valuations—i.e. effectively to all DDM valuations computed in accordance with Equation 4.12—and a 24.0% discount to the equity valuations—i.e. to all DCF model valuations calculated on the basis of Equation

[907] However, in turn, no time periods are particularly favorable, especially for intrinsic multiples (Panel E)

[908] For analyses considering earnings announcements and stock prices more specifically compare e.g. Bernard and Thomas (1990) and Brown and Han (2000); the ability, however, to achieve excess returns on the basis of such strategies is doubted by some authors; compare e.g. Koller et al. (2010, p. 388) or Cochrane (2005, p. 452)

[909] Compare Table A.6, p. A38

FIGURE 7.11: Investigating systematic over-valuations of intrinsic multiples



Note: Figures sensitize the impact of different discounts or premia (as indicated on the *x*-axes) on absolute log valuation errors of intrinsic multiples (Intrinsic P/E computed in accordance with Equation 4.12 with roots in the dividend discount model and EV/EBIT computed on the basis of Equation 4.34 relating to discounted cash flow valuations) in Panel A and on pairwise absolute error differences to valuation multiples in Panel B. Discounts applied indiscriminately to all *equity* valuation outcomes suggested by the respective Equations for each firm under investigation. Line indicates median errors or pairwise differences, pale shaded area ("ribbons") relate to interquartile ranges. Values displayed at 0% premium/discount tie with respective numbers in Figure 7.9

4.34 —minimizes median absolute valuation errors and thus maximizes valuation accuracy. Application of discounts to intrinsic (multiple) valuations moreover somewhat improves the relative performance of the intrinsic over the valuation multiple approach. However, *valuation multiples continue to outperform intrinsic multiples*, as indicated by Panel B of Figure 7.11.

Results in Figure 7.11 can be interpreted as evidence that the chosen intrinsic multiple approaches indeed produce systematic over-valuation and it might be beneficial to normalize such over-valuation through the application of discounts. Furthermore, results are consistent with prior findings by Berndt, Deglmann, and Schulz (2014, p. 28), who find that in the context of

Swiss fairness opinions, (standalone) intrinsic valuations are in line with the offered takeover prices and, more crucial for this context of publicly traded companies not impacted by any takeover situations, are at premium to unaffected trading value of 21.0% or 11.8%, respectively for arithmetic mean and median. The intrinsic (multiple) valuation approach utilized in this dissertation relies on simplified formulaic concepts rather than sophisticated DCF approaches prepared in a tailored manner for each company under investigation as is the case for fairness opinions. None the less results are directionally similar in that intrinsic valuations appear to systematically result in c. 12–25% higher valuations than valuation multiple-based concepts. The results can therefore, first, be interpreted as a confirmation of the findings of Berndt, Deglmann, and Schulz (2014) and, second, suggest that the formulaic approach for intrinsic (multiple) valuation in this dissertation might not necessarily suffer from undercomplexity biases.

Furthermore, I assert that the over-valuation suggested by intrinsic concepts may relate to *discounts for non-control* implicitly applied to trading multiple valuations. The existence of such over-valuations is of crucial relevance to valuation practitioners to avoid a potential fallacy in which intrinsic valuations are used to screen for presumably undervalued publicly traded firms: While a market underpricing relative to intrinsic valuation may indeed exist it, would be challenging to capitalize on it assuming it is systematic in nature.[910] Interestingly, both DDM-based intrinsic valuation multiples and DCF-based intrinsic valuation multiples appear to suffer from over-valuation bias. Whilst the bias appears more pronounced for DCF approaches,[911] the presence of such biases for DDM concepts can be interpreted to contrast the argument by some authors[912] to utilize DDMs for minority stakes. Under the assumption that intrinsic concepts theoretically produce unbiased valuations, the empirical findings in this Subsection therefore suggest that it is preferable to speak of *minority discounts* of trading multiple valuations rather than *control premia* of intrinsic valuations. Finally, I do not argue that a minority discount is appropriate in valuing companies where only smaller non-controlling stakes change hands[913] but merely interpret the evidence that such discount

[910] A further comparison analysis of intrinsic and multiple-based valuations would definitely be on order but is beyond the scope of this dissertation primarily concerned with meaningful valuation multiples rather than potential shortcomings of other concepts

[911] 24.0% vs. 12.0% for DDM based concepts

[912] e.g Mondello (2017, p. 272)

[913] On the contrary, such argument would but be difficult ot advocate for given intrinsic valuations are based on costs of capital generally computed on the basis of market valuations using minority pricings and forecasts current management is expected to achieve and thus should in theory be consistent with market valuations. Further theoretical arguments against minority discounts can be found in Mercer and Harms (2008, p. 81). Premia in strategic takeovers might be misleading given the value of combination synergies (Pratt, 2005,

might implicitly be considered in trading valuations.

7.7 Valuation biases as consequence of peer characteristics (Hypothesis 3b)

7.7.1 Valuation errors and input variables/intrinsic multiple models

Hypothesis 3b suggests that valuation errors might be linked to differences *in financial characteristics* between peer firms and the company under investigation. In order to investigate this further, I follow the approach of Henschke (2009, pp. 69–71), which is a multiple linear regression with the valuation error as dependent variable and differences of financial characteristics for the company under investigation vs. peer group medians as independent variables.[914] Contrary to the assessment of multiple valuation accuracy, which is relying on *absolute* log errors, there might be explanatory power in signs of errors, hence *bias* as opposed to accuracy is utilized.[915] Modeling financial characteristic *differences* relative to median peer group values rather than financial characteristics relative to peer group averages themselves is more consistent with the nature of valuation errors: the intuitive interpretation will be that high (low) differences in financial characteristics should explain high (low) valuation errors. For presentational purposes I limit the assessment to the multiple types of price/earnings and enterprise value/EBIT. Whilst the dependent variable will always be the log valuation bias, a number of regression models will be estimated, comprising the following independent variables:

- Regressions considering the *intrinsic input variables* proposed by the respective equations for price/earnings and enterprise value/EBIT proposed in Chapter 4, notably Equations 4.12 (p. 94) and 4.34 (p. 103) for price/earnings and enterprise value/EBIT, respectively

p. 146; Garber, 1998) and premia management buyouts can be justified by the ambition of the management to change the strategy (and consequently future financials) in a private context, which would not be possible in a public context. Consistent with the divergence of trading multiple valuation and intrinsic valuation and a presumption that the true value is determined by intrinsic approaches, U.S. courts have applied a concept of implied or inherent minority discount, which makes whole minority shareholders with additional premia (Matthews, 2008, p. 108; Booth, 2001)

[914] Compared to Henschke (2009, pp. 69–71), I swap signs of the differences between median peer values and the value for the firm under investigation as this results in directional consistency with the valuation bias computations set out in Table 6.2 (p. 223) and consequently more intuitive prediction directions. I note the prediction directions are broadly in line with Henschke (2009, pp. 69–71), however signs are inverted

[915] Compare Table 6.2, p. 223

- Regressions also considering *additional input variables*, even though not reflected in Equations 4.12 and 4.34 such as: size, expressed by the natural logarithm of enterprise value; profitability, expressed by EBIT/net sales, i.e. EBIT margin; and a dummy variable for the U.S. vs. European subsamples. While there is a somewhat more challenging case to make to include those variables from a theoretical perspective, they are none the less common in corporate finance studies and hence deserve to be considered, too

- For price/earnings, regressions relating to aspects often quoted as particular shortcomings of price/earnings as a multiple type such as *financial leverage* and *tax rate* differences.[916] The expectation is that large discrepancies in financial leverage and tax rates between the company under investigation and its peers might lead to biased valuations if market participants consider them relevant factors in establishing valuation levels and high explanatory power suggests that the theory of price/earnings shortcomings is empirically justified

- Regressions of the intrinsic multiple model-suggested *valuation difference* between the firm under investigation and a hypothetical peer firm, for which all financial input variables in Equations 4.12 and 4.34, respectively, amount to the median peer values.[917] This is partly motivated by the fact that the analysis presented in Chapter 4 suggests that the input variables in Equations 4.12 and 4.34 are conceptually not independent: as e.g. shown in Table 4.1 (p. 96), positive growth should have positive impact on valuation if the return on equity exceeds the cost of equity but a negative impact if cost of equity exceeds return on equity. Furthermore, the relationship between valuation and financial input variables appears to be nonlinear as suggested by Figure 4.2 (p. 110). As an alternative to utilizing hypothetical peer firms with median financial input variables I also report results relying on *median intrinsic multiples* for the peer group[918]

[916] Compare Subsection 2.4.2.1 (p. 55) and Table 2.3 (p. 59) specifically

[917] This concept is labeled "median inputs" approach in Tables 7.12 and 7.13, with the hypothetical peer firm intrinsic multiple denoted by $\hat{\mu}^{PE;FW}_{\underbrace{}_{inputs,j}}$. Mimicking the computation of log valuation biases (compare Table 6.2, p. 223) the differences of logs are chosen

[918] Median intrinsic multiples for the peer group are denoted by $\ln\left(\widetilde{\hat{\mu}_i^{EBIT;FW}}\right)_j$, where i signifies the peer index and j signifies the index for the firm under investigation

Table 7.12: Regression of selected input variables on log valuation biases: P/E

		Ordinary least square regressions					
		Dependent variable: log valuation biases $u_j^{b,log}$					
	Pred.	(1)	(2)	(3)	(4)	(5)	(6)
Individual intrinsic multiple inputs							
Δ Comparable LT growth	+[a]	3.1867***	3.3089***				2.5817***
$\left(\widetilde{g_i^{comp}}\right)_j - g_j^{comp}$		(26.36)	(25.87)				(20.44)
Δ Return on equity	+[a]	-0.0298***	-0.0303***				-0.0297***
$\left(\widetilde{r_i^{ROE}}\right)_j - r_j^{ROE}$		(-33.30)	(-34.14)				(-36.48)
Δ Cost of equity	−[a]	-3.0411***	-3.0069***				-3.9653***
$\left(\widetilde{r_i^{eq}}\right)_j - r_j^{eq}$		(-17.97)	(-17.83)				(-18.09)
Other common input variables							
Δ ln(Enterprise value)	?		-0.0148***				-0.0077
			(-5.23)				(-2.88)
Δ EBIT margin	+		0.2533***				0.3383***
			(7.84)				(10.90)
U.S. obs (dummy)	?		-0.0741***				-0.0729***
			(-12.07)				(-12.40)
Conceptually "questionable aspects" of P/E multiples[b]							
Δ Net debt/EBITDA	?			-0.0016			-0.0240***
				(-2.83)			(-12.43)
Δ Tax rate	?			0.1368**			0.0414
				(3.75)			(1.17)
Intrinsic multiple deviations							
Δ to peer median	+				0.0640***		0.0514*
$\ln\left(\widetilde{\hat{\mu}_i^{PE;FW}}\right)_j - \ln\left(\hat{\mu}_j^{PE;FW}\right)$					(11.94)		(3.54)
Δ to median inputs	+					0.0544***	-0.0845***
$\ln\left(\hat{\mu}_{\widetilde{inputs},j}^{PE;FW}\right) - \ln\left(\hat{\mu}_j^{PE;FW}\right)$						(10.52)	(-6.01)
Intercept		-0.0192***	0.0116	-0.0276	0.0073***	0.0099*	0.0230***
		(-6.54)	(3.06)	(-9.47)	(2.45)	(3.33)	(6.23)
Observations		13769	13602	18208	13020	13001	12832
R^2		13.0%	14.6%	0.1%	1.1%	0.8%	16.8%
Adjusted R^2		12.9%	14.6%	0.1%	1.1%	0.8%	16.7%
F statistic		682.60***	388.83***	10.99***	142.54***	110.77***	259.15***
df		(3;13765)	(6;13595)	(2;18205)	(1;13018)	(1;12999)	(10;12821)

Note: Table presents the results of 6 multiple ordinary least square linear regressions (columns denoted (1)–(6)). Regressions specified as $\left(\widetilde{u}_j^{b,log}\right)_j = \beta_0 + \sum_{p=1}^{P} \beta_p x_{p,j} + \varepsilon_j$, where j is the index for the number of valuations assessed (observations) and p is the index for the $P = 3, 6, 2, 1, 1$ and 9 independent variables considered in regressions (1), (2), (3), (4), (5) and (6), respectively, and indicated in the first 9 row pairs. Independent variables selected on the basis of Equation 4.12 and other common regressants. The dependent variable $u_{j,t}^{a,bias}$ is defined as log valuation biases for price/earnings. For each independent variable, the signed slope, its level of Holm-Bonferroni-adjusted significance (common codes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$) and the respective t-statistic (in parentheses) is displayed. [a] Predictions based on "median" sample case for $g_j^{comp} > 0$ and $r_j^{ROE} > r_j^{eq}$

[b] Relates to theoretical shortcomings sometimes quoted against P/E multiples (lack of leverage and tax rate normalization)

TABLE 7.13: Regression of selected input variables on log valuation biases: EV/EBIT

		Ordinary least square regressions				
		Dependent variable: log valuation biases $u_j^{b,log}$				
	Pred.	(1)	(2)	(4)	(5)	(6)
Individual intrinsic multiple inputs						
Δ Comparable LT growth	+[a]	3.2815 ***	3.2483 ***			2.8358 ***
$\left(\widetilde{g_i^{comp}}\right)_j - g_j^{comp}$		(20.44)	(20.05)			(17.90)
Δ Return on invested capital	+[a]	0.00011	0.00012			0.0003
$\left(\widetilde{r_i^{ROIC}}\right)_j - r_j^{ROIC}$		(0.28)	(0.30)			(0.86)
Δ Tax rate	−	-0.3465 ***	-0.3721 ***			-0.6137 ***
$\left(\widetilde{\tau_i}\right)_j - \tau_j$		(-7.36)	(-7.75)			(-13.22)
Δ Risk free rate	−	-0.4029	0.5002			-2.8345 ***
$\left(\widetilde{r_i^{rf}}\right)_j - r_j^{rf}$		(-0.75)	(0.84)			(-4.76)
Δ Equity beta	−	-0.1250 ***	-0.1317 ***			-0.2960 ***
$\left(\widetilde{\beta_i^{eq}}\right)_j - \beta_j^{eq}$		(-8.79)	(-9.04)			(-17.00)
Δ Financial leverage	+	0.1424 ***	0.1442 ***			0.2179 ***
$\left(\widetilde{\lambda_i}\right)_j - \lambda_j$		(7.10)	(7.11)			(10.87)
Other common input variables						
Δ ln(Enterprise value)	?		0.0122 *			0.0096
			(3.36)			(2.84)
Δ EBIT margin	+		0.0566			0.1623 **
			(1.37)			(4.18)
U.S. obs (dummy)	?		-0.0227			-0.0439 ***
			(-2.58)			(-5.28)
Intrinsic multiple deviations						
Δ Intrinsic multiple peer median	+			0.0106		-0.0111
$\ln\left(\widetilde{\hat{\mu}_i^{EBIT;FW}}\right)_j - \ln\left(\hat{\mu}_j^{EBIT;FW}\right)$				(1.84)		(-0.71)
Δ Intrinsic multiple, median inputs	+				0.0065	-0.0842 ***
$\ln\left(\hat{\mu}_{\widetilde{inputs},j}^{EBIT;FW}\right) - \ln\left(\hat{\mu}_j^{EBIT;FW}\right)$					(1.20)	(-5.53)
Intercept		-0.0185 ***	-0.0060	0.00052	0.00042	0.0161
		(-4.94)	(-1.13)	(0.15)	(0.12)	(3.18)
Observations		13690	13530	12678	12634	12485
R^2		3.9%	4.1%	0.03%	0.01%	5.4%
Adjusted R^2		3.9%	4.0%	0.02%	0.003%	5.4%
F statistic		93.10 ***	63.84 ***	3.40	1.44	65.18 ***
df		(6;13683)	(9;13520)	(1;12676)	(1;12632)	(11;12473)

Note: Notes to Table 7.12 apply. Independent variables selected on the basis of Equation 4.34 and other common regressants, excluding r_{ERP}, which is a constant for each measurement date

[a] Predictions based on "median" sample case as shown in Figure 4.1 (p.107) for $g_j^{comp} > 0$ and $r_j^{ROIC} > r_j^{WACC}$. Note Regression number (3) not allocated for comparison with precedent regression on P/E

7.7.2 Some explanatory power of individual input variables

Intrinsic input variables Tables 7.12 (p. 306) and 7.13 (p. 307) present the results of the regressions for price/earnings and enterprise value/EBIT, respectively. Columns denoted with (1) in both Tables 7.12 and 7.13 display the regression parameters for models, which solely consider the input variable differences suggested by intrinsic multiples in Equations 4.12 and 4.34. Regression slope results are for the most part consistent with the predicted directions on the basis of Equations 4.12 and 4.34 and, for enterprise value/EBIT, as displayed in Figure 4.2 (p. 110):[919] [920] e.g. a rate of growth of the peer group higher than of the individual company under investigation should result in a positive bias (over-valuation of the multiple-based concept) for the company under investigation since, despite its actually lower growth rate presumably correctly reflected in its pricing multiple, its valuation multiple is in line with the higher growth rate of its peers. Coefficients of determination of the regressions denoted with (1) are at the lower end of the findings of Henschke (2009, p. 82)[921] and I speculate that those lower coefficients of determination could be related to better overall levels of valuation accuracy in my study.[922] Results in columns denoted with (2) relate to regressions, which add common factors such as size differences (expressed by log enterprise value), profitability (expressed by EBIT margin) as well as a dummy variable for the U.S. subsample (relative to the European subsample). As expected given the addition of incremental variables, coefficients of determination improve somewhat—but not greatly. All three input variables have significant impact on the regression quality as indicated by the respective t-statistic in the case of price/earnings multiples, however, not for enterprise value/EBIT multiples.

[919] It is worth noting that, as explained in Subsections 4.2.2 (p. 94) and 4.3.3 (p. 109) in greater detail, those predictions rely on “median” cases, i.e. $g_j^{comp} > 0$ and $r_j^{ROE} > r_j^{eq}$ in the case of price/earnings and $g_j^{comp} > 0$ and $r_j^{ROIC} > r_j^{WACC}$ for enterprise value/EBIT. Other relationships between those (and other) input variables can well change the predicted impact

[920] The notable exception to directional expectations is return on equity, for which a positive impact had been anticipated but a (small) negative impact results

[921] Who obtains R^2s of between 14.5% and 40.4%, depending on the choice of underlying valuation driver forecasts for price/earnings multiples—albeit at higher absolute valuation errors, where medians amount to between 21.0% and 28.2% (Henschke, 2009, p. 80) and on the basis of independent variables chosen more at random

[922] There appears to be a potential negative correlation between valuation accuracy and coefficients of determination if the joint results presented in this Subsection and the results obtained by Henschke (2009, pp. 80,82) are considered: Hence lower valuation errors appear more challenging to further explain through financial inputs

Leverage and tax rate The regression denoted with (3) in Table 7.12 aims to analyze shortcomings of price/earnings multiples more specifically, namely the missing normalization for different leverage levels and tax rates among peers.[923] Results, however, suggest very little linear influence of leverage—expressed using the practically common metric of net debt/EBITDA—or tax rate. This points to a lack of impact of leverage and tax rates on multiple valuation biases, which I interpret as an indication for the absence of systematic bias of the theoretically considered shortcomings of price/earnings multiples.[924]

Intrinsic multiple-predicted deviations In order to address conceptual shortcomings of regressions presented under (1) and (2), such as notably the non-linearity of the relationships and the lack of independence between the variables—i.e. the varying directional impact of variables depending on values of other variables—suggested by the theoretical model considerations in Chapter 4, regressions denoted with column numbers (4) and (5) follow a different approach: Much like the computation for the dependent variable, the log valuation bias $u_j^{b,log}$, a *model-expected intrinsic log valuation bias* is computed through a comparison of individual observation intrinsic multiples with median peer-derived intrinsic multiples. The approach is motivated by the objective to explain multiple-based valuation errors through discrepancies in intrinsic valuations relative to peer intrinsic valuations. In the case of regressions denoted by (4), intrinsic peer multiples are obtained using Equations 4.12 and 4.34 as the median of all respective intrinsic multiples of the peers for the respective observation. Consistent with Equation 6.14[925] for log biases of valuation multiples, intrinsic "biases" (or more precisely: deviations) for price/earnings multiples can then be computed as[926]

$$\hat{u}_{peermedian,j}^{b,log} = \ln\left(\widetilde{\hat{\mu}_i^{FW}}\right)_j - \ln\left(\hat{\mu}_j^{FW}\right) \tag{7.2}$$

As an alternative to the regressions under (4), intrinsic peer multiples for regressions under (5) are computed on the basis of a hypothetical peer, which is assumed to be valued at the peer median intrinsic valuation inputs. Consequently, intrinsic deviations can be calculated as

$$\hat{u}_{medianinputs,j}^{b,log} = \ln\left(\hat{\mu}_{\widetilde{inputs},j}^{FW}\right) - \ln\left(\hat{\mu}_j^{FW}\right) \tag{7.3}$$

[923] For ease of reference between Tables 7.12 and 7.13, Regression (3) is not assigned in Table 7.13

[924] Additional evidence on this aspect is presented in Subsection 7.2.6 (p. 263) on the basis of relative performance of price/earnings as a multiple type

[925] Compare Table 6.2, p. 223

[926] For simplicity reasons, both price/earnings and enterprise value/EBIT multiples are computed using the same respective equations. No adjustments for differing levels of leverage is undertaken for enterprise value/EBIT

Whilst results for the regressions in columns (4) and (5) for the price/earnings multiple are significant and slopes directionally consistent with predictions, the coefficients of determination are unfortunately rather low, indicating that intrinsic deviations are likely unable to explain reasonably substantial amount of valuation multiple biases.

Regression results in columns (6) consider all of the above mentioned independent variables and do not appear to display any contravening results compared to the other regressions; however, they neither appear to produce any additional insights and hence should be considered for reference only.

To summarize, it appears that the individual financial input variables impacting the levels of price/earnings multiples such as growth, return on equity and cost of equity indeed explain part of the valuation errors of multiple valuations, in particular as far as price/earnings multiples are concerned. This at least partly confirms Hypothesis 3b. However, more sophisticated concepts, which in theory should be superior to considering individual variables, notably the proposed intrinsic multiple bias approach, fail to explain a material amount of valuation errors and results appear all together weaker for enterprise value/EBIT. Whilst it cannot be excluded that unsuitable approaches to analyze multiple valuation errors have been chosen, the overall limited ability to explain multiple valuation errors through the impact of financial input variables suggests that multiple valuation appears able to consider some unknown factors beyond financial input variables; this can be interpreted as an important aspect of multiple valuation over concepts such as DCF approaches, which rely to a considerable extent on financial input variables. In any even the question remains if a meaningful improvement in valuation multiple accuracy can be achieved if the peer group selection reflects financial input variables; such analysis follows in the next Subsection.

7.8 Valuation accuracy and peer weights in regards to Hypothesis 3c

7.8.1 A novel concept to measure improved multiple valuation accuracy

Hypothesis 3c (p. 128) argues that improvements in multiple valuations should be possible if the differing financial characteristics of peer companies are considered during aggregation. This is motivated by the deliberations in Chapter 4 around intrinsic multiples. It has furthermore been confirmed in precedent studies, which follow two general approaches: *modifications* to valuation (Henschke, 2009, p. 77) or pricing (Bhojraj & Lee, 2002, p. 415) multiples and *sub-selection* of the most similar peer firms on the basis of an algorithm, which identifies the top 6 (Alford, 1992, pp. 98–99) or top 10 (Henschke, 2009, p. 85) closest peers or cuts off a percentage of peers based on dis-similarity of selected input variables (e.g. "acceptable deviations" approach by Herrmann and Richter, 2003, pp. 208–211). Whilst those approaches document improvement potential of multiple valuations, they suffer from (a) their arbitrary nature—e.g. why are 6 peers the right number? what determines acceptable deviations?—and (b) a level of complexity and consequently valuation cost, which might be beyond practicability in real valuation settings (modified multiples).

In order to further assess the impact of financial differences within the peer group on valuation accuracy I propose the alternative *"peer weight" approach*: Instead of weighting each peer at equal proportion in the determination of valuation multiples, the peer weight approach relies on weighting peers with *higher similarity* to the company under investigation at a *higher proportion* and—without disregarding any peers—comparables, which are *less similar* at a *lower proportion*. The peer weight approach requires 3 core steps:

- First, an *algorithm for determining similarity* has to be established. Despite lackluster empirical performance in assessing valuation errors,[927] the concept of intrinsic multiples can presumably be useful in achieving this objective: For each company under investigation, the intrinsic multiple deviations $\hat{u}^{a,log}_{j,i}$ between itself and each of its peers are computed:[928]

$$\hat{u}^{a,log}_{j,i} = \left| \ln\left(\hat{\mu}_j\right) - \ln\left(\hat{\mu}_{j,i}\right) \right| \tag{7.4}$$

  where $\hat{\mu}_{j,i}$ is the intrinsic multiple of the i^{th} peer of the j^{th} company under investigation (observation) and $\hat{\mu}_j$ is the intrinsic multiple of the j^{th} company under investigation. Once those intrinsic absolute log deviations have been computed for each observation, they can be ranked:

$$RNK_{j,i} = \text{rank}\left(\hat{u}^{a,log}_{j,i}\right) \tag{7.5}$$

  among all I_j peer deviations $\hat{u}^{a,log}_{j,i=1,\dots,I}$ for the j^{th} firm under investigation. This per-observation ranking forms the basis for the similarity criterion. The underlying logic

[927] Compare previous Subsection 7.7.2, p. 308

[928] The approach follows the computation of absolute log errors for consistency reasons. Results are comparable to expressing errors in "turns" of multiples given the subsequently applied ranking procedure

is that peers with smaller (greater) discrepancy in intrinsic multiples should be more (less) similar and hence weighted over-(under-)proportionately

- Second, once the ranking is established, it needs to be transformed into a *weighting scheme*. To avoid excessive judgment, I rely on a flexible approach, which can be sensitized for varying weighting approaches, the rank exponent weight method (Roszkowska, 2013, p. 20; Danielson & Ekenberg, 2017, p. 23), in which the I weights $w_{i,t}$ for the j^{th} company under investigation (observation) are given by:

$$w_{j,i} = \frac{\left(I_j - RNK_{j,i} + 1\right)^p}{\sum_{i=1}^{I} \left(I_j - RNK_{j,i} + 1\right)^p} \tag{7.6}$$

  The rank exponent weight method is a *generalized rank sum concept* in that it allows, via the exponent factor p, an "acceleration" ($p > 1$) or a "deceleration" ($p < 1$) of the standard rank sum method ($p = 1$). For $p = 0$, it also entails the equal-weighted approach. Its attractions are therefore that for varying levels of p, a sensitivity of gradual weight acceleration can be provided, avoiding ex ante judgment on the potentially appropriate value for p. A sensitivity of resulting weights depending on varying levels of p is presented in Panel A of Figure 7.12 (p. 318)

- Third, based on the weighting scheme, *weighted valuation multiples* need to be computed. This is straightforward and common for some aggregation methods such as arithmetic mean, whilst for median it is necessary to rely on the somewhat rarer concept of *"weighted median"* introduced in Subsection 6.3.2.3 (p. 204).[929] Given the somewhat esoteric nature of the weighted median, I also report errors using the weighted harmonic mean concept, which can be traced back to the usual weighted arithmetic mean approach

I believe that the weighted peers concept offers a core advantage over existing concepts with an objective to improve peer valuation: *Consistency with intuition*. When assessing peer groups and determining valuations, I argue that valuation practitioners will often times be implicitly led by the argument of giving more weight to peers with a perceived high degree of similarity and less weight to others. Thus an algorithm, which implements this approach, should be preferable over approaches, which simply cut down on the number of peers according to potentially arbitrary criteria.[930]

[929] Weighted median is also implemented in a number of packages for the statistical software used throughout this dissertation, RStudio. I notably rely on the implementation in package `matrixStats`

[930] The weighted peer approach is not necessarily one to be recommended to valuation practitioners but more of

7.8.2 Peer weighting: meaningful improvement in valuation accuracy

Panels B and C of Figure 7.12 (p. 318) present the results of the analysis for price/earnings and enterprise value/EBIT. Under the ex post optimal weight acceleration parameter setting of c. 1,[931] median log valuation errors improve from 17.4% for price/earnings and 19.3% for enterprise value/EBIT, respectively, in the equal-peer weighted approach by approximately 0.507%-pts for price/earnings and 0.203%-pts for enterprise value/EBIT to 16.9% for price/earnings and 19.1% for enterprise value/EBIT, respectively, in the optimally weighted approach.[932] [933] Results are directionally consistent for weighted harmonic mean as an aggregation principle and between price/earnings and enterprise value/EBIT. A value of approximately $p = 1$ suggests the *classical rank sum weighting method* outperforms accelerated or decelerated weighting methods. If p is varied to values of c. 2–3, valuation errors appear to revert back to levels observed for non-weighted errors and subsequently increase beyond non-weighted amounts if values for p are further increased.

