Essays on Trade, Finance and Exchange Rate Pass-Through

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Summary

This thesis consists of three essays and examines whether adverse monetary conditions such as limited external financing or an overvalued currency prevents firms from prospering.

The first and second essay study to what extent firm-level credit constraints in developing countries can be a barrier for exporting activities and importing capital and intermediate goods. In both essays the new hypothesis is that a firm's wealth, which is approximated by liquidity and leverage ratios, should become more important determinants of trade participation in countries with weaker credit market institutions. Empirically, the quality of credit market institutions in a country is inferred from indicators, such as a creditor rights measure, a proxy for the efficiency of legal debt enforcement and accounting standards. The results of the first and second essay indicate that financing obstacles and the benefits of credit market development for entering export and capital import markets are particularly high for innovative firms that are heavily dependent on external finance. Moreover, the results also reveal that institutional development of the credit market overproportionately improves access to finance for first-time exporter and capital importer. The empirical findings also suggests that innovative and non-trading firms are more severely credit constrained in countries with underdeveloped credit markets.

Using disaggregated quarterly trade data for Switzerland over 2004-2011, the third essay investigates the effectiveness of "natural hedging" of exchange rate risk by quantifying the effect of exchange rate movements on imported input prices and their role in the pass-through into export prices. The results indicate high exchange rate pass-through into imported input prices in all sectors implying that input costs fall when the CHF appreciates. On the export side, although exporters in many sectors are not able to pass on exchange rate shocks completely to foreign consumers, which results in reduced profit margins when the CHF appreciates, cheaper imported input prices at least partly offset these adverse developments. As a consequence, the empirical results imply that the use of imported inputs is an effective strategy to reduce exchange rate risks.

Zusammenfassung

Diese Doktorarbeit besteht aus drei Aufsätzen und untersucht den Effekt von negativen finanziellen Gegebenheiten wie Kreditrestriktionen oder einer überbewerteten Währung auf die Entwicklungsmöglichkeiten von Firmen.

Der erste und zweite Aufsatz analysiert, inwieweit Kreditrestriktionen in Entwicklungsländern ein Hindernis für Firmen darstellt, welche exportieren oder Kapitalgüter (z.B. Maschinen) importieren wollen. Die neue theoretisch hergeleitete Hypothese besagt, dass die Liquidität und Eigenkapitalausstattung von Firmen eine wichtigere Determinante der Export- und Importteilnahme in Ländern mit unterentwickelten Kreditmärkten ist. Der Entwicklungsgrad von Kreditmärkten wird anhand von Indikatoren des Ausmasses von Kreditorenrechten und Buchhaltungsvorschriften sowie der Effektivität der rechtlichen Durchsetzung von Kreditverträgen beurteilt. Die Resultate des ersten und zweiten Aufsatzes zeigen auf, dass finanzielle Restriktionen und die Vorteile der institutionellen Entwicklung des Kreditmarktes in besonderem Masse bei innovativen Firmen, die stark abhängig von externen Finanzierungsquellen sind, anzutreffen sind. Weiter wird gezeigt, dass vor allem erstmalige Exporteure und Importeure von Kreditmarktreformen und dem besseren Zugang zu externen Finanzierungsquellen profitieren. Die empirischen Ergebnisse bestätigen auch eine stärkere Ausprägung von Kreditrestriktionen bei innovativen Firmen, die noch keinen Handel betreiben und in Ländern mit unterentwickelten Kreditmärkten angesiedelt sind.

Mit detaillierten Quartalsdaten zu den Schweizer Handelsflüssen zwischen 2004 und 2011 untersucht der dritte Aufsatz "natural hedging" von Wechselkursrisiken, indem der Effekt von Wechselkursschwankungen auf die Preise der importierten Inputgütern quantifiziert und deren Rolle im Preissetzungverhalten von Exporteuren studiert wird. Die Resultate zeigen, dass die Wechselkursschwankungen in den meisten Sektoren stark auf die importierten Inputpreise übertragen werden. Die Preise der importierten Inputgüter fallen also, wenn der Franken aufwertet. Auf der Exportseite zeigen die Resultate, dass die Exporteure in vielen Sektoren die Wechselkursveränderung nicht vollständig auf ausländische Konsumenten überwälzen, was bei einer Aufwertung die Profite schmälert. Die günstigeren Importe der Inputgüter kompensieren aber zumindest teilweise die Profiteinbussen der Exporteure. Der Einsatz von importierten Vorleistungen scheint daher eine effektive Strategie der natürlichen Absicherung von Wechselkursrisiken zu sein.

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1 Introduction

This dissertation discusses whether adverse monetary conditions such as the restricted availability of external finance or an overvalued exchange rate preclude firms from prospering. It also examines whether there is a role for regulation to improve the market outcome in these cases.

The second and third chapter examine to what extent firm-level credit constraints in developing countries can be an obstacle for exporting activities and importing capital (i.e. machinery & equipment) or intermediate goods. This is an important topic because trading firms have been shown to be larger, more productive and pay higher wages than non-trading firms. Importing intermediate and capital goods may also increase firm productivity along with the likely positive externalities associated with adopting advanced technologies embedded in capital goods imports. Furthermore, existing evidence suggests that *ex ante* highly productive firms can fully exploit their growth potential in export markets after trade liberalizations, resulting in intra-industry reallocations that raise aggregate productivity (Melitz, 2003; Bernard et al., 2007). Credit constraints or limited access to external finance could, however, prevent efficient firms from selling their products abroad or importing capital goods, thereby limiting two channels through which international trade could promote economic growth in developing countries. Hence, the main policy concern is that the most efficient firms do not necessarily engage in trade and upgrade technology; however, less efficient, but financially wealthier firms gain an advantage over more efficient, but poorer firms. Consequently, due to a lower productivity growth, this would likely have repercussions on the inhabitants' living standards. In the theoretical framework used in this paper, credit constraints arise because of fixed costs that must be paid up-front and as a result of imperfect credit markets that lead to incomplete profit pledgeability. Empirically, the degree of a country's credit market imperfections is inferred from institutional indicators, such as a measure of creditor rights, a proxy for the efficiency of legal debt enforcement before court and an accounting standards indicator that reflects the availability of reliable balance-sheet information. In both chapters the novel hypothesis is that a firm's wealth, which is approximated by liquidity and leverage ratios, should become a stronger determinant of trade participation in countries with weaker credit market institutions. The theoretical explanation is that more often firms resort to internal liquidity for funding, and investors are on willing to lend if a firm can provide enough collateral in financially under-

developed countries.[1] In this framework we are therefore able to test whether and what kind of institutional development can help overcome firms' financing barriers with regard to the costs involved for exporting and importing capital goods.

While the empirical results of the second chapter confirm the importance of credit constraints for a firm's decision to export in the first place, export revenues of established exporters are not affected by limited access to finance. This is reflected in the fact that more liquid firms have a significantly higher export propensity, but a firm's liquidity ratio is not a determinant of export revenues. Similarly, a lower leverage ratio raises the export propensity of R&D intensive firms. Consistent with the main theoretical hypothesis, the marginal effect of a firm's liquidity ratio is stronger in countries with weaker credit market institutions. In addition, the results are driven by firms belonging to innovative (R&D intensive) sectors that rely heavily on external finance. This implies that this subset of potentially high-growth firms is more severely credit constrained and over proportionately benefits from the institutional development of the credit market. Other specifications reveal that credit constraints are higher when firms start exporting for the first time, which suggests that fixed entry costs are substantial. Overall, the results corroborate the idea that fixed costs of remaining or becoming an exporter constitute an important financing hurdle as opposed to variable (exporting) costs whose funding is often supported by export credit agencies and/or development banks.

A variety of policy implications follow from the empirical findings of the second chapter. The analysis indicates that adopting legal creditor rights that allow lenders to recoup their investments in case of firm bankruptcy increases the availability of external finance to cover the fixed exporting costs. This would help efficient firms that lack collateral or liquid assets enter a new export market permanently (i.e. extensive export margin) and would lead to a higher allocative efficiency. In this respect, a larger credit volume, higher accounting standards and a shorter duration of debt enforcement in the country also decrease credit constraints of would-be exporters. With regard to intensive export margin, credit constraints are found to be insignificant. Trade reforms that improve the export profitability are therefore more appropriate to raise firm export revenues than institutional development of the credit market.

To our knowledge, the third chapter is the first to provide evidence that legal creditor rights, faster debt enforcement and higher accounting standards lower credit constraints for adopting a productivity-enhancing technology embodied in capital imports. In addition,

[1] A firm's level of collateralizable assets is inversely related to the leverage (debt over total assets).

the analysis suggests that creditor rights must be complemented with an efficient legal debt enforcement, which is generally weak in developing countries, to be fully effective at facilitating access to external finance. Furthermore, the regression analysis in this chapter indicates that first-time and innovative firms particularly benefit from institutional development. Firms located in countries with stronger financial institutions also substitute capital goods imports for expenses on domestic machinery and equipment. However, we do not find that credit constraints matter for the decision to import intermediate goods or for the imported value of the capital goods (i.e. the intensive import margin). As firms in developing countries often lack specialized inputs for production, the absence of credit constraints for intermediate imports has important implications for policy. More specifically, cutting import tariffs for intermediate and capital goods is the appropriate policy choice when the aim is to increase the import value of intermediate and capital goods, while institutional development improves access to credit in order to sustain the fixed cost of technology upgrade.

The fourth chapter is motivated by the announcement of the Swiss National Bank (SNB) in August 2011 to not allow the CHF/Euro exchange rate to fall under 1.20. The main fear expressed by the SNB is that exporting firms cannot adjust quickly enough to the current situation to survive.[2] Thus, the fourth chapter studies whether the SNB's steady interventions in the currency market can be justified or explained by squeezed exporters' profit margins due to limited pricing power. From a theoretical viewpoint, Baldwin and Krugman (1989) argue that a large exchange rate shock - like the recent Swiss franc appreciation in the wake of the Euro crisis - can lead to exporters' exit decisions that are not reversed after the currency approaches its pre-crisis level. Meanwhile, this chapter argues that this topic can only be investigated if the response of intermediate input prices to exchange rate changes are also considered along with export price reactions. The hypothesis is that exporters use imported input goods as a natural means of hedging exchange rate risk, which would be especially relevant during a strong Swiss franc appreciation period. Hence, we are the first to study the reaction of disaggregated imported input prices to exchange rate movements and their role in the exporters' pricing decisions. The analysis suggests high pass-through rates into imported input prices implying that prices fall when the Swiss franc appreciates. Moreover, although exporters in many sectors are not able to pass on exchange rate shocks completely to foreign consumers, which results in reduced profit

[2]Of course, another related discussion would be whether the SNB's mandate entails the goal to protect domestic exporters by intervening in the currency market.

margins, cheaper imported input prices at least partly offset these adverse developments. As a consequence, imported input goods work as an effective strategy to reduce exchange rate risks. This important aspect has been neglected in the public discussion and calls the rationale for the ongoing SNB's interventions in the currency market into question. However, future research should also focus on extensive margin adjustments of the current Swiss franc overvaluation, that is, firms that exit the export market and products no longer exported, to evaluate more carefully the exchange rate policy of the SNB.

2 Credit Constraints, Firm Exports and Financial Development: Evidence from Developing Countries

Abstract

This paper examines whether financial development reduces the impact of credit constraints on the export probability and revenues using firm-level data across 18 developing countries. We approximate credit constraints by a firm's liquidity ratio. In line with a Melitz-type model with borrowing frictions, the regression analysis confirms that the positive effect of a firm's liquidity on the export probability is larger for firms located in financially less developed countries. This result highlights the importance of financial development in reducing credit constraints. The empirical results also suggest that financing obstacles and the benefits from better access to finance on the export decision are particularly high for firms belonging to innovative sectors dependent on external finance. With regard to the intensive export margin, credit constraints have no effect on export revenues for existing exporters. The paper concludes that financial reform acts primarily through firm selection (extensive margin) into export markets on comparative advantage patterns.

Keywords: international trade, financial development, credit constraints, export margins

JEL classification: F10, F12, F14, G20

2.1 Introduction

According to the World Bank Enterprise Surveys (WBES) conducted between 2002 and 2005 in 102 developing countries, about 30% of the respondent firms report access to finance as a major or very severe obstacle for the growth of their business. Even when credit is potentially available, for three-quarters of the firms participating in the survey it appears to be expensive or unaffordable. The limited access to external funds can thus constitute a hurdle for firms located in developing countries wishing to start, maintain or expand foreign activities. Simply put, credit constraints may prevent a firm from pursuing otherwise profitable export activities.

Complementary empirical studies dealing with the origins of comparative advantage have established that financial development promotes the expansion of industries relying heavily on external finance, intangible assets and R&D in export markets (Beck, 2003; Svaleryd and Vlachos, 2005; Hur et al., 2006; Manova, 2008a). A more efficient financial system in a country may therefore ease credit constraints and allow firms to profitably access foreign markets and increase export revenues. Apart from Manova (2008b), industry-level studies do not differentiate between extensive and intensive export margins when investigating the effect of financial development on international trade patterns as opposed to our study that uses firm-level data.[3] In a related study, Berman and Héricourt (2010) explore the interaction effect between financial development and credit constraints on the export margins at the firm-level. They find that a firm's liquidity and leverage ratio, which are used to proxy for credit constraints, become stronger determinants of export participation as a country's private credit to GDP ratio rises, while the hypothesis and results presented in this paper suggest the opposite effect.[4]

This paper hence investigates whether financial development reduces credit constraints and thereby facilitates profitable expansion in export markets at both margins for firms located in developing countries. The new hypothesis, derived from a Melitz-type model with borrowing frictions, is that a firm's internal liquidity should be a more important determinant of the export decision in countries with poor access to finance, especially in

[3]Manova's findings suggest that one third of the effect of a better financial infrastructure can be attributed to firm selection into export markets and two thirds to higher export revenues.

[4]We suspect that the higher variation in financial development in our country sample of the WBES database may explain this conflicting result. However, their more emphasized result is that poor access to finance can explain the imperfect correlation or disconnection between a firm's productivity and its export status often found in the literature. Second, they highlight that financial development only matters for the foreign entry decision and not for the probability of remaining an exporter.

external finance and R&D intensive industries. A firm wanting to export has to cover additional fixed exporting costs, increasing the likelihood of credit constraints. The fixed production and exporting costs must be incurred before realizing any sales revenues.[5] As a result, higher borrowing needs for potential exporters arise naturally in this framework.

The contribution of this paper is threefold: First, by taking into account a country's level of financial development, it provides an explanation for the conflicting results concerning the importance of credit constraints on export participation found in the literature.[6] Although the sample includes only developing countries, this study can exploit a fair amount of variation in the financial development indicators. Second, the paper does not restrict the analysis to the commonly used private credit to GDP measure of financial development, but also considers institutional aspects of the financial system, such as creditor rights, legal debt enforcement and accounting standards. These institutional aspects can be improved directly by legal reforms and regulations and have been shown to be positively related to the availability of external finance.[7] Third, the use of firm-level data allows to disentangle the potential impact of financial development and credit constraints on both margins of export adjustments, after controlling for other firm and country determinants of exporting.

The empirical findings confirm the theoretical predictions. The positive marginal effect of firms' liquidity on the export probability is larger in financially less developed countries. This result is mainly driven by external finance and R&D dependent sectors, which suggests that a reform in the financial sector decreases credit constraints, particularly for innovative firms. Although of a smaller magnitude, the liquidity effect remains significant when accounting for unobserved firm heterogeneity and past exporting experience in (dynamic) panel models. A likely explanation is that credit constraints are most binding for firms at the time of entry into a new export market when the fixed (sunk) exporting costs are highest. Regarding the intensive export margin, the results show that credit constraints do not affect the export revenues once a firm is already established in an export market. In sum, the results imply that financial development shapes international trade patterns mainly through the decision of innovative firms to export.

[5]Empirical evidence suggests that the fixed exporting cost is highly relevant for the export decision (Roberts and Tybout, 1997; Bernard and Jensen, 2004; Helpman et al., 2008). The fixed exporting costs include information gathering about profitability of the export project, product customization for the foreign market, setting up the local distribution network, compliance with foreign product rules, marketing research and advertising among others (Manova, 2009).

[6]For example, Greenaway et al. (2007) and Stiebale (2011) do not find a negative effect of credit constraints on export participation for UK and French firms, while credit constraints matter in developing countries as shown by Berman and Héricourt (2010), Egger and Kesina (2010) or Manova (2009).

[7]See Section 2.2.2 and 3.2.2 for more details.

2.2 Related Literature

This section highlights previous theoretical and empirical results closely related to the empirical methodology and contribution of our paper.