The results indicate that there are benefits to the practice by valuation experts to apply judgment in determining peer valuations through implicitly overweighting financially similar compared to less similar peers, in particular if a judgment-free differentiation logic based on value-relevant intrinsic factors is followed. The concept of intrinsic multiples appears to be a useful criterion for assessing peer similarity given the concrete benefits for valuation accuracy, which can be achieved when combining it with a rank sum peer weighting approach.[934] It furthermore contributes to overall very accurate levels of trading multiple valuation precision, with median absolute valuation errors of less than 17% in the case of peer weighted price/earnings.

an operationalization of perceived (qualitative and hence challenging to model) practitioner approaches in order to determine if those approaches allow for an improvement in valuation accuracy. Furthermore, and as long as p is sensitized, the weighted peers approach also offers a relatively judgment-free concept

[931] Precise values: p_{PE} =1.2 and p_{EBIT} =0.9

[932] Measured using peer weighted median as aggregation concept, compare blue lines in Panels B and C

[933] Results also in line with pairwise error reductions of 0.507%-pts for price/earnings and 0.203%-pts for enterprise value/EBIT

[934] That means $p = 1$

7.9 Mixed success of alternative strategies for valuation accuracy improvements

7.9.1 Method: comparison to simple P/E multiple valuations as baseline

In Table 7.14 (p. 319), I report results for log valuation errors of a number of alternative multiple type selection approaches aimed at valuation accuracy improvements against the multiple type with the overall best valuation error statistics, price/earnings. Notably, Table 7.14 seeks to provide answers to Hypotheses 5a and 7, according to which in *industry-specific* multiples and *combined multiple* concepts might outperform any simple single multiple approach. Three different concepts are presented: a study of the lowest observed firm-specific valuation errors (columns 2–4 of Table 7.14), an analysis of industry-specific multiples (columns 5 and 6) and the consideration of intrinsic multiple differences (column 7). Details for 3 differently comprehensive scopes of allowable multiples is presented in the different Panels of Table 7.14: including/excluding intrinsic (multiple) valuations as well as for a subset of common valuation multiple types only.[935] Whilst the general principles of the pursued approaches have been laid out already in the context of hypothesis formulation,[936] it is instructive to summarize the approach taken in computing each of the columns:

- *Lowest ex post error for each firm-half year observation:* The “ex post” column among the “lowest observed valuation error (firm-specific)” group relates to the distribution of log-scaled valuation errors, which are picked after valuation errors for all firm half-year observations have been computed. With 3.1% median value and 81.2% of valuations within 10% of errors, they are remarkably low.[937] This suggests that extraordinarily

[935] In Panel A, all 13 valuation multiple types shown in Table 7.2 (p. 245) and elsewhere in this dissertation are considered. Furthermore, the 2 main types of intrinsic multiples, the intrinsic price/earnings and enterprise value/EBIT multiples computed in accordance with Equations 4.12 (p. 94) and 4.34 (p. 103), respectively are taken into account. In Panel B, only the 13 valuation multiple types are considered, eliminating all intrinsic multiples from the scope. This effectively allows for an assessment of intrinsic vs. multiple valuations if the results are compared to Panel A. Lastly, in Panel C, the number of considered valuation multiple types is reduced to a subset of 6 presumably common types, namely enterprise value/EBITDA, enterprise value/EBIT, price/earnings, price/earnings before tax, price/dividends and price/book. The choice of those practically common multiples is subject to a certain amount of judgment. Therefore some alternative choices were analyzed with directionally consistent results. This more selective approach allows to address biases potentially introduced by more esoteric multiple types

[936] Compare Subsections 6.2.5 (p. 193) and 6.3.4.4 (p. 220) above

[937] Results as reported in Panel A for valuation and intrinsic multiples. Data for all and for selected valuation multiple types is directionally consistent

high levels of valuation accuracy are theoretically achievable if the right multiple type is chosen and that it might be sufficient to limit the analysis to trading multiples rather than also including intrinsic (multiple) valuations given the relatively low accuracy improvement between Panels B and A of Table 7.14.[938] In the Appendix Figure A.2 (p. A39) some additional data on the relative performance of multiple types by means of a concurrent analysis of all types is presented. One can infer that an overall "good" multiple type might be one which is performing solidly in the valuation of many sample companies; but even more so, such a multiple type *performs very poorly in a limited number of valuations*.[939] While those ex post minimal error results are anecdotally interesting, it is, however, an implementational challenge to *ex ante* identify those lowest valuation errors by multiple type for useful multiple valuation in a practical context. Therefore, a methodology is required to determine the expected lowest error by multiple type for each firm and three general approaches, (1) historically well performing multiple types, (2) industry-specific multiple types and (3) intrinsic multiple type differences have been developed

- *Historically well-performing multiple types:* The column titled "short term predicted (non-weighted)" determines the lowest absolute log valuation error by multiple type measured at the 11 January measurement points (2005–2015) for each company under investigation. The single multiple types identified as yielding the lowest valuation error for each firm are then utilized to conduct a multiple valuation for the respective July measurement points in the same year on the basis of the rationale of *short-term time stability* of successful multiple types.[940] Alternatively, a long-term approach is pursued in column "long term predicted (weighted)," which relies on splitting the overall sample in 2 subsamples following a simple holdout concept,[941] the earlier and the later 11 half years, January 2005–January 2010 (the "training period") and July 2010–July 2015 (the

[938] The results can also be interpreted that a judicious valuation driver section has taken place in this dissertation, the spectrum of which covers the right multiple type for every company

[939] As an example to support this hypothesis, Appendix Figure A.2 suggests that price/earnings performs best in 10% of cases, which can be considered not too distant from the performance of the weakest multiple type, enterprise value/invested capital, which displays the strongest performance in 6% of cases. However, price/earnings does not feature among the top 9 valuation multiples in just 5% of cases, while for enterprise value/invested capital this applies to 52% of cases

[940] To illustrate the logic: e.g. if enterprise value/EBITDA performed best for a specific company in the January valuation, it is reasonable to assume that enterprise value/EBITDA might be a suitable multiple type to also utilize for a valuation 6 months later in July

[941] This is not to be confused with the exclusion of the firm under investigation from computing valuation multiples applied throughout this dissertation sometimes referred to as holdout-procedure, compare Footnote 775. Instead, the approach is closer to studies in the area of broker research such as Bradshaw et al. (2013) and Sinha, Brown, and Das (1997)

"test period"), respectively. In a true cross-sectional approach,[942] the training period ranks the different multiple types for each firm under investigation according to their valuation accuracy as measured by low absolute log valuation error, focusing on the winners for each of 11 half years and disregarding all other multiple types. Once the ranks are established, the multiple types are weighted on the basis of Equation 7.6 and with an acceleration parameter of $p = 1$.[943] Those weights obtained from the training period are then applied to select the multiple types for all valuations of the test period. The column in Table 7.14 reports the valuation outcomes in of this per company multiple type-weighted approach for the test period. Since the training and test period each span 11 sequential half years, the results can be considered an investigation of the longer-term stability of particularly useful multiple types by sample company

- *Industry-specific multiple types:* The column in Table 7.14 denoted "Single best (non-weighted)" indicates the absolute error distribution if the individual firm valuations rely on those single multiple types, which yield the lowest valuation error most often in their respective industry.[944] As an alternative to the single best multiple type by industry, a weighting concept is reported in column "Weighted by rank." This approach follows the single best multiple type approach; however, the multiple type utilized consists of a combination of several multiple types, depending on the ranks of performance from strongest to weakest and—much like in the case of the "long term predicted (weighted)" approach—weighted by their ranks utilizing Equation 7.6 with an acceleration factor of $p = 1$[945]
- *Intrinsic multiple differences:* Multiple types are determined by choosing those multiple types on a firm-by-firm basis, where the intrinsic multiple for the firm shows the lowest absolute deviation from a hypothetical intrinsic multiple of a firm with peer group

[942] Firms for which no consistent data for both time periods is available are eliminated

[943] Other acceleration parameters have been tested with directionally consistent results unless extreme values are chosen

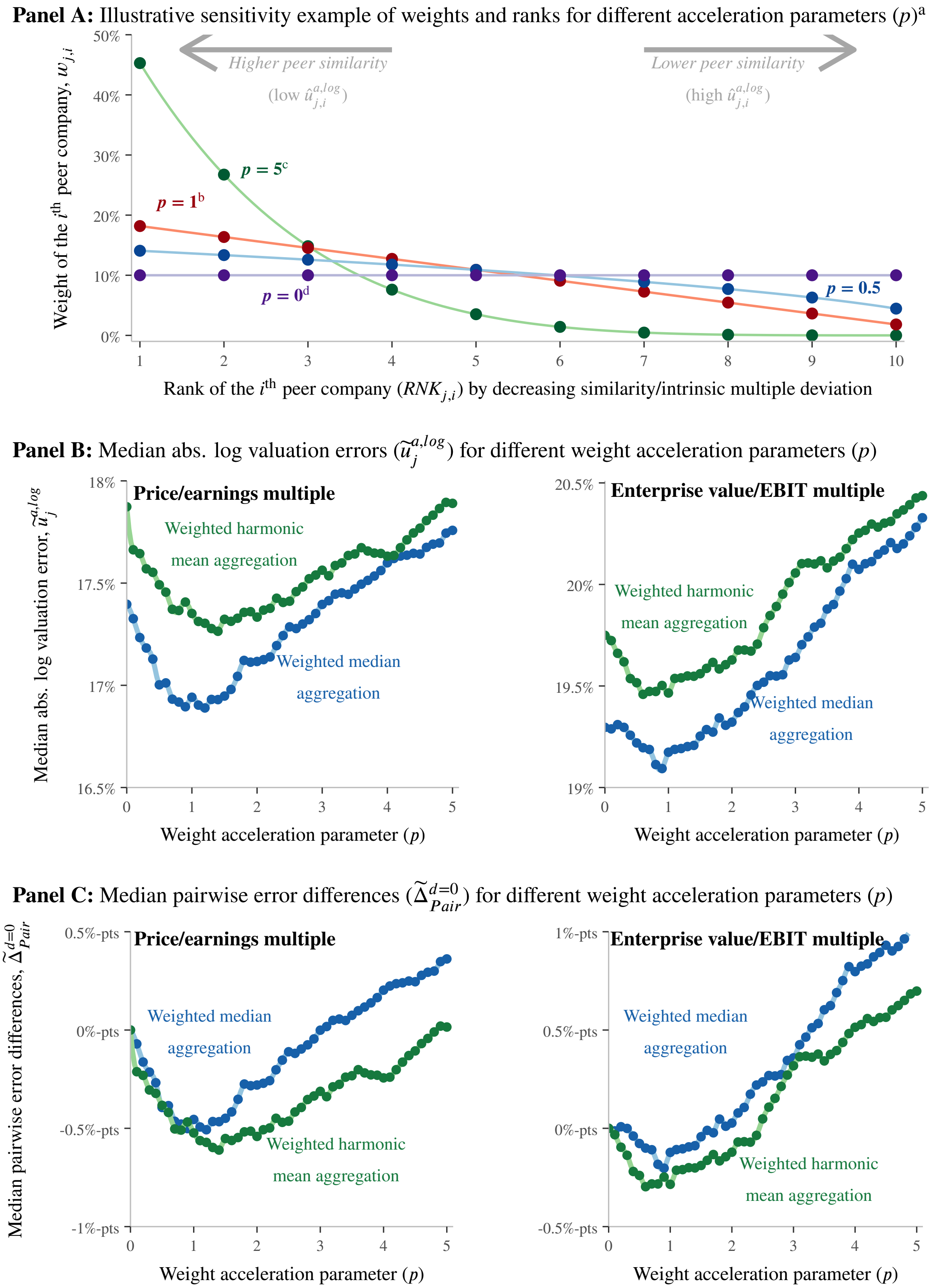
[944] I.e., absolute log valuation errors for all multiple types and all peers are computed. For each 3-digit ICB industry code, the number of best performing valuations of each multiple type is counted. The multiple type with the lowest median absolute log valuation error is picked as the representative for the respective industry and applied to all multiple valuations conducted for that industry. An alternative concept, where the industry-specific multiple types are selected on the frequency of observations for which they perform best, yielded weaker results (not reported).

[945] The results reported for industry-specific multiples are on the basis of a post hoc analysis: Multiple types are picked on the basis of assessing their respective errors, which limits the scope of interpreting better than baseline results as truly superior outcomes. Given the results actually turn out to be worse, this is not a concern though. This aspect could have been avoided by following the subsample approach utilized for the historically well performing multiple types

median financial input variables (median peer intrinsic multiple). This approach is motivated by the presumption that a low discrepancy of firm to median peer intrinsic multiple theoretically suggests that a multiple type might be particularly suitable to value a firm against its peers. A weighting concept is applied much like for the preceding industry-specific and long term predicted multiple analyses[946]

[946]The results reported rely on a weighting acceleration factor of $p = 1$. Other factors were tested with results directionally similar. This includes high values of p, which approximate the weighting method to choosing the single best available multiple type, compare Panel A of Figure 7.12 (p. 318)

FIGURE 7.12: Impact of peer weight concepts on valuation accuracy



Note: Weighted *median* used for aggregation. Panels B and C based on a matched sample to improve comparability (n_{PE} =13019, n_{EBIT} =12665) [a] Example of a peer group comprising 10 comparables [b] Rank sum weighting
[c] Low impact of peers beyond median ranking (here: $RNK_{j,i}$>5) [d] Standard approach, all peers equally weighted

TABLE 7.14: Errors distribution statistics of alternative accuracy improvement strategies

		Basis of multiple type selection					
		Lowest observed valuation error (firm-specfic)			Best performing industry-specific multiple (ex post)[d]		
	Baseline (P/E)	Ex post[a]	Short term predicted (non-weighted)[b]	Long term predicted (weighted)[c]	Single best (non-weighted)	Weighted by rank	Intrinsic multiple differences[e]
Panel A: Valuation and intrinsic multiple types[f]							
Median	18.5%	3.1%	11.9%	21.3%	17.8%	28.4%	—
Mean	26.2%	6.8%	18%	25.2%	26.1%	33.9%	—
Sample standard deviation	30.5%	11.9%	21.7%	16.2%	30.8%	59.4%	—
Fraction of errors <10%	29.6%	81.2%	43.5%	10.8%	30.7%	4.9%	—
Fraction of errors <25%	62.6%	94.9%	78.3%	60.5%	63.6%	41.2%	—
Proportion winning[k]	—	90.4%	58.5%	36.1%	28.4%	24.6%	—
Pairwise difference/significance[l]	—	-13.32%-pts/***	-3.5%-pts/***	4.15%-pts/***	0%-pts/n.s.	8.02%-pts/***	—
Number of observations	18321	18321	7189	4430	17903	18315	—
Panel B: All 13 valuation multiple types[g]							
Median	18.5%	3.4%	11.7%	20.6%	17.8%	27.7%	20.7%
Mean	26.2%	7.3%	17.4%	24.6%	26.1%	34.1%	26%
Sample standard deviation	30.5%	12.2%	20.7%	16.2%	30.8%	54.8%	23%
Fraction of errors <10%	29.6%	79.1%	44.1%	12.8%	30.7%	4.6%	26.4%
Fraction of errors <25%	62.6%	94.2%	79.1%	62%	63.6%	43.6%	58.2%
Proportion winning[k]	—	89.8%	59%	38.5%	28.4%	25.3%	39.9%
Pairwise difference/significance[l]	—	-12.92%-pts/***	-3.63%-pts/***	3.43%-pts/***	0%-pts/n.s.	7.29%-pts/***	3.45%-pts/***
Number of observations	18321	18321	7217	5048	17903	18291	8614
Panel C: Selected valuation multiple types only[h]							
Median	18.5%	6.4%	12.4%	18.5%	17.9%	24%	20.6%
Mean	26.2%	13%	18.4%	22.8%	26.1%	32%	26.1%
Sample standard deviation	30.5%	27.2%	21.7%	16.9%	30.3%	35%	22.9%
Fraction of errors <10%	29.6%	62.8%	41.4%	21.2%	30.6%	9.8%	26.7%
Fraction of errors <25%	62.6%	86.1%	76.5%	66.4%	63.2%	52.3%	58.3%
Proportion winning[k]	—	79.7%	54.7%	47.5%	28.2%	30.9%	40.2%
Pairwise difference/significance[l]	—	-8.6%-pts/***	-1.88%-pts/***	0.56%-pts/n.s.	0%-pts/n.s.	4.3%-pts/***	3.04%-pts/***
Number of observations	18321	18321	7287	6853	17959	18313	10771

Note: Table compares the "baseline" price/earnings multiple valuation as shown elsewhere (compare e.g. Table 7.2); weighted approaches based on ranking concept as described in Eq 7.6 with an acceleration parameter of $p = 1$ [a] Selection of the multiple type yielding the lowest valuation error (ex post)
[b] Selection of the multiple type in $t + 1$, which yielded the lowest valuation error in t [c] Combined multiple type approach for the later 11 half years in the sample (Jul-10–Jul-15), weighted by the ranks of lowest valuation errors in the earlier 11 half years (Jan-05–Jan-10) for each firm [d] Multiple type determined by the best single or rank-weighted combined multiple type for the respective industry (3-digit ICB code, ex post) [e] Multiple type determined based on the smallest intrinsic multiple difference between the respective industry expectation and the individual firm [f] Considers valuation and intrinsic multiples pari passu, whatever type performs best [g] Considers all 13 types of valuation multiples utilized in this dissertation (compare Table 7.2) but disregards intrinsic multiples [h] Considers a selected set of more practically common valuation multiple types only (EV/EBITDA, EV/EBIT, P/E, P/Earnings before tax, P/Dividends, P/Book) [k] "True" winners with lower valuation errors than baseline (i.e. excluding same valuation errors if method used suggests baseline approach)
[l] Median pairwise difference, relative to baseline; ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$ of a Wilcoxon sign-rank test (Holm-Bonferroni-corrected)

7.9.2 Diverse results of alternative and weighting concepts

7.9.2.1 Short-term stability of firm-specific multiple type performance and mixed results on weighted approaches

The results in Table 7.14 suggest that there might be benefits of utilizing *recently successful multiple types* in subsequent valuations: As column "Short term predicted (non-weighted)" indicates, median absolute log valuation errors drop meaningfully to approximately 12%, with comparably little variation on the scope of allowable multiple types chosen. This is consistent with an improvement of between −1.88%-pts and −3.63%-pts as measured by the pairwise median error difference and results are highly significant according to a Wilcoxon sign-rank test.

Results for *longer-term multiple type stability* and an operationalization through weighted multiple types depending on their performance during a training period are ambiguous. Whilst a broad scope of considering both valuation and intrinsic multiples or only valuation multiples[947] results in valuations with significantly worse valuation accuracy, a narrower scope of considering only 6 common multiple types yields no significantly different results to the baseline of price/earnings. Interestingly, all results for longer-term predicted multiple types display materially narrower standard deviations, consistent with a substantially better performance "in the tails" while at the same time performing worse than the baseline approach for smaller valuation errors.[948] This points to a potential practically very relevant property of the long term weighted approach in that it is able to deal better with valuation outliers. Thus, in situations where somewhat lower valuation accuracy for firms with high valuation accuracy can be "traded" for higher valuation accuracy for firms, which suffer from higher valuation errors, the long-term weighted approach might be preferable over the simple price/earnings baseline concept. With respect to Hypothesis 7 (p. 220) on positive valuation benefits of weighted multiples, the results can be interpreted as follows:

- A narrow scope of allowable multiple types results in an overall not worse (but not better) valuation error distribution compared to the best performing single multiple type

[947] Panels A and B of column "Long term predicted (weighted)" in Table 7.14

[948] E.g. whilst only 21.2% of observations of the long term predicted approach show errors of less than 10% (as indicated by the "Fractions"-line in Panel C) vs. almost 30% for the baseline, 66.4% of observations display errors of less than 25%, materially higher than the 62.6% for the baseline. Given the baseline relies on a wider sample, the baseline numbers do not exactly match the long term predicted approach, comparable numbers for a matched baseline approach sample (not reported in Table 7.14) still confirm the findings with 29.1% and 62.2%, respectively

- Weighted multiples appear to offer advantages over single multiples when it comes to their ability to deal with outlier valuations. However, valuation errors for weighted multiples are higher for valuations with low errors

- A more focused scope of allowable multiple types appears to yield relatively superior valuation outcomes than a broader scope. This suggests that esoteric multiple types might introduce biases and thus reliance on standard multiple types such as price/earnings, enterprise value/EBIT(DA) and price/book might be a superior approach as far as weighted multiples are concerned

Both the long-term and short term predicted approaches suffer moreover from a central implementation limitation: Since the best performing multiple type or combination of types is determined on a firm-by-firm basis, they are only applicable to *publicly traded* companies, for which the *historically best* multiple types can be identified.[949]

7.9.2.2 Industry-specific multiples show some (although insignificant) improvement potential

Table 7.14 also presents the results of the best performing industry-specific multiple approach, where multiple types are selected on the basis of producing the lowest median absolute log valuation error for each respective industry. Choosing the *single best multiple type* per industry appears to result in somewhat more favorable distribution statistics when compared to the baseline approach of utilizing price/earnings multiples throughout.[950] Those results appear not to be significant according to the Wilcoxon sign-rank test employed throughout this dissertation. The medians of pairwise error comparisons of 0% can be explained by the fact that in the median case, the single best valuation is actually the baseline price/earnings valuation. This is testament to the strong overall performance of price/earnings as a multiple type.[951]

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[949] This is in addition to implementation challenges for practitioners in the form of computing several multiple types for the “training period”

[950] Median valuation errors of 17.8% % (vs. 18.5% for the baseline) and 30.7% of errors below 10% (vs. only 29.6% for the baseline) in the case of considering all 13 valuation multiple types

[951] One can also argue that the Wilcoxon sign-rank test is not ideally placed for a conclusive assessment of the improvement potential of single best industry-specific multiples given the strong role price/earnings multiples play in industry-specific multiple type determination as indicated by the results for the pairwise error comparisons to the baseline.[952] This reduces the sample size materially as the Wilcoxon sign-rank test eliminates observation pairs of zero pairwise differences. Consequently I speculate that a larger sample size could have addressed this particular statistical test dynamic and that the results on the benefits of industry-specific multiple types therefore remain inconclusive

The *"weighted by rank"* extension to the single best industry multiple type approach significantly underperforms the baseline price/earnings multiple approach; valuation error distributions are less favorable for broader scopes of allowable multiples. The results suggests that a joint consideration of several multiple types is generally not conducive to improved valuation outcomes and that industry-specific multiples should be based upon the single best multiple type rather than a combination of different types.[953]

To summarize, the analysis provides little formal support of Hypothesis 5a on the benefits of industry-specific multiples since results for the single best multiple type are not statistically significant according to a Wilcoxon sign-rank test and the weighted approach performs significantly worse than the baseline approach of choosing price/earnings for all valuations throughout. This has to do with considerable pricing information contained in the price/earnings multiple, which for many industries performs best, leading to high levels of congruence between the baseline approach and the single best multiple type approach. Combined multiple concepts naturally introduce *aspects of dilution* to the impact of the best performing multiple type in overall valuation at the benefit of considering potentially value-relevant information other multiple types may carry. However, in the context of industry-specific multiples, the dilution of the best type appears to outstrip benefits of additional value-relevant information inclusion. Thus, no support of Hypothesis 7 on the benefits of weighted multiple approaches is found for industry-specific multiples.

The single best industry-specific multiple type approach, however, does also not significantly underperform the baseline approach and some of its distribution parameters such as median and fractions of valuations below a certain threshold suggest that the lack of statistical significance might potentially be related to the suggested testing method. I therefore report in Appendix Table A.7 (p. A40) the results of the rankings of the multiple types by industry: they shed some further light on the performance of price/earnings multiples, which produce the lowest valuation errors among the 13 valuation multiples studied in this dissertation in 15 and rank among the top 3 multiple types in 27 out of 33 industries, or 81.8%. In other words, price/earnings is the *best choice* in many industries and *not a bad choice* in most others. Results are directionally consistent with the findings of J. Liu et al. (2002, p. 158) around the consistently strong performance of price/earnings.[954]

[953]This even applies to a further narrowed down scope of multiple types consisting of just price/earnings and enterprise value/EBIT, which results in a median absolute log error of 19.5% and 24.1% of observations resulting in a valuation error of less than 10%, hence less favorable than the single best multiple type approach

[954]Appendix Table A.7 also contains an indication regarding underlying median financial metrics for each industry. A visual inspection indicates that price/earnings might perform particularly well for industries with

7.9.3 Intrinsic multiple difference: low dispersion but higher median error

Lastly, Table 7.14 presents results for a determination of optimal multiple types by assessing intrinsic multiples for the individual observations compared to expectations on intrinsic multiples for their respective industry. Whilst this approach performs well versus a number of single multiple types,[955] it results in lower valuation accuracy compared to the baseline approach of choosing price/earnings throughout. Notably, it does offer narrower dispersion as expressed by the sample standard deviation. Findings for intrinsic multiple differences, however, are not consistent with expectations around the benefits of weighted multiple approaches stipulated in Hypothesis 7 given their overall less favorable error distribution characteristics.

An alternative approach to investigate the performance of multiple types as a function of intrinsic financial metrics—i.e. input variables to Equations 4.12 and 4.34—and some other commonly used independent variables by means of a logit regression. Under this approach, I code the respective observations as 1 if the absolute log valuation error of price/earnings is among the top 3 lowest valuation errors of all 13 multiple types investigated (logic: P/E is a good multiple type for such a company) in this dissertation and as 0 if it does not rank among the top 3 lowest errors (logic: P/E is not an ideal multiple type for such a company). It is then possible to run a logit regression on the basis of independent variables in order to determine how much an increase of one unit—i.e. percentage point—changes the odds of P/E being among the top 3 lowest multiple types.[956] The results are presented in Appendix Table A.8 (p. A42).[957] Whilst overall the model seems well specified with reasonable coefficients of determination,[958] most of the independent variables are not significant post Holm-Bonferroni adjustments[959] and effect sizes appear to be very small anyways.[960] The results suggest that there is little relationship between intrinsic input variables and the performance of price/earnings as a strong multiple type relative to other multiple types. Instead other factors such as industry affiliation or idiosyncratic company factors might instead play a bigger role.

low comparable long-term growth, low cost of equity, high financial leverage, high EBIT margin and larger companies, however, further tests would be required to establish statistically more solid conclusions

955 Compare Table 7.2 (p. 245)

956 Compare for an overview of logit regressions and their interpretation among many: Orme and Combs-Orme, 2009

957 And in an analogous manner in Appendix Table A.9 (p. A43) for enterprise value/EBIT

958 As expressed by a Pseudo R^2 following McFadden

959 p values pre Holm-Bonferroni adjustments are significant in a number of cases

960 E.g. Appendix Table A.8 suggests for one of the few significant intrinsic valuation input variables, cost of equity, a decrease of just 4.01% in the odds that price/earnings is among the Top 3 lowest valuation errors if cost of equity is 1%-point higher

A notable exception, however, relates to what has been shown in Subsection 2.4.2.1 (p. 55) as conceptual question marks of price/earnings as a multiple: relative differences between the firm under investigation and its peers in *financial leverage*[961] display meaningful effect sizes:[962] One unit of financial leverage[963] results in a 6.92% *lower* chance that price/earnings is among the 3 best multiple valuation types. Results are highly significant according to a Wald test customary for logit regressions.[964] Therefore, while as shown in Table 7.12 (p. 306), no strong linear relationship between valuation errors measured by bias and financial leverage exists, the analysis in Table A.8 suggests that there is some evidence for price/earnings valuations being relatively less preferable to alternative multiple types in the case of differing levels of financial leverage between the firm under investigation and its peers. This is notably true only for *relative* financial leverage differences between a firm under investigation and its peers: Firms with high *absolute* levels of leverage[965] show a directionally opposite effect: price/earnings works better for higher levels of financial leverage with a 1-"turn" leverage increase leading to a 10.63% *higher* likelihood that price/earnings is among the 3 best multiple types studied.[966] This is consistent with an interpretation of multiple valuation as a strictly relative approach and corresponds furthermore to the "consistent inconsistency" principle suggested in Subsection 5.1.3.2 (p. 135), according to which conceptual issues of multiples can be disregarded as long as all firms in the peer group suffer from them equally.

7.10 The argument for a "feedback loop" corridor between P/E and stock prices

The results presented throughout this Chapter point to a generally very strong performance of the *price/earnings multiple specifically*, with median absolute log valuation errors of 18.5%.[967] The accuracy of price/earnings is remarkably consistent across industries, with price/earnings being the best multiple type of 13 types studied in 15 out of 33 industries[968] and ranking among the top 3 multiple types in 27 industries, or 81.8%. Furthermore, price/earnings as a multiple type displays inconclusive results regarding potential adjustments, with a strong

[961] Measured consistent with business practice as net debt/EBITDA
[962] Compare the logit regression in Table A.8 denoted "(2) Peer median deviations"
[963] Colloquially referred to as "turn" of leverage
[964] $p \ll 0.0001$
[965] Compare the logit regression in Table A.8 denoted "(1) Raw values"
[966] Again, results are highly significant according to a Wald test custom for logit regressions with $p \ll 0.0001$
[967] Compare Table 7.2, p. 245
[968] Followed by its close sibling price/pre-tax earnings in 7 industries

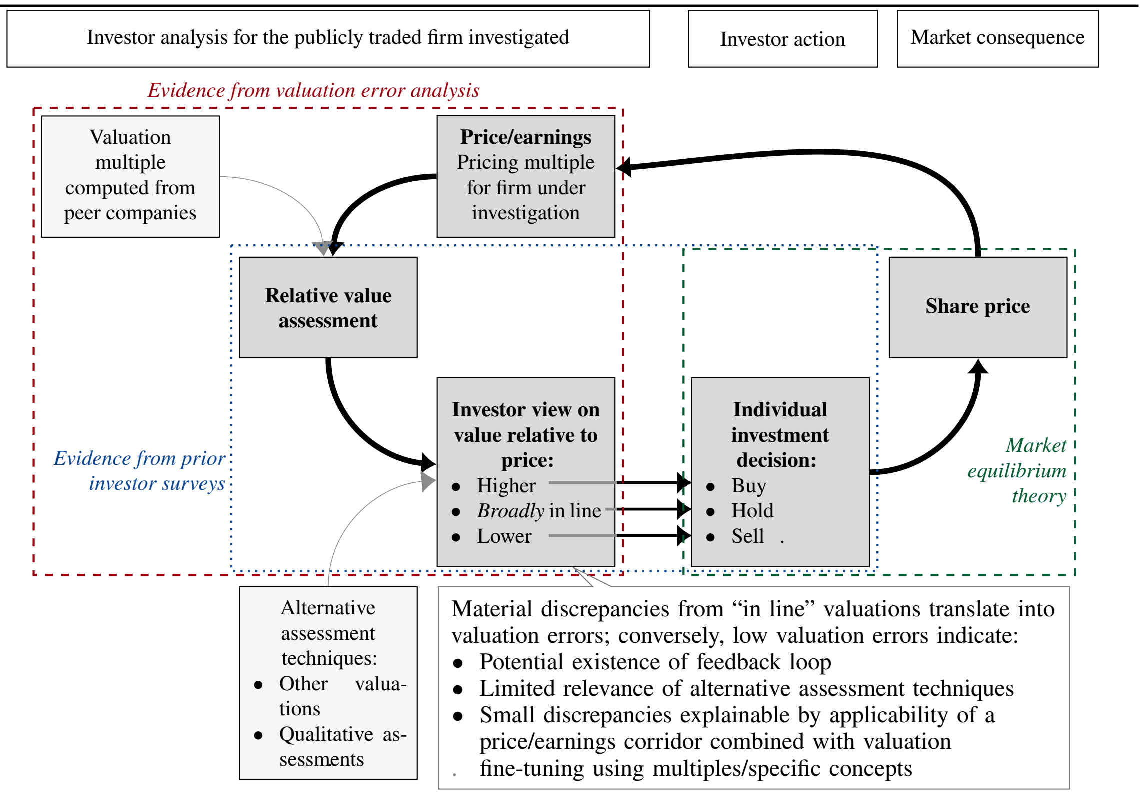
“out of the box”-performance.[969] In contrast to widely argued theoretical benefits of enterprise value multiples in past literature,[970] price/earnings has been demonstrated to outperform all enterprise value multiples studied in this dissertation, thus the strong performance of P/E is counterintuitive to the extent one follows those arguments, in particular potential biases of price/earnings from differing financing structures among peers.

In addition to the conflicting theoretical arguments and empirical findings presented in this dissertation, it has been discussed that trading multiples in general[971]—and price/earnings in particular—have been uncovered in previous survey studies of common valuation concepts as highly popular, in particular among market-making equity investors.[972] Widely considered studies of the CAPM have found an impact of price/earnings multiples specifically on stock return predictions.[973] I therefore assert that a *feedback loop* between price/earnings valuations and stock prices might be in existence, whereby multiples of public firms not only play a role as valuation tool for other firms under investigation but determine valuations in investors' minds and therefore prices of those public firms, too. The argument for the existence of a feedback loop is also consistent with the Functional Fixation Hypothesis, according to which earnings in particular might play a specific role in share price determination.[974]

Figure 7.13 (p. 326) provides a schematic of how such a feedback loop might look like: A constant re-assessment of price/earnings multiple valuations between an individual public firm and its peers determines relative valuations for the individual firm. This valuation is then compared to prevailing market prices and investment decisions are taken on the basis of any discrepancy between valuation and price. Such “buy” or “sell” decisions by individual investors then affect price, which results in changing price/earnings multiples and a recalibration of the relative value assessment, from where the feedback loop repeats itself. The role of multiple valuations in such feedback loop theory is much greater than solely a valuation tool: it turns into *a methodology by which market efficiency is established and maintained*: Share prices are abstract and in absolute terms nontrivial to compare: it is only via multiples—or alternative valuation methods—that they can be embedded into meaningful context, namely through the standardization by earnings as a valuation driver. I argue that price/earnings multiples

[969] Compare Subsection 7.4.3, p. 285
[970] Compare Subsections 2.3.2.6 (p. 49) and 2.4.2.1 (p. 55) as well as Damodaran (2012a, p. 543) and Koller et al. (2010, p. 314), among others
[971] Compare Table 1.1, p. 2
[972] Compare notably Mondello (2017, p. 541) and Asquith et al. (2005, p. 252) on price/earnings multiples specifically
[973] Compare e.g. Sanjoy Basu (1977), Ball (1978), Fama and French (1992)
[974] Compare Subsection 2.1.5.4 (p. 33) for a discussion of the Functional Fixation and Mechanistic Hypotheses

FIGURE 7.13: Schematic for a potential price/earnings feedback loop



Note: Own illustration. Thick black arrows indicate feedback loop. Colored dashed and dotted boxes indicate empirical and theoretical aspects providing support to the feedback loop theory

specifically might play a central role since (a) it is known from investor surveys that multiples—and P/E specifically—are popular and (b) valuation errors for price/earnings multiples are shown in this dissertation to be favorable relative to other multiple concepts. This suggests that alternative valuation assessment techniques might play a rather subordinated role.