2.2.1 Inference on credit constraints

Modigliani and Miller (1958) provides the theoretical benchmark for the relationship between financing and investment decisions. They demonstrate that a firm's financial condition is irrelevant for the decision to invest when the credit market works perfectly. Only investment profitability matters in this case. Conversely, if credit market imperfections are an important factor, we should observe a correlation between the availability of internal funds and the investment volume even after controlling for a firm's growth opportunities. Empirical studies usually associate this correlation with credit constraints, which are not directly observed by the econometrician. A large empirical literature has found plenty of support in favor of a significant effect of firm-level credit constraints with regard to investment for many industrialized countries (see for instance, Fazzari and Petersen, 1988 and Greenaway et al., 2007 for a detailed review) and some developing countries (see Harrison and McMillan, 2003 and Héricourt and Poncet, 2009). Relatedly, this paper exploits the sensitivity of exporting to the availability of internal funds to infer the presence of credit constraints. While most studies on the relationship between credit constraints and exporting or investment use data from one country, this paper employs a firm-level sample across countries that varies along the dimension of financial sophistication. In this respect, it bears most similarity to Love (2003) who investigates the effect of financial development on investment expenditures. She reports that the marginal effect of the internal funds variable in the investment equation is lower in countries with better financial systems. Therefore, her result suggests that financial development decreases credit constraints.

2.2.2 Financial development[8]

This paper employs the credit volume extended from banks and other financial institutions to the private sector over GDP as an outcome-based measure of financial development. This

[8]In this thesis, financial development is defined to be higher in countries with a higher ratio of private credit to GDP, more legal creditor rights, faster enforcement of debt contracts before court and higher accounting standards. The term credit market institutions is used for legal creditor rights, enforcement of debt contracts, accounting standards and credit registries that offer information about a firm's credit history (see also Section 3.3.2 for more details).

measure is widely used and has the advantage of being available for most countries. One drawback is that it only captures the actual volume of credit from financial institutions, but it excludes non-bank credit such as debt financing on securities markets. In addition, the credit volume can neither be directly affected by policymakers nor would this be desired. In contrast, policymakers can create an institutional environment that promotes the potential availability of external finance. The literature dealing with the relationship between law and finance has shown that providing creditor rights, efficient debt enforcement and accounting standards improves access to external finance (see La Porta et al., 1997 and Djankov et al., 2007). Therefore, a country's financial development will also be proxied by indicators related to these three institutional aspects of the credit market, as described in more detail in Section 2.4.1.

2.2.3 Firm-level evidence on credit constraints and exports

This paper also contributes to the more recent firm-level studies that examine the link between credit constraints and exporting. For instance, Greenaway et al. (2007) show that the causality may run from exporting to financial health indicators using panel data of UK manufacturing firms over the period 1993-2003. Minetti and Zhu (2011) estimate the impact of self-reported credit rationing on firms' exporting decisions using survey data on Italian manufacturing firms. They find that after accounting for the endogeneity of rationing the effect is a huge 39% lower export probability for rationed firms.[9] In addition, the export sales of firms belonging to high-tech sectors and hence relying on external finance are particularly hampered by credit constraints. Using a sample of Chinese firm data, Manova et al. (2009) provide evidence that foreign owned firms and joint ventures have systematically higher export revenues than private domestic firms, and that this differential export performance is more pronounced in financially vulnerable industries. This is deduced from a variety of measures, for example, from the sectoral R&D intensity. In addition, the result found by Manova et al. (2009) hints at the importance of the foreign owner as a provider of liquidity to overcome financing obstacles. Gorodnichenko and Schnitzer (2010) investigate the complementarity between exporting and innovating in a cross-country firm-level sample of Eastern European countries and find that self-reported financial constraints severely restrain the ability of domestically owned firms to simultaneously pursue innovation and exporting. Stiebale (2011) studies the effect of financial

[9]They use measures of Italian regulation of the regional banking market as instruments for firm-level credit rationing.

strength indicators on foreign market entry in a panel of French firms and concludes that there may be unobserved firm characteristics that improve a firm's financial situation and enable it to enter an export market. Finally, Egger and Kesina (2010) find that the positive relationship between a firm's financial health and both export margins holds in a sample of Chinese firms. In contrast to this essay, none of these studies exploits the cross-country variation of financial development that may affect firm-level credit constraints.

2.3 Theoretical Motivation

This section develops a two-country monopolistic competition model of the export propensity to motivate the idea that would-be exporters can be constrained by the scarce availability of credit. The two countries equal in all respects apart from the level of financial development. Firms within a country differ stochastically in their productivities φ and in the availability of internal funds ω, similar to Chaney (2005). The first condition to be met to export requires that a firm draws a sufficient level of productivity in order to generate enough operating profits to cover the fixed exporting cost, as in Melitz (2003). In addition to Melitz (2003)-type models without credit constraints, firms with intermediate levels of productivity may have to tap internal funds to pay up-front the fixed production and exporting cost as a result of the limited pledgeability of future operating profits. Besides firm productivity, internal funds in this framework thus represent another determinant of export participation that is particularly relevant for firms located in the less financially developed country.

Demand Side

Consumers at home and abroad allocate their budget among a continuum of differentiated goods $q(i)$. They exhibit CES Dixit & Stiglitz preferences over the differentiated goods.[10] These preferences deliver the following revenue function $r_d(i) = EP^{\sigma-1}p_d(i)^{1-\sigma}$ for each variety i supplied to the domestic market, where $p_d(i)$ is the price of variety i in the domestic market, $P = \left[\int_0^N p(i)di\right]^{\frac{1}{1-\sigma}}$ represents the (ideal) price index in a closed economy, N denotes the number of existing varieties and E corresponds to aggregate spending for the differentiated goods in both countries.

[10] The CES Dixit & Stiglitz consumer preferences are represented as $U = \left(\int_0^N q(i)^\rho di\right)^{\frac{1}{\rho}}$, with a constant elasticity of substitution $\sigma = 1/(1-\rho) > 1$, between any two varieties i within and across industries, to simplify matters.

Supply Side

Labor is the only factor of production and treated as the numeraire good. Thus, the wage rate is normalized to one across countries.[11] A single firm in a continuum of firms is considered to produce a differentiated good under increasing return to scale. The production technology for every variety i, manufactured each by a single firm, involves a constant marginal cost $1/\varphi$ that depends on firm productivity φ and a fixed cost f, both measured in labor units. The total labor needed to produce $q(\varphi)$ units of variety i is as follows:

$$l(\varphi) = f + \frac{q(\varphi)}{\varphi} \tag{1}$$

Firm Profits (Optimal Pricing)

Given CES preferences for the differentiated good, the optimal price is a constant markup over marginal costs. Hence, a firm with productivity φ charges the price $p_d(\varphi) = \frac{1}{\rho\varphi}$ for the domestic market and a higher price $p_x = \tau p_d$ for the export market.

Credit Constraints

Credit constraints are introduced in the simplest and most general way, as in Matsuyama (2005). As a consequence of imperfections in financial contracting and enforcement, a firm can only credibly pledge up to a fraction $\theta \in [0, 1]$ of operating profits. Equivalently, this fraction corresponds to the maximum amount the firm can borrow to finance the fixed production and exporting cost, f and f_x, the remaining part must be funded through internal funds.[12]

Matsuyama (2005) points out that several agency costs explanations can justify the assumption of limited profit pledgeability. For instance, in the moral hazard approach as laid out in Tirole (2006) and applied to trade theory by Egger and Keuschnigg (2009) a high enough profit share must be conceded to a borrower in order to avoid the entrepreneur's appropriation of private benefits from the investment. Assuming that the scope for private benefits is positively related to the level of (expected) operating profits would then naturally lead to an incomplete pledgeability of future operating profits in order to meet the

[11] Although the equality of wages across countries is unlikely to hold in our heterogenous sample, this assumption facilitates the derivation and the intuition of the theoretical hypotheses. However, wage differences across countries and sectors are considered by means of fixed effects in the empirical part.

[12] It is also possible to interpret θ without resorting to limited profit pledgeability but as a parsimonious way to incorporate the cost of external finance. In this case, the θ parameter represents the discount factor of expected operating profits: $\theta = \frac{1}{1+r}$, where r denotes the risk-adjusted interest rate demanded by financial investors.

firm's incentive compatibility constraint (see Appendix 2.9.1 for a derivation of θ and the following credit constraint condition 3).

Measures of financial development, such as creditors legal rights, the quality of debt enforcement and accounting standards, capture θ since these institutions restrain the ability of entrepreneurs to extract private benefits. As a consequence, tougher institutions increase profit pledgeability (θ goes up) and thus the availability of external funds. Therefore, we also refer to θ as the *financial development* parameter in accordance to Matsuyama (2005). This despite the fact that profit pledgeability and financial development are not perfectly correlated and the former might also change for other reasons than financial development.[13]

In this respect, profit pledgeability θ may not only be country-specific but also sector-specific. For instance, R&D intensive sectors are more likely to be credit constrained as evidence shows.[14] A potential explanation is that innovative firms are more prone to managerial misbehavior due to higher informational asymmetries (θ goes down) (Himmelberg and Petersen, 1994). Furthermore, R&D intensive firms use relatively more intangible assets such as human capital and specialized machinery that have a low resale value in case of firm default (Drakos and Giannakopoulos, 2008). In addition, these innovative sectors often correspond to the set of industries that rely inherently more on external funding because of higher investment opportunities, as highlighted by Egger and Keuschnigg (2010). Both lower profit pledgeability and higher external finance requirements result in more severe credit constraints for innovative firms.[15]

In perfect capital markets, a firm's financial situation should not matter for the export decision. In contrast, when profit pledgeability is limited, the availability of firm internal funds ω becomes crucial.

Exporting

After drawing its level of productivity φ and internal funds ω, a firm decides simultaneously whether to supply the domestic and the export market. If it enters the foreign market, on top of the domestic one, it must incur an additional fixed exporting cost f_x and an iceberg trade cost τ, such that $\tau > 1$ of each good must be shipped in order for one good to reach the export destination. Because of the usual assumption $\tau^{\sigma-1} f_x > f$ made in Melitz (2003)-type models, the cut-off productivity level for exporting profitably φ_x is

[13] I thank Peter Egger for this important remark.

[14] see Section 2.5.1 for more details also on the corresponding literature.

[15] These sector-specific components of profit pledgeability θ and external finance requirements can be exploited for the identification of credit constraints as argued in Section 2.5.1.

higher than the productivity threshold to earn nonnegative profits in the domestic market φ^*, which is implicitly defined by the following zero profit condition: $\frac{r_d(\varphi^*)}{\sigma} = f$. In addition, an exporting firm must not only be profitable in the export market, but must also overcome potential financing obstacles. Only firms that meet the following export profitability condition (2) and the credit constraint condition (3) will therefore become exporters:

$$\tau^{1-\sigma}\frac{1}{\sigma}E(P\rho)^{\sigma-1}(\varphi)^{\sigma-1} \geq f_x \tag{2}$$

$$\theta\left[\frac{1}{\sigma}(1+\tau^{1-\sigma})r_d(\varphi)\right] \geq f + f_x - \omega \tag{3}$$

Putting the above equations into words, the export profitability condition (2) states that the operating profits in the export market must be greater than the fixed exporting cost in order to accrue positive export profits. Hence, we obtain the minimum level of productivity required to profitably export φ_x by solving (2) for productivity; $\varphi_x = \frac{\tau}{P\rho}\left(\frac{\sigma f_x}{E}\right)^{\frac{1}{\sigma-1}}$. Similarly, solving the credit constraint condition (3) for productivity yields the cutoff firm productivity demanded by investors to grant the external finance needed to cover the difference between fixed production and exporting cost and the available internal funds (right hand side of 3):

$$\overline{\varphi}_x(\omega,\theta) = \frac{1}{P\rho}\left(\frac{\sigma(f+f_x-\omega)}{\theta E(1+\tau^{1-\sigma})}\right)^{\frac{1}{\sigma-1}} \tag{4}$$

Only firms that draw a firm productivity at least as high as $\varphi \geq max\left[\varphi_x, \bar{\varphi}_x(\omega,\theta)\right]$ are able to export profitably and secure access to finance.[16] This article however focuses on the subset of firms in the productivity range $\overline{\varphi}_x(\omega,\theta) > \varphi \geq \varphi_x$ that are prevented from pursuing profitable exporting activities because they lack the required external finance. Whether this is the case for a specific firm also depends on the interaction between the available amount of internal funds and the level of financial development θ according to (2) and (3) (see also the Appendix 2.9.2 for a derivation of the conditions under which

[16]The corresponding minimum productivity to secure finance for the domestic market entry is obtained by solving the condition $\theta\left[\frac{1}{\sigma}r_d(\varphi)\right] = f - \omega$ for productivity: $\overline{\varphi}(\omega,\theta) = \frac{1}{P\rho}\left(\frac{\sigma(f-w)}{\theta\mu E}\right)^{\frac{1}{\sigma-1}}$. It is clear that $\overline{\varphi}_x > \overline{\varphi}$ holds; that is, credit constraints become tighter for potential exporters relative to firms that only serve the home market. Intuitively, the additional fixed exporting and trade cost make the financing task more difficult to accomplish.

this subset of firms is non-empty). Let $\pi_{xi}(\varphi_i) = \frac{1}{\sigma}(1+\tau^{1-\sigma})r_d(\varphi_i)$ represent the overall operating profits generated at home and abroad for a firm i that would also export. We can then reformulate the credit constraint condition (3) as a linear expectation given firm productivity φ_i, the amount of internal funds ω_i, and the level of financial development θ:

$$E(\pi_{xi}(\varphi_i) \geq \frac{1}{\theta}(f + f_x - \omega_i) \mid \varphi_i, \omega_i) = \frac{1}{\sigma}(1+\tau^{1-\sigma})r_d(\varphi_i) + \frac{1}{\theta}(\omega_i - f - f_x) \tag{5}$$

In light of equation (5), a higher firm productivity φ_i directly increases the level of operating profits and thus alleviates credit constraints through this channel. In this model setup, the availability of internal funds is exogenous and is positively related to the credit constraint condition (5) not being binding. Importantly, this will be especially true for firms based in the financially underdeveloped country. Formally, the interaction effect between internal funds and financial development on the expectation (5) is the following cross partial derivative:

$$\frac{\partial^2 E(\pi_{xi}(\varphi_i) \geq \frac{1}{\theta}(f + f_x - \omega_i))}{\partial\omega\partial\theta} = -\frac{1}{\theta^2} \leq 0, \quad \theta \in [0,1] \tag{6}$$

The interaction effect (6) implies that the the impact of the availability of firms' liquid assets ω on meeting the financing constraint (3) is decreasing in the efficiency of the credit market θ or zero if the credit constraint condition (3) is not binding.

Hypothesis 1: *The positive effect of a marginal increase in the availability of internal funds on the likelihood of firm exporting (i.e. the extensive export margin) is greater in financially underdeveloped countries.*

Hypothesis 1 summarizes the interaction effect between financial development and firm liquidity. An underdeveloped financial system leads to a low profit pledgeability θ. As a result, firms find it more difficult to access external finance, and an increase in internal funds will more likely have a significant impact on export participation via the credit constraint condition (3) and (5).

The Intensive Import Margin

In reality, not only parts of the fixed costs but also a fraction of the variable costs involved with exporting are likely be funded externally.[17] Therefore, credit constraints may also affect the intensive export margin. According to Hubbard (1998), credit constraints arise

[17] In our previous model only the fixed costs of exporting are affected by financing constraints.

when the cost of external finance is higher than the (opportunity) cost of internal funds. This possibly reflects agency costs related to moral hazard or adverse selection.[18] Similarly to the previous model, the cost premium of using external funds rather than internal ones is likely to be a function of the level of financial development where the exporting firm is located. On the contrary, it could also be reasonably argued that agency costs do not play a major role in financial contracts regarding the funding of the variable exporting costs since the export goods may provide a natural collateral. In addition, export credit agencies in developing countries do often provide cheap credit to firms or take on part of the risk associated with trade financing of financial intermediaries. Finally, the variable trade costs are smaller than the fixed costs, which most likely makes credit constraints less of an issue for the intensive margin. We therefore hypothesize that credit constraints and financial development have a smaller impact on the intensive export margin.

Hypothesis 2: *A marginal increase in the availability of internal funds has a smaller effect on export revenues than on the export probability. If the effect is positive, it will be stronger in financially underdeveloped countries. Furthermore, the beneficial effect of financial development on export revenues (i.e. intensive margin) will be less pronounced than on the export probability (i.e. extensive margin).*

2.4 Data and Descriptive Statistics

2.4.1 Firm-level and financial development data

This paper uses the standardized firm-level data collected by the World Bank's Enterprise Surveys in the period between 2002 and 2005 to test the above described hypotheses.[19] The surveys employ a stratified sampling methodology in order to generate a representative sample of a country's sectoral composition of the non-agricultural economy. In addition, firm size and geographic locations within countries are used as complementary stratifying variables.[20] Within each strata, the firms are chosen randomly. Consequently, the applied sampling methodology leads to an oversampling of larger firms. This may result in biased results because credit constraints could be less severe among larger firms. However, sensitivity tests indicate that the main results hold across subsamples that are split according

[18] In trade models, it is implicitly assumed that fixed and variable costs can be financed entirely from internal funds and/or without incurring additional costs when resorting to external finance.

[19] The covered survey years differ across countries in the data sample.

[20] Information about the sampling methodology were taken from material available at www.enterprisesurveys.org.

to median firm size.[21] The data includes all of the necessary information to construct the firms' financial indicators, the productivity measures and the additional firm level control variables required for the regression analysis. Since the domain of the theory applies primarily to firms without privileged access to funding, the sample is restricted to privately owned manufacturing firms. Furthermore, firms that report an inconsistent liquid over total assets ratio above one are also dropped from the sample. Applying these two selection rules and considering only firms with information about their export behavior and financial situation, leaves us with a sample of 9072 firms from 18 developing countries listed in Table 1. Overall, the selection rules reduce the sample by about 7%. Table 1 also displays the share of firms that are dropped in each country because of employed selection criteria. In this respect, robustness checks suggest that the main conclusions are not affected by the inclusion of state-owned firms, but estimations become imprecise if firms are included that report inconsistent liquidity ratios exceeding unity.[22] In addition, the findings do not hinge on a particular country in the sample, as detailed in Section 2.7.4. The main determinant of the country sample was the availability of balance-sheet information needed for generating the credit constraints variables. Moreover, the sizable differences in the number of firms included in each country predominantly stems from the sampling methodology which is designated to replicate an economy with a relatively small number of observations. Firm selection based on the availability of balance-sheet information could increase the possibility that our sample is biased towards more established and/or larger firms.[23] As a result, a significant impact of credit constraints in our sample should reinforce the notion of access to finance as an important determinant of the export decision. Finally, the firms included in the sample are located mostly in lower-middle income countries from Asia, Africa, Central and South America. Therefore, apart from possible biases discussed before, our firm-level sample is likely to be representative of firms based in countries that are in early to middle stages of economic development.

The paper employs several proxies for a country's level of financial development (see Table 1). First, the conventional outcome-based measure *Private credit* is used, which is defined as the credit volume from banks and other financial institutions extended to the domestic sector over GDP taken from Beck et al. (2009). A further indicator is *Creditor rights.*

[21] Results are available upon request.

[22] Results are available upon request.

[23] Consistent with this interpretation is the relatively high proportion of exporting firms in the sample (see Table 2) compared to the firm exporting share observed in other firm-level studies such Bernard et al. (2007) or Mayer and Ottaviano (2008).

Table 1: Country sample coverage and financial development indicators

				Financial Development			
Country	No. of firms	% of total firms	% of firms dropped	Creditor rights	Private credit	Enforcement days	Accounting standards
Bangladesh	25	0.28	0		0.25	5.90	
Brazil	1524	16.80	0.9	1	0.30	6.34	56
Ecuador	285	3.14	3.72	0	0.30	5.96	
El Salvador	362	3.99	2.69	3	0.43	5.62	
Ethiopia	2	0.02	50	3		6.04	
Guatemala	453	4.99	0.44	1	0.21	7.29	
Honduras	407	4.49	0.73	2	0.36	6.30	
India	505	5.57	4	2	0.28	6.05	61
Indonesia	465	5.13	11.1	2	0.21	6.35	
Malawi	131	1.44	6.43	2.2	0.08	5.62	
Nicaragua	421	4.64	2.33	4		5.04	
Pakistan	919	10.13	1.08	1	0.22	5.98	73
Peru	29	0.32	0	0	0.25	6.09	38
Philippines	609	6.71	5	1	0.40	5.94	64
South Africa	516	5.69	4.26	3	1.24	5.62	79
Sri Lanka	336	3.70	16	2	0.27	6.09	74
Thailand	1347	14.85	1.68	2	1.10	5.97	66
Vietnam	736	8.11	35.27	1	0.34	6.00	
Total	9072	100	7.1				
Mean				1.79	0.39	6.01	62

It is an index ranging from 0 (weak creditor rights) to 4 (strong creditor rights) drawn from Djankov et al. (2007) and is intended to capture the investor protection dimension of financial development.[24] More specifically, it can be interpreted as a measure of a creditor's legal power to recoup her investment in a defaulting firm. The more creditor rights are provided, the higher the investment probability should be in the first place. The variable *Enforcement days* also comes from Djankov et al. (2007) and is measured by the log number of days it takes to enforce an unhonored debt contract worth 50% of the country's GDP per capita, constructed as of January 2003. This measure reflects the important legal enforcement dimension of financial development. Even in countries with strong creditor rights, investors may be reluctant to lend money because of slow contract enforcement in the case of a firm bankruptcy. The last financial development variable employed is the *Accounting standards* indicator from the Center for International Financial Analysis and Research (CIFAR) for the year 1995.[25] It is a proxy for the transparency of a firm's financial disclosure in a country or, more generally, for a country's corporate governance standards. Stated differently, the reduction of informational asymmetries between lenders and borrowers as a result of better accounting standards is likely to increase the probability of obtaining credit.

2.4.2 Firm characteristics

Liquidity ratio is the variable used to detect credit constraints at the firm level, which can be viewed as the empirical counterpart of the liquid assets variable ω in the conditions (3) and (5). It is defined as current over total assets and reflects a firm's availability of internal funds. [26] [27] Current assets can be liquidated within a short period and used for financing purposes (see also Tirole, 2006). A firm with a high liquidity ratio ω requires less external finance and therefore has a lower probability of hitting the credit constraint condition (3). Furthermore, this paper includes the *Leverage,* specified as total debt over assets, mainly

[24]Both indicators *Private credit* and *Creditor rights* are averaged over the period 1999-2003

[25]The accounting standards indicator changes very slowly over time, as shown by Rajan and Zingales (1998) and Manova (2008b), so the ranking between countries in this indicator is very unlikely to be different for the sample period. Furthermore, it is of high quality and accurate as argued by Hope (2003) and is the only indicator that is available for 8 countries in the sample.

[26]This ratio takes into account that the availability of internal funds should be assessed in relation to the size of the firm.

[27]The liquidity ratio has been widely used as a financial health indicator in studies dealing with credit constraints and exporting (see for instance Greenaway et al., 2007; Berman and Héricourt, 2010; Bas and Berthou, 2011a)

as a control variable related to credit constraints.[28] In Section 2.7.4, we also employ the firm's leverage as an alternative inverse measure of the firm's assets variable ω (see also the equations 3 and 5). The higher the leverage, the lower the amount of collateral a firm can provide is. As a consequence, a more indebted firm should be less likely to obtain credit.

More productive firms set lower prices which result in larger domestic and foreign operating profits; thus, these firms are more profitable in the foreign market and less likely to be credit constrained. As a measure of productivity *(Log productivity),* the log value added per worker is considered. To capture additional aspects of a firm that the empirical and theoretical literature on firm exporting have shown to be important the following variables are also included in all specifications: the firm size proxy *Log employment* (the log number of employees), *Log capital intensity* measured by the logarithm of total assets per worker and the dummy variable *Foreign*, which equals one for foreign-owned firms and zero otherwise.

Table 2 displays the descriptive statistics of all firm characteristics. In line with the literature on the export determinants, exporters are bigger, more productive, employ a better educated workforce and CEO, are technologically more advanced, use a higher share of foreign inputs and are more likely to be foreign-owned. Somewhat surprisingly, the production of exporters seem to be less capital- and skill-intensive. As the sample consists of developing countries only, this result could be explained by Heckscher-Ohlin forces at play. Finally, exporters on average have a statistically significant higher liquidity ratio than non-exporters, whereas there is no difference between exporters and non-exporters with regard to the leverage.

(For a more detailed description of firm characteristics, financial development indicators and country characteristics as well as their data sources see the Appendix 2.9.3)

[28] However, it is a priori not clear whether a higher leverage indicates better or poorer access to finance. While more levered firms may face larger external financing costs or limited access to finance in the future, for instance, because of a rise in the risk of default or more severe incentive problems due to less collateralizable assets, at least in the past they have received substantial funding from outside investors (see also Bellone et al., 2010 and Stiebale, 2011).

Table 2: Descriptive statistics of firm characteristics

	Non-exporters	Exporters	Mean equality t-test
Number of firms (n=9072)	5330	3742	
Liquidity ratio	0.46	0.52	-10.19***
	(0.28)	(0.25)	
Leverage	0.48	0.57	-1.14
	(4.41)	(0.77)	
Log productivity	1.65	2.30	-18.98***
	(1.36)	(1.38)	
Log employment	3.40	4.94	-55.15***
	(1.16)	(1.48)	
Log capital intensity	3.00	2.85	2.79***
	(2.87)	(2.07)	
Foreign	0.03	0.20	-26.79***
	(0.18)	(0.40)	
Foreign input share	16.40	32.32	-21.48***
	(30.51)	(37.88)	
New technology	0.77	0.81	-4.13***
	(0.42)	(0.40)	
share of workforce with university degree	12.77	17.78	-9.78***
	(19.34)	(22.08)	
CEO graduate degree	0.14	0.20	-7.34***
	(0.35)	(0.40)	
skilled share of production workers	0.51	0.45	7.50***
	(0.38)	(0.38)	

Notes: Mean values of firm characteristics are reported by export status and the t-statistics of the mean equality test. Significance levels: ***p<0.01, **p<0.05, *p<0.1. Standard deviations in parentheses.

2.5 Empirical Methodology

2.5.1 The extensive export margin

This section develops a binary outcome model of the exporting decision. The dependent variable Exp_{ict} takes on the value one for an exporter and zero for a non-exporter. The decision to export is modeled as a function of the not directly observed export profitability and credit constraints, and it can be interpreted as a firm's export probability as customary in a binary choice model. From Section 2.3 we know that export profits and credit constraints are related to firm productivity, the availability of internal funds and financial development according to the conditions (2) and (3). Consequently, we specify the probability that a firm i exports at time t in country c as follows:

$$\begin{aligned} Pr(Exp_{ict} = 1) &= Pr(\alpha + \beta\varphi_{ict-1} + (\gamma_1 + \gamma_2\theta_c)\omega_{ict-1} + \delta Z + \lambda_c + \nu_k + \mu_{ck} + \eta_t + \varepsilon_{ict} > 0) \\ &= \Lambda(\alpha + \beta\varphi_{ict-1} + (\gamma_1 + \gamma_2\theta_c)\omega_{ict-1} + \delta Z + \lambda_c + \nu_k + \mu_{ck} + \eta_t), \end{aligned} \tag{7}$$

where $\Lambda(..)$ represents the standard normal distribution function which results in a probit model. φ_{ict-1} is a measure of firm productivity defined as the log value added per worker, ω_{ict-1} captures firms' availability of internal funds and is approximated by the liquidity ratio, and θ_c denotes the country-level measure of financial development. Z is a vector containing other firm characteristics (see also Section 2.4.2). All regressions include interactions between a country and a sector μ_{ck} and their main effects, λ_c, ν_k. The country dummy λ_c soaks up the non-interacted effect of financial development and other country characteristics affecting the export probability. The sectoral dummy ν_k captures differences in relative prices that may result from differing sectoral factor prices or demand conditions, whereas the country-sector dummy μ_{ck} is intended to pick up export determinants at the country and industry level, such as Heckscher-Ohlin determinants of trade, the differential impact of a country's institutions across industries and sectoral (export) subsidies and exchange rate pass-through rates, among others.[29] The time fixed effect η_t absorbs changes in the global economic environment that have a similar effect across all firms in the sample, for instance the state of the world business cycle. Hypothesis 1 predicts that the expected positive impact of a firm's internal funds on the export participation decision is decreasing with the level of financial development. This hypothesis translates into the following

[29] The analysis contains 36 sectoral dummies at the three- and four-digit ISIC level.

predictions about our coefficients of interest: $\gamma_1 > 0$ and $\gamma_2 < 0$ for the private credit, creditor rights and accounting standards indicators. For the enforcement indicator, we expect the opposite sign, $\gamma_2 > 0$, since slower enforcement should make a firm's liquidity more important.

To circumvent concerns about reverse causality, the liquidity ratio and all other firm characteristics are lagged one year. However, the liquidity ratio may still potentially suffer from endogeneity due to omitted or unobserved firm characteristics and dependence on past export status.[30] To identify the effect of credit constraints specification (7) is estimated in two firm subsamples.[31] The strategy consists of dividing the sample into a group of firms that faces a high probability of being credit constrained, and into a second group for which the availability of external finance is less likely to constitute a problem. The a priori division is made along exogenous or technologically driven sectoral characteristics, such as the external financial dependence measure proposed by Rajan and Zingales (1998) or a R&D intensity index. Both measures are calculated from the median US-firm within a three- or four-digit ISIC sector and taken from Kroszner et al. (2007).[32] In terms of the theory from Section 2.3, R&D intensive firms can pledge a lower fraction θ of profits, reflecting their inherently riskier nature and opacity for investors, while for firms relying more on external finance the right-hand side of condition (3), the required amount of borrowing $f + f_x - \omega$, rises. Empirical studies lend support to the argument that R&D and external finance intensive sectors have a higher probability of being credit constrained. Rajan and Zingales (1998) and Freitas (2004) show that financial development predominantly promotes sectors that are dependent on R&D and external finance. Using firm-level panel data, Himmelberg and Petersen (1994) and Carpenter and Petersen (2002) provide evidence that high-tech companies receive little debt financing and must rely on internal funds and new equity to finance R&D activities. Moreover, a regression of a self-perceived credit constraints measure on our sectoral R&D intensity index yields a positive coefficient of 0.49, which is significant at the 5%-level for the R&D variable, after controlling for

[30]The high persistence in the export status may be attributed to high sunk costs (Roberts and Tybout, 1997; Bernard and Jensen, 2004)

[31]This has been done similarly in recent related trade papers such as Manova et al. (2009), Berman and Héricourt (2010) and Minetti and Zhu (2011).

[32]External finance dependence is defined as capital expenditures minus cash-flow from operations over capital expenditures. R&D intensity is specified as R&D expenditures over total sales. These measures are calculated from the median US-firm within a ISIC sector because capital markets are assumed to be relatively frictionless in the US. Therefore, the measures are more likely to capture the technologically (or exogenously) driven demand for R&D and capital investments. Importantly, these measures are not correlated with our firm financial variables and financial development indicators.

sectoral financial dependence and country differences by fixed effects. Thus, in our sample firms belonging to R&D intensive sectors perceive credit constraints to be higher.[33] [34]As a result, it is expected that hypothesis 1 is empirically more strongly supported in the group of external finance or R&D intensive firms (above sample median level) than in the second group (below sample median level).[35] In this case, an (absolute) amplification of the coefficients γ_1 and γ_2 in the first group - in terms of magnitude and significance - would support the view of financial development as a means for reducing credit constraints and promoting exporting.

The presence of time-invariant unobserved firm heterogeneity such as entrepreneurial ability, product quality and corporate strategy, are likely to be important determinants of the exporting decision and correlated with included firm characteristics. For instance, the productivity proxy used is unlikely to capture all aspects related to firm productivity and future export profitability. Thus, unobserved firm characteristics may improve a firm's liquidity situation and increase the export probability simultaneously. Fortunately, the data allow for retrospective questions to construct a short three-year panel and also to estimate specification (8) with a linear probability model with fixed effects.[36] The one year lagged export status will be included in a dynamic panel specification of (7) with fixed effects estimated in the GMM setting proposed by Arellano and Bond (1991). Following the empirical work of Roberts and Tybout (1997) and Bernard and Jensen (2004), a significant positive effect of the export history should reflect export hysteresis due to a higher sunk exporting cost at the first-time entry into a foreign market compared to the fixed exporting cost later. Omitting the past export status may therefore bias the estimated effect of credit constraints because of a possible contemporaneous correlation between export status and a

[33]The measure for self-perceived credit constraints ranges from zero (no problem) to four (very severe obstacle) according to responses to the following question; *"How problematic for the operation and growth of the firm's business is access to financing?"* See also Section 3.8.1 for more details.

[34]Performing an ordered probit regression instead of OLS in a linear model does not alter the result qualitatively.

[35]The basic premise that allows this strategy to work is that an endogeneity bias of the liquidity ratio must be distributed in a similar way across all firms, independently of the group classification (see also Bond and Van Reenen, 2007). This is likely to be satisfied - as also argued by Berman and Héricourt (2010).

[36]The fact that there are too few firms switching export status and contributing to the likelihood function prevents us from estimating a logit model with fixed effects. The panel specification will therefore be estimated as a linear probability model despite its well-known odd characteristics. In particular, the estimated probabilities may take on values outside the (0,1)-range. A linear probability model may, however, still provide a consistent and good estimate of the average marginal effects and is computationally simple (Wooldridge, 2002).

firm's liquidity.[37] Similarly, exporters may have privileged access to credit markets making credit constraints less binding. And not insignificantly, the Arellano-Bond GMM estimation also allows for instrumenting the first-differences of firm characteristics (particularly the liquidity ratio) by their lagged values to address their potential endogeneity.

2.5.2 The intensive export margin

To investigate the adjustment of the intensive export margin to changes in the availability of internal funds across countries with different levels of financial development, the following linear equation is estimated:

$$Log(y_{ict}) = \alpha + \beta\varphi_{ict-1} + (\gamma_1^{'} + \gamma_2^{'}\theta_c)\omega_{ict-1} + \delta Z + \lambda_c + \nu_k + \mu_{ck} + \eta_t + \varepsilon_{ict}, \qquad (8)$$

where $Log(y_{ict})$ is the logarithm of export revenues which replaces the binary (0,1)-export status variable from specification (7). The right hand side of equation (8) remains identical to specification (7), described thoroughly in the previous Section 2.5.1. Hypothesis 2 argues that credit constraints and the effect of financial development is less pronounced for the export revenues of established exporters. This subset of existing exporters can be viewed as a sort of control group with lower exporting costs as opposed to potential exporters. Therefore, $\gamma_1 > \gamma_1^{'} \geq 0$ and $\gamma_2 < \gamma_2^{'} \leq 0$ is expected. In addition, more productive firms are expected to have larger export revenues $\beta > 0$, as usual in a Melitz-type model setup.