The theory of the price/earnings feedback loop might be instructive for the broader market and many different industries; it is, however, worth noting that—as shown in Figure A.2 (p. A39)—price/earnings overall performs particularly well because it scores badly in very few instances.[975] This can be interpreted as the price/earnings feedback loop providing a *corridor* rather than the consistently most precise valuation outcome: According to this proposition, some valuation discrepancy under price/earnings would be acceptable and the exact price might be found on the basis of other valuation techniques, which possibly are company-specific alternative multiple type valuations or different valuations all together.[976] [977]

[975] As opposed to because it outperforms all other multiple types in a materially larger number of cases

[976] Compare the high levels of valuation accuracy of company-specific valuation drivers shown in Table 7.14 (p. 319)

[977] A casual interpretation of the proportion of price/earnings valuations within a specific threshold is consistent

The corridor theory furthermore contextualizes trading multiples as a whole: Even though carefully prepared valuation alternatives could potentially yield more precise valuations,[978] trading multiples and price/earnings in particular appear to perform *directionally* very well, leaving little doubt regarding their importance for company valuation.

To summarize, I believe that there is strong evidence pointing to a privileged role of price/earnings in trading multiple valuation given (a) its importance in survey studies, (b) its strong empirical performance, (c) its relative resilience to economically sensible adjustments, (d) prior findings on the impact of price/earnings on stock return predictability in the context of tests of the CAPM and, finally, (e) the Functional Fixation Hypothesis. This fact pattern supports the presumed existence of a "feedback loop" corridor between price/earnings and market prices. Price/earnings as a multiple type can consequently also be considered a reasonable default option compared to other multiple type alternatives if a market-consistent valuation is to be obtained and unless specific indications exist that price/earnings might not be suitable.[979]

with this argument, compare Table 7.2 (p. 245)

[978] A clear speculation since the suggested (simplified) intrinsic valuation alternatives conducted in this dissertation yield highly significantly less accurate valuations, compare Figure 7.9 (p. 294)

[979] There is arguably some suggestion that this might be the case for substantially elevated levels of net financial debt with the relative performance of P/E compared to other multiple types decreasing as financial leverage increases, compare Subsection 7.9.3 (p. 323) and Table A.8 (p. A42)

CHAPTER 8

Stakeholder implications and prospective research areas

"The investor's primary interest lies
in acquiring and holding suitable securities
at suitable prices."
—BENJAMIN GRAHAM[980]

8.1 Overview

This Chapter contextualizes the empirical results presented in Chapter 7 (p. 239) as well as the theoretical deliberations in other Chapters, distilling suggested courses of action for stakeholders interacting with topics of corporate valuation. Six relevant stakeholder groups have been identified, which deserve dedicated consideration: First, *valuation professionals*, i.e. individuals concerned with conducing valuations. They include investment bankers, appraisers and valuation experts, fairness opinion providers, investment professionals and investors as well as auditors; second, *the firms*, which are under consideration to be valued, namely their management teams, in particular chief financial officer and accounting functions; third, *accounting standard setters*, since, as argued in Chapter 5 (p. 129) some adjustments to multiples rely on figures drawn from accounting statements; forth, *equity research analysts*,

[980] Compare B. Graham (1949, Ch. 8); Benjamin Graham, renown for establishing the concept of "value investing." This Chapter summarizes how multiples can help investors assessing *suitable* prices, among other implications of the empirical findings

since their multiple valuations might be relied upon by investors with access to their reports but even more so since their financial projections influence multiple computations to the extent multiples utilized rely on forecasts; fifth, *financial database providers*, acting as source for financial information; and last but not least, sixth, the *academic community* concerned with valuation research, also in light of areas of further potential research.

8.2 Implications for valuation professionals and investors

8.2.1 Cursory considerations on valuation users and use cases

In order to determine implications of the findings of this dissertation for the users of valuation it is instructive to provide a high-level overview of their identity and objectives, which can take place from 2 directions: the person potentially concerned with conducting the valuation ("who?") and the role, which the valuation might play ("why?"). Following Hoover (2006, pp. 2–4), a number of groups and their respective core valuation purposes can be identified:[981]

- Equity research analysts in order to provide stock recommendations[982]
- Investment bankers in the context of analyzing and marketing corporate transactions and financings as well as providing fairness opinions[983]
- Asset managers in their ambition to uncover over- and under-valuations of current and prospect portfolio companies and investment opportunities as well as "stock-pickers" [984]
- Private and retail investors
- Central banks and economic policy makers to determine the state of the economy and deduct an appropriate course of policy action—both on a macroeconomic/sector level[985]

[981] Sorting amended

[982] See e.g. Demirakos, Strong, and Walker (2004) for empirical data on the valuation practice of analysts

[983] Fairness opinions have been analyzed comparably comprehensively given publication requirements, see e.g. Schönefelder (2007), Cain and Denis (2013) and Berndt, Froese, et al. (2014)

[984] The concept regarding the potential existence of over- and under-valuation scenarios goes back to B. Graham and Dodd (1934) and B. Graham (1949) who postulated that (a) there are at times securities for which on the basis of valuation a purchase or sale recommendation can easily be derived and that (b) that, eventually, prices will align with values (Spremann & Gantenbein, 2005, pp. 166–170)

[985] Most prominently, Alan Greenspan's "Fed Model" (Penman, 2013, pp. 197–199), which was allegedly based on an earnings yield model (i.e. inverse of price/earnings multiple). For a more recent illustrative example, consider the meeting minutes of the U.S. Federal Open Market Committee dated March 14–15, 2017, according to which "some standard measures of valuations [were] above historical norms."(United States Federal Reserve Board, 2017, p. 5)

and on an asset-specific level[986]

- Corporate managers in efforts to create shareholder value[987]

Consistently, Damodaran (2012a, pp. 6–9) refers to the purposes of valuation on the basis of 4 use cases: portfolio management, M&A transactions, corporate finance aspects and value-focused management teams.
Numerous additional valuation users and purposes come to mind, including:

- Accountants and auditors with regards to financial statement preparation. While applicable to virtually all firms, valuation questions are particularly relevant for holding and investment companies as well as financial institutions[988]
- Valuation experts in a legal context[989]
- Tax professionals and authorities to determine the basis for taxable earnings and capital gains[990]
- Regulators, in particular with regards to banking regulation[991]

[986] Particularly in the context of collateral valuation acceptable by the European Central Bank through the Common Eurosystem Pricing Hub (CEPH), albeit more focused on debt- and asset-backed securities

[987] One of the most respected corporate valuation textbooks, Koller et al., is in the first place addressed to corporate managers (2010, p. xii)

[988] Valuation aspects pertain numerous topics with the "fair value"-concept (IFRS 13; ASC 820) playing a central role, including the treatment of financial instruments (IAS 39, for fiscal years beginning on or after January 1, 2018: IFRS 9; SFAS 157, 159; see Georgiou and Jack (2011) for some history on fair value accounting and Benston (2008) as well as Laux and Leuz (2009) regarding a discussion of issues) and fair value/value in use calculations in the context of goodwill impairments following IAS 36, see Küting and Wirth (2005) and Budde (2003) as well as Husmann and Schmidt (2008) for a discussion on valuation aspects in general and the appropriate discount rate specifically

[989] It would be too far-reaching to provide a broad discussion of the international situation. The German case, however, is a particularly interesting example as some valuation approaches and considerations have been developed into the IDW Standard S1 (Institut der Wirtschaftsprüfer in Deutschland [IDW], 2008), which sets out best practices for auditors regarding valuations stipulated by law, e.g. takeover offers and squeeze-outs. See IDW (2000) as well as Nestler (2012) for the situation on SMEs and PricewaterhouseCoopers (2010) for the case of squeeze-outs and some general typology; Hüttche (2014) provides empirical findings on Swiss Supreme Court cases around valuation. The three most frequent areas relate to company law, family law and tax law, followed by insolvency law; for a summary on the situation in the United States including the formerly popular Delaware Block Method see e.g. Yee (2004a, pp. 24–25) as well as F. Chen, Yee, and Yoo (2007) for some empirical data on more forward-looking valuation methods and a more discretionary approach since the mid 1980ties

[990] In the United States, earnings-based concepts have been of relevance for valuing stocks for a long time where no market price is available, (United States Internal Revenue Service, 1959-01-01); Beatty et al. (1999, p. 193) provides empirical data on the valuation concepts used in U.S. tax court cases. For tax purposes in a German context, IDW S1 is also as a consequence of the German principle of congruency ("Massgeblichkeitsprinzip") "generally deemed acceptable" (König and Möller, 2014, p. 983 with further reference), however a number of tax-specific rules apply, such as IDW RS HFA 10 (Franken & Schulte, 2005)

[991] See e.g. Chircop and Novotny-Farkas (2016) for a discussion on the application of reporting standard-derived fair value concepts on banking regulation

The users and use cases of valuation in general are heterogeneous; none the less they share some common objectives, most notably the importance of valuation precision, hence low valuation errors are desirable, and the fact that more sophisticated valuations will manifest themselves as more costly, hence a preference for simplicity.

8.2.2 Specific implications regarding the use of multiples

Even though, at its core, company valuation on the basis of multiples appears to be a very simple and straightforward concept, it has been demonstrated that anybody tasked with conducting such valuation is facing a number of critical decisions.[992] This aspect is at the core of the dissertation and can be summarized as follows:

- *Reliance on trading multiple valuation (vs. other methods) justified by comparably high valuation accuracy:* Trading multiple-based valuations perform strongly compared to other concepts such as intrinsic valuations, notably DDM and DCF models.[993] Any valuation professional should therefore consider trading multiples as important part of his or her methodological toolbox. The relatively inferior results for intrinsic valuations in this dissertation are based upon somewhat simplifying valuation approaches[994] and hence carry some risk of undue simplicity. In other words, more sophisticated intrinsic valuation approaches may fare better relative to trading multiple valuation and their simplified siblings. However, from a practitioner perspective, there is a cost to valuation, and it increases as with complexity. I argue that the simplified intrinsic approach relied upon in this dissertation compares well to the structurally straightforward multiple approach, whilst a comparison of much more sophisticated intrinsic approaches with the simple multiple approach would disregard any cost to valuation. In any event, practitioners' strong reliance on multiples relative to alternative approaches appears justified

- *Choice of the right multiple type key—price/earnings useful as "base case multiple type":* An important decision for the valuation professional in the context of multiples relates to the selection of the valuation driver, which determines the multiple type utilized. The valuation quality of multiple valuations is based on the type of valuation

[992] It is worth noting that the role of the valuation professional or investor who conducts the valuation is different from the other stakeholders identified in this Chapter since he or she relies on information provided by or on the basis of definitions and rules formulated by the other stakeholders

[993] Compare Subsection 7.9, p. 294

[994] Notably Equations 4.12 (p. 94) and 4.34 (p. 103)

driver selected: In general, i.e. across all industries and over time, flow multiples such as enterprise value/EBIT or price/earnings, outperform stock multiples such as price/book;[995] accounting-based multiple types (price/earnings) yield lower valuation errors than cash-oriented and more esoteric types such as enterprise value/EBITDA-Capex.[996] With absolute valuation errors medians of 18.5%, price/earnings performs overall best relative to other multiple types, which appears to be particularly driven by the fact that it performs well in many instances, but even more so that it does perform poorly only in few cases; results are consistent for many industries. Price/earnings can hence be considered from a valuation practitioner perspective as a suitable "default" multiple type with strong performance throughout. Notably, I speculate that price/earnings might benefit from a feedback loop to market prices, which limits the risk of extreme valuation errors[997]

- *Strong short-term firm-specific stability of successful multiple types beneficial for accuracy; however, challenging to operationalize in general valuation settings:* More specifically, with a median of the lowest absolute valuation error of 3.4% if the ex post best performing valuation multiple type is relied upon, there appears to be a suitable multiple type for every firm and an opportunity to obtain highly accurate multiple valuations if only the right multiple type is chosen.[998] However, it proves challenging to determine this multiple type ex ante in order to operationalize the best choice of multiple types for practical valuation settings. Most promising are approaches to rely on multiple types, which historically performed well for a specific firm under investigation—with the caveat that such approach can only be employed for historically publicly traded firms. A choice of multiple types by industry results in improved sample valuation statistics, however, results are not significant.[999] Intrinsic input variables to valuation such as cost of capital, growth, return on equity offer little improvement potential. From a practitioner perspective, reliance on industry-specific multiple types[1000] and on historically well performing company-specific multiple types appear to be the promising approaches to further improve valuation accuracy over generally relying on pricing/earnings

[995] Compare Subsection 7.2.5, p. 259
[996] Compare Subsection 7.2.4, p. 258
[997] Compare above, Subsection 7.10, p. 324
[998] Compare Subsection 7.9 (p. 314) and Panel B of Table 7.14 (p. 319)
[999] Low levels of statistical significance can be observed prior to conducting a Holm-Bonferroni-adjustment to *p*-values
[1000] Compare Appendix Table A.7 (p. A40) for a ranking of best performing multiple types by industry

- *The practice of qualitatively considering closer peers more than peers showing larger discrepancies to the firm under investigation appears appropriate to increase valuation accuracy:* The quality of multiple valuations depends on the similarity of the peer group to the firm under investigation. While general industry dynamics are typically reflected through industry peer selection,[1001] the practitioner approach of qualitatively weighting firms within one industry with higher (lower) perceived similarity to the firm under investigation stronger (less), appears justified; one way to quantitatively operationalize this approach is via a rank-of-similarity weighting concept, which yields valuation error reductions of up to 0.507%-pts[1002]

- *Median is an appropriate aggregation method to derive a valuation multiple from peer pricing multiples:* Peer pricing multiple aggregation into a valuation multiple is one of the examples mentioned on Wikipedia for the conceptual superiority of the harmonic mean as opposed to the arithmetic mean approach.[1003] There might none the less be a practical lack of familiarity with harmonic means, resulting in potentially unwanted challenges to valuations presented on that basis. Therefore, reliance on median as an aggregation concept might be preferable, the more as it appears to yield higher quality valuation outcomes than harmonic mean and numerous other alternative concepts of practical relevance.[1004] If median is chosen as aggregation concept, there are little benefits on valuation accuracy from the inclusion of negative multiples, hence the practitioner approach of excluding negative multiples all together appears reasonable

- *Forward-looking valuation drivers (such as next-twelve months earnings) outperform historical valuation drivers:* Projection-based valuation drivers relating to future time periods outperform their historical siblings,[1005] suggesting the common practitioner approach to consider next year earnings is warranted. Since two year forward-looking valuation drivers appear to display even stronger performance, practitioners can consider looking somewhat further into the future—however, the right balance should be found given underperformance and general lack of data for "three years out" valuation drivers[1006]

[1001] Compare Chapter 6.2 (p. 185), an approach also widely employed in this dissertation

[1002] For price/earnings multiples, compare Subsection 7.8.2 (p. 313)

[1003] Compare Harmonic mean, n.d. also compare the discussion in Subsection 6.3.2.1 (p. 199)

[1004] E.g. median absolute valuation error for price/earnings of 18.5% for median aggregation vs. 18.9% for harmonic mean aggregation. Results are directionally consistent for all multiple types (with the exception of price/dividends), compare Subsection 7.2.3.1 (p. 246) for details

[1005] Compare Subsection 7.5, p. 287

[1006] This might be achieved in a practical manner by considering the next but one rather than the next calendar

- *Even "automated" adjustments to enterprise value multiples offer room valuation quality improvements compared to unadjusted multiples:* Lastly and importantly, as had been argued in Chapter 5 (p. 129), there are theoretical benefits for valuation accuracy from consistently adjusting enterprise value multiples for economic aspects of relevance such as equity investments, minority interest or pension liabilities: Empirically, meaningful and statistically significant median pairwise error reductions of 0.89%-pts result from a comparison of fully adjusted to unadjusted enterprise value multiples.[1007] Since the empirical part relies on automated adjustments based on financial database downloads, I speculate that further improvements are achievable in a more hand-picked approach, albeit at increased valuation cost[1008]

8.3 Implications for firms under investigation

The results presented in this dissertation also carry important implications for firms, which might be subject to multiple valuations, be they private/closely held or publicly traded. To some extent, those implications rely on the assumption that multiple valuation follows the aspects highlighted in the preceding Subsection on perspectives for valuation practitioners. Fundamentally, it is implied that it is in the best interest of the firm under investigation to enable valuation professionals and investors achieve the *most appropriate*—rather than necessarily most attractive or from a company perspective desired—multiple valuation.[1009]

- *Reporting transparency is beneficial for multiple valuation accuracy:* In particular when it comes to adjustments to multiples, reporting transparency is of considerable importance. Whilst the requirements and approaches to reporting some of the aspects, which may warrant an adjustment to a multiple will to a large extent depend on accounting standards and potentially stock market regulations, in certain instances

year earlier on in the current calendar year, say post second quarter results as opposed to only once the year has come to a conclusion

1007 Results ar of adjustments furthermore have positive effects on valuation accuracy for all enterprise value flow multiples (significant in for 5 out of 6 multiple type cases studied); compare Subsection 7.4 (p. 270) for details on the full results

1008 In any event, operationalization of the "automated" approach, however, is straightforward through suitable templates, which allow the download of many necessary financial statement elements relating to adjustments directly from commercial databases

1009 Under the assumption that multiple valuation in general and price/earnings more specifically facilitate market efficiency through the feedback loop as has been argued in Subsection 7.10 (p. 324), appropriate multiple valuation contributes to an overall desirable feature of functioning markets according to the broader economic theory, compare among many Mankiw (2002, pp. 152–153) companies are free to choose, which information they disclose.[1010] One particularly relevant example relates to pro forma numbers in the context of M&A transactions, i.e. financials which set out a hypothetical situation, in which the target company would have been owned/disposed during the full duration of the financial reporting period. From a multiple computation perspective, these pro forma numbers are crucial since they allow to base the multiple on a set of financials which better represents the future economic cash generation potential.[1011] More generally, a high degree of transparency facilitates the most appropriate multiple computation and hence is desirable over more opaque reporting techniques. Whilst heightened transparency might well have negative implications from a competitive perspective, from a multiple valuation perspective I argue that it almost always will be beneficial, since, at best, valuation professionals will be able to consider the information and, at worst, it will be disregarded[1012]

- *Peer reporting consistency can be expected to support peer similarity with positive aspects for the ease of preparing appropriate multiple valuation:* Closely related to transparency is the aspect of similarity to peers. In this dissertation, it has been shown that valuation benefits result from weighting similar peers stronger than peers with higher degree of dissimilarity.[1013] It is therefore reasonable to conclude that efficient multiple valuation will be facilitated by firms choosing similar accounting policies to their peers, so multiple valuations can be conducted on level playing field. Therefore, peer accounting principles should inform accounting choices for any firm

- *Effort on the preparation of non-GAAP measures for key expected valuation drivers (earnings, EBITDA, EBIT) likely beneficial:* The empirical findings in this dissertation suggest that certain valuation drivers and related multiple types provide more accurate valuation outcomes than others, notably earnings and EBIT or operating profit. It is hence reasonable to expect that the market may focus on those valuation drivers in particular.[1014] Consequently, companies wishing to allow valuation professionals a sound assessment through multiples should spend additional effort on those line items.

[1010] Such information might for example be given during investor events, as part of investor conference calls (compare Duss (2017) for the relevance of such calls) or as non-GAAP metrics

[1011] Compare Subsection 5.3.4 (p. 149) for a more detailed discussion and Table 7.7 (p. 276) for results of individual adjustments to enterprise value multiples

[1012] As has been shown by the relatively weak performance of multiple types, which do not consider relevant information such as profitability in the case of enterprise value/net sales or which do consider ambiguous information such as is the case with price/earnings growth multiples; compare Subsection 7.2.7, p. 266

[1013] Compare Subsection 7.8.2, p. 313

[1014] This has also been confirmed by studies investigating which multiple types are used in fairness opinions (Schönefelder, 2007, p. 105)

This may include presentation of certain non-GAAP figures or additional explanations around underlying trends and normalizations to strengthen their run-rate nature and hence suitability as proxy for the long-term economic cash generation potential[1015]

- *Financial guidance given on future time periods carries importance:* Consistent also with prior literature,[1016] the empirical results in this dissertation demonstrate that forward-looking valuation drivers outperform historical numbers.[1017] Empirical evidence furthermore suggests that earnings guidance given by management has at least some relevance; this guidance is particularly meaningful to the extent it relates to internal and firm-specific aspects difficult to assess from the outside (Hutton, Lee, & Shu, 2012). Therefore, valuation practitioners can expect to pay substantial attention to any guidance publicly listed companies may formulate on future expected financials. Whilst the valuation practitioner community may rely on aggregated forecast numbers prepared by equity research analysts, this broker consensus can expected to be informed by the guidance provided by management. Therefore, firms should provide measured and transparent guidance, allowing the equity research community to form appropriate views on future financials

8.4 Implications for accounting standard setters

Accounting standard setters might be pleased to hear that the empirical results in this dissertation point to a strong performance of accounting-based over cash-focused valuation drivers;[1018] this indicates that there are merits in following the long-established practice to consider earnings as a proxy for long-term valuation creation potential of companies. Therefore, continued high levels of attention will likely be paid by investors to earnings, operating profit and other accounting-based metrics and continued effort by standard setters to ensure the value relevance of such line items remains intact can assumed to be beneficial[1019]:

- *Requiring reporting transparency around key enterprise value adjustments is beneficial:* Reporting standards, which improve the transparency of adjustments to multiples as

[1015] It is, however, important to understand that a too generous favorable application of normalization adjustments may lead to artificially high levels of valuation and therefore potential biases. Consequently, companies should follow a measured approach
[1016] Compare e.g. J. Liu et al. (2002), Yoo (2006) or Schreiner (2007)
[1017] Compare Subsection 7.5, p. 287
[1018] Compare the empirical findings presented in Subsection 7.2.4 (p. 258)
[1019] A reasonable argument, compare Footnote 1009

discussed in Chapter 5 are welcome since it can be expected that they lead to more appropriate multiple valuation outcomes as more precise adjustments are enabled. Some potential suggestions, which could potentially offer improved multiple valuations on the basis of more exact adjustments include: reporting of market values—as opposed to solely book values—for minority investments and equity interest; sensitivities for ESOP dilution as a function of share price scenarios; improved segmental reporting to allow appropriate valuation/peer consideration of conglomerates;[1020] and more stringent M&A pro forma accounting requirements

- *Within-industry accounting comparability crucial for meaningful multiple valuation:* Comparability is particularly important within industries as peer groups for multiple valuations tend to be based on industry affiliation. Therefore, from a multiple valuation perspective, within industries, optional accounting principles should be kept to a minimum or at least required to be transparently disclosed so a more sophisticated multiple analysis can consider them through normalization. The proposed concept of "consistent inconsistency"[1021] counteracts potential biases to the extent all firms within one peer group are affected in a similar manner
- *Form carries relevance:* Multiple valuation is based upon computing pricing multiples for numerous peer companies. The higher the consistency of reporting between peer companies when it comes to line item labeling, the quicker it is to conduct adjustments; consequently, the lower are the valuation costs. The requirement to consistently label items which potentially result in an adjustment in the context of multiple valuation furthermore allows higher-quality automated adjustments on the basis of financial databases
- *"Rolling-up" some of the proposed adjustments in base metrics as a potential alternative to transparency:* Not all details are important as long as base numbers reflect economic reality: (Costly) adjustments to multiples are undertaken to approximate it. Therefore, the preferable solution from a valuation practitioner perspective is the certainty that no such adjustments are necessary given the unadjusted numbers already reflect the economic situation. Any effort in ensuring this is the case such as e.g. the new rules on operating lease accounting, which express future operating lease expenditure in financial

[1020] Compare e.g. Gutsche and Rif (2017) for a discussion on the importance of segment reporting in the context of valuation

[1021] See above, Subsection 5.1.3.2, p. 135

debt directly[1022] are welcome from a multiple valuation perspective: For a consistent multiple valuation, the details of operating leases are not relevant as long as operating leases are considered in net debt. An adjustment is then not necessary since multiples appropriately reflect economic reality "out of the box"

8.5 Implications for equity research analysts

It has been argued in this dissertation that there is compelling logic and empirical evidence[1023] to utilize forward-looking valuation drivers. Whilst, for the company under investigation, the necessary forecasts of valuation drivers could be estimated by the preparer of the multiple valuation, the computation of peer pricing multiples will in practice rely on averaged forecasts provided by equity research analysts ("broker consensus").[1024] The question therefore arises, which implications result from the findings and arguments in this dissertation for equity research analysts. As discussed,[1025] valuation drivers to be chosen in multiple valuations should optimally reflect single-period proxies for the long term economic value generation potential.[1026] It is therefore helpful if equity research analysts consider the following aspects:

- *Comprehensive financial forecasts in research reports are helpful—most important, however, are key value driver line items:* Particular diligence on the forecasting of valuation driver types commonly used in multiple valuation such as earnings, EBIT and EBITDA is desirable from a multiple valuation perspective; since customarily the next twelve months, next calendar year end or next but one calendar year end are utilized, specific focus should lie on those time periods compared to time frames further out in future or the next quarterly results

- *Transparency around adjustments is important for consistent consensus computation:* This includes transparent reporting of normalization adjustments for future time periods, i.e. through separate "GAAP" and "adjusted" line items. It can then be decided upon by the individual conducting the multiple valuation which metric to use[1027]

[1022] Compare the discussion in Subsection 5.5.1 (p. 159)
[1023] Compare Subsections 2.3.2.2 (p. 42) and 7.5 (p. 287), respectively
[1024] There is some body of literature, which compares the ability of equity research analysts to predict earnings, compare Hutton et al. (2012), who find that in about 50% of cases, analyst forecasts are more accurate than management guidance and Call, Chen, and Tong (2013), who discuss the interrelation between analysts' earnings and cash flow forecasts relevant to different valuation drivers in multiple valuation
[1025] Compare Subsection 2.4, p. 52
[1026] Or as the case may be for stock multiples: point in time
[1027] A number of studies analyze the differences between reported (i.e. GAAP) earnings and adjusted earnings

- *Increasing focus on pro forma financials,* i.e. financials consistently and for all time periods adjusted for M&A. As described in greater detail in Subsection 5.3.4 (p. 149), pro forma financials are better suited as a starting point for assessing the future cash generation potential of a firm under the assumption that all parts of the business—including the ones acquired or disposed—will continue to form part of the company

- *Best practice in broker multiple computation:* Equity research reports commonly contain multiple computations, which serve as basis of qualitative and quantitative valuation assessments—including target prices and buy/sell/hold recommendations—for the firms covered (Berndt & Deglmann, 2017). Some preparers of valuation may furthermore rely on those multiples directly and/or mirror specific adjustments undertaken by brokers in their own computations. This should encourage equity research analysts to utilize some of the best practices suggested and studied in this dissertation to maximize analytical precision

8.6 Implications for financial database providers

As a consequence of improving quality and levels of sophistication offered by financial databases, pricing multiple computations increasingly rely on subscription-based online financial databases.[1028] All the individual tasked with a multiple valuation exercise has to do is to provide the respective tickers of the peer group constituents and a well-constructed Microsoft® Excel® template takes care of computing pricing multiples. While this reduces the cost of multiple valuation tremendously compared to researching the necessary inputs from company accounts and broker reports,[1029] it results in a number of implications for the database providers:

- *A detailed set of available financial line items allows for more sophisticated adjustments with positive impact on valuation accuracy:* As theoretically elaborated on in Chapter

(sometimes referred to as “street” or “pro forma” earnings, with the latter not to be confused with M&A adjustments to earnings specifically). Compare e.g. Abarbanell and Lehavy (2002), who find that adjusted earnings are ofter times materially larger than reported earnings

[1028] Such as the ones offered by FactSet Research Systems Inc., Thomson Reuters, Bloomberg L.P. or S&P CapitalIQ, from which financials are “pulled” by means of Microsoft® Excel® add-ins in a more or less automated process

[1029] The author of this dissertation was himself involved in preparing multiple valuations in this manner earlier in his career before the necessary information was available from the databases. It would take around 20–30 minutes per peer company to compute a common set of trading multiples compared to around 5–10 minutes today for a full peer set completely relying on databases

5 and empirically shown in Subsection 7.4 (p. 270), adjustments are beneficial to enterprise value multiple accuracy. Therefore, databases should provide the raw data to perform such adjustments in a consistent manner. The “reasonable approximations” described in Table 5.3 (pp. 180–182) can be implemented using various database providers. However, in particular as far as a more precise computation of dilution through employment stock option programs is concerned, many databases lack the detailed information necessary to apply the treasury stock method or other more sophisticated approaches[1030] and some line items such as tax loss carryforwards are currently not available in at least some of the databases. Furthermore, there is historical evidence that databases suffer from coding errors (Yang, Vasarhelyi, & Liu, 2003; Courtenay & Keller, 1994; Nam, No, & Lee, 2017) and discrepancies between each other (Kern & Morris, 1994). Even though some of those studies are dated or consider smaller markets and hence might not be applicable in a similar manner to today’s situation for large U.S. and European firms, this suggests that a manual collection of inputs required for multiple valuation from annual reports might still be beneficial if the cost of valuation is not a concern

- *Consensus-estimated future valuation drivers are a “black box”—optionality around more customized downloads might be beneficial:* Whilst the utilization of hand-picked broker reports allows for a strong understanding of underlying assumptions—e.g. with regards to the consolidation assumption of announced but not yet closed M&A transactions—reliance on a simple consensus download figure for future earnings or EBIT from financial databases carries the risk that the information might be biased: some broker forecasts reflected in the consensus might be outdated, others might be based on conceptually differing adjustments. For longer-term time series, there are furthermore potential growth rate biases resulting from some brokers dropping out of the consensus in the outer years given they only provide near-term forecasts[1031]

[1030]Compare Subsection 5.4.5 (p. 156) for details

[1031]Financial database providers increasingly offer options to download broker data individually; however, this data would still come without further qualitative explanation. A more rigorous disclosure around consensus computation can provide relevant additional clarity to individuals tasked with valuation

8.7 Suggested further areas of research

8.7.1 Main areas of further research

This dissertation advances the theory and provides empirical evidence around practically relevant aspects of trading multiple valuation. At the same time some of the results suggest that multiple valuation accuracy could benefit from a number of additional investigations, falling into 3 groups: Incremental questions *raised by the results* in this dissertation, *limitations* of the approaches chosen in this dissertation and *additional areas of importance* for multiple valuation, which, given scope, could not be covered in great depth.

8.7.2 Company-specific multiple type selection

While it has been argued that price/earnings might be a reasonably solid "default" multiple type with strong performance across all industries (18.5% median absolute valuation error), Table 7.14 (p. 319) demonstrates that material valuation improvements with median absolute valuation errors of as low as 3.4%—a drop by 15.1%-pts—can be achieved, if a method could be found, which allows the *ex-ante identification of the best multiple type* on a company-by-company basis.[1032] Even under the assumption that no operationalization can be found, which in *all* instances ex ante determines the lowest valuation error, this ex post result suggests that there is material improvement potential from devising a technique, which is at least able to do so in certain instances.[1033] Given the considerable optimization potential, firm-specific multiple types in my opinion are the next frontier of empirical multiple valuation assessment.