The estimation of the linearly specified model (8) for the intensive margin proceeds in several steps. It will first be estimated by OLS to obtain benchmark estimates. These results will be compared to 2SLS estimates accounting for the potential endogeneity of the liquidity ratio and the interaction term. Instruments are *Liquidity ratio(t-3)*, the *Liquidity ratio(t-2)* interacted with financial development, the log of firm age and the interaction between financial development and the sectoral liquidity needs variable taken from Raddatz (2006). Liquidity needs is calculated for the median US firm within a three- or four-digit ISIC sector as the value of inventory over sales, and it should capture the exogenous or product-specific driven part of a firm's liquidity ratio according to Raddatz (2006). Then, a split-sample analysis will be performed in above and below median levels of external finance dependence. In the next step, a Heckman selection model addresses the potential bias due to a non-random firm selection into export markets. The identification of the

[37] This would bias the estimates upward.

Heckman-model relies on the firms' perceptions of the severity of some business constraints that are assumed to affect the fixed production and exporting cost and, consequently, the extensive export margin alone (see also Helpman et al., 2008). Specifically, the dummy variables "access to land" and "customs and trade regulations", which equal one when these constraints are perceived as severe or major obstacles, are included in the first-step probit estimation of the selection model but excluded in the second stage OLS estimation of equation (8) augmented by the Heckman's lambda ("the inverse mill's ratio"). Unfortunately, a panel estimation of (8) that controls for firm fixed effects is not feasible since data including information about export revenues for a firm over time is missing.

2.6 Results

2.6.1 The extensive export margin

Table 3 reports the results of the empirical model (7) using the financial development measures described in Section 2.4.1. All estimated marginal effects have the expected signs. Productivity, firm size, capital intensity and foreign ownership are all highly significant and exert a positive impact on the propensity to export. Apart from column 2, more liquid firms have a significantly higher export probability suggesting that credit constraints play a non-negligible role in the export decision. In line with hypothesis 1, the effect of the availability of liquid funds on the export propensity is higher in countries with fewer creditor rights, slower enforcement of financial contracts and poorer accounting standards - as indicated by the negative interaction terms (columns 1,3 and 4). All of the interaction coefficients are significant at least at the 5%-level. The liquidity ratio and its interaction with private credit over GDP both enter with expected signs, but they are not statistically significant in the second column.

We ultimately want to assess the quantitative effect of a change in the liquidity ratio on the export probability, which in turn depends on a country's level of financial development. Therefore, Figure 1 depicts the marginal effect of the liquidity ratio as a function of the creditor rights index (from column 1 of Table 3). All marginal effects of the liquidity ratio are multiplied by its sample standard deviation of 0.27 to obtain the effect of a change in one standard deviation. According to Figure 1, these marginal effects are strictly decreasing in the creditor rights index, as predicted in hypothesis 1. For instance, the effect of a standard deviation increase in the liquidity ratio for a firm in a country with a creditor rights index of zero is 3.7 percentage points. Given an average export probability of about 0.44, this would amount to a considerable 8.3% increase in the average export probability. The effect of liquidity is as strong as firm productivity when creditor rights are absent. In a country with a creditor rights index of 1, this effect is substantially reduced and becomes less than half as strong. Interestingly, the marginal effect is already zero for firms located in countries with an index value zero of 2 and turns negative after that.

Table 4 presents the results of the estimation of the empirical model (7). It is now performed in subsamples split along the sample median of the external finance dependence indicator. In the subsample of external finance dependent firms the sensitivity of the export propensity to the liquidity ratio and the beneficial effect of financial development is much larger than for firms not relying on external finance. This can be seen from the amplified magnitude

Table 3: Credit constraints and the export probability

Dependent variable	Pr(Exp=1)			
	(1)	(2)	(3)	(4)
Log productivity(t-1)	0.0649***	0.0632***	0.0632***	0.0823***
	(0.0127)	(0.0135)	(0.0128)	(0.0176)
Log employment(t-1)	0.205***	0.206***	0.204***	0.196***
	(0.00964)	(0.0101)	(0.00955)	(0.0117)
Log capital intensity(t-1)	0.0227**	0.0270**	0.0239**	0.0201
	(0.0102)	(0.0105)	(0.00996)	(0.0128)
Foreign	0.155***	0.155***	0.152***	0.189***
	(0.0345)	(0.0361)	(0.0348)	(0.0405)
Leverage(t-1)	0.0288*	0.0297*	0.0290*	0.0434***
	(0.0148)	(0.0157)	(0.0150)	(0.0105)
Liquidity ratio(t-1)	0.212**	0.0584	-1.122**	0.865**
	(0.0880)	(0.0801)	(0.463)	(0.406)
Liquidity ratio(t-1) x Creditor rights	-0.121***			
	(0.0429)			
Liquidity ratio(t-1) x Private credit		-0.0734		
		(0.102)		
Liquidity ratio(t-1) x Enforcement days			0.183**	
			(0.0758)	
Liquidity ratio(t-1) x Accounting standards				-0.0130**
				(0.00641)
Observations	5,994	5,620	5,994	4,172
Estimation	Probit	Probit	Probit	Probit
Log-Pseudolikelihood value	-2715	-2545	-2717	-1898
Pseudo-R-squared	0.342	0.344	0.341	0.343

Notes: Marginal effects at means are reported.

Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

All specifications include country-industry, country, industry and year dummies.

Error correction for correlation at the country-industry level.

Figure 1: The effect of creditor rights on the marginal effect of the liquidity ratio

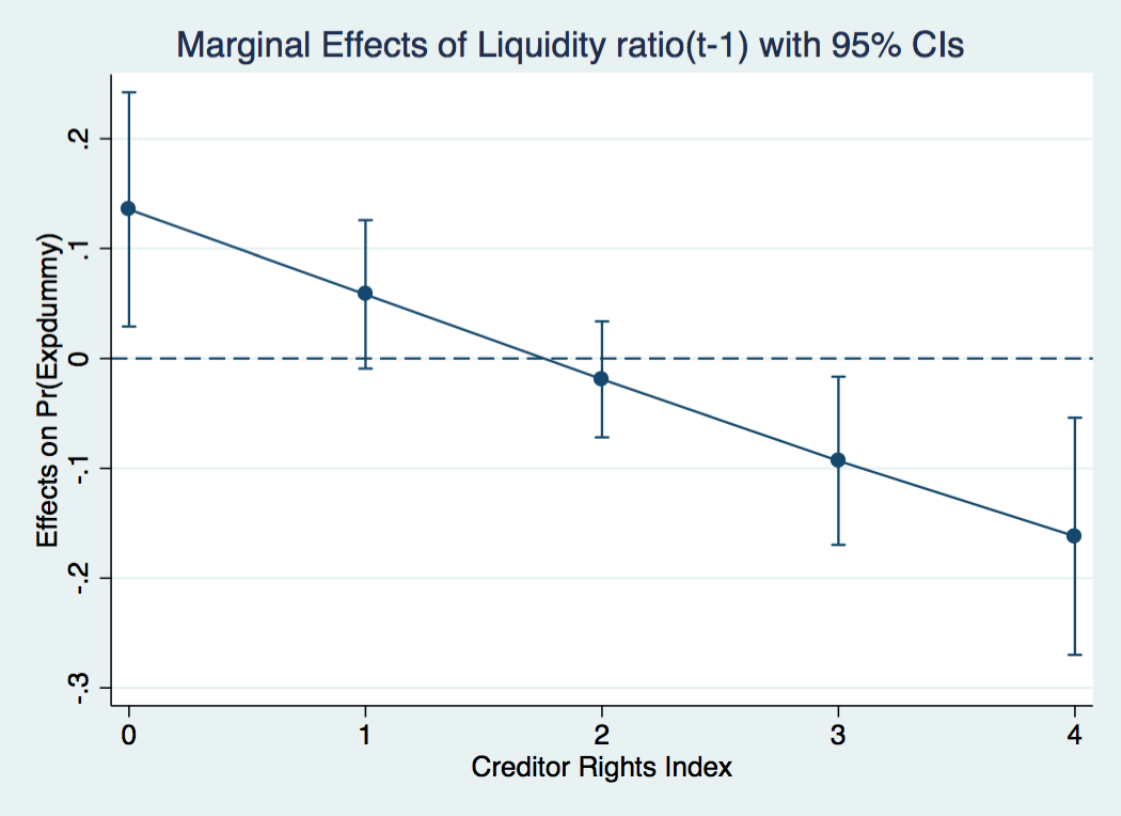


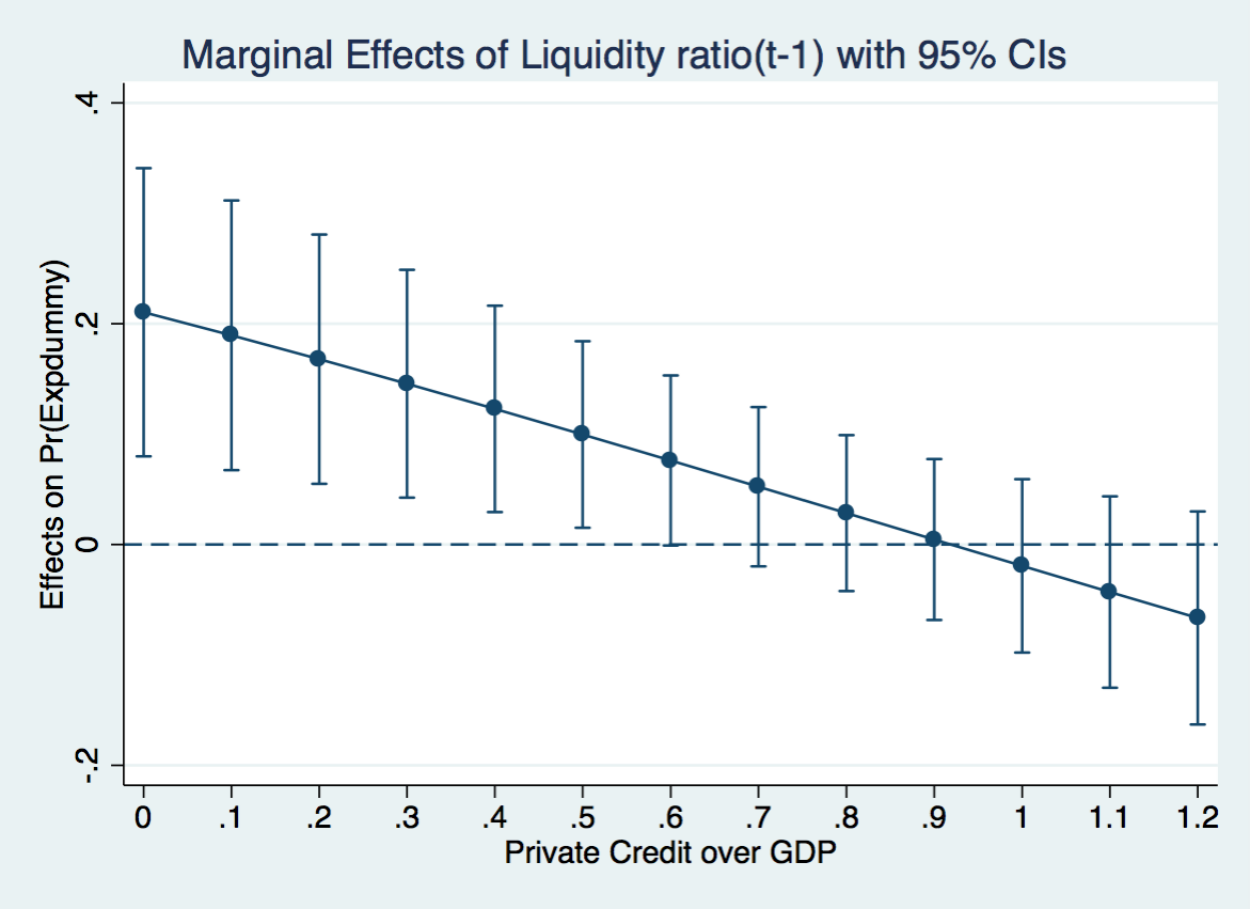
Table 4: Credit constraints and the export probability in low and high external finance dependent industries

Dependent variable	Pr(Exp=1)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
External finance intensity	*Low*	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
Log productivity(t-1)	0.0632***	0.0706***	0.0632***	0.0660***	0.0618***	0.0676***	0.0934***	0.0606***
	(0.0157)	(0.0178)	(0.0171)	(0.0177)	(0.0157)	(0.0179)	(0.0238)	(0.0213)
Log employment(t-1)	0.194***	0.221***	0.197***	0.217***	0.194***	0.219***	0.188***	0.208***
	(0.0115)	(0.0156)	(0.0124)	(0.0153)	(0.0114)	(0.0153)	(0.0153)	(0.0161)
Log capital intensity(t-1)	0.0138	0.0403***	0.0178	0.0444***	0.0149	0.0422***	0.00338	0.0496***
	(0.0128)	(0.0150)	(0.0135)	(0.0145)	(0.0125)	(0.0146)	(0.0159)	(0.0165)
Foreign	0.134***	0.158***	0.117**	0.167***	0.131**	0.154***	0.161**	0.193***
	(0.0507)	(0.0460)	(0.0570)	(0.0460)	(0.0516)	(0.0457)	(0.0719)	(0.0479)
Leverage(t-1)	0.0579***	0.00334	0.0618***	0.00263	0.0582***	0.00284	0.0484***	0.0334
	(0.0166)	(0.0181)	(0.0179)	(0.0182)	(0.0163)	(0.0182)	(0.0124)	(0.0247)
Liquidity ratio(t-1)	0.125	0.513***	-0.0490	0.339***	-0.882*	-2.603**	0.577	1.718***
	(0.0935)	(0.147)	(0.0951)	(0.119)	(0.502)	(1.019)	(0.486)	(0.642)
Liquidity ratio(t-1) x Creditor rights	-0.0911*	-0.245***						
	(0.0476)	(0.0757)						
Liquidity ratio(t-1) x Private credit			0.0900	-0.369***				
			(0.151)	(0.135)				
Liquidity ratio(t-1) x Enforcement days					0.138*	0.440***		
					(0.0809)	(0.170)		
Liquidity ratio(t-1) x Accounting standards							-0.00885	-0.0255**
							(0.00790)	(0.01000)
Observations	3,935	2,059	3,608	2,012	3,935	2,059	2,510	1,662
Estimation	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Log-Pseudolikelihood value	-1742	-962.9	-1589	-944.4	-1743	-963.8	-1091	-802.3
Pseudo-R-squared	0.348	0.325	0.355	0.322	0.348	0.324	0.369	0.303

Notes: Marginal effects at means are reported. Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

All specifications include country-industry, country, industry and year dummies. Error correction for correlation at the country-industry level.

Figure 2: The effect of private credit over GDP on the marginal effect of the liquidity ratio in financially dependent industries



and statistical significance of the coefficients of the liquidity ratio and its interactions in columns 2, 4, 6 and 8 compared to columns 1, 3, 5 and 7. In other words, the linkage between firm-level credit constraints, financial development and export probability seems to be mainly driven by external finance and R&D intensive firms (see also Table 11 in the Appendix 2.9.4 for probit estimations in below and above median level of R&D intensive sectors).[38] This set of results supports the view that the liquidity ratio does indeed capture credit constraints. Along the same reasoning, financial reform does improve access to finance, particularly for innovative firms.

Based on the specification of column 4 in Table 4, Figure 2 displays the marginal liquidity effect for firms that belong to financially dependent industries. This effect is dependent on

[38]Table 11 shows that signs and magnitudes of the effect of the liquidity ratio and the interaction terms remain almost unchanged compared to Table 4

a country's level of private credit over GDP. Assuming that no credit is extended to the private sector, an increase in one standard deviation of the firm's liquidity ratio would lead to an average export propensity that is 5.7 percentage points higher. Given an average export probability of 0.51 in the estimation sample, this corresponds to a large increase of 11.1% in the average probability to export. If we raise the private credit over GDP ratio to about Indonesia's level of 0.2, the marginal effect reduces to approximately + 4.5 percentage points. Accordingly, the average export probability rises now by 8.9%. At Brazil's private credit over GDP level of 0.3, the positive marginal impact of a firm's liquidity ratio change drops to + 3.9 percentage points, and the increase in the average export probability to about 7.6%. When private credit to GDP reaches a level of about 0.6, the availability of firm internal funds does not constitute an export determinant anymore. More generally, the marginal effect of an increase in firms' liquidity is decreasing in the level of financial development. This is consistent with hypothesis 1.

2.6.2 The intensive export margin

Following hypothesis 2, the liquidity ratio and financial development are predicted to exert a less stronger impact on the log of firms' exported value than on the probability to export at all. Once a firm successfully entered a foreign market and thus overcame the fixed exporting cost, the export revenues should depend less strongly on credit constraints than the decision to export in the first place. Like hypothesis 1, hypothesis 2 also states that if credit constraints are present, they will be more severe in financially less developed countries.

Table 5 reports the regression results of liquidity on the intensive export margin with creditor rights and private credit in OLS and 2SLS estimations. In line with previous results of the empirical literature, productivity, employment size, capital intensity and foreign ownership all display a positive impact on export revenues at the 1%-significance level in all four specifications. In contrast, the liquidity ratio and its interaction with creditor rights (columns 1 and 2) and private credit (columns 3 and 4) are insignificant in all four specifications. The set of instruments used passes the weak identification test as indicated by the value of the heteroskedastic- and cluster-robust Kleinbergen-Paap statistic and its corresponding critical value. The Hansen J statistic of overidentifying restrictions, however, rejects the joint validity of the instruments. It is suspected that the two instruments based on the lags of the liquidity ratio, which allow to circumvent a weak identification problem,

Table 5: Credit constraints and the intensive export margin

Dependent variable	Log(y)			
	(1)	(2)	(3)	(4)
Log productivity(t-1)	0.782***	0.787***	0.794***	0.802***
	(0.0447)	(0.0487)	(0.0439)	(0.0474)
Log employment(t-1)	1.098***	1.107***	1.099***	1.105***
	d.0266)	(0.0260)	(0.0271)	(0.0264)
Log capital intensity(t-1)	0.163***	0.166***	0.161***	0.161***
	(0.0341)	(0.0348)	(0.0344)	(0.0343)
Foreign	0.379***	0.420***	0.376***	0.405***
	(0.0796)	(0.0866)	(0.0789)	(0.0863)
Leverage(t-1)	0.0272	0.0216	0.0262	0.0233
	(0.0227)	(0.0221)	(0.0245)	(0.0221)
Liquidity ratio(t-1)	-0.174	0.330	-0.125	-0.101
	(0.308)	(0.726)	(0.203)	(0.377)
Liquidity ratio(t-1) x Creditor rights	0.185	-0.0924		
	(0.135)	(0.349)		
Liquidity ratio(t-1) x Private credit			0.477*	0.340
			(0.263)	(0.416)
Observations	2,731	2,248	2,626	2,218
R-squared	0.806	0.717	0.796	0.718
Estimation	OLS	2SLS	OLS	2SLS
Country/Industry and Year dummies	yes	yes	yes	yes
Country-industry dummies	yes	no	yes	no
Hansen J statistic		19.86		23.46
Hansen J p-value		0.000		0.000
Kleinbergen-Paap (KP) statistic		40.85		109.9
Critical KP statistic value (5%)		11.04		11.04

Notes: Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Error correction for correlation at the country-industry level. Instruments for the Liquidity ratio and its interaction with financial development are Liquidity ratio(t-3), Liquidity ratio(t-2) interacted with financial development, the log of firm age and the interaction between financial development and the liquidity needs variable from Raddatz (2006). Critical KP statistic value (5%) indicates the threshold for rejecting the null of weak identification allowing for 5% relative 2SLS bias.

are not completely exogenous in specifications 2 and 4. Therefore, the 2SLS estimates may not be too reliable.

Table 6 presents OLS estimations for firms belonging to sectors that operate in below and above median levels of external financial dependence. Productivity, firm size and capital intensity are important and significant determinants of export revenues in all specifications. But again, these set of regressions do not confirm concerns about credit constraints affecting the intensive export margin. The liquidity ratio and the interactions with all of the financial development indicators are mostly insignificant.

The following regressions reported in Table 7 take into account the possibility of biased estimates because of firms' self-selection into exporting. This is done by running a two-step Heckman selection model. The excluded variables that capture the severity of business constraints such as "access to land" in columns 1 and 3 and "customs and trade regulations" in columns 2 and 4 identify the model in the second step. Both variables should affect only the fixed production and exporting costs and therefore the extensive margin alone (see also Helpman et al., 2008). The Heckman's lambda (sometimes called the inverse mill's ratio) is not significant in this set of regressions. This suggests that the evidence for a sample selection bias is rather weak. In comparison to Table 5, the estimated coefficients and their statistical significance remain almost unaffected.

In sum, we can conclude that credit constraints and their interaction with financial development indicators are not significant determinants of export revenues once a firm already serves a specific export market.

Table 6: Credit constraints and the intensive export margin in low and high external finance dependent industries

Dependent variable	Log(y)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
External finance intensity	*Low*	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
Log productivity(t-1)	0.712***	0.896***	0.727***	0.894***	0.714***	0.894***	0.769***	0.906***
	(0.0497)	(0.0636)	(0.0485)	(0.0637)	(0.0499)	(0.0634)	(0.0563)	(0.106)
Log employment(t-1)	1.102***	1.098***	1.106***	1.092***	1.102***	1.097***	1.067***	1.087***
	(0.0364)	(0.0377)	(0.0377)	(0.0385)	(0.0368)	(0.0378)	(0.0486)	(0.0436)
Log capital intensity(t-1)	0.171***	0.162***	0.167***	0.164***	0.169***	0.164***	0.123***	0.182***
	(0.0437)	(0.0476)	(0.0444)	(0.0481)	(0.0441)	(0.0474)	(0.0433)	(0.0663)
Foreign	0.304***	0.414***	0.284***	0.420***	0.309***	0.412***	0.214	0.484***
	(0.108)	(0.0988)	(0.106)	(0.0974)	(0.108)	(0.0987)	(0.133)	(0.104)
Leverage(t-1)	0.0322	-0.00735	0.0316	-0.0121	0.0314	-0.00635	0.0231	-0.0170
	(0.0232)	(0.0584)	(0.0244)	(0.0586)	(0.0224)	(0.0579)	(0.0310)	(0.0638)
Liquidity ratio(t-1)	-0.418	0.711	-0.151	0.211	2.712*	-2.255	-3.169**	2.126
	(0.365)	(0.500)	(0.241)	(0.374)	(1.594)	(2.601)	(1.457)	(2.303)
Liquidity ratio(t-1) x Creditor rights	0.283*	-0.181						
	(0.158)	(0.249)						
Liquidity ratio(t-1) x Private credit			0.468*	0.208				
			(0.267)	(0.494)				
Liquidity ratio(t-1) x Enforcement days					-0.425	0.434		
					(0.267)	(0.425)		
Liquidity ratio(t-1) x Accounting standards							0.0491**	-0.0260
							(0.0209)	(0.0350)
Observations	1,659	1,072	1,565	1,061	1,659	1,072	1,144	870
R-squared	0.805	0.806	0.790	0.803	0.805	0.806	0.773	0.794
Estimation	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

Notes: Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. All specifications include country-industry, country, industry and year dummies. Error correction for correlation at the country-industry level.

Table 7: Credit constraints and the intensive export margin in a Heckman selection model

Dependent variable	Log(y)			
	(1)	(2)	(3)	(4)
Log productivity(t-1)	0.780***	0.793***	0.791***	0.805***
	(0.0298)	(0.0293)	(0.0302)	(0.0297)
Log employment(t-1)	1.118***	1.136***	1.117***	1.141***
	(0.0428)	(0.0398)	(0.0431)	(0.0401)
Log capital intensity(t-1)	0.169***	0.166***	0.167***	0.165***
	(0.0241)	(0.0233)	(0.0248)	(0.0240)
Foreign	0.386***	0.393***	0.382***	0.392***
	(0.0665)	(0.0649)	(0.0679)	(0.0664)
Leverage(t-1)	0.0328	0.0372	0.0320	0.0374
	(0.0264)	(0.0260)	(0.0285)	(0.0281)
Liquidity ratio(t-1)	-0.125	-0.110	-0.116	-0.103
	(0.256)	(0.255)	(0.179)	(0.178)
Liquidity ratio(t-1) x Creditor rights	0.172	0.154		
	(0.124)	(0.123)		
Liquidity ratio(t-1) x Private credit			0.519**	0.461*
			(0.247)	(0.241)
Heckman's lambda	0.074	0.177	0.068	0.201
	(0.161)	(0.162)	(0.163)	(0.165)
Observations	5,906	5,338	5,801	5,234
Estimation	Heckman	Heckman	Heckman	Heckman
Excluded variable	access to land	customs/trade regulation	access to land	customs/trade regulation

Notes: Standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

All specifications include country-industry, country, industry and year dummies.

First-stage Probit estimates are not reported, but can be made available upon request.

2.7 Robustness Checks and Additional Findings

This section aims to show that credit constraints and the beneficial effect of financial development at the extensive margin are robust to various specifications and estimation techniques.

2.7.1 Controlling for unobserved firm heterogeneity, past export status and endogeneity

Table 8 presents a set of pooled and panel regressions with creditor rights interactions. To begin with, the pooled probit regressions in low and high R&D intensive industries confirm the previous results: credit constraints are more pronounced in financially underdeveloped countries and for innovative firms (see columns 1 and 2). In columns 3 to 5 firm fixed effects in a linear probability model that account for unobserved firm heterogeneity are included. Although the size and significance of all firm characteristics are diminished due to fixed effects, the effect of the liquidity ratio and of the creditor rights interaction also carries through in the full sample (see column 3) and in the subset of R&D intensive firms (see column 5).[39] The dynamic specifications in columns 6 to 9 are estimated in first-differences by GMM and instrumented by the second order lags of the regressors. As a consequence, we also control for the potential endogeneity of the financial variables on top of unobserved firm heterogeneity and past export status. The relevant overidentifying restriction tests (Sargan statistics) cannot be rejected so the employed instruments seem to be appropriate (Arellano and Bond, 1991).[40] The results in columns 6 to 9 imply that past exporting experience is an important and significant determinant of the export probability. This is likely to reflect substantial sunk costs of foreign market entry.[41] Furthermore, most within variation of firm characteristics appears to be insignificant after controlling for time-invariant firm heterogeneity and past export status. However, the liquidity ratio and its interaction with creditor rights continue to have the expected effect (see columns 6 to 9) and are the only regressors that retain significance at the 10%-level in column 6.

[39]The very low within variation in the panel as opposed to the cross-sectional variation of all the firm characteristics could also partly explain the small size of the estimated coefficients.

[40]However, we cannot test the assumption of no second-order autocorrelation of the first-differenced errors required for consistent estimation because the data is only available for three years.

[41]See also Table 12 in the Appendix 2.9.4 for a probit regression including only firms that have not exported in the previous year. The results confirm that the past exporting status matters for the export propensity in the following year.

Table 8: Credit constraints and the export probability in panel specifications

Dependent variable	Pr(Exp=1)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
R&D intensity	*Low*	*High*		*Low*	*High*			*Low*	*High*
Exporter(t-1)						0.363***	0.397***	0.377***	0.315***
						(0.052)	(0.059)	(0.063)	0.09
Log productivity(t-1)	0.0681***	0.0370**	-0.000450	-0.00327	0.00483*	-0.00291	-0.00188	-0.00417	-0.000886
	(0.00960)	(0.0161)	(0.00214)	(0.00286)	(0.00279)	(0.00255)	(0.00272)	(0.00364)	(0.00265)
Log employment(t-1)	0.203***	0.195***	0.0116*	0.00651	0.0203*	0.00175	0.000347	-0.00298	0.00541
	(0.00843)	(0.0139)	(0.00621)	(0.00759)	(0.0107)	(0.00193)	(0.00569)	(0.00691)	(0.00901)
Log capital intensity(t-1)	0.0164*	0.0613***	-0.00261	-0.00576*	0.00344	-0.00342	-0.00512*	-0.00559	-0.000629
	(0.00849)	(0.0148)	(0.00289)	(0.00329)	(0.00550)	(0.00215)	(0.00283)	(0.00412)	(0.00388)
Foreign	0.183***	0.192***							
	(0.0486)	(0.0386)							
Leverage(t-1)	0.0127	0.0202**	4.86e-05	-0.000123	0.000134*	6.38e-07	3.52e-06	-4.07e-05	4.13e-06
	(0.00874)	(0.00931)	(4.08e-05)	(0.000383)	(7.23e-05)	(4.33e-05)	(3.93e-05)	(0.000335)	(1.72e-05)
Liquidity ratio(t-1)	0.163**	0.474***	0.0594**	0.0333	0.119**	0.0387**	0.0295	0.0318	0.0231
	(0.0766)	(0.149)	(0.0255)	(0.0251)	(0.0604)	(0.0192)	(0.0240)	(0.0245)	(0.0453)
Liquidity ratio(t-1) x Creditor rights	-0.0805**	-0.254***	-0.0248**	-0.0157	-0.0472*	-0.0183**	-0.0147	-0.0138	-0.0108
	(0.0367)	(0.0765)	(0.0100)	(0.00977)	(0.0243)	(0.00834)	(0.00965)	(0.00953)	(0.0192)
Observations	10,176	4,699	15,046	10,179	4,867	8,436	8,436	5,542	2,894
Estimation	Pooled Probit	Pooled Probit	Within	Within	Within	GMM	GMM	GMM	GMM
Firm fixed effects	no	no	yes	yes	yes	yes	yes	yes	yes
Country/Industry dummies	yes	yes	no	no	no	no	no	no	no
Country-industry dummies	no	yes	no	no	no	no	no	no	no
Year dummies	yes	yes	yes	yes	yes	no	yes	yes	yes
Number of firms			6,222	4,327	1,895	4,460	4,460	2,943	1,517
R-squared			0.020	0.017	0.031				

Notes: Marginal effects at means are reported. Firm cluster- and heteroskedastic-robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0. 5, * p<0.1. Dynamic GMM estimations use second order lags of firm variables and export status to instrument for all regressors and the lagged export status denoted by the Exporter(t-1).

2.7.2 Different aspects of financial development

Table 9 presents a set of pooled probit estimations that is intended to shed some light on the importance of different aspects of the financial system. However, the high correlation between the interaction terms makes it hard to identify the impact of the different financial development indicators.[42] The problem becomes apparent in the imprecisely estimated interaction terms in columns 1 to 7. Nonetheless, one can see that creditor rights and private credit over GDP achieve statistical significance in columns 3 and 7. As a result, both creditor rights and bank credits are likely to improve access to finance. However, the importance of legal debt enforcement and accounting standards cannot be dismissed due to high collinearity. Along the lines of La Porta et al. (1997), the results in column 1 may also suggest that providing creditor rights does not only promote credit activities by financial institutions, which is captured by the private credit interaction, but also deepens other non-bank debt financing.

2.7.3 Controlling for other country characteristics in the interaction terms

The next robustness check, reported in Table 10, tests whether the interaction terms are just picking up other country-specific characteristics that are correlated with the employed measures of financial development. This regression is performed in the subsample of firms in high need of external finance and for the financial development indicators creditor rights and private credit over GDP.[43] The country-level control variables that are included comprise the average GNI per capita as a proxy for the overall level of economic development (source: WDI), the rule of law measure from the World Bank's Governance Matters database (Kaufmann et al., 2003) that captures the quality of the institutional environment (for instance the degree of property rights protection), the average years of schooling drawn from the data provided by Barro and Lee (2001) and the average growth and inflation rates (source: WDI) as a measure of a country's economic performance. Column 1 adds all described variables interacted with the liquidity ratio at once. Despite the relatively high correlation between the included country characteristics, the interaction between liquidity

[42]The correlation between the financial interactions ranges between 0.52 and 0.94. Therefore, we enter the interactions two by two and then all at once in column 7 of Table 9.

[43]The empirical analysis so far has shown that firms heavily dependent on external finance particularly benefit from financial development. Thus, it is likely that concerns about collinearity of country characteristics and financial development indicators are less severe in the subsample of firms dependent on external finance.

Table 9: Different aspects of financial development

Dependent variable	Pr(Exp=1)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log productivity(t-1)	0.0614***	0.0616***	0.0700***	0.0607***	0.0696***	0.0688***	0.0690***
	(0.00900)	(0.00864)	(0.0109)	(0.00900)	(0.0109)	(0.0109)	(0.0109)
Log employment(t-1)	0.202***	0.203***	0.195***	0.202***	0.195***	0.195***	0.195***
	(0.00768)	(0.00753)	(0.00888)	(0.00769)	(0.00887)	(0.00888)	(0.00887)
Log capital intensity(t-1)	0.0309***	0.0286***	0.0282***	0.0313***	0.0279***	0.0288***	0.0287***
	(0.00813)	(0.00779)	(0.00981)	(0.00813)	(0.00979)	(0.00981)	(0.00980)
Foreign	0.200***	0.194***	0.219***	0.198***	0.219***	0.218***	0.217***
	(0.0320)	(0.0312)	(0.0359)	(0.0321)	(0.0360)	(0.0360)	(0.0360)
Leverage(t-1)	0.0133	0.0132	0.0126	0.0135	0.0124	0.0127	0.0126
	(0.00822)	(0.00807)	(0.00860)	(0.00829)	(0.00853)	(0.00872)	(0.00868)
Liquidity ratio(t-1)	0.218**	-0.0547	0.868	-0.304	0.658*	-2.481	3.077
	(0.0852)	(0.784)	(0.563)	(0.705)	(0.388)	(3.091)	(4.462)
Liquidity ratio(t-1) x Creditor rights	-0.0781	-0.0974*	-0.00882				0.309
	(0.0573)	(0.0587)	(0.131)				(0.215)
Liquidity ratio(t-1) x Private credit	-0.0934			-0.139	-0.148		-0.408*
	(0.102)			(0.104)	(0.123)		(0.244)
Liquidity ratio(t-1) x Enforcement days		0.0406		0.0685		0.432	-0.226
		(0.114)		(0.108)		(0.390)	(0.550)
Liquidity ratio(t-1) x Accounting standards			-0.0128		-0.00814	-0.00158	-0.0295
			(0.0117)		(0.00689)	(0.0122)	(0.0218)
Observations	14,182	14,828	11,703	14,182	11,703	11,703	11,703
Estimation	Pooled Probit						
Log-Pseudolikelihood value	-6353	-6636	-5268	-6354	-5266	-5266	-5263
Pseudo-R-squared	0.349	0.348	0.347	0.349	0.347	0.347	0.347

Notes: Marginal effects at means are reported. Firm cluster- and heteroskedastic-robust standard errors in parentheses.