8.7.3 Investigation of practically relevant intrinsic concepts (e.g. DCF)

Both intrinsic valuation concepts assessed in this dissertation, DCF and DDM, underperform their respective trading multiple valuation concepts significantly and with considerable effect sizes.[1034] I argued that the underperformance of the proposed intrinsic models[1035] might be in

[1032]Even if the scope of multiple types considered is narrowed down to 6 very common practical types, errors materially reduce to a median of 6.4% as demonstrated by Panel C of Table 7.14

[1033]Possible ideas for such implementations could be hybrid concepts considering both industry affiliation and financial metrics or an analysis of the temporary persistence of successful multiple types beyond the short-term time period studied in this dissertation, possibly also in connection with an assessment of successful multiple types as a function of economic cyclicality

[1034]Median pairwise error differences to the benefit of valuation multiples of -15.7%-pts and -24.9%-pts, for enterprise value/EBIT and price/earnings, respectively

[1035]Whilst in prior empirical literature on valuation, concepts such as RIV have been favored over DCF and DDM, it is hard to context that the latter models are of practically much higher relevance (compare the part related to an *upward bias* of such models as indicated by Figure 7.11 (p. 302) and in part be related to aspects of *undercomplexity* of the Equations derived[1036] to compute the valuations. I speculate though that a residual bias will remain even if those to impacts are accounted for;[1037] there may furthermore be theoretical explanations for it, such as implied minority discounts in traded stocks. In any event and while not primarily a question of multiple valuation, the aspects warrant further assessment, in particular since the strong performance of multiple valuation shown in this dissertation casts doubt on the preference of some academics[1038] for intrinsic concepts over multiples.[1039]

8.7.4 More sophisticated multiple adjustment strategies

It has been demonstrated that adjustments of enterprise value multiples are beneficial for valuation efficiency;[1040] even more strikingly, for the best performing enterprise multiple type enterprise value/EBIT with the exception of adjustments for employee share option programs (ESOPs), all adjustments appear to contribute positively to multiple valuation accuracy.[1041] The proposed ESOP adjustment has been designed as a fall-back to the theoretically preferable treasury stock or option pricing methods.[1042] It could therefore be interesting to establish if the negative impact of the ESOP adjustment undertaken in this dissertation is caused by the fact that ESOPs might not be priced in by the market or by a bias in the proposed adjustment.[1043]

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studies referred to in Table 1.1, p. 2) and hence will be considered as alternative or complement to multiples by practitioners

1036 Compare Equations 4.34 and 4.12 for DCF and DDM, respectively; this assertion is based on speculation and not quantified

1037 This has also been the result of a study of fairness opinions I have been involved with (Berndt, Deglmann, & Schulz, 2014)

1038 Compare e.g. Matschke and Brösel (2013, p. 689) or Koller et al. (2010, p. 313)

1039 One interesting empirical assessment could relate to a more intertwined approaches between the DCF concept and trading multiples, e.g. through consideration of DCF forecasts for a finite period in combination with an exit valuation through trading multiples as opposed to on the basis of the Gordon Growth formula (a practically common approach, compare Rosenbaum and Pearl (2009, pp. 111,132))

1040 Compare Subsection 7.4.2, p. 273

1041 Or at least not negatively affect it systematically, compare Table 7.8, p. 278

1042 Compare Subsection 5.4.5, p. 156

1043 A smaller-sample study researching the data required for more sophisticated adjustments on a firm-by-firm basis may be suitable until financial databases enable a more automated system to do so for large samples. Another adjustment with somewhat inconclusive results in this dissertation relates to M&A. Whilst a theoretical preference points to "pro forma'ing" financial statements for announced but not completed M&A transactions (Compare Subsection 5.3.4, p. 149), this is challenging to implement for large samples; I hence rely on the elimination of firms, which have engaged in meaningful M&A as a second best solution. A smaller-sample study could be beneficial to assess the impact of "pro forma'ing" financial statements of firms affected

8.7.5 Improved implementation of joint multiple type concepts

Whilst I have argued that there should be theoretical benefits of considering two multiple types at the same time,[1044] implementation challenges remain. Table 7.14 (p. 319) suggests that the weighting concept utilized with success for peer weighting does not produce lower valuation errors for a weighting of multiple types than single-multiple type approaches.[1045]

8.7.6 Further empirical assessment of the P/E-feedback loop corridor

In Subsection 7.10 (p. 324), I have argued that the strong performance of the price/earnings multiple throughout might be a consequence of a two-way-street between multiple valuation and stock prices, a presumption further supported by survey studies and the immunity of price/earnings to economically sensible adjustments. There is evidence from alternative study designs, among others Sanjoy Basu (1977), who finds in an assessment of the CAPM that stock returns are negatively correlated with price/earnings multiples.[1046] None the less, the feedback loop concept[1047] deserves some further empirical attention,[1048] also since it currently implies all investors would act in an identical fashion.[1049]

8.7.7 Transaction multiple valuation

This dissertation assesses trading multiples and, via the concept of intrinsic multiples, fundamental valuations. Other practically relevant valuation approaches, notably transaction multiples, are not considered; their joint assessment with trading multiples and intrinsic approaches appears to be a logical step. There is a scarcity[1050] of studies on transaction multiples, despite their high practical relevance[1051] and it would be desirable if transaction multiples received similar attention from empiricists going forward as trading multiples in the past.

[1044] Compare Subsection 6.3.4.2, p. 212

[1045] Alternative approaches could include error minimization algorithms to determine optimal multiple type weights for industries or individual companies

[1046] Also compare similar studies by Fama and French (1992), Sanjoy Basu (1983) and Ball (1978)

[1047] Which has been derived on the basis of the empirical results and for post-hoc reasons therefor should not be subjected to any further tests on the basis of the sample used in this dissertation

[1048] Tools which could be contemplated include e.g. event studies connecting material shifts in peer multiple valuation levels to share price movements for the company under investigation

[1049] There is, however, evidence that this might not be the case: e.g. Bushee (2001) documents the differing importance of earnings for short- and longer-term investors

[1050] Studies considering transaction multiples tend to focus on specific situations such as transactions requiring fairness opinions (Berndt, Deglmann, & Schulz, 2014; Schönefelder, 2007) or specific transactions themselves such as leveraged buyouts (Kaplan & Ruback, 1995) rather than large cross-sectional samples

[1051] For the aspect of practical relevance compare the survey studies referred to in Table 1.1 (p. 2)

CHAPTER 9

Summary in brief statements

"Valuation is expectation and expectation is imagination."

—G. L. S. SHACKLE[1052]

This Chapter comprises a summary of the dissertation in brief statements, with particular consideration to the empirical findings. Fundamentally, I argue that (a) trading multiple valuation is a useful tool to establish a value for both public and closely held companies, (b) successful multiple valuation is at its core about precision relative to market prices and therefore minimization of absolute valuation errors and (c) strategies to minimize such errors exist, which can be utilized in practical settings to obtain more precise outcomes. The objective of this dissertation is to uncover such strategies, synthesizing theoretical considerations and empirical evidence, relative to common market practice.

- **Forward-looking valuation drivers outperform historical valuation drivers, with the one year time period in 12 months performing best**. Consistent with a forward-orientation of valuation and in line with precedent literature, forward-looking valuation drivers such as "next twelve months" earnings outperform historically-oriented valuation drivers. Relying on valuation driver forecasts spanning a 12 month to 24 month future time period ("NTM+2") yields optimal results, indicating a positive effect of long-term normalized equity research views over noise introduced by forecasting uncertainty. Even longer-term forward periods perform inferior, consistent with a shifting balance towards ad Hypothesis 1a

[1052]Compare Shackle (1972, p. 8); G. L. S. Shackle, a British economist of the 20th century, who started his Ph.D. with F. A. Hayek but later focused on Post-Keynesian theories increasing forecasting uncertainty for more distant future time periods; moreover, a lack of distant forecasts impacts sample size beyond NTM+2. Valuation practitioners can capitalize on those findings by relying on broker consensus financials relating to time periods further out in the future, e.g. by considering next calendar year forecasts already earlier on in the current calendar year

ad Hypothesis 1b

- **M&A consolidation bias is not to blame for the strong performance of forward-looking valuation drivers**. An obvious bias of historical financials resulting from a lack of using M&A pro forma numbers does *not* appear to be the central explanation of the relatively weak performance of historical valuation drivers. This provides further assurance around the argument that expectations on future performance are most central to multiple valuation

ad Hypotheses 2a,2e

- **Valuation driver selection is crucial for multiple valuation accuracy, with widely varying error statistics**. Whilst "intrinsic multiples" offer a framework to investigate valuation dynamics of many common multiple types, the guidance provided is limited to the identification of obviously incongruent multiple types, e.g. enterprise value/net sales and PEG; optimal multiple type selection is best investigated empirically and accuracy varies meaningfully by valuation driver

ad Hypotheses 2b–2d

- Several directional statements apply to valuation driver families: **Valuation drivers with roots accounting numbers outperform valuation drivers emulating cash generation potential**; **flow multiples outperform stock multiples**; and, **despite some theoretical attractions, multiples normalizing for capital structure discrepancies do not generally outperform multiple types, which do not consider such differences**

- **Price/earnings as a multiple type performs strongest overall** and thus can be recommended as a "default" multiple type. This points to the potential **presence of a feedback loop corridor**, according to which public firm valuations might actually be influenced by price/earnings: Rather than solely a metric of measurement, price/earnings can be considered an **influencing factor** to public company pricing. Whilst existence of the feedback loop requires further investigation, the concept is empirically supported by (a) strong performance of price/earnings relative to enterprise value multiples despite theoretical shortcomings, (b) the standard price/earnings multiple being insulated to improvements through adjustments and (c) challenges to identify a consistent set of quantitative firm characteristics, which influence price/earnings performance relative to alternatives. The low proportion of poor price/earnings valuation outcomes points to a corridor nature of the feedback loop, where price/earnings might act as a directional "cross-check" metric in stock price formation within a certain range

- **Common intrinsic valuations (DDMs, DCF models) are shown to significantly underperform trading multiple-based valuations**. These findings—albeit based on some simplification of the intrinsic concepts used—solidify the role of trading multiples as useful valuation approach and support their high popularity with practitioners ad Hypothesis 3a
- **Valuation errors resulting from multiple approaches can to some extent be explained by intrinsic discrepancies of the company under investigation relative to its peer group**. In other words, differences between a company under investigation and its peer group regarding aspects which can theoretically be demonstrated should result in discrepancies of multiples empirically explain part of the observed valuation errors. Considerable idiosyncratic errors remain, in particular for enterprise value multiples ad Hypothesis 3b
- **Over-proportionate consideration of peers with high similarity to the company under investigation yields increased valuation accuracy**. This supports the presumed practitioner approach to apply qualitative judgment by overweighting some peers as opposed to indiscriminate median aggregation during valuation multiple determination ad Hypothesis 3c
- **Application of an economically justifiable set of adjustments to enterprise value multiples increase valuation accuracy—however, equity value multiple precision does not meaningfully change if adjusted**. The practice to adjust enterprise value multiples is appropriate since it is shown to result in higher valuation accuracy; it can therefore be encouraged. Increased valuation costs can be kept in balance with an automatic download of required line items from common financial databases ad Hypothesis 4a
- **Most individual adjustment items contribute positively to valuation accuracy of enterprise value multiples**. With the exception of some conceptually weaker adjustments on stock dilution, proposed consistency and comparability adjustments are all contributing positively to valuation accuracy. This provides support to the proposed adjustment framework and underpins the systematic nature of adjustments ad Hypothesis 4b
- **Industry-specific multiple types produce higher valuation accuracy, indicated by lower median valuation errors**; however, **results are not significant** according to the ad Hypothesis 5a

Holm-Bonferroni-adjusted Wilcoxon sign-rank test applied throughout this dissertation. Even though median valuation errors of an industry approach appear more favorable relative to the baseline approach of utilizing price/earnings, results are not significant, which I ascribe to statistical test dynamics and could presumably be addressed by a larger sample. In any event, price/earnings performs well across most industries

ad Hypothesis 5b

- **Optimal multiple type selection is firm-dependent; however, challenges to operationalize the ex ante discovery of best multiple types exist**. Firm-specific multiple types, which historically have performed well, will in the short term retain their strong performance; however, over longer time periods, the effect fades considerably and its implementation is limited to public companies where historically successful multiple types can be determined. Intrinsic multiple approaches—which perform well in explaining valuation errors partly and are useful in peer weighting concepts—fail to offer improved multiple type selection compared to baseline price/earnings

ad Hypothesis 6a

- **Median appears to be a generally suitable aggregation approach to translate pricing multiples into a valuation multiple**, outperforming conceptually equally valid alternatives such as harmonic mean. More complex methods such as the Theil–Sen approach exist, however, their practical relevance is presumably limited

ad Hypothesis 6b

- **Negative multiples carry little value-relevant information**; if median is used as aggregation methodology negative multiples can either be included or excluded, with little difference to valuation accuracy

ad Hypothesis 7

- **No evidence is found that a combination of multiple types increases valuation accuracy**, albeit this is only studied in a cursory manner connected to other Hypotheses. Given inconclusive results of some of the firm-specific and industry-specific approaches, which were developed to contextualize weighted multiple concepts, further analysis to establish a suitable set of multiple type weighting criteria is required

In their entirety, the above statements provide comprehensive and practically relevant guidance framework to anyone considering implementation of a meaningful trading multiple valuation with the obvious ambition to maximize valuation accuracy.

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List of abbreviations and acronyms

CAGR compounded annual growth rate, a geometric progression ratio providing a constant rate of return. 104

CAPE cyclicality-adjusted price/earnings multiple, sometimes also referred to as "Shiller-P/E". 10, 32, 69

Capex capital expenditure. 65, 119, 138, 258, 259, 261, 333

CAPM capital asset pricing model. 55, 90, 91, 95, 102, 125, 200, 238, 325, 327, 344

D&A deprecitation and amortization expenses. 57, 114, 117–119, 138, 261

DCF discounted cash flow to the firm valuation analysis. xii, xiii, 2, 4, 6, 23, 25, 31, 34, 37, 43, 45, 47, 49, 50, 88, 89, 98, 109, 120, 124–126, 166, 175, 187, 214, 217–220, 258, 289, 295, 296, 301, 303, 310, 332, 342, 343, 347

DDM dividend discount model valuation analysis. xii, xiii, 4, 6, 23, 25, 37, 50, 55, 88–91, 95, 98, 120, 124–127, 137, 175, 214, 217, 295, 301, 303, 332, 342, 343, 347

EBIT Earnings before interest and taxes. 1, 9, 11, 35, 42, 46–49, 56–60, 62, 65, 75, 98–100, 103, 104, 108, 114, 118–120, 122, 141, 145, 147, 148, 153, 160, 161, 169, 172, 173, 193, 200, 210, 246, 258, 261, 266, 284, 285, 293, 305, 308, 323, 336, 339, 341, 343

EBITDA Earnings before interest, taxes, depreciation and amortization. 9, 21, 34, 42, 46, 49, 56–62, 65, 75, 77, 81, 99, 100, 114–119, 135, 138–141, 144, 145, 147, 148, 160, 161, 174, 193, 200, 206, 210, 212, 246, 258, 259, 261, 268, 277, 287, 309, 314, 315, 324, 333, 336, 339

EBT earnings before taxes. 46, 62

EPS earnings per share, a measure of net income by shares outstanding, either relying on diluted shares outstanding, which consider potential dilution from ESOPs, convertibles and other sources of dilution or basic shares outstanding pre dilution. 42, 50, 51, 157

ESOP employee share option program, with potentially diluting effects to shareholders. 49, 156–159, 275, 277, 280, 281, 285, 287, 338, 343

Note: Numbers at the end of each entry refer to pages where the acronym or abbreviation appears (excluding Tables and Figures)

EV enterprise value, i.e. the value corresponding to the claim of all capital providers (as opposed to equity value as the value of the claim of only the shareholders) of a firm. 114, 272

GAAP Generally Accepted Accounting Principles (independent of concrete standards followed, i.e can refer to both IFRS and U.S. GAAP or any other standard utilized). 152, 165, 167, 258, 336, 337, 339

GDP gross domestic product, a measure for economic activity of a geography. 105

I/B/E/S Institutional Broker Estimate Service, a commercial database containing individual and aggregated broker forecasts ("consensus estimates"). 73, 105, 122

IAS International Accounting Standards. 50, 51, 144, 331

ICB Industry Classification Benchmark, a classification framework, which allows assigning individual firms to a list of pre-defined industries. 73–75, 188, 221, 231, 243, 247, 272, 316

IFRS International Financial Reporting Standards as issued by International Accounting Standards Board. 50, 131, 141, 144–147, 152–159, 162, 167, 168, 331

IPO initial public offering, the process of introducing a formerly privately held company to the stock market. 46, 142, 218, 220, 236

LAD least absolute deviation model, an alternative statistical approach to OLS. , , A20

LTM rolling last twelve month historical financials. 289, ,

M&A Mergers & Acquisitions. 3, 11, 33, 44, 46, 47, 104, 133, 149, 150, 164, 272, 273, 277, 285–287, 290, 331, 336, 338, 340, 341, 343, 346

MPI Minority passive investments. 144, 176, 180, 182

NOPAT net operating profit after taxes. 99, 169

NOPLAT net operating profit less adjusted taxes. 56, 99, 104

NTM rolling next twelve month measurement time period for financials. 289, 290, 345, 346

OLS ordinary least square regression, a statistical method for estimating unknown parameters in a regression model. 198, 203, 281, A18

P/E price/earnings multiple, a very common multiple type. xii, 47, 88, 147, 289, 290, 323, 325, 326

P&L profit and loss statement, used interchangeably in this dissertation with income statement. 35, 42, 50, 57, 58, 60, 73, 81, 99, 104, 148, 149, 159, 160, 167, A26

PEG price-earnings growth ratio or multiple, a hybrid price/earnings multiple normalized for units of growth. 75, 122–125, 346

R&D research & development expenses. 48, 104, 138, 168, 172

RIV residual income valuation. 14, 23, 25, 47, 89, 120, 124–127, 217, 295, 342, A19

SFAS Statements of Financial Accounting Standards per U.S. GAAP. 50, 51, 144, 158, 331

SIC Standard Industry Classification, a classification framework, which allows assigning individual firms to a list of pre-defined industries. 73, 187, 188, 192, 231

U.S. GAAP Generally Accepted Accounting Principles as used in the United States. 50, 131, 141, 144, 146, 152–155, 157–159, 162, 168

WLS weighted least square regression, an alternative statistical approach to OLS. , , A20

List of notations, variables and symbols

$A_{j,t}^{Ent;\,Eq}$ adjustments to derive corresponding enterprise value on the basis of equity value or vice-versa, notably net debt and other adjustments proposed in Chapter 5 as the case may be. 226

$\boldsymbol{AMRT}_{i,1}$ amortization expense of company i at time t.

β_i^{eq} firm-dependent relative return volatility factor ("levered equity beta"). 102

β_i^{u} firm-dependent relative return volatility factor, normalized for leverage ("unlevered beta"). 103

$\boldsymbol{BE}_{i,t}$ book value of equity of firm i at time t. 120

$\boldsymbol{CAPEX}_{i,t}$ capital expenditure of company i at time t.

$d_{i,t}$ discrepancy factor for firm i at time t, which allows theoretical deduction of intrinsic multiple types on the basis of other known intrinsic multiple types. 116

$\boldsymbol{D}_i^{\boldsymbol{MV}}$ debt at market value of firm i (time index withheld for brevity). 102

$\boldsymbol{DPR}_{i,1}$ depreciation expense of company i at time t.

$\boldsymbol{DIV}_{i,t}$ dividend for firm i at time t. 91

$\widetilde{\Delta}_{Pair}$ median of pairwise error differences, a comparative metric to determine outperformance of one multiple valuation methodology over another in terms of %-point differences. 255

$\boldsymbol{ERN}_{i,t}$ earnings (i.e. net income) of firm i at time t.

$E_i^{\boldsymbol{MV}}$ equity at intrinsic value of firm i (time index withheld for brevity). 102

f an aggregation function to be determined in order to obtain a valuation multiple from numerous pricing multiples (e.g. median) or, as the case may be, a function such as Equations 4.12 and 4.34 to compute an intrinsic multiple from input variables to be specified. 25, 26

$\boldsymbol{FCF}_{i,t}$ free cash flow to the firm (prior to financing charges) for company i at time t. 98

Note: Numbers at the end of each entry refer to pages where the variable is first introduced or discussed (excluding Tables and Figures); excludes some obvious variable descriptors such as *SALES* and *EBIT*, some of which are included in the List of abbreviations and acronyms; emphasis is on variables used throughout this dissertation, i.e. list omits some local variables used only in individual sections in the spirit of brevity

$\boldsymbol{ff}_{i,t}$ — fade factor for company i at measurement time t, determining the degree of growth deceleration towards steady-state growth, with $0 \leq ff_{i,t} \leq 1$; $ff_{i,t}$ constant for all projection time periods τ. 106

$g_{i,t}$ — growth rate of a financial metric such as free cash flow or dividends for firm i at time t.

h_i — the ratio of return on incremental investment r_i^{ROE} and cost of equity r_i^{eq} for firm i. 94

i — index for the I in total peer companies used to compute a pricing multiple. 23, 25

$\boldsymbol{IC}_{i,t}$ — invested capital of firm i at time t. 103, 121

$\boldsymbol{INT}_{i,t}$ — interest expense paid by firm i at time t. 169

j — index for the company under investigation, i.e. the company for which a peer-based trading multiple valuation is sought. 26

λ_i — leverage factor of firm i (time index withheld for brevity), expressed as the market value of debt (D_i^{MV}), divided by the market value of debt plus the market value of equity ($D_i^{MV} + E_i^{MV}$). 102

$\mu_{i,t}^{MT;\,MP}$ — pricing multiple of type MT (e.g. price/earnings—"PE") measured for time period MP (e.g. next twelve months—"FW") for the i^{th} comparable company at valuation time t. 23

$\hat{\boldsymbol{M}}_{j,t}$ — valuation multiple for the company j under investigation at time t obtained through aggregation of I peer pricing multiples using a formula to be specified (e.g. median). 26

$\hat{\mu}_{i,t}^{MT;\,MP}$ — intrinsic multiple for the company i under investigation at time t obtained through first computing a valuation with background in fundamental/intrinsic concepts, then dividing it by a corresponding valuation driver to mimic a multiple of type MT, measured for time period MP. 25

$\boldsymbol{NWC}_{i,t}$ — net working capital of company i at time t.

$\boldsymbol{P}_{i,t}$ — the measured price reference used in a pricing multiple for peer firm i, measured at t. It comprises stock price, equity value or enterprise value as the case may be for the respective multiple. 23

$\hat{\boldsymbol{P}}_{j,t}$ — the inferred price reference resulting from a valuation multiple multiple for firm under investigation j, measured at t. It can be expressed as implied stock price, equity value or enterprise value as the case may be for the respective multiple. 26

p — an acceleration parameter used in weighting concepts. 312

$q_{i,t}$ — earnings retention rate (i.e. the complement to dividend payout ratio) for firm i at time t. 93

r_i^{eq} — cost of equity of firm i. 91

r_i^{ROE} — return on incremental investment of firm i. 94

r_i^{WACC} — weighted cost of capital of firm i. 98, 102

r_i^{ROIC} — return on invested capital of firm i. 101, 103

r_{rf} — risk free rate of return (time index withheld for brevity). 102

r_{ERP} — equity risk premium (time index withheld for brevity). 102

r_{CRP} country risk premium applicable to some markets (time index withheld for brevity). 292

$r^d_{i,t}$ Pre-tax cost of debt or, by approximation, blended interest rate paid by firm i at point in time t. 169

t the main time index denoting the time of valuation or the relative timing of financial metrics vs. the time of valuation as the case may be. 23, 25, 26

τ a subordinated time index, distinguishable from the tax rate τ_i of firm i by the lack of index i; τ mostly relates to projection years. 92

τ_i the tax rate of firm i. 92, 99

$u_{j,t}$ measured valuation error for company under investigation j at time t, as indicated by "a" as absolute error or "b" as signed error (bias) and measured either in percentage terms ("pct"), logarithmically ("log") or in turns of multiple. 222

$\boldsymbol{V}_{i,t}$ a valuation estimate for firm i at time t on the basis of an intrinsic or fundamental valuation model. 25

$\boldsymbol{VD}_{i,t}$ the valuation driver utilized in a pricing, valuation or intrinsic multiple, i.e. the denominator or normalization factor of the multiple. Examples include earnings, book value of equity or EBIT. 23, 25, 26

$w_{i,t}$ the individual weight for firm i at time t out of I weights adding up to 1 for the purposes of weighting individual pricing multiples in order to determine a valuation multiple. 204, 312

APPENDIX A

Tabulated summary for quick reference

TABLE A.1: Summarizing overview of core topics covered in this dissertation

	Prior findings and theory		
Topic of research	Considerations and relevance	Key prior findings and remaining research gaps	Hypotheses
1. Valuation accuracy of different multiple types/-valuation drivers	• Valuation drivers as single-period proxies for the economic value of (all) future cash flows the key precision factor of multiple valuation • Academic criticism around arbitrary nature of practitioners' valuation driver choice	• Anecdotal reporting and little conceptual rigor of valuation driver performance • Inconclusive results regarding equity value and enterprise value multiples specifically	• H2a Impacted by their valuation drivers, different multiple types display materially diverging levels of valuation accuracy • H2b Valuation drivers close to single period cash flow do not necessarily outperform more cash-flow remote accounting-based drivers • H2c Flow multiples outperform stock multiples given their conceptually closer relationship with future cash generation potential • H2d Multiples, which normalize for different capital structures outperform multiples, which do not consider capital structure differences • H2e Value-relevance of valuation driver composition is important for valuation accuracy of multiple types [...]
2. Valuation driver timing considering M&A consolidation	• Conflict resulting from choice of valuation driver timing: forecasting uncertainty from valuation drivers relating to time periods in the more distant future vs. the generally forward-oriented nature of company valuation • Near-term valuation drivers potentially affected by M&A biases	• Current evidence of gradual valuation accuracy increases for valuation drivers relating to increasingly more distant time periods not intuitive • No prior studies on potential M&A consolidation aspects on multiple accuracy	• H1a Valuation drivers computed on the basis of forecasted financials for the near future outperform valuation drivers relying on historical time periods and those relating to time periods further ahead • H1b The strong performance of outer-year valuation drivers results from M&A biases suffered by nearer-year valuation drivers
3. Industry-specific multiple types operationalized through combined multiple concepts	• Ex-ante a reasonable assumption that multiple valuation could be improved through industry-specific multiple type selection and weighted combinations of different multiple types • Substantial part of valuation errors not explained by fundamentals; could be related to qualitative industry aspects	• E.g. Schreiner (2007) provides some initial indication on both aspects, however operationalization contains simplifying and arbitrary elements	• H5a Industry-specific multiple types offer an opportunity to increase valuation accuracy compared to utilizing one single multiple type for valuations across all industries • H5b Best-performing multiple types are firm-specific; strategies to uncover the multiple type which is best suited for each firm can meaningfully increase valuation accuracy • H7 Valuation precision can be improved through the combination of several multiple types and the concurrent consideration of different general valuation approaches
4. Adjustments to multiples	• Strong theoretical arguments that multiples adjusted for certain economic aspects should provide higher valuation accuracy	• Prior studies (Berndt, Deglmann, & Vollmar, 2014; Chullen, Kaltenbrunner, & Schwetzler, 2015) suggest accuracy benefits from some (but not all) adjustments • No comprehensive framework for adjustments established yet and adjustment studies so far limited to enterprise value multiples	• H4a Adjusted multiples outperform unadjusted multiples as far as valuation precision is concerned • H4b Each adjustment provides incremental valuation precision

Note: Own illustration to be read in conjunction with the following page. [a] Relates to Subsection containing additional information on theory ("T"), hypotheses ("H") and results ("R")

Conducted analyses			
Methodology summary	Own empirical findings and interpretation	Limitations and further research ideas	Details[a]
• Side-by-side comparison of valuation errors for different multiple types • Well-established "horse race"-methodology, paired with more rigorous statistical testing (Wilcoxon sign-rank tests)	• Significant discrepancies between valuation drivers: Strong relative performance of (1) flow multiples, (2) accounting-based multiples and (3) multiples focusing on value-relevance • Mixed performance of equity value vs. enterprise value multiples • Common price/earnings multiple with remarkably strong performance—median absolute log valuation error of 18.5%	• Relies on unadjusted multiples and other base-line assumptions; however, addressed in later parts of the empirical study • Aggregation across industries considered appropriate	T/H: ↑ 2.4 R: ↑ 7.2.3
• Comparison of valuation accuracy in matched samples for different valuation driver horizons • Elimination of M&A firms from the sample to assess potential M&A biases	• Weak performance of historical valuation drivers, consistent with forward-oriented nature of valuations (and, potentially, one-off biases) • Valuation errors for different valuation driver horizons v-shaped, with a 2 year forward time period performing best (effect sizes of c. 0.5–1.0%-pts vs. next twelve months approach) • Limited forecast availability negatively impacts suitability of longer-term horizons—sample size for NTM+3 drops by 50% • No distinctly different trends if M&A firms are adjusted—little bias caused by M&A consolidation effects	• Study excludes of M&A firms rather than conducting theoretically preferable pro forma adjustments • Devising a "template" suitable to conduct automatic pro forma adjustments for M&A on the basis of available financial databases or conduct smaller-sample study	T/H: ↑ 2.3.2.2 R: ↑ 7.5
• Comparison of a valuation using the best performing type by industry vs. using the best performing type overall (P/E) • Alternatively adaption of a multiple type weighting concept based on industry	• Industry-specific multiples produce higher valuation accuracy, however results are not significant and price/earnings is the strongest performing multiple type in many industries • Best multiple type selection is firm specific and hence challenging to operationalize • A weighted approach considering several multiple types does not outperform the selection of the best performing multiple type P/E throughout	• Results directionally pointing to industry-specific multiples but outperformance of generally best multiple type (P/E) not significant—potential test biases? • Failure of combined multiple concepts only established for the specifically proposed approach, thus inconclusive	T/H: ↑ 6.2.5, 6.3.4 R:↑ 7.9.2
• Compute adjusted and unadjusted multiples side-by-side and evaluate improvements with a Wilcoxon sign-rank test • Regression-based assessment of valuation errors depending on adjustment permutations	• Fully-adjusted enterprise value multiples outperform their unadjusted counterparts significantly, with median error reduction by 1.3%-pts for enterprise value/EBIT • Most (but not all) individual enterprise value adjustments beneficial • Less clear benefits of adjustments to price/earnings multiples	• Not all adjustments can be automatically undertaken in a truly sophisticated manner for large samples—reliance on "reasonable approximation" rather than "gold standard" to balance cost of valuation for a large sample • Gain a better understanding of the accuracy-reducing dilution adjustment (quality of adjustment undertaken vs. lack of underlying economic justification for the adjustment?)	T/H: ↑ 5 R: ↑ 7.4

Note: To be read in conjunction with preceding facing page

	Prior findings and theory		
Topic of research	Considerations and relevance	Key prior findings and remaining research gaps	Hypotheses
5. Improved valuation accuracy through peer weighting depending on the similarity of financial characteristics	• Fundamental factors appear to explain valuation errors to some extent empirically and are a strong theoretical driver of valuation differences; therefore, a consideration of intrinsic variables may contribute to improved valuation accuracy	• Documented multiple valuation improvement through a consideration of intrinsic variables • However, existing approaches to reflecting peer differences such as algorithms sub-setting peers, which match certain similarity criteria or modified valuation multiples are arbitrary, complex and presumably inconsistent with valuation practitioner approaches	• H3c Considering differing financial characteristics of peers allows for improved multiple valuations
6. Aggregation of multiples through median, including value relevance of negative multiples	• Median proposed as generally suitable aggregation concept • Value-relevance of including negative peer multiples • Address potential biases in mean-based aggregation methods through selection of median as aggregation principle	• Usefulness of median as aggregation principle already widely studied (Chullen, Kaltenbrunner, & Schwetzler, 2015, p. 654; Dittmann & Maug, 2008, p. 2; Herrmann & Richter, 2003, p. 213), so analysis on median vs alternatives will be more confirmatory in nature for the sample at hand • Expands recent studies by Sommer, Rose, and Wöhrmann (2014), who find that exclusion of negative multiples beneficial for valuation accuracy to a theoretically more defensible median aggregation method	• H6a Median is a suitable central tendency measure relative to its theoretically most appropriate alternative, harmonic mean • H6b Negative multiples carry value-relevant information; their inclusion using appropriate aggregation concepts such as median is beneficial
7. A closer analysis of valuation errors and strategies for their reduction	• Valuation precision is one aspect of successful multiple valuation; another element is the understanding the source of potentially systematic errors • Notably is it possible to explain multiple valuation errors through peer group differences of financial factors?	• Extend the findings of Henschke (2009) to independent variables suggested by the intrinsic multiple concept • Consider enterprise value multiples (enterprise value/EBIT) in addition to price/earnings	• H3b Imprecision in valuation multiple computations can in part be explained by differing financial characteristics of peer companies considered
8. Multiple valuations vs. fundamental valuations	• Academia strongly prefers fundamental valuation concepts—in contrast to practitioner priorities • Doubts in the existence of valuation drivers as one-period/one-metric proxy with sufficient ability to predict full future economic cash generation potential • A measurement of different aspects? Market efficiency (fundamental valuations) vs. Law of One Price (multiple-based valuations)	• Practically most common fundamental valuation types (DCF, DDM) have received surprisingly little attention compared to RIV models (e.g. Courteau, Kao, O'Keefe, and Richardson, 2006, Henschke, 2009) as "sparring partners" of multiple valuations outside of studies focusing on very specific corporate situations (e.g. Kaplan and Ruback, 1995) • Considerable research gap in comparing the relative performance of the most practically common valuation types in the context of a broader public company setting	• H3a Intrinsic valuation approaches can be expected to outperform multiple-based approaches