Significance levels: *** p<0.01, ** p<0.05, * p<0.1. All specifications include country-industry, country, industry and year dummies.

Table 10: Credit constraints and the export probability with interaction control variables

Dependent variable	Pr(Exp=1)					
	(1)	(2)	(3)	(4)	(5)	(6)
External finance intensity	*High*	*High*	*High*	*High*	*High*	*High*
Liquidity ratio(t-1)	0.425	0.137	-0.110	0.0294	-0.0403	-0.507
	(0.485)	(0.336)	(0.447)	(0.628)	(0.353)	(0.371)
Liquidity ratio(t-1) x Log average GNI per capita	7.40e-05	0.000120*	0.000217***	0.000167	0.000185**	0.000319***
	(8.02e-05)	(6.35e-05)	(7.88e-05)	(0.000141)	(8.89e-05)	(7.03e-05)
Liquidity ratio(t-1) x Average inflation rate	0.0225	0.0223		0.0148	0.0136	
	(0.0195)	(0.0186)		(0.0200)	(0.0207)	
Liquidity ratio(t-1) x Average GDP per capita growth	-0.0836	-0.0696		-0.0634	-0.0581	
	(0.0683)	(0.0612)		(0.0845)	(0.0744)	
Liquidity ratio(t-1) x Average years of schooling	-0.0312		0.000455	9.40e-05		0.0588
	(0.0398)		(0.0457)	(0.0554)		(0.0510)
Liquidity ratio(t-1) x Rule of law	0.137		-0.431**	0.0870		-0.149
	(0.182)		(0.201)	(0.209)		(0.161)
Liquidity ratio(t-1) x Creditor rights	-0.127*	-0.148**	-0.187**			
	(0.0750)	(0.0649)	(0.0752)			
Liquidity ratio(t-1) x Private credit				-0.323	-0.301	-0.658***
				(0.301)	(0.230)	(0.169)
Observations	2,012	2,059	2,012	2,012	2,012	2,012
Estimation	Probit	Probit	Probit	Probit	Probit	Probit
Log-Pseudolikelihood value	-939.7	-958.3	-942.0	-940.1	-940.1	-940.5
Pseudo-R-squared	0.325	0.328	0.324	0.325	0.325	0.325

Notes: Marginal effects at means are reported. Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. All specifications include country-industry, country, industry and year dummies. Error correction for correlation at the country-industry level. Firm characteristics (Log productivity, Log employment, Log capital intensity, Foreign and Leverage) are included but not reported.

ratio and creditor rights displays the predicted negative sign and is about half the size of the corresponding interaction term in Table 4 (column 2). In addition, the *Liquidity ratio(t-1) x Creditor rights* variable is the only interaction that is statistically significant at the 10%-level (see column 1). In column 2, we control for GNI per capita, growth and inflation rates. The coefficient of the creditor rights interaction remains negative and significant at the 5%-level. Column 3 controls for the rule of law, schooling and again GNI per capita. Yet the size of the of beneficial creditor rights effect stays significant at the 5%-level and qualitatively unaffected. Private credit over GDP replaces creditor rights in columns 4 to 6. Although the interactions between private credit over GDP and firms' liquidity also show the expected negative signs, only the interaction effect in column 6 achieves statistical significance. High collinearity between regressors is a likely explanation for this outcome. In sum, the interaction effect between financial development and credit constraints on firm selection into exporting is robust to the inclusion of other confounding economic and institutional country characteristics.

2.7.4 Further robustness checks

Several further tests are conducted to ensure the robustness of our conclusions. First, the liquidity ratio is replaced by the leverage (total debt over assets) as an alternative measure of credit constraints. A higher firm indebtedness has a negative impact on the export propensity if a firm is R&D intensive and operates in a country with a low private credit to GDP ratio (see Table 13 in the Appendix 2.9.4). On the other hand, no negative leverage effect is found for non-innovative firms.[44]

Second, additional firm characteristics related to the human capital endowment of employees and management and the use of new technology and foreign inputs are added to the baseline specification. The role of financial development on improving access to finance remains unaffected by the additional variables, as can been seen in Table 14 in the Appendix 2.9.4.

Third, dropping countries one by one in the estimation sample conveys that the size of the credit constraint and financial development impact is smaller and less significant without Brazilian firms. This is not surprising since Brazilian firms represent about 25% of the estimation sample, and Brazil is a country with a below average level of financial development (see Table 1). As a consequence, dropping Brazilian firms does increase the standard

[44]See also Egger and Keuschnigg (2010) for a theoretical explanation of this empirical result.

errors substantially due to the reduced number of firms and the variation of the financial development indicators. To partly circumvent this effect on standard errors, we weight every firm with one over the probability of being included in a specific country sample instead of dropping observations altogether (see Table 15 in the Appendix 2.9.4).[45] [46] This robustness check confirms the importance of financial development for R&D and finance dependent firms as the magnitude and significance of the liquidity variables are similar to unweighted estimations.

Fourth, we replace the logarithm of employment as our measure of firm size with log revenues. This is important since the analysis has revealed that firm size is the strongest predictor of the export propensity.[47] However, the inclusion of this alternative firm size measure does not change our results neither qualitatively nor quantitatively.[48]

Fifth, Figure 3 in the Appendix 2.9.4 shows the financial interaction term calculated by the method of Ai and Norton (2003) for all firms as a function of the predicted export probabilities.[49] This method takes into account the often neglected second order derivatives to calculate interaction effects in nonlinear models such as the Probit model. The interaction of the liquidity ratio with the creditor rights index of column 1 in Table 3 is negative for all observations and intuitively strongest for firms close to an export propensity of 0.5.[50] However, this method does not significantly alter the size of the interaction effect compared to the conventional result.

Sixth, we interact all firm characteristics simultaneously with the financial development indicators. The liquidity variables remain unchanged by the inclusion of the additional interaction terms. The additional variables are mostly insignificant. This raises our confidence that the liquidity ratio and its interaction with financial development capture empirically the degree of access to external finance.[51]

[45] The firm weighting does, however, also somewhat increase the standard errors of the estimated marginal effects.

[46] For instance, in these estimations firms located in countries such as Brazil or Thailand are assigned low weights, whereas firms from Sri Lanka or India obtain larger weights.

[47] Firm size is an important determinant of the export participation theoretically and empirically (see for instance Melitz, 2003 and Bernard and Jensen, 2004). It is positively related to firm productivity and thus to marginal and average costs of production. Moreover, large firms have been successful in the past for whatever reason.

[48] Results are available upon request.

[49] The interaction terms are calculated from column 1 of Table 3.

[50] In addition, according to Figure 4, which displays z-statistics computed by the delta method, the interaction effect is statistically significant for almost all firms.

[51] Results are available upon request.

Finally, we augment the sample selection and also include state-owned firms. These additional state-owned firms do not affect the conclusion drawn with regard to the relationship between credit constraints, financial development and the export probability.[52]

2.8 Conclusions

This paper studies the effect of financial development on the export propensity and revenues employing firm-level data from 18 developing countries. In line with the main prediction derived from a Melitz-type model with borrowing frictions, the empirical results show that a better financial system increases the export probability through the reduction of credit constraints. The marginal effect of the liquidity ratio appears to be particularly high in financially underdeveloped countries and driven by firms belonging to R&D intensive industries that rely more on external funding. As a consequence, the benefits from financial development is at least twice as large for innovative firms as it is for other firms. Estimates from dynamic specifications also suggest that the quality of financial contracting and enforcement may be particularly beneficial for firms that enter a foreign market for the first time. Regarding the intensive export margin, the state of the credit market in a country does not seem to influence export revenues for firms already established in the foreign market. Overall, the findings support the idea that fixed costs of remaining or becoming an exporter constitute an important financing hurdle as opposed to variable (exporting) costs of existing exporters. Relatedly, the results also imply that financial development shapes comparative advantage patterns mainly through firm selection into exporting (i.e. the extensive export margin), especially of innovative firms.

The analysis indicates that adopting legal creditor rights that allow lenders to recoup their investments in case of firm bankruptcy increases the availability of external finance to cover the fixed exporting costs. This would help productive firms that lack liquid assets or collateral enter a new export market permanently. In this respect, a larger credit volume, higher accounting standards and a shorter duration of debt enforcement in a country also reduce credit constraints of would-be exporters. In our Melitz-type framework, lower credit constraints promote foreign market entry of efficient firms and increase the average productivity as well as employment size of exporters. As credit constraints are found to be insignificant for the intensive export margin, trade reforms that improve the export profitability are more appropriate to raise firm export revenues than institutional

[52]Results are available upon request.

development of the credit market.

Ideally, future research could attempt to investigate the differential impact of credit constraints and financial development for incumbent firms and for first-time exporters while employing an enlarged cross-country panel with a higher within variation of the export variables and other firm characteristics, in particular of balance-sheet variables. This would also allow a more thorough characterization of the beneficial effect of financial development across different types of firms. Furthermore, the impact of financial development on firm-level credit constraints could be confirmed and generalized with a broader set of countries, both developing and developed. Finally, with more detailed firm-level data, it could also be examined how financial development affects the range of products exported and the number of export destinations reached by domestic firms.

2.9 Appendix

2.9.1 Microeconomic foundation of credit constraints

This Appendix provides a microeconomic foundation of the fraction $\theta \in [0, 1]$ of the operating profits that is credibly pledgeable to investors. Furthermore, the credit constraint condition (CC) that corresponds to equation (3) in the Section 2.3 is deduced. In addition, this Appendix relies on Antras et al. (2009), Egger and Keuschnigg (2009) and Tirole (2006).

When an entrepreneur starts a project, she injects her wealth ω as equity into the project. Alternatively, she could invest these assets in the deposit market yielding the deposit interest factor $R = 1 + r$, which determines the opportunity cost, ωR. A key feature of the model is that financial investors face an agency problem as the entrepreneur may not manage the financed exporting activity diligently. The entrepreneur may take a private benefit and thereby reduce the success probability of exporting. The private benefit is inefficient in the sense that its value for the entrepreneur is lower than the foregone profit; yet the entrepreneur, who receives the entire private benefits, but only part of the profit, may choose the private benefits.[53] To avoid such potential moral hazard misbehavior, a high enough stake in the financial outcome of domestic and exporting activities must be conceded to the entrepreneur. Then, an incentive is given not to waste money and the interests of the entrepreneur are aligned with those of the lender. As a result, the project's expected generated profits cannot fully be pledged to investors, which in turn implies that the project may not receive financing, even if it would be otherwise profitable. Thus, in this framework the possibility for credit constraints for some otherwise profitable activities arises. Next, the incentive problem of financing export participation is explained.

An entrepreneur must raise debts, $D = f + f_x - \omega$, to enter the foreign market in addition to serving the home market.[54] Given a lending or loan rate i, the investor collects repayment $(1 + i)D$ if the project is successful and zero if it fails. The probability of a successful exporting project is λ. The firm's surplus of the financed export project is split between

[53] For example, an entrepreneur in the biotechnology sector may use a small part of the funding for the development of a specific product for financing research on other projects. In this case, the entrepreneur's private benefits would be the research output on these other projects. The shift in researcher's attention then reduces the probability of success of the considered project.

[54] Required debt for only serving the home market would be lower, namely, $D = f - \omega$.

the entrepreneur, π_x^e, and the financial investor, π^{FI}, according to:[55]:

$$\pi_x^e = \lambda \left[\frac{1}{\sigma}(1+\tau^{1-\sigma})r_d(\varphi) - D(1+i) \right] - \omega R, \quad D = f + f_x - \omega \qquad (I)$$

$$\pi^{FI} = \lambda(1+i)D - DR = 0 \qquad (II)$$

With a competitive financial system, investors just break even, that is $\pi^{FI} = 0$, implying $\lambda(1+i) = R$. The supply of funds is perfectly elastic at this rate R when entrepreneurial incentives are aligned.[56] Summing (I) and (II), the total surplus of the firm's sales is obtained:

$$\pi_k^x = \lambda \frac{1}{\sigma}(1+\tau^{1-\sigma})r_d(\varphi) - (f+f_x)R \qquad (III)$$

Without loss of generality, the convenient normalizations $\lambda = R = 1$ are imposed. Not surprisingly, as the investor's profits are zero, the entire surplus (III) goes to the entrepreneur. Next, firms' activities are subject to moral hazard so that some exporting activities with a positive total surplus are not funded. The entrepreneur can exert high effort ("behave," "work," "take no private benefits") or exert low effort ("misbehave," "shirk," "take private benefits"). Exerting high effort yields a higher probability of success $\lambda = 1$, but the entrepreneur forgoes private benefits. In contrast, low effort results in a lower probability of success, $\lambda_L < 1$, and positive private benefits for the entrepreneur defined as follows:

$$B = (1-\delta)b_k \frac{1}{\sigma}(1+\tau^{1-\sigma})r_d(\varphi) \qquad (IV)$$

It is assumed that the private benefits of misbehaving, B, are increasing in the size of the project and, therefore, they are specified to be proportional to the (expected) level of operating profits, $\frac{1}{\sigma}(1+\tau^{1-\sigma})r_d(\varphi)$. Then, importantly, the scope for private benefits is decreasing in the degree of investor protection in a country, $\delta \in \{0,1\}$, and increasing in the severity of agency problems related to sectoral characteristics, for instance, because of more reliance on intangible human capital, which is captured by a sector-specific variable, $b_k \in \{0,1\}$. The idea behind the formulation (IV) is that legal investor protection constraints the ability of entrepreneurs to extract private benefits and that some sectors are inherently,

[55] See Egger and Keuschnigg (2009)

[56] Hence, in general the loan rate exceeds the deposit rate by a margin, which reflects the incorporation of the probability of a project failure and consequential credit losses for the financial investor, $i > r$.

or technologically determined, more prone to entrepreneurial moral hazard than others, for example, due to a greater degree of asymmetric information or less collateralizable, tangible assets (see also Antras et al., 2009; Egger and Keuschnigg, 2009).

To ensure that the entrepreneur "behaves", the creditor must leave her a large enough (expected) share of operating profits, $\alpha^e \equiv \frac{1}{\sigma}(1+\tau^{1-\sigma})r_d(\varphi) - D$, if the risky project succeeds. Having a high enough stake in the project's future profits aligns the entrepreneur's interests with those of the investor. Simply put, the entrepreneur must be compensated for the foregone private benefits by an exceeding profit share. As a consequence, the entrepreneur exerts high effort if the following incentive compatibility constraint is satisfied:

$$\alpha^e \geqslant \lambda_L \alpha^e + B \qquad (IC^e)$$

$$\Leftrightarrow$$

$$\alpha^e \equiv \frac{1}{\sigma}(1+\tau^{1-\sigma})r_d(\varphi) - D \geqslant (1-\theta)\frac{1}{\sigma}(1+\tau^{1-\sigma})r_d(\varphi), \quad 1-\theta \equiv \frac{(1-\delta)b_k}{1-\lambda_L}$$

From the (IC^e) we infer that, $\theta\left[\frac{1}{\sigma}(1+\tau^{1-\sigma})r_d(\varphi)\right]$, is the (operating) profit share that can be credibly pledged to the investor without jeopardizing a borrower's incentives. This maximum incentive compatible repayment may not suffice to allow the investor to break even and restricts the firm's debt capacity, which leads to the following credit constraint condition, CC, or the maximum amount of credit that a financial investor is willing to lend:

$$\theta\left[\frac{1}{\sigma}(1+\tau^{1-\sigma})r_d(\varphi)\right] \geqslant D = f + f_x - \omega, \quad \frac{\partial\theta}{\partial\delta} > 0, \quad \frac{\partial\theta}{\partial b_k} < 0 \qquad (CC)$$

The left-hand side denotes the (expected) pledgeable operating profit which must be high enough to cover a lender's cost of financing on the right-hand side of (CC), which equals D.[57] Hence, it arises the possibility that despite exporting is profitable in the sense that it satisfies, $\tau^{1-\sigma}\frac{1}{\sigma}r_d(\varphi) \geq f_x$ (see equation (2) in the Section 2.3), it will not receive funding due to a tighter (CC). The credit constraint condition (CC) corresponds to equation (3) in the Section 2.3.