Note: Own illustration to be read in conjunction with the following facing page. [a] Relates to Subsection containing additional information on theory ("T"), hypotheses ("H") and results ("R")

Conducted analyses			
Methodology summary	Own empirical findings and interpretation	Limitations and further research ideas	Details[a]
• Consideration of fundamental input factors operationalized through a ranking and weighting concept, which relies on model-predicted differences between the firm under investigation and its peers via intrinsic multiples • Emulates presumable practitioner approach granting higher (lower) relevance of financially similar (dissimilar) peers	• Fundamental-factor peer weighting concept produces lower valuation errors compared to standard equal peer weighting approach • Conventional "rank sum" weighting approach performs strongest, with P/E valuation errors reducing by 0.507%-pts	• Quantitative peer weighting concept relying on intrinsic multiples may disregard further aspects of dissimilarity; however, industry peer group formation maintained, which might account for some of those aspects	H: ↑ 6.4 T/R: ↑ 7.8
• Computation of valuation errors for median and harmonic mean as well as alternative concepts • Comparison of valuation errors excluding and including negative multiples, using median aggregation methods	• Median appropriate as aggregation concept • Theil-Sen method as equally precise alternative, however, with more limited practical relevance	—	T/H: ↑ 6.3.2.1, 6.3.3.2 R: ↑ 7.2.3, 7.3
• Regression of valuation errors (as dependent variable) on a variety of (a) fundamental valuation input differences, (b) other factors such as size and profitability differences, (c) intrinsic model-suggested differences between the individual company under investigation and its peer group	• Some relationship of intrinsic valuation individual input factor differences relative to peer group (e.g. growth, return on equity) for price/earnings; directional consistency with predictions • Results for enterprise value/EBIT and the more sophisticated intrinsic discrepancy model less meaningful	• Overall lower coefficients of determination than Henschke (2009)	T: ↑ 4.1—4.6 H: ↑ 6.4 R: ↑ 7.7
• Reliance of corporate finance theory in the determination of suitable intrinsic valuation approaches • Computation of "fade factors" to determine a long-term comparable growth rate for intrinsic valuation purposes • Pairwise comparison of valuation errors of (simplified) fundamental and multiple valuations • Intrinsic multiples as proposed approach to connect the concept of multiples with fundamental valuation aspects	• Valuation multiples offering substantially higher valuation accuracy compared to fundamental valuations, winning c. 75% of pairwise valuation comparisons • Proposed fundamental valuation concept is based on well-established approaches and free of excessive judgment • Intrinsic multiple distribution median not too dissimilar from pricing multiples and intrinsic multiples, however, with marked positive skewness	• Simplification of fundamental valuations limits interpretation as conclusive evidence due to potential undercomplexity but is none the less instructive as (a) a more sophisticated analysis has higher cost and multiple valuation quality could equally be pushed to a more precise level (b) no obvious median mis-pricing (c) reliance on common textbook DCF methodologies	T: ↑ 4.1—4.6 H: ↑ 6.4 R: ↑ 7.6

Note: To be read in conjunction with preceding facing page

APPENDIX B

Additional descriptive sample statistics

TABLE A.2: Median EV/EBIT multiples by measurement date and industry affiliation

ICB classification[a]		Median sector EV/EBIT multiple by measurment date[b]								
Code	Descr.	Jan-05	Jul-05	Jan-06	Jul-06	Jan-07	Jul-07	Jan-08	Jul-08	Jan-09
053	Oil & Gas Producers	10.5x	9.8x	8.2x	7.2x	7.6x	8.2x	7.7x	6.8x	6.6x
057	Oil Equipment, Services & Distr.	14.6x	15.3x	15.4x	12.5x	11.6x	12.0x	8.9x	10.2x	5.6x
058	Alternative Energy	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.7x
135	Chemicals	10.7x	10.7x	10.3x	10.5x	13.0x	13.4x	11.6x	9.3x	8.2x
173	Forestry & Paper	14.7x	16.8x	17.3x	15.8x	14.4x	12.9x	12.5x	12.9x	12.2x
175	Industrial Metals & Mining	7.4x	6.6x	10.2x	7.5x	8.7x	9.3x	7.2x	6.9x	6.2x
177	Mining	8.6x	7.6x	9.5x	6.7x	7.0x	8.0x	7.5x	5.8x	7.1x
235	Construction & Materials	10.7x	11.5x	11.8x	11.0x	12.1x	11.8x	9.3x	8.4x	8.3x
271	Aerospace & Defense	12.4x	11.8x	12.1x	11.2x	11.3x	11.4x	10.2x	8.4x	7.5x
272	General Industrials	10.4x	10.1x	10.2x	10.0x	10.8x	10.7x	9.1x	9.5x	8.7x
273	Electronic & Electrical Equipment	12.7x	12.7x	13.2x	11.2x	14.0x	12.9x	11.0x	10.3x	8.8x
275	Industrial Engineering	11.6x	11.3x	11.9x	10.7x	12.1x	11.5x	8.8x	9.0x	7.0x
277	Industrial Transportation	12.0x	11.7x	12.8x	13.4x	13.1x	13.0x	11.3x	11.3x	9.0x
279	Support Services	13.1x	12.5x	12.8x	11.5x	12.3x	12.3x	10.5x	10.3x	9.6x
335	Automobiles & Parts	11.7x	11.3x	11.4x	11.7x	12.5x	12.6x	10.6x	9.6x	11.4x
353	Beverages	12.4x	12.2x	13.2x	13.5x	13.8x	13.3x	12.0x	10.8x	10.1x
357	Food Producers	12.3x	11.9x	11.8x	12.7x	12.7x	12.7x	11.5x	11.3x	10.4x
372	Household Goods & Home Constr.	6.7x	7.5x	7.5x	7.4x	9.8x	10.5x	8.1x	8.8x	9.3x
374	Leisure Goods	11.7x	12.6x	17.0x	11.6x	16.0x	20.0x	13.4x	12.4x	11.9x
376	Personal Goods	13.3x	13.1x	13.2x	12.9x	13.4x	12.8x	11.5x	11.3x	8.3x
378	Tobacco	11.4x	11.3x	11.2x	11.9x	13.0x	12.0x	11.4x	10.8x	8.0x
453	Health Care Equipment & Services	17.0x	15.7x	15.6x	14.9x	16.2x	15.7x	13.8x	13.4x	10.9x
457	Pharmaceuticals & Biotechnology	14.0x	14.7x	14.6x	14.2x	14.8x	15.0x	12.8x	12.1x	10.0x
533	Food & Drug Retailers	11.4x	12.1x	11.8x	11.6x	12.1x	11.5x	10.3x	9.3x	8.1x
537	General Retailers	10.3x	10.2x	10.1x	9.3x	10.8x	9.4x	8.5x	7.9x	8.2x
555	Media	13.8x	12.0x	12.2x	11.3x	12.1x	11.5x	9.8x	8.8x	8.5x
575	Travel & Leisure	13.1x	12.9x	12.9x	12.6x	14.0x	13.2x	11.0x	10.1x	9.1x
653	Fixed Line Telecommunications	11.2x	11.3x	10.9x	11.1x	12.5x	12.2x	11.6x	10.2x	8.8x
657	Mobile Telecommunications	11.0x	12.1x	11.8x	11.3x	12.0x	12.1x	11.9x	9.6x	9.1x
753	Electricity	12.6x	13.0x	12.2x	12.2x	12.4x	11.8x	11.6x	11.1x	10.1x
757	Gas, Water & Multiutilities	12.2x	12.6x	12.4x	11.6x	12.6x	12.6x	12.1x	11.0x	10.2x
953	Software & Computer Services	15.9x	17.1x	14.8x	13.9x	13.9x	14.2x	12.5x	10.8x	8.7x
957	Technology Hardware & Equipment	14.9x	16.4x	16.4x	12.7x	14.7x	16.0x	11.3x	13.6x	12.2x
Median across industries		**12.1x**	**12.2x**	**12.2x**	**11.7x**	**12.3x**	**12.1x**	**10.7x**	**10.1x**	**8.8x**
o.w.: STOXX® Europe 600		11.8x	12.0x	12.3x	11.8x	12.4x	12.4x	10.6x	9.8x	8.8x
o.w.: S&P 500®		12.7x	12.6x	12.1x	11.6x	12.2x	11.8x	10.9x	10.5x	8.9x

Note: Table should be read in conjunction with the table on the facing following page. Color coding refers to relative difference between overall sample median enterprise value/EBIT multiple shown at the intersection of total median column/ row (highlighted in bold): red (green) represents a discount (premium) to that multiple. Intensity of color indicates relative quantum of difference. All medians computed on the basis of individual observations (rather than related median aggregates) [a] Industry Classification Benchmark by "Sector," which relates to the first 3 digits of the respective ICB codes and includes all respective "Subsectors," which are defined by the full 4 digit ICB taxonomy [b] The measurement date is the last trading day of the month and year specified in the column heading. The valuation driver (EBIT) is recalendarized to a rolling next twelve month level [c] Sample as detailed in Table 3.1, excluding companies classified by ICB in the industry "Financials" (ICB code 8xx) [d] "Total" refers to median over time, also including corresponding line item of the table on previous page in the conjunction with which it should be read [e] Please refer to previous page for row labels (i.e. industries)

Median sector EV/EBIT multiple by measurment date[b](continued)[e]

Jul-09	Jan-10	Jul-10	Jan-11	Jul-11	Jan-12	Jul-12	Jan-13	Jul-13	Jan-14	Jul-14	Jan-15	Jul-15	Total[d]
9.4x	9.2x	8.6x	10.5x	9.1x	8.0x	8.0x	8.9x	9.0x	8.5x	10.9x	11.5x	14.9x	**8.9x**
11.1x	13.1x	11.2x	13.7x	12.5x	10.1x	10.0x	9.8x	10.1x	9.4x	10.4x	8.9x	11.4x	**11.1x**
10.3x	13.0x	15.2x	12.2x	11.3x	9.8x	18.0x	N/A	N/A	16.2x	15.0x	12.3x	15.0x	**12.4x**
12.4x	12.7x	10.6x	11.1x	9.9x	10.2x	10.5x	11.3x	12.2x	12.3x	13.0x	14.0x	13.5x	**11.3x**
16.1x	17.7x	15.0x	12.1x	9.5x	12.3x	11.8x	13.5x	14.9x	14.7x	13.2x	14.0x	13.2x	**13.4x**
15.6x	12.8x	10.3x	11.3x	9.3x	10.0x	9.7x	11.2x	12.3x	12.6x	11.3x	9.8x	11.3x	**9.7x**
12.8x	8.8x	6.9x	6.7x	6.0x	6.7x	6.6x	8.6x	10.5x	12.0x	13.3x	11.8x	11.7x	**8.6x**
12.9x	11.8x	11.1x	11.8x	10.1x	10.5x	10.3x	11.7x	11.6x	12.3x	13.9x	13.0x	13.9x	**11.3x**
8.2x	9.7x	9.5x	9.8x	9.0x	8.7x	8.8x	9.9x	10.4x	11.9x	11.1x	11.8x	12.0x	**10.6x**
12.7x	11.2x	10.2x	9.9x	8.9x	9.6x	9.3x	11.0x	11.4x	11.8x	11.8x	12.5x	12.0x	**10.7x**
12.1x	12.5x	11.8x	11.6x	10.8x	10.9x	9.8x	12.0x	11.6x	13.4x	13.2x	13.1x	14.5x	**11.9x**
11.3x	12.4x	11.7x	11.5x	10.1x	11.4x	10.5x	11.6x	11.9x	13.2x	13.3x	13.8x	13.8x	**11.7x**
12.0x	12.5x	12.6x	12.1x	11.4x	11.1x	11.0x	12.1x	12.8x	12.6x	13.1x	13.4x	13.8x	**12.4x**
10.0x	10.7x	10.5x	11.1x	10.1x	10.0x	10.0x	11.2x	12.4x	12.4x	12.9x	13.1x	13.4x	**11.6x**
16.1x	13.8x	13.9x	12.5x	10.8x	9.9x	9.0x	10.6x	11.9x	12.2x	12.7x	12.4x	11.9x	**11.6x**
11.4x	11.2x	12.1x	11.0x	11.1x	11.3x	12.9x	13.3x	13.6x	13.9x	14.2x	15.2x	15.5x	**12.9x**
11.1x	11.2x	10.8x	11.1x	11.0x	11.3x	11.1x	12.3x	13.3x	12.8x	14.0x	15.3x	15.8x	**12.1x**
13.5x	12.9x	11.1x	11.5x	10.2x	9.7x	10.0x	11.2x	11.3x	11.6x	10.5x	12.5x	13.0x	**10.3x**
12.7x	14.8x	11.4x	11.0x	9.9x	10.6x	10.5x	11.0x	11.7x	11.9x	12.0x	12.2x	14.1x	**11.8x**
12.3x	12.7x	12.7x	12.1x	12.9x	11.6x	12.2x	13.1x	14.3x	13.5x	13.2x	14.6x	15.5x	**12.8x**
10.2x	8.8x	9.3x	8.8x	10.2x	10.0x	11.6x	10.7x	11.1x	10.8x	11.9x	13.0x	14.1x	**11.2x**
10.6x	11.6x	10.3x	11.6x	11.1x	11.3x	11.0x	12.2x	13.3x	13.8x	14.2x	15.0x	15.6x	**13.4x**
11.1x	11.2x	9.9x	10.4x	10.6x	12.1x	13.4x	13.5x	14.9x	15.5x	16.4x	16.6x	17.9x	**13.6x**
8.8x	9.5x	9.0x	9.4x	8.9x	8.9x	8.9x	9.7x	10.3x	11.4x	11.5x	12.3x	12.1x	**10.3x**
10.2x	9.1x	8.5x	9.0x	8.9x	9.2x	9.5x	9.2x	10.3x	9.8x	11.0x	11.7x	11.9x	**9.5x**
9.8x	9.9x	9.9x	9.9x	9.0x	8.8x	9.1x	10.3x	11.1x	11.7x	12.0x	12.5x	12.0x	**10.9x**
10.9x	11.1x	11.2x	11.0x	10.4x	10.7x	11.7x	12.7x	12.9x	12.8x	13.3x	13.9x	13.9x	**11.9x**
9.8x	9.4x	10.0x	9.6x	9.1x	8.8x	9.1x	9.8x	10.9x	12.2x	13.1x	14.5x	15.5x	**10.9x**
9.8x	9.9x	10.0x	10.2x	10.3x	10.1x	11.1x	10.5x	12.2x	12.3x	13.0x	14.2x	13.8x	**11.3x**
10.4x	10.7x	10.8x	11.2x	11.5x	11.5x	12.0x	12.5x	12.9x	12.8x	13.1x	14.5x	13.6x	**12.0x**
11.6x	11.3x	10.9x	11.6x	12.2x	12.0x	12.7x	13.5x	14.3x	13.7x	14.7x	15.7x	16.0x	**12.2x**
10.8x	11.0x	10.9x	12.6x	11.3x	11.8x	11.1x	13.3x	13.8x	13.9x	13.9x	14.5x	16.5x	**13.2x**
17.2x	12.5x	10.7x	11.4x	10.0x	11.4x	11.3x	11.8x	13.0x	12.6x	13.0x	12.6x	13.0x	**12.8x**
11.0x	**11.1x**	**10.5x**	**10.9x**	**10.3x**	**10.5x**	**10.5x**	**11.4x**	**12.2x**	**12.3x**	**12.7x**	**13.3x**	**13.5x**	11.5x
11.2x	11.6x	11.0x	11.0x	10.2x	10.3x	10.4x	11.4x	12.0x	12.3x	12.8x	13.2x	13.5x	**11.5x**
10.8x	10.6x	10.2x	10.8x	10.5x	10.7x	10.5x	11.4x	12.5x	12.4x	12.6x	13.4x	13.6x	**11.5x**

Note: Table should be read in conjunction with table on the facing previous page and footnotes apply accordingly

TABLE A.3: Correlation coefficients for selected variables

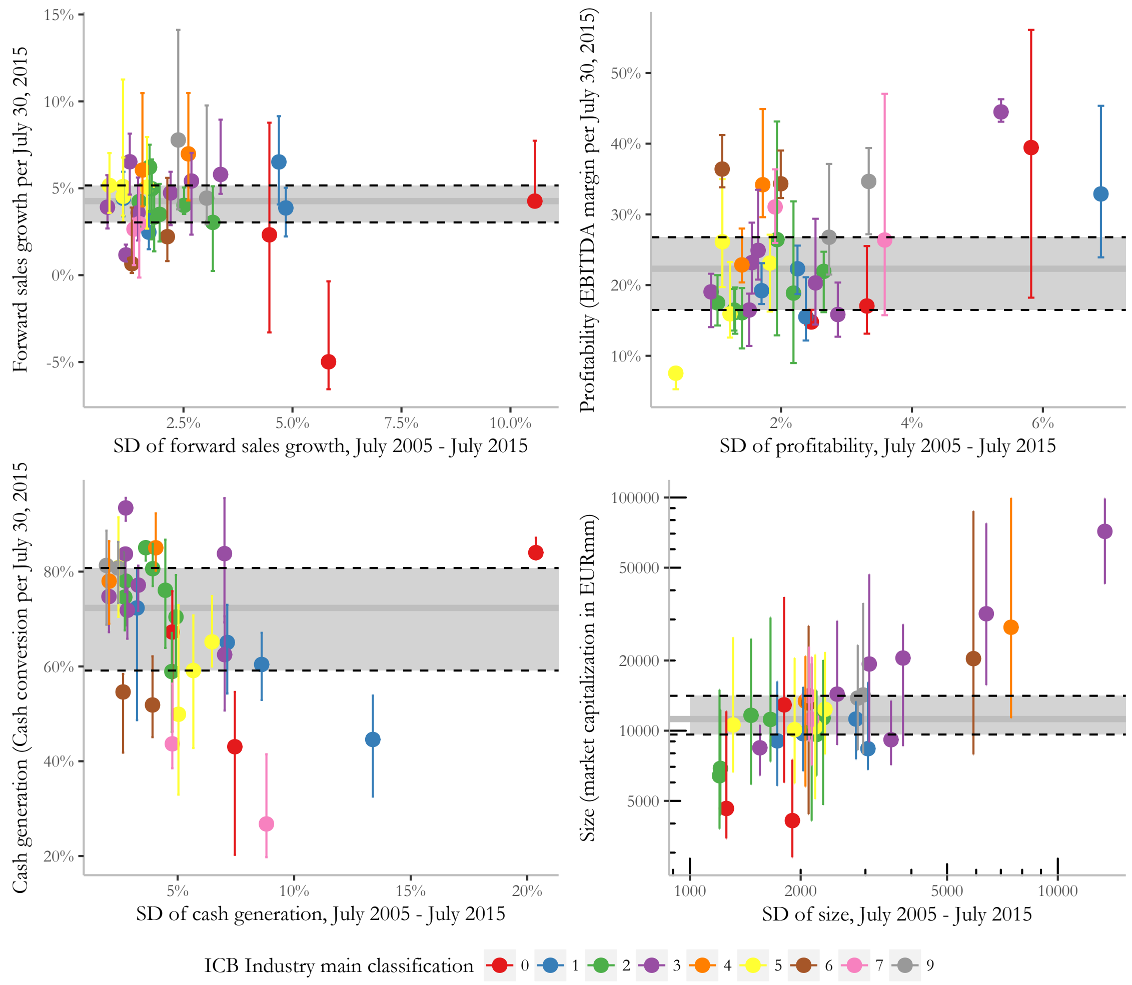
		Operational and financial ratios																			
		EBITDA margin	EBIT margin	Cash conversion	Capital exp./net sales	Net sales/total assets	Tax rate	Net sales, hist. growth	EBITDA, hist. growth	EBIT, hist. growth	EPS, hist. growth	Net sales, fut. growth	EBITDA, fut. growth	EBIT, fut. growth	EPS, fut. growth	EPS fut. LT growth	Net debt/EBITDA	Gearing	Levered equity beta	ROIC	WACC
Operating and financial ratios	EBITDA margin		0.94	0.08	0.63	-0.55	-0.08	0.12	0.13	0.05	0.04	0.01	-0.05	-0.07	-0.07	0.02	-0.01	0.03	0.01	0.02	0.01
	EBIT margin	0.96		0.26	0.43	-0.51	-0.08	0.16	0.19	0.08	0.05	0.04	-0.02	-0.07	-0.09	0.05	-0.11	-0.08	0.01	0.07	0.06
	Cash conversion	0.16	0.33		-0.62	-0.03	-0.05	0.02	0.10	0.03	0.07	-0.04	-0.03	-0.07	-0.06	0.01	-0.24	-0.21	0.00	0.14	0.12
	Capital exp./net sales	0.54	0.38	-0.68		-0.35	0.01	0.07	0.03	0.02	-0.01	0.05	0.00	0.00	-0.01	0.03	0.18	0.20	0.01	-0.10	-0.08
	Net sales/total assets	-0.69	-0.62	-0.05	-0.42		0.17	0.05	0.00	0.00	0.01	0.09	0.03	-0.01	-0.01	0.06	-0.26	-0.21	-0.03	0.12	0.09
	Tax rate	-0.11	-0.10	-0.06	-0.03	0.15		0.01	0.00	-0.02	-0.01	-0.01	-0.04	-0.05	0.02	0.05	-0.01	-0.02	-0.05	-0.02	-0.11
	Net sales, hist. growth	0.06	0.11	0.02	0.03	0.10	0.01		0.74	0.41	0.22	0.06	0.04	-0.02	-0.09	0.17	-0.08	-0.08	0.08	0.02	0.11
	EBITDA, hist. growth	0.09	0.15	0.12	-0.03	0.03	-0.01	0.72		0.66	0.43	0.08	-0.03	-0.10	-0.16	0.22	-0.10	-0.11	0.12	0.03	0.14
	EBIT, hist. growth	0.07	0.12	0.12	-0.04	0.03	-0.03	0.64	0.93		0.39	0.04	0.01	-0.04	-0.12	0.15	-0.06	-0.07	0.08	0.01	0.08
	EPS, hist. growth	0.05	0.09	0.13	-0.06	0.06	-0.03	0.40	0.63	0.71		0.03	-0.03	-0.05	-0.17	0.15	-0.05	-0.04	0.06	0.01	0.06
	Net sales, fut. growth	0.03	0.09	0.01	0.03	0.10	-0.01	0.27	0.24	0.21	0.14		0.59	0.43	0.24	0.23	-0.12	-0.13	0.04	0.04	0.09
	EBITDA, fut. growth	-0.07	-0.03	0.01	-0.04	0.06	-0.04	0.14	0.10	0.09	0.03	0.66		0.86	0.48	0.28	-0.09	-0.11	0.11	0.01	0.13
	EBIT, fut. growth	-0.08	-0.07	-0.01	-0.04	0.01	-0.06	0.07	0.05	0.06	0.00	0.57	0.90		0.59	0.25	-0.03	-0.06	0.11	-0.01	0.11
	EPS, fut. growth	-0.07	-0.08	0.01	-0.06	0.00	-0.02	-0.06	-0.08	-0.08	-0.16	0.37	0.59	0.68		0.20	0.06	0.03	0.07	-0.03	0.02
	EPS fut. LT growth	-0.03	0.01	0.07	-0.06	0.13	0.06	0.21	0.26	0.25	0.24	0.41	0.40	0.38	0.35		-0.13	-0.13	0.13	0.02	0.15
	Net debt/EBITDA	-0.01	-0.09	-0.24	0.18	-0.33	-0.03	-0.13	-0.15	-0.13	-0.10	-0.20	-0.14	-0.08	0.03	-0.18		0.89	-0.12	-0.31	-0.51
	Gearing	0.10	0.01	-0.21	0.23	-0.25	-0.03	-0.09	-0.12	-0.12	-0.07	-0.18	-0.17	-0.13	0.00	-0.16	0.93		-0.15	-0.32	-0.50
	Levered equity beta	-0.04	-0.04	0.00	-0.04	-0.01	-0.06	0.04	0.09	0.09	0.07	0.05	0.12	0.13	0.09	0.13	-0.14	-0.18		-0.04	0.75
	ROIC	0.03	0.13	0.39	-0.28	0.36	-0.14	0.05	0.08	0.07	0.09	0.10	-0.01	-0.05	-0.04	0.12	-0.62	-0.49	-0.05		0.11
	WACC	-0.04	0.01	0.13	-0.14	0.14	-0.12	0.12	0.15	0.14	0.08	0.13	0.15	0.14	0.05	0.17	-0.51	-0.52	0.76	0.26	
Pricing muliples	EV/Net sales	0.86	0.89	0.33	0.32	-0.63	-0.16	0.05	0.09	0.06	0.06	0.15	0.06	0.03	0.00	0.07	-0.04	0.04	-0.12	0.06	-0.09
	EV/EBITDA	0.16	0.27	0.42	-0.21	-0.13	-0.16	0.01	0.03	0.01	0.03	0.26	0.24	0.19	0.13	0.17	-0.09	-0.08	-0.20	0.13	-0.12
	EV/EBIT	0.12	0.12	0.11	0.01	-0.19	-0.16	-0.08	-0.08	-0.09	-0.06	0.19	0.22	0.20	0.16	0.12	0.08	0.05	-0.20	-0.09	-0.22
	EV/(EBITDA-Capex)	0.07	0.07	-0.29	0.27	-0.13	-0.11	0.00	-0.05	-0.07	-0.08	0.27	0.24	0.20	0.10	0.12	0.09	0.06	-0.20	-0.16	-0.21
	EV/taxed EBIT	0.07	0.07	0.08	-0.01	-0.14	0.19	-0.08	-0.09	-0.10	-0.07	0.18	0.20	0.18	0.16	0.15	0.07	0.05	-0.22	-0.14	-0.27
	EV/(t. EBIT+D&A-Capex)	0.02	0.02	-0.42	0.33	-0.06	0.22	0.03	-0.04	-0.06	-0.09	0.26	0.22	0.16	0.08	0.13	0.07	0.04	-0.19	-0.21	-0.22
	Price/Earnings	0.10	0.12	0.11	-0.01	-0.01	0.00	-0.04	-0.06	-0.07	-0.03	0.26	0.23	0.20	0.17	0.23	-0.15	-0.12	-0.22	0.09	-0.15
	Price/Earnings before tax	0.13	0.15	0.13	0.01	-0.05	-0.32	-0.03	-0.05	-0.05	-0.01	0.26	0.24	0.21	0.16	0.19	-0.13	-0.11	-0.18	0.13	-0.10
	Price/Earnings growth	0.09	0.07	-0.02	0.08	-0.13	-0.05	-0.20	-0.27	-0.26	-0.23	-0.24	-0.26	-0.26	-0.25	-0.82	0.08	0.07	-0.24	-0.07	-0.24
	Price/Dividends	0.01	0.07	0.11	-0.06	0.11	0.08	0.20	0.22	0.19	0.20	0.36	0.31	0.25	0.22	0.43	-0.28	-0.26	0.08	0.13	0.12
	Price/Book value of equity	0.08	0.15	0.35	-0.21	0.22	-0.08	-0.02	-0.02	-0.03	0.05	0.10	0.01	-0.02	0.04	0.13	-0.17	-0.03	-0.24	0.74	-0.09
	EV/total Assets	0.37	0.47	0.40	-0.04	0.18	-0.06	0.16	0.15	0.11	0.14	0.32	0.16	0.06	0.02	0.23	-0.39	-0.21	-0.15	0.45	0.05
	EV/Invested capital	0.07	0.17	0.39	-0.24	0.25	0.00	0.01	0.04	0.02	0.06	0.16	0.10	0.05	0.03	0.20	-0.55	-0.45	-0.12	0.80	0.13
Valuation multiple accuracy	EV/Net sales	-0.16	-0.19	-0.15	-0.03	0.15	0.03	0.04	-0.01	-0.01	-0.03	-0.01	-0.02	-0.02	-0.01	0.00	0.06	0.04	0.02	-0.08	0.00
	EV/EBITDA	0.02	-0.02	-0.15	0.13	0.02	-0.03	0.00	-0.04	-0.03	-0.03	-0.01	-0.03	-0.02	0.02	-0.01	-0.01	0.01	0.02	0.00	0.01
	EV/EBIT	0.07	0.02	-0.16	0.17	-0.07	-0.01	0.02	0.00	0.00	-0.01	-0.03	-0.03	-0.02	0.00	-0.02	0.02	0.01	0.07	-0.07	0.05
	EV/(EBITDA-Capex)	0.01	-0.06	-0.26	0.19	-0.05	-0.02	0.01	-0.02	-0.03	-0.06	-0.04	-0.04	-0.04	-0.03	-0.06	0.09	0.07	0.04	-0.16	0.00
	EV/taxed EBIT	0.05	0.00	-0.16	0.16	-0.08	-0.07	0.03	0.00	0.00	-0.02	-0.05	-0.05	-0.03	-0.02	-0.07	0.08	0.08	0.06	-0.09	0.01
	EV/(t. EBIT+D&A-Capex)	0.02	-0.05	-0.36	0.28	-0.08	0.01	0.01	-0.01	-0.02	-0.06	-0.04	-0.04	-0.03	-0.03	-0.08	0.15	0.13	0.04	-0.21	-0.04
	Price/Earnings	0.02	0.00	-0.05	0.03	0.03	-0.04	0.04	0.01	0.00	0.00	0.00	-0.02	0.00	0.01	0.02	-0.08	-0.07	0.07	0.04	0.09
	Price/Earnings before tax	0.05	0.04	-0.04	0.04	-0.02	0.02	0.04	0.01	0.01	0.00	0.01	0.01	0.02	0.02	0.04	-0.07	-0.08	0.07	-0.01	0.08
	Price/Earnings growth	-0.01	-0.05	-0.09	0.05	-0.06	-0.03	-0.07	-0.07	-0.05	-0.06	-0.13	-0.08	-0.04	-0.04	-0.23	0.01	-0.01	0.07	-0.12	0.06
	Price/Dividends	0.02	0.03	0.03	-0.01	0.05	0.02	0.10	0.06	0.04	0.04	0.08	0.05	0.04	0.03	0.09	-0.12	-0.11	0.09	0.03	0.09
	Price/Book value of equity	0.01	0.00	0.03	-0.02	0.09	-0.04	-0.05	-0.04	-0.04	-0.02	-0.05	-0.06	-0.06	-0.02	-0.02	0.02	0.08	-0.04	0.08	-0.06
	EV/total Assets	-0.01	-0.01	-0.02	0.00	0.12	-0.01	0.04	0.01	0.01	-0.01	0.04	0.02	0.02	0.03	0.06	-0.04	-0.02	-0.09	0.10	-0.06
	EV/Invested capital	0.00	0.00	0.08	-0.06	0.11	0.06	0.02	0.01	0.01	0.01	0.05	0.00	0.00	0.01	0.04	-0.07	-0.04	-0.03	0.11	-0.01

Note: Table displays Pearson correlation coefficients in the upper triangle and Spearman correlation coefficients in the lower triangle. Coloring denotes degree of positive (green) or negative (red) correlation

		Pricing multiples													Valuation multiple accuracy												
		EV/Net sales	EV/EBITDA	EV/EBIT	EV/(EBITDA-Capex)	EV/taxed EBIT	EV/(t. EBIT+D&A-Capex)	Price/Earnings	Price/Earnings before tax	Price/Earnings growth	Price/Dividends	Price/Book value of equity	EV/total Assets	EV/Invested capital	EV/Net sales	EV/EBITDA	EV/EBIT	EV/(EBITDA-Capex)	EV/taxed EBIT	EV/(t. EBIT+D&A-Capex)	Price/Earnings	Price/Earnings before tax	Price/Earnings growth	Price/Dividends	Price/Book value of equity	EV/total Assets	EV/Invested capital
Operating and financial ratios	EBITDA margin	0.75	0.10	0.06	0.06	0.03	0.05	0.07	0.10	0.03	0.06	0.02	0.28	0.03	-0.06	0.07	0.11	0.10	0.07	0.07	0.07	0.09	0.05	0.07	0.00	0.02	-0.02
	EBIT margin	0.80	0.23	0.06	0.04	0.02	0.02	0.08	0.10	0.01	0.10	0.05	0.40	0.08	-0.09	0.00	0.05	0.00	0.00	-0.02	0.06	0.08	0.01	0.07	0.00	0.05	0.00
	Cash conversion	0.26	0.37	0.08	-0.41	0.06	-0.55	0.08	0.08	-0.04	0.05	0.12	0.31	0.13	-0.17	-0.19	-0.18	-0.33	-0.18	-0.47	-0.06	-0.07	-0.10	-0.01	0.02	0.00	0.06
	Capital exp./net sales	0.30	-0.19	-0.02	0.30	-0.03	0.42	-0.01	0.00	0.04	0.03	-0.07	-0.06	-0.09	0.06	0.15	0.19	0.27	0.16	0.35	0.08	0.10	0.10	0.06	-0.02	-0.02	-0.07
	Net sales/total assets	-0.45	-0.09	-0.13	-0.08	-0.07	-0.02	0.03	-0.03	-0.04	0.09	0.10	0.17	0.11	0.21	0.01	-0.06	-0.05	-0.06	-0.07	0.01	-0.02	-0.07	0.07	0.10	0.11	0.10
	Tax rate	-0.18	-0.17	-0.17	-0.14	0.16	0.17	-0.01	-0.30	-0.02	0.05	0.07	-0.03	0.00	0.01	-0.02	0.00	-0.04	-0.05	0.05	-0.02	0.02	-0.01	0.02	0.03	-0.01	0.05
	Net sales, hist. growth	0.07	-0.01	-0.09	-0.03	-0.09	0.01	-0.05	-0.05	-0.06	0.15	-0.05	0.13	0.01	0.03	0.02	0.05	0.02	0.04	0.01	0.07	0.06	-0.01	0.11	-0.04	0.05	0.02
	EBITDA, hist. growth	0.09	-0.01	-0.11	-0.07	-0.11	-0.04	-0.09	-0.09	-0.07	0.17	-0.05	0.11	0.01	-0.01	-0.02	0.02	0.00	0.02	-0.01	0.04	0.03	-0.01	0.10	-0.04	0.02	0.01
	EBIT, hist. growth	0.02	-0.03	-0.08	-0.04	-0.08	-0.03	-0.07	-0.06	-0.05	0.11	-0.04	0.03	0.00	0.00	-0.01	0.03	0.00	0.03	-0.01	0.01	0.01	0.01	0.06	-0.02	0.01	0.00
	EPS, hist. growth	0.02	-0.01	-0.04	-0.05	-0.04	-0.04	-0.03	-0.03	-0.04	0.09	-0.02	0.03	0.01	-0.02	0.00	-0.01	-0.01	-0.01	-0.02	0.01	0.01	0.00	0.05	-0.01	-0.01	0.01
	Net sales, fut. growth	0.10	0.17	0.12	0.20	0.12	0.17	0.16	0.16	-0.06	0.24	-0.01	0.22	0.07	0.00	0.01	-0.01	0.02	-0.03	0.01	0.04	0.05	-0.08	0.11	-0.03	0.06	0.05
	EBITDA, fut. growth	0.06	0.15	0.13	0.16	0.12	0.13	0.14	0.14	-0.07	0.21	-0.02	0.10	0.03	0.00	-0.01	0.00	0.02	-0.01	0.01	0.03	0.04	-0.04	0.08	-0.02	0.03	0.02
	EBIT, fut. growth	0.00	0.07	0.12	0.12	0.11	0.09	0.11	0.11	-0.05	0.14	-0.04	0.01	0.01	0.01	0.01	0.02	0.03	0.02	0.02	0.04	0.04	0.00	0.07	-0.03	0.04	0.01
	EPS, fut. growth	-0.04	0.02	0.09	0.06	0.10	0.04	0.07	0.07	-0.04	0.09	-0.02	-0.04	-0.01	0.03	0.04	0.04	0.03	0.03	0.01	0.03	0.04	0.02	0.04	-0.01	0.03	0.01
	EPS fut. LT growth	0.09	0.10	0.09	0.09	0.11	0.07	0.14	0.12	-0.21	0.24	-0.02	0.14	0.04	0.02	0.03	0.03	0.01	-0.01	-0.02	0.09	0.09	-0.01	0.10	-0.03	0.07	0.03
	Net debt/EBITDA	-0.10	-0.14	0.01	0.06	0.01	0.08	-0.18	-0.17	0.02	-0.24	-0.01	-0.37	-0.30	0.11	0.01	0.06	0.14	0.14	0.22	-0.07	-0.06	0.02	-0.11	0.03	-0.03	-0.07
	Gearing	-0.11	-0.19	-0.05	-0.01	-0.05	0.01	-0.18	-0.17	0.01	-0.24	0.13	-0.32	-0.32	0.07	0.03	0.04	0.10	0.10	0.16	-0.08	-0.08	0.00	-0.10	0.14	-0.02	-0.06
	Levered equity beta	-0.09	-0.17	-0.16	-0.15	-0.18	-0.10	-0.17	-0.14	-0.03	0.09	-0.17	-0.12	-0.05	0.02	0.04	0.10	0.06	0.09	0.02	0.08	0.08	0.07	0.12	-0.07	-0.07	-0.04
	ROIC	0.06	0.06	-0.01	-0.05	-0.02	-0.07	0.04	0.04	-0.01	0.03	0.15	0.18	0.73	-0.05	-0.04	-0.05	-0.08	-0.06	-0.09	0.01	0.00	-0.04	0.00	0.12	0.03	0.23
	WACC	-0.04	-0.08	-0.15	-0.15	-0.20	-0.13	-0.09	-0.06	-0.02	0.11	-0.14	0.04	0.08	-0.01	0.00	0.05	0.00	0.00	-0.07	0.08	0.08	0.05	0.10	-0.09	-0.05	0.00
Pricing muliples	EV/Net sales		0.66	0.54	0.41	0.47	0.21	0.48	0.52	0.02	0.21	0.08	0.59	0.15	0.00	0.05	0.04	0.03	-0.02	-0.02	0.12	0.14	-0.05	0.05	0.02	0.12	0.03
	EV/EBITDA	0.60		0.88	0.64	0.82	0.31	0.77	0.79	0.02	0.32	0.12	0.62	0.20	-0.07	-0.07	-0.08	-0.09	-0.13	-0.12	0.08	0.10	-0.12	0.02	0.01	0.10	0.06
	EV/EBIT	0.51	0.86		0.75	0.94	0.41	0.85	0.87	0.04	0.27	0.06	0.44	0.14	-0.02	0.00	0.04	0.05	-0.01	0.01	0.14	0.16	-0.05	-0.01	0.00	0.08	0.05
	EV/(EBITDA-Capex)	0.39	0.69	0.80		0.70	0.82	0.64	0.66	0.05	0.24	0.01	0.31	0.08	0.03	0.02	0.04	0.28	-0.01	0.35	0.11	0.14	-0.04	0.02	-0.02	0.06	0.01
	EV/taxed EBIT	0.44	0.79	0.92	0.75		0.46	0.85	0.76	0.04	0.28	0.09	0.43	0.14	-0.02	-0.01	0.03	0.03	0.00	0.03	0.14	0.15	-0.06	0.00	0.02	0.08	0.06
	EV/(t. EBIT+D&A-Capex)	0.27	0.51	0.60	0.91	0.68		0.38	0.31	0.03	0.19	-0.02	0.14	0.02	0.03	0.02	0.04	0.27	0.00	0.57	0.09	0.10	-0.02	0.04	-0.03	0.02	-0.01
	Price/Earnings	0.44	0.77	0.82	0.69	0.82	0.58		0.95	0.04	0.37	0.10	0.53	0.19	-0.03	0.03	0.03	0.01	-0.04	-0.03	0.18	0.18	-0.07	0.05	0.02	0.12	0.08
	Price/Earnings before tax	0.47	0.78	0.83	0.69	0.70	0.47	0.94		0.04	0.33	0.07	0.51	0.18	-0.02	0.04	0.03	0.03	-0.03	-0.05	0.17	0.19	-0.05	0.04	0.01	0.12	0.06
	Price/Earnings growth	0.18	0.22	0.30	0.25	0.28	0.18	0.28	0.29		-0.06	-0.01	-0.01	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.51	-0.02	0.01	0.02	0.01
	Price/Dividends	0.20	0.37	0.31	0.28	0.33	0.28	0.46	0.41	-0.17		-0.02	0.26	0.07	-0.04	0.02	0.00	-0.02	-0.04	-0.03	0.07	0.08	-0.14	0.53	-0.05	-0.01	0.00
	Price/Book value of equity	0.26	0.42	0.29	0.16	0.27	0.08	0.39	0.39	0.07	0.18		0.27	0.15	-0.06	-0.05	-0.07	-0.10	-0.08	-0.10	-0.03	-0.04	-0.08	-0.04	0.66	0.12	0.17
	EV/total Assets	0.60	0.65	0.46	0.36	0.43	0.28	0.57	0.56	0.08	0.38	0.57		0.35	-0.07	-0.01	-0.06	-0.10	-0.11	-0.14	0.09	0.09	-0.12	0.06	0.17	0.34	0.17
	EV/Invested capital	0.26	0.43	0.26	0.14	0.26	0.08	0.41	0.38	0.01	0.32	0.76	0.60		-0.04	-0.03	-0.04	-0.06	-0.07	-0.09	0.04	0.04	-0.02	0.02	0.13	0.10	0.48
Valuation multiple accuracy	EV/Net sales	-0.20	-0.09	-0.04	0.01	-0.03	0.03	-0.05	-0.05	-0.02	-0.06	-0.10	-0.16	-0.14		0.40	0.29	0.26	0.25	0.17	0.25	0.27	0.10	0.09	0.05	0.32	0.02
	EV/EBITDA	-0.06	-0.14	-0.06	-0.03	-0.07	-0.02	-0.06	-0.05	0.00	-0.02	-0.04	-0.10	-0.06	0.34		0.73	0.53	0.62	0.31	0.54	0.53	0.16	0.18	0.07	0.33	0.10
	EV/EBIT	-0.04	-0.19	-0.12	-0.09	-0.11	-0.06	-0.15	-0.14	-0.03	-0.06	-0.15	-0.14	-0.14	0.22	0.63		0.62	0.83	0.34	0.61	0.61	0.20	0.21	0.03	0.18	0.06
	EV/(EBITDA-Capex)	-0.10	-0.21	-0.09	-0.01	-0.09	0.00	-0.15	-0.14	0.01	-0.10	-0.20	-0.20	-0.21	0.23	0.47	0.58		0.53	0.70	0.41	0.43	0.14	0.15	-0.01	0.12	0.03
	EV/taxed EBIT	-0.07	-0.22	-0.15	-0.11	-0.16	-0.11	-0.20	-0.16	-0.01	-0.11	-0.17	-0.19	-0.20	0.17	0.48	0.70	0.47		0.38	0.56	0.43	0.18	0.19	0.03	0.15	0.03
	EV/(t. EBIT+D&A-Capex)	-0.11	-0.25	-0.12	0.06	-0.11	0.09	-0.17	-0.16	0.02	-0.11	-0.24	-0.24	-0.27	0.18	0.34	0.41	0.70	0.48		0.25	0.22	0.09	0.08	-0.03	0.04	-0.01
	Price/Earnings	-0.01	-0.06	-0.03	-0.03	-0.03	-0.03	-0.08	-0.06	-0.03	-0.02	-0.03	-0.03	-0.02	0.20	0.46	0.53	0.39	0.50	0.33		0.88	0.24	0.35	0.07	0.31	0.11
	Price/Earnings before tax	0.03	-0.02	0.01	0.01	0.02	0.02	-0.03	-0.04	-0.03	0.01	-0.07	-0.01	-0.02	0.23	0.45	0.53	0.41	0.32	0.25	0.72		0.23	0.33	0.06	0.30	0.10
	Price/Earnings growth	-0.09	-0.15	-0.08	-0.09	-0.10	-0.09	-0.13	-0.11	0.22	-0.19	-0.19	-0.17	-0.17	0.10	0.13	0.16	0.16	0.14	0.14	0.16	0.15		0.09	-0.01	0.06	0.04
	Price/Dividends	0.00	-0.03	-0.06	-0.04	-0.05	-0.03	-0.03	-0.03	-0.07	0.16	-0.05	0.05	0.02	0.06	0.12	0.14	0.11	0.14	0.09	0.22	0.19	0.05		0.01	0.08	0.05
	Price/Book value of equity	0.02	0.02	0.02	0.00	0.02	-0.01	0.02	0.03	0.03	-0.07	0.15	0.07	0.05	0.11	0.09	0.07	0.02	0.04	0.00	0.11	0.09	0.01	0.02		0.29	0.41
	EV/total Assets	0.01	0.03	0.04	0.04	0.04	0.04	0.07	0.07	-0.01	-0.02	0.10	0.08	0.06	0.31	0.26	0.12	0.09	0.08	0.06	0.22	0.22	0.04	0.05	0.29		0.24
	EV/Invested capital	0.01	0.05	0.03	-0.01	0.06	0.00	0.05	0.03	0.00	0.01	0.09	0.09	0.17	0.08	0.11	0.06	0.03	0.03	0.01	0.14	0.12	0.01	0.08	0.47	0.26	

Note: To be read in conjunction with the previous facing page

FIGURE A.1: Summarizing the dispersion of operating metrics within and among industries



Note: Illustrative dispersion indication for selected metrics: growth (as expressed by the next 2 year equity research consensus expected compounded annual growth rate), profitability (as expressed by EBITDA margin for the rolling next twelve months per equity research consensus), cash generation potential (as expressed by cash conversion, i.e. (EBITDA-Capital expenditures)/EBITDA for the next twelve months) and size (market cap. in EUR mm), for each ICB Sector (third taxonomy level per ICB definition; excluding "Financials" Industry). Coloring by ICB Industry as indicated (first taxonomy level). Dots represent median operating metric per ICB Sector per latest sample measurement date (July 30, 2015) on the *y*-axis and standard deviation ("SD") of the ICB Sector-median operating metric over time (22 semi-annual measurements between July 30, 2005 and July 30, 2015) on the *x*-axis. Vertical "whiskers" represent lower and upper quartile of the individual sample company operating metrics by ICB Sector per July 30, 2015. Grey-shaded boxes with black dashed lines represent lower and upper quartile of the ICB Sector median metrics (dots), dark gray line represents median.

APPENDIX C

Further theoretical background

Multiple aggregation on the basis of regression approaches

Price vs. multiple as dependent variable

Regression analyses have two close connections to multiple valuations, which are important to differentiate.

- *Price reference as the dependent variable:* First, as is visually obvious from Figure 6.1 on p. 196, regression approaches can be considered a potential aggregation tool—and hence alternative to central tendency approaches.[1053] In such concepts, the predictor is the valuation driver $VD_{i,t}$, the dependent variable is the price reference $P_{i,t}$ and the resulting valuation multiple is the slope of the regression line. Consistently with using central tendency approaches such as median or mean, multiple valuation is achieved by multiplying the slope of the regression line (which symbolizes the pricing multiple) with the valuation driver of the company under investigation. Common empirical approaches include test implementing the Ohlson (1995) and Feltham and Ohlson (1995) models, compare among many Barth, Beaver, Hand, and Landsman (2005, p. 324). Since it is argued that error terms might be biased by relative company size, a number of studies such as J. Liu et al. (2002, p. 142) and Beatty et al. (1999, p. 183) operationalize price reference regression equations through deflation, i.e. division by price reference on

[1053]Previously discussed in Subsection 6.3.2 (pp. 199 and following) and, most notably, Table 6.1 (p. 201) both sides in addition to some further restrictions.[1054] Meitner (2006, p. 167), uses the traditional non-deflated form of regressing price on selected valuation drivers, both with and without intercept term. However, he is primarily interested in coefficients of determination in order to assess value reference of valuation drivers rather than discussing the resulting slopes, which would represent multiples

- *The pricing multiple as dependent variable:* Second, following early studies by Kisor and Whitbeck (1963) a number of textbooks and empirical studies including Damodaran (2012a, p. 484), Pratt (2008, p. 297), Herrmann and Richter (2003), Zarowin (1990) and as early as Beaver and Morse (1978, p. 72) have performed or are suggesting analyses in which the pricing multiple is the dependent variable, which is predicted by financial variables such as growth, risk, payout ratio or return metrics, which often have a backing in corporate finance theory.[1055] This approach is also common among valuation practitioners (Löhnert & Böckmann, 2009, p. 584).[1056] The model-estimated slopes for each predictor variable in connection with the intercept can then be used to compute a valuation multiple for the company under investigation to the extent the predictor variables for that company are known. This results in a "moderated" valuation, i.e. the valuation multiple depends not only on the valuation driver as is the case for classical multiple valuation theory, but also on the model-determined predictor variables. Such moderated multiple valuations can be seen in close connection to weighted central tendency measures in that the ambition is to improve the valuation outcome through modifying the valuation multiple to account for dissimilarities: either through a re-balanced peer aggregation or through direct modification of the valuation multiple on the basis of variables which appear to influence it. In a more immediate connection between valuation and pricing multiples, M. Kim and Ritter (1999, pp. 417, 422) utilize a regression approach for the pricing multiple as dependent variable, where the median-aggregated peer multiple (or valuation multiple) is the independent variable. The expected value for the slope of the regression line is then argued to be one and—implicitly—the intercept zero, since this would indicate that the valuation multiple equals equals the pricing multiple. Prediction error statistics appear comparably more favorable than for traditional aggregation methods but the coefficients of determination

[1054]See Appendix (p. A18) and Equation C.6 for details
[1055]Compare Subsections 4.2.2 (p. 94) and 4.3.3 (p. 109)
[1056]Numerous additional studies such as Easton and Harris (1991) have relied on the inverse of multiples, i.e. return metrics for similar analyses. This approach is also followed by the highly important studies conducted by Fama and French (1992) and Fama and French (1996)

are low throughout (below 9%) and errors high compared to other studies.[1057] Bhojraj and Lee (2002) propose a concept of "warranted multiples," which are modified pricing multiples calculated on the basis of a multi-factor regression, which includes averaged peer multiples of the same type as one of the independent variables much like in the study of M. Kim and Ritter (1999); however, Bhojraj and Lee (2002) also include other independent variables into their regression, which relate to growth, risk and profitability aspects. Even other types of multiples are included. Valuation multiples are then determined using firms with closest warranted multiples in the same industry and on this basis, valuation errors can be determined. The inclusion of additional factors, which results in generally more attractive prediction accuracy[1058]

Uncovering the link between regression and central tendency measures

Surprisingly little statistical or corporate finance literature seems to be available to uncover in detail the connection between standard central tendency measures presented in Subsection 6.3.2.1 (p. 199) and regression approaches. The relationship between those two general aggregation approaches is relevant to decide which approach should be given priority from a theoretical perspective and furthermore allows to uncover advantages and drawbacks of either concept. To my knowledge only Cooper and Cordeiro (2008, p. 19) provide some theoretical connection between the two methodologies, however considering a case where the multiple is the independent variable.

Assuming the multiple valuation problem as indicated by Figure 6.1 (p. 196) should be expressed in a standard regression equation, where the valuation multiple $M_{k,t}$ signifies the slope of the regression line more commonly abbreviated by β, and this slope is assumed to run through the origin,[1059] the model can be specified as follows:

$$P_{i,t} = M_{k,t} \cdot VD_{i,t} + \varepsilon_{i,t} \tag{C.1}$$

The highly common concept of ordinary least square ("OLS") regression is a technique to minimize the sum squares of prediction errors.[1060] Assuming a regression through the origin

[1057] See Subsection 6.6 (p. 235) for an illustrative comparison
[1058] Compare Bhojraj and Lee (2002, Table 6, p. 428). Unfortunately Bhojraj and Lee (2002) do not report more traditional valuation error concepts
[1059] A restriction justified by the concept of multiples in particular in so far as the non-negativity applies
[1060] Compare among many Graybill and Iyer (1994, p. 113)

as stipulated by Equation C.1, the valuation multiple $M_{k,t}$ can be estimated as:[1061]

$$\hat{M}_{k,t} = \frac{\sum_{i=1}^{I} VD_{i,t} \cdot P_{i,t}}{\sum_{i=1}^{I} VD_{i,t}^2} \tag{C.2}$$

It is now instructive to consider weighted least square regression approaches as a generalized concept of the common OLS approaches. It can be shown that, for a weighted least square regression through the origin, the slope[1062] and hence the valuation multiple can be calculated as[1063]

$$\hat{M}_{k,t} = \frac{\sum_{i=1}^{I} w_{i,t} \cdot VD_{i,t} \cdot P_{i,t}}{\sum_{i=1}^{I} w_{i,t} \cdot VD_{i,t}^2} \tag{C.3}$$

Equation C.3 is a strong foundation to explain the connection between central tendency methods and regression, depending on how the weights $w_{i,t}$ are defined

- For $w_{i,t} = 1$ follows the special weighted least square case of OLS through the origin (Graybill & Iyer, 1994, p. 574)
- For $w_{i,t} = \frac{1}{VD_{i,t}^2}$ follows the arithmetic mean as defined in Equation 6.3, to which Equation C.3 simplifies if $w_{i,t}$ is substituted:

$$\hat{M}_{k,t} = \frac{\sum_{i=1}^{I} \frac{1}{VD_{i,t}^2} \cdot VD_{i,t} \cdot P_{i,t}}{\sum_{i=1}^{I} \frac{1}{VD_{i,t}^2} \cdot VD_{i,t}^2} = \frac{\sum_{i=1}^{I} \frac{P_{i,t}}{VD_{i,t}}}{\sum_{i=1}^{I} 1} = \frac{1}{I} \cdot \sum_{i=1}^{I} \frac{P_{i,t}}{VD_{i,t}} \tag{C.4}$$

- Similarly, for $w_{i,t} = \frac{1}{VD_{i,t} \cdot P_{i,t}}$ follows the harmonic mean as defined in Equation 6.4, to which Equation C.3 simplifies if $w_{i,t}$ is substituted:

$$\hat{M}_{k,t} = \frac{\sum_{i=1}^{I} \frac{1}{VD_{i,t} \cdot P_{i,t}} \cdot VD_{i,t} \cdot P_{i,t}}{\sum_{i=1}^{I} \frac{1}{VD_{i,t} \cdot P_{i,t}} \cdot VD_{i,t}^2} = \frac{I}{\sum_{i=1}^{I} \frac{VD_{i,t}}{P_{i,t}}} \tag{C.5}$$

[1061] See already Equation 6.1 (p. 198) and compare among many for further background Rawlings (1998, p. 21) or Graybill and Iyer (1994, p. 210)

[1062] usually denominated by $\hat{\beta}$

[1063] This follows from the starting point of the weighted least square regression to minimize $\sum_{i=1}^{I} w_{i,t} \cdot \left[P_{i,t} - \left(M_{0,t} + M_{1,t} \cdot VD_{i,t}\right)\right]^2$ (Graybill & Iyer, 1994, p. 574). With the restriction $M_{0,t} \stackrel{!}{=} 0$ follows the minimization equation of $S = \sum_{i=1}^{I} w_{i,t} \cdot \left(P_{i,t} - \hat{M}_t \cdot VD_{i,t}\right)^2$. With $\frac{\partial S}{\partial M_t} = -\sum_{i=1}^{I} 2VD_{i,t} \cdot w_{i,t}\left(P_{i,t} - M_t \cdot VD_{i,t}\right) \stackrel{!}{=} 0$ and some basic algebra to solve for $\hat{M}_t$ follows Equation C.3. This train of thought has been adapted from Regression through the origin (2017)

- Moreover, for $w_{i,t} = \frac{1}{VD_{i,t}}$ follows the value-weighted mean defined in Equation 6.6, to which Equation C.3 simplifies if $w_{i,t}$ is substituted

Thus, ordinary least square regression analysis and mean central tendency metrics *are interconnected via the concept of weighted least squares,* with each of them relying on a different interpretation of the weights. The weights relate to assumptions of the variance of the error terms (Rawlings, 1998, p. 413; Gujarati, 2011, p. 90). Notably, under the existence of heteroscedasticity—i.e. non-constant or conditional variance of the dependent variable with regard to the predictor variable (Gujarati, 2003, p. 388)—it can be shown that the OLS regression concept is no longer best or most efficient (Gujarati, 2003, p. 394). Whilst a number of formal empirical tests on homoscedasticity are available (Gujarati, 2003, pp. 403–415) and could be applied to any multiple valuation comprising a suitably large number of peer companies, there is a strong intuitive argument that indeed a regression of a valuation driver such as earnings on a regression of a price reference will be heteroscedastic: Since both variables are measured as monetary amounts, it is a reasonable assumption that price references will vary more (less) in absolute terms for larger (smaller) companies, which are assumed to have larger (smaller) earnings. Whilst for many of the examples given in the context of heteroscedasticity there is additional inner logic for the increasing dispersion for larger dependent/independent variable pairs,[1064] Gujarati states for an example broadly comparable to multiple valuation that "[...] in a cross-sectional analysis involving the investment expenditure in relation to sales, rate of interest, etc., heteroscedasticity is generally expected if small-, medium-, and large-size firms are sampled together" (2003, p. 401). Therefore, ordinary least squares might not be a preferable approach in the context of valuation multiple aggregation. Given the strong theoretical attraction of harmonic mean specifically, one could argue that the regression relying on the weights corresponding to a harmonic mean maximum likelihood estimate demonstrated in Equation C.5 i.e. $w_{i,t} = \frac{1}{VD_{i,t} \cdot P_{i,t}}$ might be most appropriate. It would imply standard error proportionality to price reference and valuation driver.

The above considerations offer an opportunity to analyze the (implicit) weights featured by the central tendency measures: The arithmetic mean implies an error variance proportional to the squared valuation driver: from a model perspective, data points with large valuation driver amounts will be weighted lower, i.e. will have less of an impact on the slope of the

[1064]Classical examples include regressions of household income and food expenditure (Gujarati, 2003, p. 401; Koenker & Hallock, 2000, p. 4), where the additional argument can made that low-income households need to spend a higher and more consistent share of earnings for food, whilst high-income households can elect to relatively spend more or less of their household income on food regression line, compared to data points with small valuation driver amounts, which will influence the slope of the regression line to a larger degree. If variance was plotted against valuation driver amounts, a figure comparable to Gujarati (2003, p. 419) would result. Under the weight suggested by the arithmetic mean, absolute size of the dependent variable, i.e. the price reference, would not have an impact on weighting and hence its variance be considered irrelevant for determination of the slope. This is a notable difference to the harmonic mean, whose weights implicitly consider both the absolute amounts of the valuation driver and the price reference and a strong intuitive argument for the theoretical superiority of harmonic mean over arithmetic mean in multiple aggregation: a sizable (compared to a smaller firm) is appropriately adjusted on the basis of both valuation driver and pricing reference size and to be expected variability of both variables.

Improvement strategies on the shortcomings of OLS regressions in the context of multiples

As an alternative to utilizing presumably more robust estimators than those proposed by the ordinary least square approach, two concepts remaining within the spirit of regression can be followed: a focus on returns or multiples as dependent variable—consistent with the typical approach of scaling variables if the presence of heteroscedasticity is presumed—as well as utilization of regression techniques and/or incremental analyses other than basic OLS.[1065] The former approach has already been briefly discussed,[1066] which is why the focus here lies on the latter concept instead:

- *White (1980) heteroscedasticity-consistent robust standard errors:* While relying on standard OLS approaches, Meitner (2006, pp. 166, 173) uses heteroscedasticity-corrected errors, which are then subjected to significance statistics. This concept can expected to support effective tests of significance but coefficients, which signify multiples, might remain biased, which is a substantial draw-back of the approach

- *Price-deflated regression:* Citing Baker and Ruback (1999) as well as Beatty et al. (1999) regarding the presumed proportionality of the regression error to price in the standard regression equation, J. Liu et al. (2002, pp. 142–143) divide the standard

[1065] This is not to say that weighted least squares cannot also be used on regressions in which multiples are the dependent variable, compare e.g. Taliento (2013, p. 13)

[1066] Compare above in the Apendix (p. A14) with further references regression equation in which price is explained by the valuation driver by price:

$$P_{i,t} = M_{k,t} \cdot VD_{i,t} + \varepsilon_{i,t} \Rightarrow 1 = M_{k,t} \cdot \frac{VD_{i,t}}{P_{i,t}} + \frac{\varepsilon_{i,t}}{P_{i,t}} \tag{C.6}$$

Equation C.6 is convenient as it expresses the valuation error as a relative metric, scaled by price and the error term should not suffer from any biases for companies of different sizes (Baker & Ruback, 1999, p. 5).[1067] J. Liu et al. (2002, p. 143) furthermore argue, that the regression transformation, together with an imposed restriction on expected scaled valuation errors to be zero, results in econometric best practice to focus on unbiasedness over reduced dispersion. This approach is also followed by other authors, including Schreiner (2007, p. 90), Yoo (2006, p. 112) and Deng, Easton, and Yeo (2010)

- *Theil–Sen method:*[1068] Departing from the OLS approach all together, Ohlson and Kim (2015) propose in a study, which regresses market cap on net income[1069] reliance on another estimation approach all together: the Theil–Sen method, which, whilst demonstrating similar levels of efficiency as OLS, addresses not only heteroscedasticity but also deals effectively with outliers as is illustratively shown by Ohlson and Kim (2015, pp. 433–434) in a comparison of Theil–Sen and OLS approaches for a numerical sample. The Theil–Sen method is also applied by Ohlson and Johannesson (2016) in recent a study to test the RIV model and results in what Ohlson and Johannesson describe as "robust" coefficient estimates; this is "by contrast" to OLS estimates, which differ materially between two measurement periods (2016, p. 84)

- *Least absolute deviation models:* Other alternative regression approaches utilized in price reference regressions relate to least absolute deviation (LAD) models, including by K. Chen, Guo, Lin, and Ying (2010) as well as, related to studies on analyst earnings predictions, empirical work by Sudipta Basu and Markov (2004) and Hughes, Liu, and Su (2008). Sudipta Basu and Markov (2004, p. 198) highlight that the operationalization of LAD approaches have become more palatable due to advances in linear programming and point to the statement of Bassett and Koenker (1978, p. 618), according to which the LAD estimator is to be preferred over OLS for applications where the median is a

[1067] It is common to restrict the model such that the mean of percentage valuation errors equals zero (J. Liu et al., 2002, p. 143; Yoo, 2006, p. 113), as this allows to operationalize the regression estimation as a harmonic mean estimate (J. Liu et al., 2002, p. 143)

[1068] Compare: Wilcox (2010, pp. 193–200) for a textbook explanation of the approach, its benefits and limitations

[1069] Compare Table 2, Panel 2c of Ohlson and Kim (2015, p. 411) better location estimator than the mean. LAD approaches therefore offer an opportunity to connect regression to median

To summarize, whilst Figure 6.1 on p. 196 may suggest to the casual observer that a simple OLS regression approach between price and earnings could be considered to derive a multiple, there is considerable additional complexity—most notably in the form of heteroscedasticity—which would need to be properly dealt with. Whilst alternatives in the form of LAD approaches and the Theil–Sen model exist, their complexity might result in practitioners' preference to be given to traditional central tendency moment metrics such as harmonic mean and median, which have been demonstrated to be special cases of weighted least square (WLS) regressions.