What are ultimately the determinants of credit constraints in the model? First, it depends

[57]Please remind that the investor breaks even whenever $\lambda(1+i)D = CR$ $(credit\,C) \Longrightarrow \lambda(1+i) = R$ is given and due to aforementioned normalizations $\lambda = 1$ and $R = 1$ (zero deposit rate / refinancing cost of investors) $D = C$ accordingly.

on the size of operating profits, which in turn is a function of a firm's productivity φ. Secondly, on the needed external financing, $D = f + f_x - \omega$. Then, another critical determinant is $\theta \in [0, 1]$, which is the fraction of operating profits the entrepreneur can credibly pledge to the financial investor and, consequently, the amount she can borrow. On the one hand, θ is affected positively by the degree of legal protection of investors in a country. If investor protection is such that financial contracts are perfectly secured and enforced ($\delta = 1$), we are back in the neoclassical world with perfect financial markets ($\theta = 1$), in which any entrepreneurial exporting decision only depends on profitability. In this case, credit constraints are never binding, also implying that a firm's wealth, ω, becomes irrelevant for the export propensity. With imperfect financial markets $\theta < 1$, some entrepreneurs are prevented from profitably exporting because of credit constraints. Apart from the degree of investor protection δ, $\theta \equiv 1 - \frac{(1-\delta)b_k}{1-\lambda_L}$ also depends on the sector-specific ability to extract private benefits, b_k, and the accordant sector-specific likelihood ratio $1 - \lambda_L$.[58] For instance, asymmetric information and, consequently, the scope for entrepreneurial misbehavior is believed to be a more severe problem ($b_k \uparrow$) in innovative industries. Moreover, firms in these sectors are often equipped with relatively less tangible assets that can serve as collateral than in well-known mature industries. Finally, because of higher growth opportunities, these innovative firms often require more external financing, which makes credit constraints more binding for this subset of firms.

2.9.2 Credit constrained exporters

Proposition: *If φ and ω are continuously distributed variables from $[0, \infty]$, and if $\frac{f+f_x}{f_x(1+\tau^{\sigma-1})} > \theta, \quad \theta \in (0, 1)$ then there exists a non-empty set of credit constrained exporters (denoted by Ω). These firms could export profitably, but are prevented from doing so because they lack sufficient external finance (see also Chaney, 2005)*

Proof. T*his proposition is proved by substituting equation (4) into the left-hand side of inequality $\overline{\varphi}_x(\theta, \omega) > \varphi_x = \frac{\tau}{P\rho}\left(\frac{\sigma f_x}{\mu E}\right)^{\frac{1}{\sigma-1}}$ and setting firms' liquidity ω to zero. $\overline{\varphi}_x(\theta, \omega = 0) > \varphi_x$ is a necessary and sufficient condition for Ω to be non-empty and will hold if the above conditions of the proposition are met.*

It is assumed that these conditions are satisfied.

[58] The higher the likelihood ratio, the better is the firm's performance measurement, the more visible is the firm's effort choice and the easier is access to external finance.

2.9.3 Data

Variable	Description
Firm characteristics:	
Liquidity ratio	Current assets over total assets.
Leverage	Total debt over total assets.
Log productivity	Logarithm of value added per employee.
Log employment	Logarithm of the number of employees.
Log capital intensity	Logarithm of total assets per employee.
Foreign	A dummy variable that equals one if at least 50% of the firm is owned by foreigners and zero otherwise.
Foreign input share	Percentage share of the use of foreign inputs to total inputs.
New technology	A dummy that equals one if a new technology was introduced in the last three years and zero otherwise.
Share workforce with university degree	Percentage share of the workforce with a university degree.
CEO graduate degree	A dummy variable that equals one if the CEO of the firm obtained a post graduate degree (PhD, Masters) and zero otherwise.
Skilled share of production workers	Share of production workers reported as skilled to total production workers.
Log firm age	Logarithm of the firm age
	Source of firm-level variables: World Bank Enterprise Surveys (2002-2005)
Financial development:	
Creditor rights	An index ranging from 0 (weak creditor rights) to 4 (strong creditor rights). A score of one is given if the following rights are legally adopted by a country: *(I)* There are restrictions, such as creditor consent or minimum dividends, to file for bankruptcy. *(II)* Secured creditors are able to seize their collateral if a firm reorganization is approved (no automatic stay or asset freeze). *(III)* Secured creditors are the first to be paid out of the liquidated assets of a bankrupt firm. *(IV)* If the debtor does not retain the management of the firm during the reorganization. Data is averaged over the period from 1999 to 2003. *Source:* Djankov et al. (2007).

(continued)

Variable	Description
Private credit	Private credit volume from banks and other financial institutions extended to the domestic sector over the country's GDP. Data is averaged over the period from 1999 to 2003. *Source:* Beck et al. (2009).
Enforcement days	The logarithm number of days it takes to enforce a debt contract worth 50% of a country's GDP per capita before court, constructed as of January 2003. *Source:* Djankov et al. (2007).
Accounting standards	Index from 1 to 90 created by the Center for International Financial Analysis and Research (CIFAR), constructed by rating a cross-section of a country's firms' 1995 annual reports on the inclusion and omission of 90 items that fall into 7 categories such as general information, income statement, balance sheets, funds flow statement, accounting standards, stock data and special items. *Source:* Bushman et al. (2004).
Country characteristics:	
Rule of law	A composite index from -2.5 to +2.5 that captures perceptions of the extent to which citizens have confidence in a country's rule of law, in particular the efficiency of contract enforcement, property rights enforcement, the police, the courts, as well as the probability of crime and violence. Average from the biannual data from 1998 to 2002. *Source:* Government IV database (1996-2002) from the World Bank. (Kaufmann et al., 2003)

(continued)

Variable	Description
Average years of schooling	Average years of schooling of people older than 25 within a country for the year 2000. *Source:* Barro and Lee (2001).
Log average GNP per capita	The logarithm of the gross national product averaged from 2001 to 2003. *Source:* World Development Indicators.
Average GDP per capita growth	Average growth rate of the gross domestic product per capita from 1999 to 2003. *Source:* World Development Indicators.
Average inflation rate	Average inflation rate over the period from 1999 to 2003. *Source:* World Development Indicators.

2.9.4 Tables and figures

Table 11: Credit constraints in high and low R&D intensive industries

Dependent variable	Pr(Exp=1)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
R&D intensity	*Low*	*High*	*Low*	*High*	*Low*	*High*	*Low*	*High*
Log productivity(t-1)	0.0679***	0.0414***	0.0693***	0.0327**	0.0666***	0.0388**	0.0984***	0.0426***
	(0.0153)	(0.0157)	(0.0168)	(0.0154)	(0.0154)	(0.0164)	(0.0245)	(0.0152)
Log employment(t-1)	0.202***	0.207***	0.205***	0.204***	0.201***	0.205***	0.193***	0.197***
	(0.0116)	(0.0145)	(0.0126)	(0.0143)	(0.0115)	(0.0143)	(0.0149)	(0.0156)
Log capital intensity(t-1)	0.0139	0.0569***	0.0187	.0595***	0.0150	0.0575***	0.00322	0.0579***
	(0.0117)	(0.0147)	(0.0123)	(0.0143)	(t.,114)	(0.0145)	(0.0151)	(0.0159)
Foreign	0.135***	0.160***	0.128**	0.164***	0.130***	0.160***	0.206***	0.166***
	(0.0496)	(0.0427)	(0.0553)	(0.0420)	(0.0504)	(0.0420)	(0.0635)	(0.0464)
Leverage(t-1)	0.0563***	0.00768	0.0593***	0.00730	0.0562***	0.00736	0.0465***	0.0398*
	(0.0142)	(0.0188)	(0.0153)	(0.0187)	(0.0139)	(0.0189)	(0.0111)	(0.0242)
Liquidity ratio(t-1)	0.144*	0.493***	-0.0441	0.303**	-0.812*	-2.855**	0.364	1.917***
	(0.0865)	(0.163)	(0.0906)	(0.148)	(0.478)	(1.165)	(0.479)	(0.631)
Liquidity ratio(t-1) x Creditor rights	-0.0995**	-0.241***						
	(0.0442)	(0.0848)						
Liquidity ratio(t-1) x Private credit			0.0795	-0.353**				
			(0.119)	(0.164)				
Liquidity ratio(t-1) x Enforcement days					0.127	0.480**		
					(0.0777)	(0.193)		
Liquidity ratio(t-1) x Accounting standards							-0.00538	-0.0290***
							(0.00769)	(0.0101)
Observations	4,260	1,760	3,911	1,727	4,260	1,760	2,688	1,484
Estimation	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Log-Pseudolikelihood value	1985	-838.4	-1811	-831.2	-1986	-839.2	-1170	-722.3
Pseudo-R-squared	0.313	0.310	0.321	0.301	0.313	0.309	0.366	0.295

Notes: Marginal effects at means are reported. Robust standard errors are not displayed. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

In contrast to other specifications, columns 1, 3 and 5 do not contain country-industry dummies due to convergence problems.

Error correction for correlation at the country-industry level.

Table 12: New exporters

Dependent variable	Pr(Exp=1)			
	(1)	(2)	(3)	(4)
Log productivity(t-1)	0.000439	0.000637	0.000456	0.000529
	(0.00106)	(0.00109)	(0.00108)	(0.00133)
Log employment(t-1)	0.00585***	0.00569***	0.00590***	0.00654***
	(0.00103)	(0.00103)	(0.00105)	(0.00120)
Log capital intensity(t-1)	0.000199	0.000117	0.000234	0.000213
	(0.000963)	(0.000979)	(0.000974)	(0.00118)
Foreign	0.00724	0.00662	0.00679	0.00646
	(0.00725)	(0.00697)	(0.00711)	(0.00790)
Liquidity ratio(t-1)	0.0242***	0.0169***	-0.119	0.0902**
	(0.00792)	(0.00633)	(0.0732)	(0.0420)
Liquidity ratio (t-1) x Creditor rights	-0.0116**			
	(0.00470)			
Liquidity ratio(t-1) x Private credit		-0.0163*		
		(0.00982)		
Liquidity ratio(t-1) x Enforcement days			0.0205*	
			(0.0119)	
Liquidity ratio(t-1) x Accounting standards				-0.00132*
				(0.000696)
Observations	6,070	5,965	6,070	5,672
Estimation	Pooled Probit			
Log-Pseudolikelihood	-588.5	-572.5	-589.8	-540.2
Pseudo-R-squared	0.163	0.165	0.161	0.153

Notes: Marginal effects at means are reported. Firm cluster- and heteroskedastic-robust standard errors in parentheses.

Significance levels: *** p<0.01, ** p<0.05, * p<0.1. All specifications include country-industry, country, industry and year dummies.

Table 13: Firm leverage and the export probability

	Pr(Exp=1)					
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)
R&D intensity				*High*	*High*	*High*
Log productivity(t-1)	0.0637***	0.0646***	0.0636***	0.0421***	0.0373**	0.0422***
	(0.0126)	(0.0136)	(0.0127)	(0.0157)	(0.0154)	(0.0158)
Log employment(t-1)	0.204***	0.206***	0.204***	0.205***	0.204***	0.206***
	(0.00954)	(0.0101)	(0.00954)	(0.0146)	(0.0143)	(0.0146)
Log capital intensity(t-1)	0.0241**	0.0265***	0.0238**	0.0556***	0.0586***	0.0568***
	(0.00968)	(0.0102)	(0.00968)	(0.0149)	(0.0146)	(0.0145)
Foreign	0.152***	0.156***	0.151***	0.159***	0.162***	0.156***
	(0.0348)	(0.0361)	(0.0347)	(0.0425)	(0.0419)	(0.0424)
Leverage(t-1)	0.0560***	0.0240	0.00707	0.00495	-0.0434**	0.667
	(0.0176)	(0.0289)	(0.180)	(0.0452)	(0.0196)	(0.429)
Leverage(t-1) x Creditor rights	-0.0156*			0.00138		
	(0.00811)			(0.0252)		
Leverage(t-1) x Private credit		0.0116			0.0957***	
		(0.0351)			(0.0266)	
Leverage(t-1) x Enforcement days			0.00346			-0.106
			(0.0311)			(0.0690)
Observations	5,994	5,620	5,994	1,760	1,727	1,760
Estimation	Probit	Probit	Probit	Probit	Probit	Probit
Log-Pseudolikelihood value	-2720	-2546	-2721	-843.1	-832.2	-842.1
Pseudo-R-squared	0.341	0.344	0.340	0.306	0.300	0.306

Notes: Marginal effects at means are reported. Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. All specifications include country-industry, country, industry and year dummies. Error correction for correlation at the country-industry level.

Table 14: Credit constraints and the export probability with additional firm characteristics

Dependent variable	Pr(Exp=1)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
R&D intensity	*Low*	*High*	*Low*	*High*	*Low*	*High*	*0ow*	*High*
Log productivity(t-1)	0.126***	0.0385**	0.125***	0.0377**	0.126***	0.0384**	0.126***	0.0390**
Log employment(t-1)	0.214***	0.178***	0.214***	0.178***	0.214***	0.178***	0.213***	0.178***
Log capital intensity(t-1)	0.0188	0.0574***	0.0182	0.0591***	0.0188	0.0576***	0.0164	0.0568***
Foreign	0.104	0.109**	0.106	0.107**	0.104	0.109**	0.0777	0.110**
Leverage(t-1)	0.0470**	0.0449*	0.0466**	0.0434	0.0469**	0.0448*	0.0471**	0.0451*
Foreign input share	0.00105	0.00345***	0.00106	0.00338***	0.00106	0.00345***	0.00100	0.00347***
New technology	0.0365	0.0545	0.0363	0.0501	0.0365	0.0542	0.0352	0.0557
Share workforce with university degree	0.000915	0.000772	0.000888	0.000786	0.000912	0.000771	0.000846	0.000782
CEO graduate degree	0.0583	0.114***	0.0564	0.113***	0.0583	0.114***	0.0506	0.114***
Skilled share of production workers	0.0163	0.00566	0.0168	0.000836	0.0164	0.00542	0.0207	0.00625
Liquidity ratio(t-1)	0.0963	0.689***	0.139	0.597***	-0.0466	-5.892***	0.202	1.990***
Liquidity ratio(t-1) x Creditor rights	-0.00467	-0.351***						
Liquidity ratio(t-1) x Private credit			-0.0758	-0.631***				
Liquidity ratio(t-1) x Enforcement days					0.0221	0.984***		
Liquidity ratio(t-1) x Accounting standards							-0.00197	-0.0300***
Observations	1,906	1,239	1,902	1,239	1,906	1,239	1,876	1,239
Estimation	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Log-Pseudolikelihood value	-811.6	-611.2	-811.2	-609.6	-811.6	-611.0	-804.3	-611.7
Pseudo-R-squared	0.378	0.286	0.377	0.288	0.378	0.286	0.373	0.285

Notes: Marginal effects at means are reported. Robust standard errors are not displayed. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.

All specifications include country-industry, country, industry and year dummies. Error correction for correlation at the country-industry level.

Table 15: Credit constraints and the export probability in weighted regressions

Dependent variable	Pr(Exp=1)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
External finance and R&D intensity	*High fin.*	*High R&D*	*High fin.*	*High R&D*	*High fin.*	*High R&D*	*High fin.*	*High R&D*
Log productivity(t-1)	0.106***	0.0318	0.101***	0.0214	0.103***	0.0309	0.116*	0.0116
	(0.0327)	(0.0284)	(0.0349)	(0.0227)	(0.0331)	(0.0289)	(0.0593)	(0.0306)
Log employment(t-1)	0.252***	0.233***	0.245***	0.218***	0.250***	0.232***	0.240***	0.209***
	(0.0241)	(0.0185)	(0.0250)	(0.0175)	(0.0239)	(0.0183)	(0.0343)	(0.0240)
Log capital intensity(t-1)	0.00452	0.0594***	0.0165	0.0627***	0.00669	0.0596***	-0.00364	0.0574**
	(0.0227)	(0.0196)	(0.0227)	(0.0180)	(0.0224)	(0.0196)	(0.0329)	(0.0249)
Foreign	0.110*	0.193***	0.172***	0.188***	0.102	0.193***	0.217***	0.256***
	(0.0658)	(0.0778)	(0.0558)	(0.0645)	(0.0661)	(0.0678)	(0.0496)	(0.0733)
Leverage(t-1)	-0.0195*	-0.0196*	-0.0195*	-0.0143	-0.0199*	-0.0196*	0.0424	0.0496*
	(0.0113)	(0.0116)	(0.0116)	(0.0117)	(0.0113)	(0.0115)	(0.0381)	(0.0299)
Liquidity ratio(t-1)	0.464***	0.117	0.139	-0.00866	-1.908**	-0.948	1.217*	1.348
	(0.147)	(0.225)	(0.119)	(0.168)	(0.948)	(1.227)	(0.657)	(0.856)
Liquidity ratio(t-1) x Creditor rights	-0.208***	-0.0617						
	(0.0782)	(0.103)						
Liquidity ratio(t-1) x Private credit			-0.125	-0.0251				
			(0.156)	(0.191)				
Liquidity ratio(t-1) x Enforcement days					0.322**	0.155		
					(0.155)	(0.203)		
Liquidity ratio(t-1) x Accounting standards							-0.0173*	-0.0221*
							(0.00963)	(0.0126)
Observations	2,055	1,759	2,008	1,726	2,055	1,759	1,662	1,484
Estimation	Probit	Probit	Probit	Probit	Probit	Probit	Probit	Probit
Log-Pseudolikelihood value	-862.6	-748.8	-853.0	-775.8	-863.6	-748.4	-703.8	-644.4
Pseudo-R-squared	0.393	0.385	0.387	0.346	0.392	0.385	0.387	0.370

Notes: Marginal effects at means are reported. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. All specifications include country-industry, country, industry and year dummies. Error correction for correlation at the country-industry level. Weights correspond to the inverse of the probability of being included in the estimated country sample.