Distribution of pricing multiples in the context of confidence intervals

Considerations around the distribution

Following the above cited findings on financial ratio distribution[1070] an argument can be made to consider a lognormal distribution for both the valuation driver and the pricing reference:[1071]

$$\tilde{VD} \sim Log\text{-}N\left(\mu_{\tilde{VD}}, \sigma^2_{\tilde{VD}}\right) \tag{C.7}$$

and

$$\tilde{P} \sim Log\text{-}N\left(\mu_{\tilde{P}}, \sigma^2_{\tilde{P}}\right) \tag{C.8}$$

It is then helpful to introduce an anti-logarithm function based on $\tilde{Y}$, such that

$$e^{\tilde{Y}} = \frac{\tilde{P}}{\tilde{VD}} \tag{C.9}$$

Taking the natural logarithm on both sides of Equation C.9 yields

$$\tilde{Y} = \ln\left(\frac{\tilde{P}}{\tilde{VD}}\right) = \ln\left(\tilde{P}\right) - \ln\left(\tilde{VD}\right) \tag{C.10}$$

Since $\ln\left(\tilde{VD}\right) \sim N\left(\mu_{VD}, \sigma^2_{VD}\right)$ and $\ln\left(\tilde{P}\right) \sim N\left(\mu_P, \sigma^2_P\right)$, for $\tilde{Y}$, the rules of subtracting paired data applies (Ott & Longnecker, 2010, p. 317):

$$\tilde{Y} \sim N\left(\mu_{\tilde{P}} - \mu_{\tilde{VD}}, \sigma^2_{\tilde{P}} + \sigma^2_{\tilde{VD}} - 2\rho\sigma_{\tilde{VD}}\sigma_{\tilde{P}}\right) \tag{C.11}$$

or, relying on the parameters of $\tilde{Y}$:

$$\tilde{Y} \sim N\left(\mu_{\tilde{Y}}, \sigma^2_{\tilde{Y}}\right) \tag{C.12}$$

Since I am ultimately concerned with the distribution of $\frac{\tilde{P}}{\tilde{VD}}$ or $e^{\tilde{Y}}$, it is instructive to remember

[1070] Compare Footnote 700

[1071] The below discussion utilizes thoughts from What are the mean and variance of the ratio of two lognormal variables? (2012) since, despite extensive research, no more formal sources were available. The individual steps are reasonably straightforward and one-by-one part of standard statistical approaches that for any $\tilde{X} \sim N\left(\mu_{\tilde{X}}, \sigma^2_{\tilde{X}}\right) x \Rightarrow e^{\tilde{X}} \sim Log\text{-}N\left(\mu_{\tilde{X}}, \sigma^2_{\tilde{X}}\right)$ and therefore

$$e^{\tilde{Y}} = \frac{\tilde{P}}{\tilde{VD}} \sim Log\text{-}N\left(\mu_{\tilde{Y}}, \sigma^2_{\tilde{Y}}\right) \tag{C.13}$$

It has thus been demonstrated that, assuming $\tilde{P}$ and $\tilde{VD}$ follow a lognormal distribution, one could expect that $\frac{\tilde{P}}{\tilde{VD}}$ does so, too. This is in line with the statement of Dittmann and Maug (2008, p. 25). Hence the approach of Kelleners (2004) can be motivated theoretically within the limitations discussed above.

Confidence intervals of valuation multiples

Under the assumption of a lognormal distribution of trading multiples, it is possible to obtain confidence intervals for the lognormal mean by following one of a number of approaches (Zhou & Gao, 1997), including what is probably the most common concept, the "naïve method" (Zhou & Gao, 1997, p. 784), where to the standard normal distribution two-sided confidence interval formula

$$\bar{Y} \pm Z_{(1-\frac{\alpha}{2})} \frac{SD_Y}{\sqrt{I}} \tag{C.14}$$

with $\bar{Y}$ denoting the estimate of the sample mean, Z denoting the α^{th} percentile of the standard normal distribution and SD_Y the estimate of the sample standard deviation, normalized to a standard error through division by the square route of observations (or in this case, peer companies), I, an anti-logarithm function is applied such that

$$e^{\bar{Y} \pm Z_{(1-\frac{\alpha}{2})} \frac{SD_Y}{\sqrt{I}}} = e^{\ln(\bar{M}_j) \pm Z_{(1-\frac{\alpha}{2})} \frac{SD_{\ln(M_j)}}{\sqrt{I}}} \tag{C.15}$$

describes the confidence interval for a valuation multiple on the basis of a given trading multiple sample distribution.[1072] [1073] This approach is conceptually consistent with Kelleners (2004, p. 160); since it presumes that both valuation drivers and price reference are lognormally distributed, an empirical investigation whether this is a reasonable assumption is on order.[1074]

[1072] The "naïve method" has been subject to some criticism, as it results in biases for any substantial amounts of sample variance, since it solves for an estimate for e^{μ} as opposed to the true mean, which for the lognormal distribution is defined as $e^{\mu+\frac{\sigma^2}{2}}$ (Zhou & Gao, 1997, pp. 783–784)

[1073] Note that Equation C.15 is based upon Equation C.10 for the relationship between Y and M

[1074] Compare Subsection 6.3.3.1 (p. 205)

Additional considerations on negative valuation drivers

In Subsection 6.3.3.2 (p. 210), it has been argued that a suitable way to deal with negative pricing multiples (commonly caused by negative valuation drivers) has to be found. A number of possible strategies could be utilized and are discussed at greater length on the basis of an illustrative numerical example in Table A.4 (p. A23):

TABLE A.4: Negative valuation drivers—an illustrative example on central tendency impact

	Price reference ($P_{i,t}$)	Value driver ($VD_{i,t}$)	Pricing multiples ($\mu_{i,t}$)	Aggregated valuation multiple ($\hat{M}_{k,t}$) using different methods	
Panel A: Ignore loss-making firms					
Peer firm $_{i=1}$	4000	200	20.0x	Arithm. mean	18.0x
Peer firm $_{i=2}$	155	10	15.5x	Harm. mean	17.8x
Peer firm $_{i=3}$	222	12	18.5x	Geom. mean	17.9x
Peer firm $_{i=4}$	100	-100	**N/M**	VW mean	19.7x
				Median	18.5x
Panel B: Consideration of a “deeply” loss-making firm					
Peer firm $_{i=1}$	4000	200	20.0x	Arithm. mean	13.3x
Peer firm $_{i=2}$	155	10	15.5x	Harm. mean	-4.8x
Peer firm $_{i=3}$	222	12	18.5x	Geom. mean	N/A
Peer firm $_{i=4}$	100	-100	**-1.0x**	VW mean	36.7x
				Median	17.0x
Panel C: Consideration of a somewhat loss-making firm					
Peer firm $_{i=1}$	4000	200	20.0x	Arithm. mean	-11.5x
Peer firm $_{i=2}$	155	10	15.5x	Harm. mean	25.2x
Peer firm $_{i=3}$	222	12	18.5x	Geom. mean	N/A
Peer firm $_{i=5}$	100	-1	**-100.0x**	VW mean	20.3x
				Median	17.0x
Panel D: Artificially set the multiple of a loss-making firm to zero					
Peer firm $_{i=1}$	4000	200	20.0x	Arithm. mean	13.5x
Peer firm $_{i=2}$	155	10	15.5x	Harm. mean	N/A
Peer firm $_{i=3}$	222	12	18.5x	Geom. mean	N/A
Peer firm $_{i=5}$	100	-1	**0.0x**	VW mean	20.3x
				Median	17.0x

Note: Own illustration. All values set to determine illustrative effects of negative valuation drivers. VW mean denotes value-weighted mean. Peer firms 1 to 3 represent the usual situation of positive valuation drivers, peer firms 4 and 5 represent cases of negative valuation drivers, “deeply” and somewhat loss-making firms, respectively.

- *Ignore the issue all together:* How negative valuation drivers will affect multiple valuations can best be demonstrated with an illustrative numerical example, which is presented in Table A.4. One possible approach is to aggregate the pricing multiples to valuation multiples none the less, i.e. including peers which display negative pricing multiples. In particular depending on peer multiple dispersion and relative negativity of the problematic cases, this can lead to materially biased valuation multiples: Consider e.g. the case of the somewhat loss-making firm in combination with arithmetic mean as aggregation method in Panel C of Table A.4: The suggested valuation multiple would be negative and hence its application to (positive) valuation drivers of the company, for which the multiple valuation is to be conducted would result in non-meaningful valuation negative outcomes. This is despite 3 out of the 4 peers indicating valuations between 15x and 20x. The harmonic mean would suggest a positive valuation multiple, however, this multiple would exceed even the highest peer multiple (25.2x versus 20.0x), again resulting in a highly questionable valuation outcome. Geometric mean cannot be calculated on the basis of a negative inner product and thus in cases where there is an odd number of negative peer multiples, therefore it is not generally suitable either. Hence, it cannot be recommended to just ignore the issue of negative peer multiples all together if either of the above mentioned mean-based aggregation metrics is relied upon

- *Exclude only affected multiples from the analysis and form a peer group consisting of only non-negative multiples:* This is a common approach among practitioners, demonstrated in Panel A of Table A.4 and from a statistical perspective is broadly consistent with the concept of non-symmetrical truncation: multiples are denoted as "non-meaningful" in output tables and means or medians are computed excluding them all together. However, as discussed by Schwetzler (2003, p. 89), this approach leads to biased multiple valuation outcomes: Resulting industry multiples may appear higher as they should be if companies which on the basis of their negative valuation drivers can be considered "troubled" are excluded. This is particularly the case if a larger number of multiples are excluded on this basis as may be necessary for certain nascent or highly cyclical industries, where many rather than just a few peers will suffer from negative multiples

- *Replace negative multiples with another value such as e.g. zero:* Assuming negative multiples can be considered outliers, an alternative to their exclusion can be an approach known in statistics as winsorizing. Whilst the statistical concept is usually applied in a symmetrical manner to a certain percentile of high/low values, in the context of negative peer multiples, one could argue that winsorizing negative multiple through zero as shown in Panel D of Table A.4 can be a useful approach. Indeed, arithmetic mean appears to be dealing best among the approaches of including negative peer multiples presented in Panels B to D. However, as a consequence of division by zero, harmonic mean cannot be calculated using this approach and it conceptually suggests that companies with negative valuation drivers should be valued at zero, which is empirically known not to be the case

- *Utilize specific aggregation methods (I): The value-weighted mean.* As an alternative to excluding/winsorizing affected multiples or ignoring the issue all together, it is possible to chose only those aggregation methods, which allow for a consistent consideration of negative multiples. Schwetzler (2003) proposes to use what has been referred to as value-weighted means,[1075] where, rather than calculating an average multiple, all price references are added up and then divided by the sum of all valuation drivers, following Equation 6.6. However, as is obvious from Panels A and C of Table A.4, the use of value-weighted means results in two issues: First—as demonstrated by the value-weighted mean outcome of 19.7x in Panel A, very close to the largest peer firm ($i = 1$) of 20.0x—peers are weighted by their value, i.e. large companies with high absolute price references will have a much more profound influence on the valuation multiple consistent with their size rather than smaller companies. This is not a desired feature of a concept, which relies on the Law of One Price[1076] with respect to the valuation driver but not other aspects such as size, thus it introduces a bias to the pure multiple theory. Second, it may result in valuation multiples exceeding the highest positive peer pricing multiple in the case of large comparable firms with negative pricing multiples as is demonstrated by Panel C of Table A.4. Whilst there is some potentially useful connection of the value-weighted mean approach to stock market index computations (Adrian, 2005a, p. 69), it can still not be recommended for multiple aggregation

- *Utilize specific aggregation methods (II): The median.* As is obvious from Panels B, C and D of Table A.4, median appears to be performing well for all illustrative cases of negative multiples: Their position in the ranking will be reflected by the median computation, their absolute quantum will not be considered, however, which may be a desired outcome for multiple aggregation. Therefore, median can be a preferred aggregation metric in cases, where both positive and negative peer multiples are considered. However, even the median implies some degree of judgment, namely that negative multiples should per se be considered as relevant and not declared non-meaningful all

[1075] Compare e.g. Baker and Ruback (1999, p. 28) or Sommer et al. (2014, p. 31) for the value-weighted means terminology; Beatty et al. (1999, p. 182) uses "ratio of averages," Plenborg and Coppe Pimentel (2016, p. 59) "weighted average" instead

[1076] Compare Subsection 2.1.5.1, p. 27

together. Furthermore, the number of positive peer multiples will need to exceed the number of negative peer multiples for the resulting (positive) valuation multiple to be applicable to the company, for which the multiple valuation is prepared

- *Select a different multiple type:* As previously outlined,[1077] one argument of utilizing common enterprise value multiples rather than price/earnings, is the fact that their valuation drivers "sit higher" in the P&L. Consequently, if respective valuation divers are chosen, the frequency of negative multiples can be reduced. This approach has two drawbacks: First, it can be argued that another valuation driver means another valuation approach all together (Sommer et al., 2014, p. 31); second, it may mean using multiple types with doubtful valuation precision such as enterprise value/net sales.[1078] Thus it comprises a trade-off between bias reduction from excluding negative valuation driver types and selecting the highest quality multiples

[1077] Compare Subsection 2.4.2.1 (p. 58) for a discussion on arguments against price/earnings multiples and additional sources on this aspect

[1078] See Subsection 7.2.7 (p. 266) for the mediocre valuation quality of enterprise value/net sales relative to other multiple types

APPENDIX D

Tabulated review of prior literature on multiple valuation accuracy

TABLE A.5: Overview of prior empirical literature on multiple valuation precision

Study	Sample	Research question, theory and/or motivation	Methodology highlights	Accuracy[m]	Core qualitative interpretation	Potential drawbacks or omissions	oth cnpts[a]	oth mult tps[b]	composites[c]	timing[d]	consistency[e]	peers[f]	aggregtn[g]	err measre[h]	further regr[i]	smple bias[k]
Boatsman et al., 1981	1600 U.S. public firm years 1957-76 from 80 firms	• Error distribution beyond mean vs. potential investor utility function	• Comparison of different valuation concepts (P/E, CAPM-based model, index-based model, including with a ranking concept ("second degree stochastic dominance") • Peer group formation including growth • Industry peer group	• Mean error of P/E-based valuation: 58% • Valuation error <15%: c. 18% of cases[1]	• Peer group formation including growth outperforms peer group formation excluding growth • CAPM-based approach preferable to P/E approach from a valuation precision perspective	• Small sample sizes and high errors	✓					~				
LeClair, 1990	1165 U.S. firms measured around 1985	• Multiples as a suitable alternative to simple fundamental valuation concepts based on book value and dividends	• Comparison of different valuation concepts: P/E vs. Adjusted book value method (ABV) used by the IRS at the time • Accurate peer group formation on the basis of SIC codes, however high minimum requirement of 10 peers in existence • Regression analysis on error terms	• In 11 selected industries large errors (>50%) occur in less than 25% of cases	• P/E offers higher valuation accuracy than ABV model • Quality of P/E valuation depends on industry • 2 year backward-looking earnings offers higher precision than • Regression analysis of errors on dividends and book values significant	• No summary metrics across all industries provided • Low coefficient of determination of dividend and book value on valuation error regression	✓			~					~	
Alford, 1992	c. 4700 U.S. firms-years 1978-86	• Fundamental factors (Size as expressed by total assets, return on equity) as alternative and incremental peer group formation methods • Median as aggregation method excluding outliers • Expected valuation benefits of enterprise value vs. equity value multiples given leverage is considered	• Comparison of different peer group formation models and multiple types using t-tests to determine relative accuracy • Variation of industry finesse by increasing number of SIC digits considered	• Depending on methodology, median errors range from 23.9% to 29.6%, averaged over the observation time periods for P/E • Median errors for EV/EBIT of 51.8%, significantly less accurate	• Peer selection by industry provides substantial improvement over market-wide selection • Incremental peer selection on the basis of fundamental factors does not significantly improve valuation precision • Enterprise value multiples less accurate, suggesting leverage adjustment not beneficial	• Arbitrary selection of fundamental factors (e.g. omission of growth) • No improvement through additional layers of peer selection criteria • Results for enterprise value multiples rely on a small sample • No improvement of utilizing forward-looking compared to historical earnings		~		~		✓		~		
Kaplan et al., 1995	51 U.S. leveraged buyouts 1980—89	• Risk of "hardwired" forecasts given management incentives to drive leveraged transactions at preferred terms • Considers enterprise value/EBITDA	• Comparison of CAPM-based with transaction and trading multiple valuations • Reverse estimation of discount rate through CAPM • Industry peer determination	• Mean error of P/E-based valuation: 24.7% • Valuation error <15%: 37.3% of cases	• CAPM-based fundamental valuations perform together with transaction multiple valuations best	• Trading multiples naturally disadvantaged given market prices affected by transaction, as indicated by negative mean and median of error biases • Small sample size and situation specific study limits generalization of results	✓									~

Note: Refer to page A35 for further explanations and footnotes [1] Own interpolation from data presented for prediction errors below 10% and below 20%

Study	Sample	Research question, theory and/or motivation	Methodology highlights	Accuracy[m]	Core qualitative interpretation	Potential drawbacks or omissions	oth cnpts[a]	oth mult tps[b]	composites[c]	timing[d]	consistency[e]	peers[f]	aggregtn[g]	err measre[h]	further regr[j]	smple bias[k]
Baker et al., 1999	225 U.S. public firms in 1995	• Best-performing central tendency measure • Determination of narrowest distributions for different valuation drivers	• Gibbs sampling to uncover best-performing central tendency measure • Definition of a dispersion metric to maximize substitutability • Simultaneous estimate of minimum variance multiple and error specification	• Average bias of EV/EBITDA multiple (harmonic mean) of -1.86%	• Best-performing multiple type is industry specific	• Small, non-cross-sectional sample with reliance on enterprise value multiples and no elimination of financial companies • Analysis of different multiple types does not include P/E • Does not report accuracy, limiting comparability with other studies		~				~	✓			
Beatty et al., 1999	28318 U.S. public firms 1980-92	• Improvement potential of popular U.S. court valuation models through better aggregation concepts and regression	• Traditional proportional models relative to deflated regression approaches • Combination of earnings and book value as valuation drivers	• Average bias of combined P/E M/B multiple (harmonic mean) of -2% (vs. -118% for arithmetic mean)	• Substantially lower valuation biases of the harmonic mean aggregation method	• Does not report individual multiple errors to assess improvements from a combined multiple approach • Does not report accuracy, limiting comparability with other studies			~				✓			
M. Kim et al., 1999	190 U.S. IPOs 1992—93	• Low valuation precision of multiples for IPO firms ascribed to their nature as "young" firms	• Valuation errors also computed on the basis of a linear regression • Studies P/E, market/book and price/sales multiples • Industry peer determination on SIC code basis as well as peers proposed by a broker house	• Traditional approach: mean error of P/E multiples: 68.6%/; Valuation error <15%: 12.1% of cases • Regression approach: mean error of P/E multiples: 56.5%; Valuation error <15%: 14.2% of cases	• Adherence to the principle of equivalence improves sales multiple precision • Forecasts outperform historical valuation drivers • Consideration of growth rates can improve multiple valuation outcomes • Investment banker judgment can improve valuation outcome to "out of the box" multiples	• IPO offer price used, limiting comparability with true trading multiples and leading to bias if relying on traded peers rather than other IPOs • Reliance on regression approach with low coefficients of determination • Situation-specific study limits generalization of results		✓		~		~				~
Cheng et al., 2000	30310 U.S. public firm years 1973-92	• Combined multiples (P/E and M/B) as alternative to single multiples • Peer group formation	• Combination of multiples relies on simplistic equal-weight approach	• Median error of P/E based valuation of 27.6% (industry peer selection)	• Precision benefits of a combined equally-weighted P/E and P/B multiple • Some improvement in P/E valuation if return on equity is considered as an incremental peer selection criterion	• Combined P/E P/B results reported with scaled errors, limiting numeric comparability • No justification for simplistic multiple weighting • Additional consideration of r_i^{ROE} as peer selection criterion not stable for different combinations			✓							

Study	Sample	Research question, theory and/or motivation	Methodology highlights	Accuracy[m]	Core qualitative interpretation	Potential drawbacks or omissions	oth cnpts[a]	oth mult tps[b]	composites[c]	timing[d]	consistency[e]	peers[f]	aggregtn[g]	err measre[h]	further regr[j]	smple bias[k]
Gilson et al., 2000	63 U.S. Chapter 11 bankruptcy-emerging public firms 1984—93	• Traditional comparable company analysis has limits in bankruptcy-emergence cases	• Comparison of different valuation concepts (incl. DCF, multiples) in post-bankruptcy situations • Industry peer determination	• Mean error of enterprise value/forward EBITDA of 47.0% • Valuation error <15%: 21.0%	• Discounted cash flow valuation with more favorable error metrics • Risk of biased financials and lack of complete information in the context of bankruptcy emergence	• Small sample size and situation specific study limits generalization of results	✓								~	~
Bhojraj et al., 2002	c. 2750 U.S. public firm years 1982—98	• Multiples should be affected by fundamental valuation aspects (growth, risk, profitability)	• “Warranted multiples” obtained from regressing industry multiples but also fundamental valuation inputs • Industry peer determination	• Mean error of enterprise value/sales of 55% and 36% using traditional and warranted-multiple approaches, respectively	• Warranted multiples result in more favorable error metrics compared to the traditional approach for enterprise value/sales and price/book multiples	• Partly relies on enterprise value and price/sales multiples, multiple types showing weak results in other studies		~		~		✓				
Lie et al., 2002	5107 U.S public firms 1998	• Comparison of different multiple types • Classification of overall sample in sub-samples by size, profitability and intangibles	• Standard methodology of multiple (industry approach) and error computation • Adjustment for cash levels	• Mean error for forward P/E multiple of 40.6% • Valuation error <15%: 31.0% of cases	• Forward P/E multiples outperform historical P/E multiples • Strong relative performance of EV/EBITDA and EV/IC • Ambiguous benefits from adjusting for cash levels	• No cross-sectional data and reported overall errors also include financial companies • Descriptive results presentation without statistical tests		✓		~	~					
J. Liu et al., 2002	19879 U.S. public firm years 1982—99	• Which valuation multiple type and computation method offers best valuation quality? • Multiples as a proxy for cash flow streams	• Numerous valuation driver types and time references ranked by relative performance • Testing the principle of equivalence, industry peer group formation and harmonic mean as aggregation concept • Non-zero intercept in multiple regression	• Mean bias for P/E and EV/EBITDA of -1.3% and -0.5%, respectively	• No evidence for principle of equivalence • Strong performance from forward P/E multiples • Multiples outperform intrinsic RIV models • Cash-flow based multiples underperform earnings • Findings stable over time	• No explicit reference of absolute valuation errors results in comparability drawbacks compared to other studies	~	✓		✓	~	~		~		
Herrmann et al., 2003	1974 U.S. and European public firms 1997—99	• Improved peer group formation through fundamental factors, which are shown to impact valuation	• Fundamental drivers (e.g. 6 different growth portfolios) as additional or sole peer determinants • Wilcoxon rank sum test to compare model prediction qualities	• Mean error for P/E and EV/EBIT of 29.3% and 31.3%, respectively • P/E multiple Valuation error <15%: 29.0% for median peer aggregation concept	• Traditional median error concept outperforms proposed regression approach • Consideration of incremental performance aspects in peer group selection results in significant valuation accuracy outperformance • Measured by mean error, P/E multiple performs best, followed by EV/EBIT and M/B	• Statistical tests of relative performance of proposed valuation concepts only available for different peer formation concepts, not multiple types • Performance control appears to be centered on growth for P/E multiples and it is unclear how other factors may feature in peer likelihood selection		✓		~		✓		✓	✓	

Study	Sample	Research question, theory and/or motivation	Methodology highlights	Accuracy[m]	Core qualitative interpretation	Potential drawbacks or omissions	oth cnpts[a]	oth mult tps[b]	composites[c]	timing[d]	consistency[e]	peers[f]	aggregtn[g]	err measre[h]	further regr[j]	smple bias[k]
Bhojraj et al., 2003	26626 international public firm years 1990—2000	• Extension of the "warranted multiple" approach to an international sample • Explainability of future price references through todays multiples	• Combination of fundamental inputs, industry and market membership via a regression approach	• Warranted EV/sales and P/E models with a 53% (vs. 72.2% for U.S. study in Bhojraj and Lee, 2002, p. 421) and 28% R^2	• Warranted approach benefits from international peer inclusion • Relevance of lagged multiples for current multiples	• Regression assumes linear relationship • Traditional error metrics not reported • Lower coefficient of determination compared to U.S.-centric study		~		~		✓				
Kelleners, 2004	4630 U.S and European public firm-years 1994—2003	• Improved peer group formation through fundamental factors, which are shown to impact valuation	• Fundamental peers determined based on the multiplicative percentiles of their deviation • Decomposition of errors into a multiple error and a fundamental error	• Traditional: median error for P/E of 29-47%, P/E valuation error <15%: 17-29%, subject to period • Fundamental approach: median error for P/E of 18-21%, valuation error <15%: 18-44%	• Growth and risk-controlled peer group performs better than peer group formed on the basis of industry affiliation • Strong performance of P/E multiples relative to other types	• Does not consider an integrated approach comprising of fundamental factors and industry peer selection • Whilst all of the more sophisticated approaches considers growth, only one considers risk and none considers return on capital		~		~		✓		~		
Dittmann et al., 2005	67433 mature-market firm years 1993—2002	• Peer selection from same headquarter countries vs. a more international consideration of comparables	• Standard methodology with focus on enterprise value/EBIT • Selection of peers by country/region/globally • Selection by return on assets vs. industry approach	• N/R for aggregated sample, per-country results point to mean P/E errors of 45-75%	• Return on assets outperforms industry affiliation for selection • For EU firms, peers are best selected from overall EU, for UK and US firms, domestic peers are preferable	• Relatively high overall error level • Exact definition of location unclear						✓				
Courteau et al., 2006	41435 U.S. public firm-quarters 1990—2000	• Comparison of 2 residual-income based valuations with a 4 period ahead P/E multiple and a hybrid RIV/multiple approach	• Standard methodology for multiple computations (averaged over 4 coming periods) and industry formation • Also runs instructive tests on buy-hold strategies and abnormal returns	• Mean error for 4 period forward averaged P/E of 20%	• P/E model is outperformed by the direct RIV method, however, a hybrid approach consisting of an equal-weighted P/E and direct model approach performs best	• 4 period ahead P/E model is unusual in the context of multiple valuation which usually relies on single period financials	✓		~	~						
Meitner, 2006	928 German firm year observations 1998—2003	• Test of a proposed 2-factor model which considers a combination of recursion and reorganization value, variably weighted depending on return on equity • Value relevance of common valuation drivers	• Combination model regresses book value and earnings on market value (recursion value, a peer-based regression estimate) and the next period-expected equity value (reorganization value) • Usual industry peer formation method	• Mean error for P/E of 42%-45% for different aggregation methods • Proposed 2-factor model with mean error of 39%	• Proposed 2-factor model appears more precise but improvement not significant throughout	• Relatively small sample size focused on one market only			✓				~			

Study	Sample	Research question, theory and/or motivation	Methodology highlights	Accuracy[m]	Core qualitative interpretation	Potential drawbacks or omissions	oth cnpts[a]	oth mult tps[b]	composites[c]	timing[d]	consistency[e]	peers[f]	aggregtn[g]	err measre[h]	further regr[j]	smple bias[k]
Yoo, 2006	29929 public firm-years 1981—99	• Improved valuation outcome from a combination of standard multiple types rather than individual multiples	• Price-deflated regression of individual multiple valuations for each peer company to determine weights • Industry peer group formation • *t*-statistic to assess relative model accuracy	• Traditional: Mean error for historical P/E of 34.5%; Valuation error <15% for 30.7% of cases • Combined multiples: Mean error of 31.9%; Valuation error <15% for 33.3% of cases	• Combined historical multiple approach outperforms individual historical multiples, however no improvement if forecast earnings are considered • High information content of future earnings	• No comparison of a concept relying in several future valuation drivers vs. individual future multiples conducted • Combination of multiples based on a linear approach			✓	✓						
J. Liu et al., 2007	1.6mm non-US inter-na-tional firm-months 1987—2004	• Relevance of (accounting-based) earnings vs. cash-based operating cash flow and dividends as valuation driver • International sample	• Error assessment on the basis of interquartile ranges • *t*-statistic on relative performance of different models	• N/R	• Forecast EPS as valuation driver with significantly lower interquartile ranges than operating cash flow	• By far largest sample, however fewer details reported compared to other studies, including lack of absolute valuation errors		✓								
Schreiner, 2007	5920 Euro-pean public firm-years 1996—2005, vali-dated with U.S. sample	• Best performing multiple types, including “knowledge multiples” • Forward-looking vs. trailing multiples • Industry-preferred multiples • Combinations of several multiple types	• Focus on traditional approach, ensuring good comparability with other studies	• Mean error for forward P/E and P/EBIT of 36.5% and 197.1%, respectively • Valuation error <15% for 36.1% and 33.5% of P/E and P/EBIT valuations, respectively	• Forward P/E and price/earnings before tax with overall solid performance • No evidence for principle of equivalence • Forward outperform historical multiples • 3 digit ICB industry granularity performs strongest • Some evidence for industry-preferred multiples	• No statistical tests on relative accuracy between the different proposed methods • Some reported statistics appear to violate the principle of equivalence • Some error distributions appear to be skewed, indicating improvement potential from better outlier control		✓	~	✓		✓				
Cooper et al., 2008	49757 U.S. public firm-years 1982—2006	• Optimal number of comparables	• Standard harmonic mean methodology determining peers by industry • Narrow number of peers identified by growth similarity to the firm under investigation	• Mean error for 2-period forward P/E of 27.9%	• Choice of 10 peers is as accurate as choosing all peers • Relying on 5 peers is only slightly less precise	• Second similarity criterion (besides industry) relies entirely on growth						✓				
Dittmann et al., 2008	52112 U.S. public firm-months 1994—2003	• Aggregation and error measurement	• Theoretically focused on most appropriate error measurement and aggregation	• Mean error for P/E of 126.5% (median aggregation method)	• Positive bias of percentage errors • Log errors and median or geometric mean an unbiased estimator	• Overall comparably high valuation errors but focus of paper more on theoretical background	~	~					✓	✓		

Study	Sample	Research question, theory and/or motivation	Methodology highlights	Accuracy[m]	Core qualitative interpretation	Potential drawbacks or omissions	oth cnpts[a]	oth mult tps[b]	composites[c]	timing[d]	consistency[e]	peers[f]	aggregtn[g]	err measre[h]	further regr[j]	smple bias[k]
Deloof et al., 2009	49 Belgian IPOs 1993—2001	• Investment bank valuation models in the context of IPOs	• Comparison of methods and errors resulting from lead underwriter valuations in the context of IPOs • Traditional error reporting metrics • Reliance on valuations prepared by underwriters	• Pre-IPO valuation vs. stock price (peer valuations): Mean error for forward P/E of 23.9%; Valuation error <15% for 48.2% of valuations	• Valuation errors of DCF and DDM models broadly similar to forward P/E multiples • P/E multiples based on forward valuation drivers more accurate than historical earnings	• Small sample size and possibly limited ability to generalize • IPO underpricing effects may result in biases	✓			~						~
Harbula, 2009	9200 European public firm years 1986—2009	• Best performing types of multiples • Combined multiples • Industry-specific multiples • Timing of valuation drivers	• Standard descriptive concepts	• Mean error for forward P/E of 33%	• Forward EV/EBITDA, EV/EBIT and P/E the best performing multiples • Anecdotal evidence on industry-specific multiple performance by type	• Descriptive in nature with no statistical tests		✓	~	✓		~				
Henschke, 2009	24308 U.S. public firm years 1985—2004	• Analysis of different valuation methods • For multiples specifically: different fundamental factors should lead to different valuation outcomes	• Peer score model, which estimates similarity peer scores based on fundamental input factor differences from mean fundamental input factors • Peer scores can be used to exclude peers on lack of similarity, to modify peer multiples to address similarity or a combination of both	• Traditional approach: mean error for forward P/E of 28.9% • Best peer score approach: mean error for forward P/E of 25.4%	• Peer score approach outperforms standard approach • Further improvement over the regression approach by Bhojraj and Lee (2002) • Gradual improvement of error metrics as industry finesse is increased	• Covers different valuation methods but no direct summarizing comparison of relative valuation accuracy • Peer score methodology assumes linear relationship between fundamental input factors, theoretically challenging to justify	~	~		~		✓			~	
Deng et al., 2010	69678 U.S. public firm years 1963—2008	• Best-performing multiple types including smaller and loss-making companies • Further improvements through combination of multiples	• Extension of the common J. Liu, Nissim, and Thomas (2002) approach of deflated multiples to allow for joint consideration of 2 multiples	• Traditional approach: mean error for P/E:66% (harmonic mean) • Combined P/E M/B valuation errors of 36% (intercept, non-negativity)	• Material valuation quality improvement from combined multiples • Positive impact on valuation accuracy for allowing regressions with intercept	• Relies on historical valuation drivers, only tests potential biases from negative valuation drivers for combined multiples • Valuation errors of individual multiples overall relatively high			✓							
Sommer et al., 2011	10720 U.S. public firm years 1981—2009	• Interaction effects between valuation drivers, time horizons and aggregation methods • Objective to provide the best possible combination of those methods rather than the best of each method	• Wilcoxon signed rank test for best performing type of multiple • Reliance on industry peer group formation	• Traditional approach: mean error for P/E of 27.3% • Valuation error <15% for 30.4% of valuations	• P/E provides highest-quality valuations • Forecast valuation drivers more accurate than longer-term future averages • Harmonic mean outperforms other aggregation methods • Above rankings change in a consolidated analysis, suggesting interaction	• Disregards other obvious interaction effects, e.g. industry affiliation and fundamental metrics		✓		✓			✓			

Study	Sample	Research question, theory and/or motivation	Methodology highlights	Accuracy[m]	Core qualitative interpretation	Potential drawbacks or omissions	oth cnpts[a]	oth mult tps[b]	composites[c]	timing[d]	consistency[e]	peers[f]	aggregtn[g]	err measre[h]	further regr[i]	smple bias[k]
Nissim, 2013	>31000 U.S. public firm months 1990—2011 (insurances)	• Uncover specificities of multiple valuation for insurance companies	• Provides *t*-statistic on percentage-point differences	• Prediction error <25% for 49%-50% of P/E multiple valuations, depending on adjustments to earnings	• M/B based multiples outperform P/E multiples • Benefits to conducting (certain) normalization adjustments to earnings as a valuation driver	• Focused on insurance companies, which are as part of financial companies typically excluded from other studies, resulting in possibly limited ability to generalize results		✓			~	~				~
Berndt, Deglmann, and Vollmar, 2014	2503 international public firm years 2011—13	• Improvement to multiple valuation precision from consistency adjustments to multiples	• Comparison of typical valuation errors for adjusted, partly adjusted and unadjusted enterprise value multiples • Industry peer group formation • Wilcoxon signed-rank tests	• Traditional approach mean error for P/E of 27.0% (log-scaled) • Valuation error <15% for 35.3% of valuations • Reported only for subsample	• Adjusted enterprise value multiples outperform their unadjusted counterparts • All adjustments contribute positively to valuation accuracy with the exception of equity investments • EV/EBIT overall best-performing multiple	• Comparably small sample size • No detailed regression analytics on individual adjustments		✓			✓					
Sommer et al., 2014	10387 U.S. public firm years 1994—2010	• Biases caused by the omission or inclusion of negative multiples, in particular negative valuation drivers	• Wilcoxon signed rank test for best performing type of multiple • Reliance on industry multiples	• Traditional approach: mean error for P/E of 40.3% (log error) • Harmonic mean P/E log error of 29.9% with negative multiples eliminated (vs. 40.6% negative multiple inclusion)	• Significantly better performance of peer groups which exclude negative multiples for P/E and EV/EBIT multiples • Value-weighted mean of EV/EBITDA with negative multiples outperforms elimination • Elimination preferred to alternative multiple types for negative cases	• Lacks consideration of negative multiples for median computation • Comparably high errors relative to other studies		~					✓			
Chullen et al., 2015	6030 German public firm-years 1998—2011	• Benefits of valuation consistency between price reference and valuation driver	• Pair-wise comparison of individual adjustment layer combinations • Considers different multiple types and aggregation methods	• Median bias for P/E and EV/EBITDA of -8.1% and 5.6%, respectively (best performing metric geometric mean)	• Adjusted multiples perform overall with higher accuracy • All adjustments provide positive accuracy impact with the exception of equity investments • Common enterprise value multiples (EBITDA, EBIT valuation drivers) outperform P/E	• Sample restricted to Germany and includes small companies with low liquidity • Comparably high bias errors and skewed distribution metrics, absolute errors N/R • No statistical test used for precision assessment		✓			✓		~			
Young et al., 2015	21205 European public-firm years 1997—2008	• Impact of accounting comparability (IFRS introduction) on multiple valuation	• Reliance on a modified approach used by Bhojraj and Lee (2002) • Comparison of valuation errors for "low" and "high" reporting alignment periods	• Mean error for M/B of 64.1% and 56.0% for the low and high reporting alignment period, respectively	• Improved peer based valuation post introduction of common accounting standards	• Analysis limited on M/B multiples • Relatively high valuation errors compared to other studies					✓	~			~	

Study	Sample	Research question, theory and/or motivation	Methodology highlights	Accuracy[m]	Core qualitative interpretation	Potential drawbacks or omissions	oth cnpts[a]	oth mult tps[b]	composites[c]	timing[d]	consistency[e]	peers[f]	aggregtn[g]	err measre[h]	further regr[j]	smple bias[k]
Rossi et al., 2016	19980 U.S. public firm-years 1990—2014	• Illustrative study providing up-to-date multiple valuation data	• Traditional approach using harmonic mean as aggregation method • Industry peer group formation with detailed result reporting • Also runs tests on portfolio strategies	• Median bias for forward P/E and EV/EBTIDA of 28.8% and 33.1%, respectively • Valuation error <25% for 22.2% and 26.3% of forward P/E and EV/EBITDA multiple valuations	• Anecdotal evidence on industry-specific multiple type performance • Multiple valuation accuracy with some variation over time, prediction error <25% for forward P/E in 40% of cases in 1991 vs. only 17% of cases in 2013	• No reporting of aggregated accuracy metrics but bias suggests comparably high valuation errors compared to other studies • Results more descriptive in nature with little statistical tests performed		✓		~		~	~			

Notes relating to all preceding pages of A.5: Highly illustrative summary, for general indication only. ✓ relates to core topics of the respective study, ~ relates to peripheral topic in the respective study per highly indicative assessment. Alternating gray/black font color for improved readability purposes only

[a] Study covers a comparison of multiple valuation to other concepts [b] Valuation accuracy of different multiple or valuation driver types is considered

[c] Approaches discussing benefits of combined or composite multiple valuation rather than reliance on individual multiple types only

[d] Timing of the valuation driver (e.g. historical vs. forward valuation driver measurement) [e] Benefits of consistency adjustments to multiples to mirror potential economic effects [f] Considerations on peer group formation, specifically departure from the standard approach to select peers on the basis of industry classification

[g] Discussion of potential aggregation techniques of pricing multiples into valuation multiples

[h] Considerations on how to measure valuation errors or determine valuation accuracy [j] Further regression analysis with the valuation error as dependent variable

[k] The objective of the study on a very specific aspect (e.g. initial public offerings, leveraged buy-outs, companies in distress) and hence sample selection may limit ability to generalize results [m] Accuracy measured through the mean of absolute valuation errors (determined either as percentage or as log-scaled error as the case in the respective study may be). This literature review focuses on general trading multiple studies of broader markets and disregards studies on local markets (e.g. Minjina (2009) for the Romanian market and Nel, Bruwer, and Le Roux (2013) for the South African market), specific industries (e.g. Asche and Misund (2016)), unless they provide substantial incremental contribution to the body of literature. The analysis also disregards studies referred to at times in existing literature, but which are not readily accessible such as Choudhary (as cited in Meitner, 2006) or Liu and Ziebart (as cited in M. Kim and Ritter, 1999). While this list of 34 studies is considered a fair representation of common empirical studies on the topic of multiples and valuation precision specifically, it should not be considered fully exhaustive

APPENDIX E

Ancillary empirical results

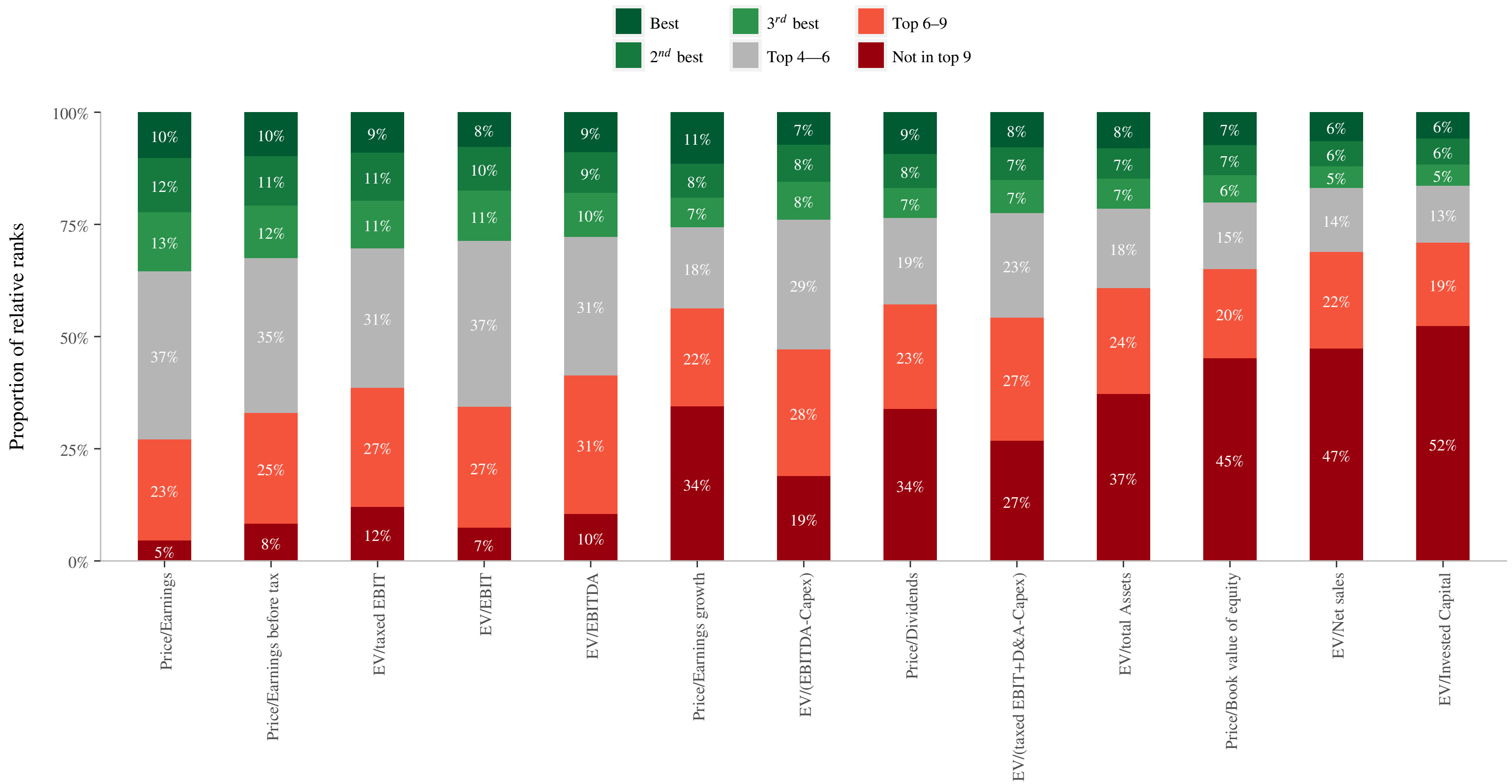
TABLE A.6: Logit regression to detect intrinsic multiple outperformance

Logit regressions: $DV^a = \begin{cases} 1 \text{ if intrinsic outperforms valuation multiple} \\ 0 \text{ otherwise} \end{cases}$

		(1) Intr. multiple inputs				(2) Cyclicality metrics				(3) Absolute cyclicality metrics			
	Pred.	Coeff.		Odds ratio	Odds incr.[a]	Coeff.		Odds ratio	Odds incr.[a]	Coeff.		Odds ratio	Odds incr.[a]
Intrinsic multiple inputs													
Comparable LT growth	?	-0.0715	***	0.9310	-0.0690								
		(-9.56)											
Return on equity	?	-0.000067		0.9999	-0.000067								
		(-0.93)											
Cost of equity	?	0.1757	***	1.1921	0.1921								
		(18.41)											
ln(Enterprise value)	?	-0.0152		0.9849	-0.0151								
		(-0.86)											
EBIT margin	?	0.0097	***	1.0098	0.0098								
		(5.28)											
U.S. obs (dummy)	?	-0.1941	***	0.8236	-0.1764								
		(-4.61)											
Cyclicality metrics													
Δ Market EPS long term growth	?					-0.0484		0.9527	-0.0473	-0.2518	***	0.7774	-0.2226
						(-1.23)				(-5.08)			
Δ Shiller CAPE cyclicality adj.	?					0.0077		1.0077	0.0077	0.0119		1.0120	0.0120
						(1.12)				(1.66)			
Δ Equity risk premium	?					0.1052	***	1.1109	0.1109	-0.0025		0.9975	-0.0025
						(6.52)				(-0.10)			
Intercept		-2.2030	***			-0.8238	***			-0.7536	***		
		(-11.23)				(-36.50)				(-18.58)			
Observations		12862				13020				13020			
Pseudo R^2 (McFadden)		4.3%				0.4%				0.2%			
Likelihood ratio test (χ^2)		509.76	***			59.42	***			26.28	***		

Note: Independent variables in Regression (1) are selected on the basis of Equation 4.12; independent variables in Regression (2) are based on signed cyclicality metric differences between the respective median market values at valuation point in time (compare lines/dots in Figure 7.10) and the medians of those values over time (compare dashed lines in Figure 7.10). Independent variables in Regression (3) are based on absolute values of Regression (2) independent variables. For each independent variable, the signed slope, its level of Holm-Bonferroni-adjusted significance (common codes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$) and the respective z-statistic (Wald test, in parentheses) is displayed. [a] Odds increase—computed as odds ratio minus 1—can be interpreted as the increase for the odds of P/E being among the 3 lowest valuation errors for a one-unit increase in the respective independent variable (i.e. 1%-point increase for percentage-denoted independent variables; a negative sign of "odds increase" suggests that an increase of the independent variable decreases the odds of P/E being among the top 3 multiple types)

FIGURE A.2: Highest quality multiple valuation—a concurrent multiple type analysis



Note: Figure shows the proportion of relative ranks of observation-by-observation absolute log valuation errors; e.g. in 10% of cases where it actually produces a valuation multiple within cut-off limits as detailed in Subsection 3.4.2 (p. 74), price/earnings produces the lowest valuation error, in 12% of cases the second lowest valuation error and in 5% of cases it produces a valuation error ranking 10^{th} or worse relative to the 12 other multiple types studied. Multiple types are sorted descending by their ranking within the top 3 of valuations. The data suggests that the most successful multiple types are those, which produce little bad (i.e. low-ranked) valuations rather than those, which produce an overwhelming amount of lowest valuation errors—even the best overall performer, price/earnings, achieves this in only 10% of cases, whilst the overall worst performer, enterprise value/invested capital does so in still comparably high 6% of cases. Number of observations range from 15183 to 18661 depending on multiple type

TABLE A.7: Ranks of best performing multiple types by industry

ICB classification[a]		Rank of multiple type by low absolute log valuation error												
Code	Descr.	Price/Earnings	Price/Earnings before tax	EV/EBIT	EV/taxed EBIT	EV/EBITDA	EV/(EBITDA- Capex)	EV/(t. EBIT+ D&A-Capex)	Price/Earnings growth	Price/Dividends	Price/Earnings	Price/Earnings before tax	EV/EBIT	EV/taxed EBIT
653	Fixed Line Telecommunications	1	2	4	7	3	6	8	13	5	9	11	10	12
453	Health Care Equipment & Services	1	2	5	4	7	6	8	3	9	12	11	10	13
757	Gas, Water & Multiutilities	1	2	5	6	4	11	12	9	3	8	10	13	7
277	Industrial Transportation	1	2	6	3	7	4	11	8	9	5	10	13	12
753	Electricity	1	2	3	7	6	12	13	10	5	9	8	11	4
353	Beverages	1	2	4	3	9	5	7	6	8	10	13	11	12
335	Automobiles & Parts	1	2	5	6	7	4	9	10	3	12	8	13	11
275	Industrial Engineering	1	3	2	4	5	6	7	12	8	10	9	11	13
271	Aerospace & Defense	1	3	2	6	5	4	7	9	8	11	10	12	13
135	Chemicals	1	3	4	2	8	5	7	10	6	9	11	13	12
376	Personal Goods	1	3	4	7	6	2	5	8	10	11	12	9	13
235	Construction & Materials	1	4	2	3	5	6	7	11	8	9	10	12	13
357	Food Producers	1	4	2	3	5	6	8	7	9	10	12	11	13
273	Electronic & Electrical Equipment	1	4	5	3	7	6	2	8	9	11	10	12	13
378	Tobacco	1	5	8	3	4	6	2	10	7	11	12	9	13
657	Mobile Telecommunications	2	1	5	3	4	7	9	11	6	10	12	8	13
537	General Retailers	2	1	3	4	6	7	8	5	10	9	12	11	13
057	Oil Equipment, Services & Distr.	2	1	3	4	5	7	10	8	11	6	12	9	13
177	Mining	2	1	4	5	3	7	10	13	8	6	11	9	12
533	Food & Drug Retailers	2	1	4	3	6	7	8	5	9	10	12	11	13
053	Oil & Gas Producers	2	3	6	5	1	8	9	7	12	4	11	13	10
272	General Industrials	2	3	1	4	5	6	7	11	10	9	8	13	12
175	Industrial Metals & Mining	2	3	1	6	4	5	8	13	11	12	9	10	7
173	Forestry & Paper	3	1	6	5	4	7	10	11	2	8	13	9	12
457	Pharmaceuticals & Biotechnology	3	5	1	4	2	6	8	9	11	10	12	7	13
555	Media	3	6	2	5	4	1	7	8	10	11	13	9	12
957	Technology Hardware & Equipment	3	6	2	1	7	4	5	8	11	10	9	12	13
575	Travel & Leisure	4	2	1	3	5	6	8	9	7	10	11	12	13
372	Household Goods & Home Constr.	4	3	2	5	1	6	7	13	12	9	8	10	11
279	Support Services	4	3	1	2	6	5	7	8	9	10	11	13	12
953	Software & Computer Services	4	7	2	1	3	8	6	5	12	11	10	9	13
374	Leisure Goods	5	1	3	7	4	2	6	8	12	9	10	11	13
058	Alternative Energy	5	6	2	4	1	10	9	11	7	3	13	8	12
Across industries		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Number of industries, top ranked[b]		15	7	5	2	3	1	0	0	0	0	0	0	0
Number of industries, among top 3[b]		27	24	18	13	7	3	2	1	3	1	0	0	0

Note: Industries sorted by the performance of price/earnings (and, second, price/earnings before tax) multiples. Green color coding highlights ranks of multiple types from 1 (top ranked) to 5, with ranks of 6 and below not highlighted; sample as detailed in Table 3.1, excluding companies classified by ICB in the industry "Financials" (ICB code 8xx) [a] Industry Classification Benchmark by "Sector", which relates to the first 3 digits of the respective ICB codes and includes all respective "Subsectors" which are defined by the full 4 digit ICB taxonomy [b] Counts the number of industries in which the respective multiple type is top ranked or ranked among the 3 best performing multiple types

Intrinsic P/E metrics			Intrinsic EV/EBIT metrics					Other		ICB
Comparable LT growth	Return on equity	Cost of equity	Return on invested capital	Tax rate	Risk free rate	Equity beta	Financial leverage	EBIT margin	ln(Enterprise value)	Code
2.5%	21.1%	9.7%	13.8%	25.0%	4.5%	0.99	31.9%	18.8%	9.47	653
5.5%	20.5%	8.3%	16.5%	25.4%	3.5%	0.76	6.6%	20.4%	8.98	453
2.9%	13.7%	8.7%	8.3%	27.8%	3.8%	0.78	43.4%	18.6%	9.7	757
5.2%	21.0%	8.9%	12.3%	34.3%	3.7%	0.82	22.2%	16.3%	9.52	277
2.9%	11.5%	7.3%	7.4%	32.3%	3.8%	0.62	41.4%	19.1%	9.75	753
4.5%	27.6%	8.5%	14.7%	25.8%	3.7%	0.77	19.8%	19.5%	9.63	353
5.1%	21.2%	11.1%	12.9%	26.6%	3.7%	1.22	26.9%	8.3%	9.73	335
4.6%	22.8%	10.5%	17.6%	28.3%	3.7%	1.12	7.9%	11.8%	8.65	275
4.8%	27.9%	9.6%	23.1%	29.1%	3.7%	1	7.8%	11.6%	9.19	271
4.1%	21.0%	9.8%	16.2%	24.5%	3.7%	1.02	13.9%	12.7%	8.9	135
5.1%	25.0%	8.8%	23.5%	29.9%	3.7%	0.82	4.7%	17.3%	9.47	376
4.6%	13.8%	10.6%	9.9%	30.1%	4.2%	1.09	21.9%	10.3%	8.88	235
3.8%	22.6%	7.8%	15.7%	29.1%	3.8%	0.67	16.6%	12.5%	9.12	357
5.6%	20.0%	10.2%	17.4%	23.4%	3.7%	1.05	8.5%	15.3%	8.81	273
3.7%	83.7%	7.9%	27.2%	30.0%	3.7%	0.76	13.7%	36.2%	10.21	378
3.2%	17.5%	9.0%	11.2%	25.0%	3.7%	0.88	26.1%	21.2%	10.25	657
5.7%	26.0%	8.9%	23.1%	35.4%	3.5%	0.9	5.1%	10.0%	9.08	537
6.4%	8.9%	11.2%	8.6%	29.7%	3.7%	1.26	7.1%	14.5%	8.63	057
4.5%	10.3%	11.4%	10.2%	32.0%	3.7%	1.27	8.7%	29.7%	9.25	177
5.1%	21.3%	8.5%	16.3%	32.2%	3.7%	0.79	15.3%	4.4%	9.5	533
4.7%	9.9%	11.0%	9.7%	32.0%	3.5%	1.24	14.4%	24.9%	9.51	053
4.6%	24.0%	10.5%	16.3%	27.1%	3.5%	1.09	17.0%	11.3%	8.81	272
5.0%	8.6%	11.0%	8.2%	32.0%	3.8%	1.19	16.6%	9.6%	8.79	175
3.4%	14.7%	9.3%	7.9%	20.2%	3.7%	0.93	29.9%	9.6%	9.23	173
5.2%	28.9%	9.0%	23.3%	20.6%	3.7%	0.9	2.7%	26.5%	9.61	457
4.4%	24.2%	9.6%	17.0%	29.9%	3.8%	0.95	17.7%	18.1%	8.83	555
5.9%	19.0%	10.5%	24.5%	22.6%	3.4%	1.19	-9.5%	18.8%	8.99	957
4.8%	26.1%	9.8%	19.8%	28.5%	3.8%	0.97	16.4%	14.3%	8.91	575
5.3%	23.9%	10.8%	20.7%	23.8%	3.7%	1.21	14.4%	11.6%	8.53	372
5.4%	29.6%	9.6%	20.3%	29.6%	3.7%	0.99	8.6%	12.9%	8.5	279
5.9%	24.5%	9.7%	25.1%	26.8%	3.5%	1.06	-5.3%	23.6%	8.81	953
6.4%	22.7%	8.7%	23.5%	23.6%	3.4%	0.86	0.1%	14.1%	8.99	374
8.8%	17.4%	14.4%	14.3%	25.0%	3.8%	1.52	16.9%	9.5%	8.23	058
4.9%	**20.2%**	**9.6%**	**15.4%**	**28.8%**	**3.7%**	**0.98**	**13.1%**	**15.3%**	**9.1**	**All**

Note: Table should be read in conjunction with table facing this page. Color coding refers to relative difference between industry median metric and overall sample metric (bottom row, highlighted in bold): red (green) represents a higher (lower) value to overall median for the metric. Intensity of color indicates relative quantum of difference. ICB code repeated for ease of readability

TABLE A.8: Logit regression on the odds of P/E as well-performing multiple type

		Logit regressions							
		DV[a] = {1 if P/E among the 3 lowest errors; 0 otherwise}							
		(1) Raw values				(2) Peer median deviations			
	Pred.[b]	Coeff.		Odds ratio	Odds increase[c]	Coeff.		Odds ratio	Odds increase[c]
Intrinsic multiple inputs									
Comparable LT growth	?	-0.0107		0.9894	-0.0106	0.0129		1.0130	0.0130
		(-1.60)				(1.64)			
Return on equity	?	-0.000016		1.0000	-0.000016	0.000017		1.0000	0.000017
		(-0.26)				(0.28)			
Cost of equity	?	-0.0409	***	0.9599	-0.0401	0.0112		1.0113	0.0113
		(-4.76)				(1.07)			
Other common input variables									
ln(Enterprise value)	?	0.0667	**	1.0690	0.0690	-0.0550		0.9465	-0.0535
		(3.98)				(-3.13)			
EBIT margin	?	-0.0069	**	0.9932	-0.0068	0.0070	*	1.0070	0.0070
		(-3.93)				(3.44)			
U.S. obs (dummy)	?	-0.1425	*	0.8672	-0.1328	-0.1199		0.8870	-0.1130
		(-3.62)				(-3.12)			
Conceptually "questionable aspects" of P/E multiples[d]									
Net debt/EBITDA	–	0.1011	***	1.1063	0.1063	-0.0718	***	0.9308	-0.0692
		(9.00)				(-5.71)			
Tax rate	–	0.0080	*	1.0080	0.0080	-0.0023		0.9977	-0.0023
		(3.54)				(-1.00)			
Intercept		-0.9903	***			-0.6137	***		
		(-5.19)				(-25.81)			
Observations		13618				13618			
Pseudo R^2 (McFadden)		38.7%				38.3%			
Likelihood ratio test (χ^2)		195.60	***			75.20	***		

Note: Table presents the results of 2 logit regressions. Independent variables in Regression (1) are based on "raw values" as measured for the respective variables, with percentage variables multiplied by 100 for easier interpretation of the odds increase as a percentage-point sensitivity. Independent variables in Regression (2) based on deviations to peer median values (consistent with the approach around intrinsic multiple regressions taken in Table 7.12 (p. 306), multiplied by 100 for percentage-based metrics. Independent variables selected on the basis of Equation 4.12 and other common regressants. For each independent variable, the signed slope, its level of Holm-Bonferroni-adjusted significance (common codes: ***: $p < 0.001$, **: $p < 0.01$, *: $p < 0.05$) and the respective z-statistic (Wald test, in parentheses) is displayed. [a] Dependent variable coded as dichotomous variable: 1 if the absolute log valuation error of P/E is among the three lowest valuation errors for the 13 different multiple types considered, 0 in all other cases. Same dependent variable applied to both Regressions (1) and (2) [b] No ex ante predictions formulated

[c] Odds increase—computed as odds ratio minus 1—can be interpreted as the increase for the odds of P/E being among the 3 lowest valuation errors for a one-unit increase in the respective independent variable (i.e. 1%-point increase for percentage-denoted independent variables; a negative sign of "odds increase" suggests that an increase of the independent variable decreases the odds of P/E being among the top 3 multiple types). [d] Relates to theoretical shortcomings sometimes quoted against P/E multiples (lack of leverage and tax rate normalization)

TABLE A.9: Logit regression on the odds of EV/EBIT as well-performing multiple type

		Logit regressions					
		$DV^a = \begin{cases} 1 \text{ if Enterprise value/EBIT among the 3 lowest errors} \\ 0 \text{ otherwise} \end{cases}$					
		(1) Raw values			(2) Peer median deviations		
	Pred.[b]	Coeff.	Odds ratio	Odds increase[c]	Coeff.	Odds ratio	Odds increase[c]
Intrinsic multiple inputs							
Comparable LT growth	?	-0.0028 (-0.41)	0.9972	-0.0028	0.00000071 (0.000086)	1.0000	0.00000071
Return on invested capital	?	-0.000028 (-0.57)	1.0000	-0.000028	0.000024 (0.55)	1.0000	0.000024
Tax rate	?	0.00076 (0.32)	1.0008	0.00076	-0.0023 (-0.92)	0.9977	-0.0023
Risk free rate	?	-0.0555 (-3.02)	0.9460	-0.0540	0.0516 (1.68)	1.0530	0.0530
Equity beta	?	-0.00092 (-1.43)	0.9991	-0.00092	-0.0110 (-0.15)	0.9891	-0.0109
Financial leverage	?	-0.0019 (-2.16)	0.9981	-0.0019	0.0018 (1.81)	1.0018	0.0018
Other common input variables							
ln(Enterprise value)	?	-0.0681 ** (-3.86)	0.9342	-0.0658	0.0772 ** (4.15)	1.0802	0.0802
EBIT margin	?	0.000039 (0.022)	1.0000	0.000039	-0.0051 (-2.43)	0.9949	-0.0051
U.S. obs (dummy)	?	0.0245 (0.54)	1.0248	0.0248	0.0282 (0.63)	1.0286	0.0286
Intercept		0.0266 (0.13)			-0.9040 *** (-33.53)		
Observations		13635			13635		
Pseudo R^2 (McFadden)		34.2%			34.2%		
Likelihood ratio test (χ^2)		33.97			31.82		

Note: Notes to Table A.8 apply, with the exception that this Table is based on enterprise value/EBIT rather than price/earnings. Furthermore, independent variables selected on the basis of Equation 4.34 and other common regressants, excluding r_{ERP}, which is a constant for each measurement date; Regression (2) independent variable approach consistent with intrinsic metric differences concept shown in Table 7.13 (p. 307)

About the author

Florian Deglmann is an Executive Director at a leading global investment bank in London, United Kingdom. Over the past 12 years, Mr. Deglmann has advised numerous companies in the consumer goods industry across Europe, the Middle East and Africa on a variety of M&A and capital market transactions.

After completing his undergraduate studies in Business Administration as well as Law and Economics at the University of St.Gallen, Mr. Deglmann graduated with an M.A. in Accounting and Finance (2007), a CEMS Master in International Management (2007) and an M.A. in Law and Economics (2014) from the University of St.Gallen. In addition to his studies at the University of St.Gallen, Mr. Deglmann studied at Stockholm School of Economics, Sweden, Singapore Management University, Singapore, and the University of Passau, Germany. Mr. Deglmann was a member of the 34th International Students' Committee, which organizes the annual St. Gallen Symposium at the University of St.Gallen.

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Note: Any views and conclusions expressed in this dissertation are based on the theory and empirical findings presented. They do not represent the opinion of any past, current or future employers. The content of this dissertation is purely academic in nature, published in order to stimulate free discussion and should not be used to trade securities or relied upon for commercial decision making of any kind