Figure 3: Relationship between the magnitude of the interaction effect and the predicted export probabilities

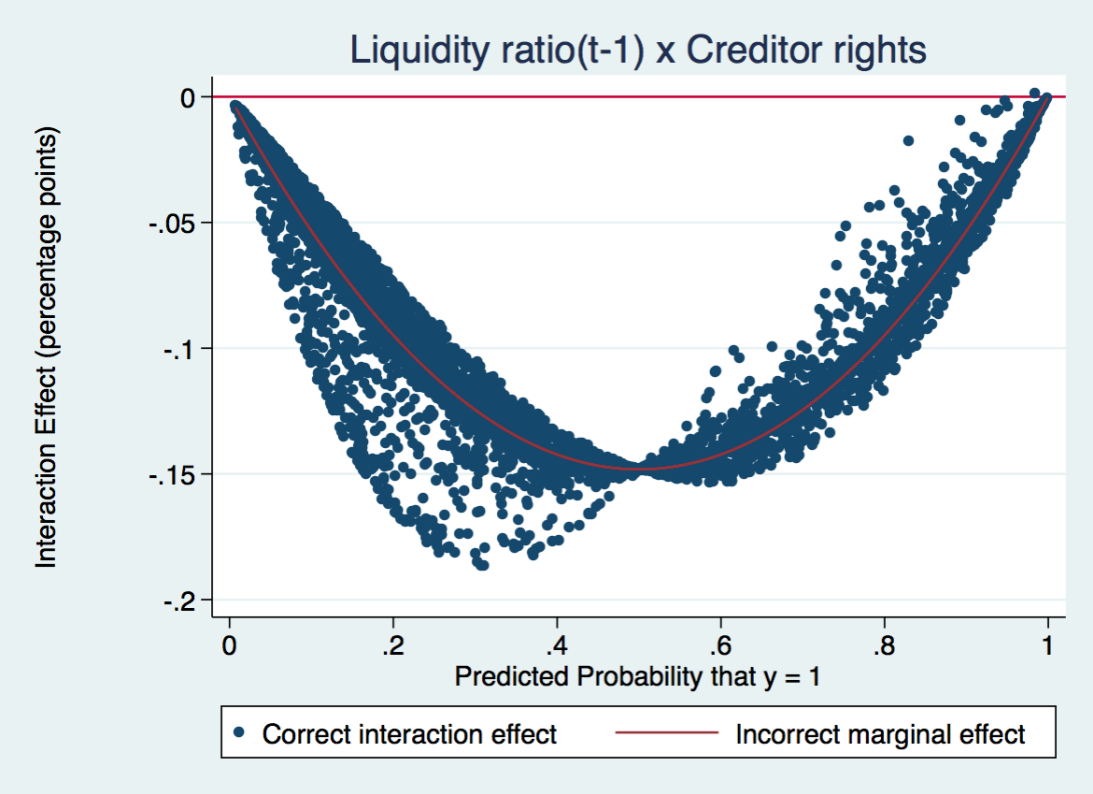
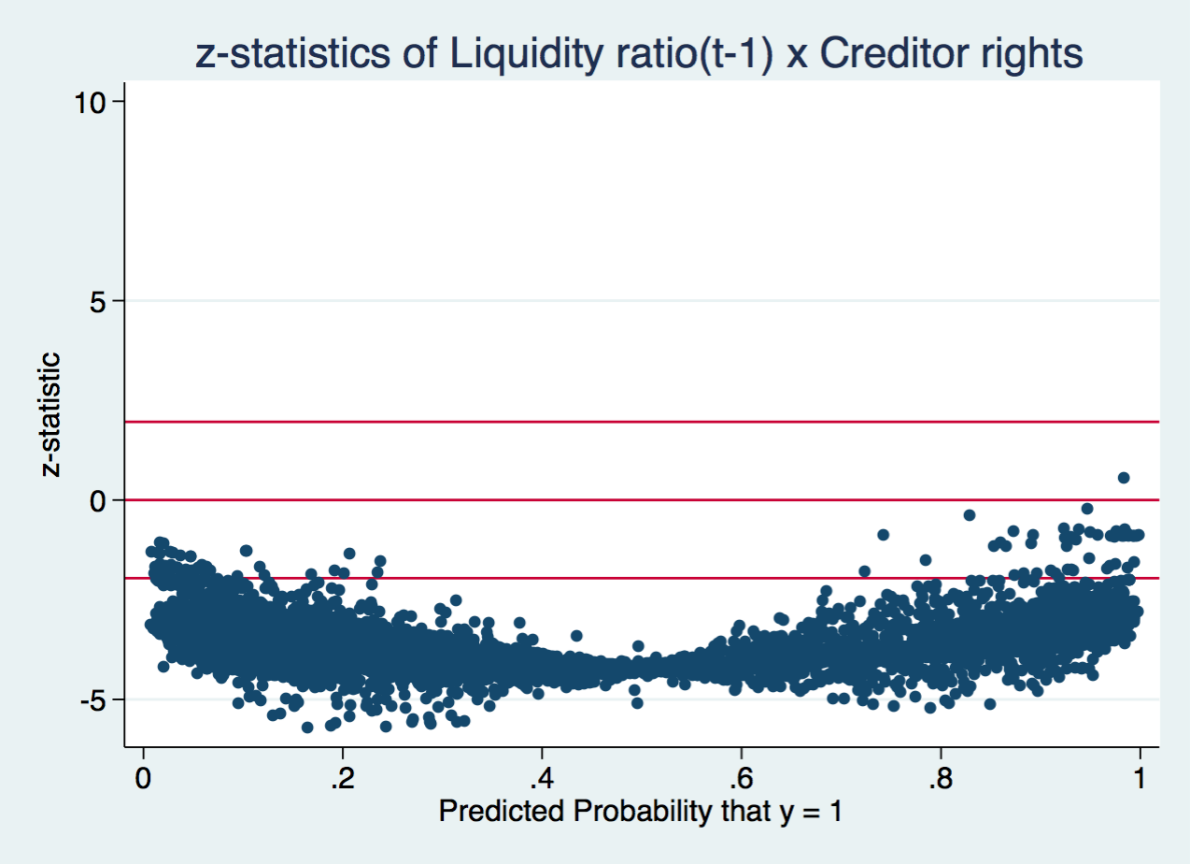


Figure 4: Relationship between the z-statistics of the interaction effect and the predicted export probabilities



3 Credit Market Institutions and Firm Imports of Capital Goods: Evidence from Developing Countries

Abstract

Using firm-level data across seven developing countries, this paper studies the interaction between a firm's wealth and a country's credit market institutions on machinery & equipment imports (=capital imports). A firm's wealth approximates unobserved credit constraints and is inversely measured by a firm's leverage (total debt over assets). The analysis suggests that credit constraints have a negative impact on the probability to import capital at all (extensive margin) but not on the capital import value (intensive margin) and intermediate imports. However, the results also indicate that institutions such as creditor rights, an efficient debt enforcement and accounting standards improve access to external finance and reduce credit constraints with regard to capital imports. Innovative firms and first-time capital importers particularly benefit from a country's institutional reform. The main conclusions also hold using self-reported measures of credit constraints.

Keywords: international trade, capital imports, machinery & equipment, financial development, credit constraints

JEL classification: F10, F12, F14, G20

3.1 Introduction

Firms from developing countries can increase their productivity by adopting an advanced technology embodied in imported capital and intermediate goods, as recent evidence shows.[59] In this process developing countries benefit from capital goods imports through the diffusion of superior technologies. Eaton and Kortum (2001) document that the vast majority of machinery and equipment imports worldwide stem from a small number of rich R&D intensive countries, but also that capital goods purchases in developing countries still exhibit a strong home bias.[60] We hypothesize that limited access to external finance prevents many firms from importing better technology and provides a possible explanation of this stylized fact. Furthermore, the institutional environment that should facilitate financial contracting and enforcement is weak in poorer countries and may act as a barrier to financing capital goods imports (IFC, 2010). World Bank data shows that about 35 percent of firms located in middle and low income countries complain about poor access to finance as a major investment constraint compared to only 15 percent for high-income OECD countries (World Bank Enterprise Surveys 2006-2009).[61]

Building on Bustos (2011), this paper develops a simple model of the decision to import capital goods in which only more productive firms invest in foreign technology because of higher fixed adoption costs. Financial frictions are introduced into the framework that depend on a country's strength of credit market institutions. As a result, a subset of firms would import capital goods if credit markets were perfect, but do not receive the required external finance due to financial frictions. They are credit constrained. The model yields a testable prediction on the relationship between a firm's wealth or assets and a country's credit market institutions: A firm's wealth becomes a stronger determinant of the import propensity in countries with weaker institutions. Put differently, for investors a higher amount of collateralizable firm assets may substitute for weak institutions in a country. We test this hypothesis using cross-country data at the firm-level from the 2002 to 2005 waves of the World Bank Enterprise Surveys (WBES).

To our knowledge, there are two papers addressing similar questions. Bas and Berthou

[59] See for instance Amiti and Konings (2007) for an assessment of the impact of cutting intermediate import tariffs on firm productivity in a sample of Indonesian firms and Kasahara and Rodrigue (2008) for an estimated effect of imported intermediates on firm productivity for Chilean firms.

[60] We use the terms capital goods and machinery & equipment interchangeably.

[61] The share of firms reporting finance as a problem is significantly higher in Africa and Latin America, namely about 45 to 50 percent, compared to East and South Asia, where the share ranges from 25 to 30 percent (see also WB, 2008).

(2011a) study a panel of Indian firms and find evidence that a better financial position increases the probability of importing capital goods. Using the same Indian dataset, Bas and Berthou (2011b) show that more liquid firms are more likely to import capital goods, in particular if they are located in financially developed regions measured by the credit volume over GDP of the region. In contrast, our theoretical formulation and results suggest a negative interaction between a firm's financial position and the quality of credit market institutions, which is more in line with the evidence from Love (2003) for firm investments. A further distinction of our paper is that it not only exploits financial development proxied by the credit volume over GDP, but also its institutional determinants. These institutional determinants are of additional interest because they can be directly affected by a country's policymakers as opposed to the lending activities of financial institutions.[62] In related work examining industry-level trade data from 1980 to 1997, Alfaro and Hammel (2007) suggest that stock market liberalizations leading to a lower cost of capital promote the import of machinery and equipment in poorer countries. However, due to the authors' use of industry-level data, they cannot determine whether the positive impact is caused by a higher profitability of the projects or reduced credit constraints at the firm-level.

To our knowledge, this is the first paper to provide firm-level evidence that creditor rights, an efficient legal enforcement of debt contracts and accounting standards lower credit constraints for introducing a foreign technology embodied in capital imports. The reduction of unobserved credit constraints is inferred from the lower sensitivity of the capital import propensity to the firm leverage observed in countries with stronger institutions. For example, in a country with few creditor rights like Brazil (creditor rights index of 1), a standard deviation increase of the leverage decreases the import propensity of the average firm by 9%, whereas the same change in the firm's leverage has no effect in a country with more creditor rights such as Thailand (creditor rights index of 2). Better institutions, firms' liquidity and debt situation also reduce the incidence of self-perceived credit constraints, which have a strong negative impact on the capital import probability. First-time and R&D intensive importers particularly benefit from institutional development and firms in financially developed countries allocate a higher share of capital goods expenses to imports. We do not find that credit constraints matter for intermediate imports. The empirical findings are robust to various specifications and estimation techniques and are not driven by a particular country.

[62]However, institutional determinants vary only across countries which poses additional empirical challenges.

3.2 Differences to Export decision

A justified question is whether the relationship between credit constraints and import decision requires a separate analysis. Put differently, can the conclusions from Chapter 2 be generalized to import decisions? We argue that some substantial differences prevent such generalizations. Credit constraints are likely to affect trade decisions because exporting and importing involve fixed costs that must be paid and financed up-front. However, fixed costs of both activities differ fundamentally. Empirically supported fixed exporting costs include collecting information on export markets and analysis of export profitability, compliance with local product rules, setting up a foreign distribution network, marketing and advertisement in foreign markets, market-specific capacity investments, and export product customization, among others (see for instance Roberts and Tybout, 1997; Bernard and Jensen, 2004; Das et al., 2007).[63] In contrast, fixed costs of importing machinery and equipment entail different cost drivers such as searching for an adequate foreign technology and establishing a relationship with a foreign supplier for installment, maintenance and instruction of the new technology (Bas and Berthou, 2011a). Furthermore, upgrading foreign technology also involves so-called technology adoption costs because the firm's workforce, management and organization must adapt to the new technology to fully exploit its potential (Yeaple, 2005; Bustos, 2011).[64] As a result, a priori the prevalence of credit constraints for the exporting and importing decision does not need to be equal because the size of fixed costs may be markedly different. This Chapter's research is also highly relevant from an economic policy perspective since firms in developing countries often lack specialized domestic inputs and machinery and thus must resort to foreign suppliers (Tybout, 2000).

Similar Melitz (2003)-type frameworks augmented by financial frictions are employed in Chapter 2 and 3 to theoretically derive testable hypotheses. The reason they are used is that empirical evidence largely supports the view that a priori more productive firms self-select into export and import markets, which can be suitably modeled in this framework (Bernard et al., 2007; Kugler and Verhoogen, 2009). As a consequence, the empirical baseline specifications in the two chapters are similar, but there are also many notable differences in the corresponding empirical parts. For instance, empirical specifications in Chapter 3 are adapted to the specific data situation and to capital import markets, namely in Section 3.9 we control for the size of domestic second-hand machinery markets and for

[63] See footnote 5.

[64] See also footnote 59.

import tariffs, check sensitivity to a particular country by dropping countries one by one, and perform further sample sensitivity tests with respect to applied selection rules. Firm fixed effects are represented using the Mundlak-Chamberlain-Wooldridge device in static and dynamic probit models that account for the past importing status (see Sections 3.7.3 and 3.7.4). In Section 3.8.2 additional credit constraints proxies and firm characteristics related to skill and organizational capacities deemed as a precondition for technology upgrading are included. Section 3.8.1 analyzes and discusses the relationship between self-perceived credit constraints and capital imports. We differentiate between intermediate goods and machinery & equipment in order to test the importance of credit market institutions and constraints for both types of imports (see Section 3.8.3). Finally, Section 3.8.4 also studies, in a two-limit tobit model, whether there is a substitutive relationship between using domestic and imported capital equipment when credit constraints are present.

3.3 Related Literature

This section aims to justify the theoretically derived methodology to detect firm-level credit constraints and the set of credit market institutions used in the empirical analysis.

3.3.1 Inference of credit constraints

As mentioned in the introduction, access to finance seems to be problematic for firms located in the developing world, according to WBES surveys. Some skeptics may however feel uncomfortable drawing conclusions about the prevalence of credit constraints from survey data because firms may justifiably be denied credit for the lack of project profitability. As a consequence, the comprehensive literature dealing with the relationship between real investments and financial frictions infers the presence of unobserved credit constraints theoretically grounded in Modigliani and Miller (1958) but in a indirect way: A firm's wealth or financial position and institutional indicators of a country's credit market should have no effect on real economic outcomes if credit constraints are absent (see also Hubbard, 1998 for a survey of this literature, Love, 2003 and Rajan and Zingales, 1998). In line with this literature, the theoretical model outlined in Section 3.3 reaches the same conclusion. In econometric terms, the theory predicts a negative interaction term between a firm's financial position and the level of financial institutional development.

3.3.2 Institutional determinants of external finance

La Porta et al. (1997, 1998) initiated a strand of literature that emphasizes the importance of institutional determinants for the development of debt and equity markets. La Porta et al. (1997) provide evidence in a sample of 49 countries that both legal rules protecting creditors and shareholders and the quality of law enforcement raise the size of capital markets and extend its reach to more firms within a country. Put differently, their results suggest that establishing legal creditor protection and an efficient law enforcement facilitates a broader access to financial markets. Rajan and Zingales (1998) show that countries that have higher accounting standards grow faster in sectors that rely heavily on financial resources. Related to the availability of external finance, Svaleryd and Vlachos (2005) and Manova (2008b) find that higher accounting standards improve the export performance and increase specialization in financially dependent sectors. Djankov et al. (2007) investigate in a panel sample of 129 countries over 25 years the institutional factors that increase the volume of private credit over GDP. They suggest that better legal protection of creditors is associated with higher ratios of private credit to GDP, especially in richer countries. In addition, their analysis shows that credit markets in poorer countries particularly benefit from the presence of credit registries that offer information about a firm's credit history, while creditor rights seem to matter less. Examining WBES data, Beck et al. (2006) conclude that firms located in countries with higher levels of institutional development, measured by a composite indicator that accounts for the effectiveness of law enforcement, are less likely to report credit constraints even after controlling for other country characteristics such as private credit over GDP. Acemoglu and Johnson (2005) emphasize the primacy of securing property rights against state expropriation over contracting institutions for financial development. More generally, the importance of these contractual, enforcement, information-sharing and property rights institutions for facilitating access to finance has been recognized by the more policy-oriented literature from international institutions such as the World Bank, the International Finance Corporation and the G-20 (IFC, 2010; WB, 2008, 2009).[65]

[65]For instance, a World Bank research report that summarizes the findings from academic research and reviews the different policy options to improve financial access acknowledges that reforming the aforementioned institutions in developing countries is a fundamental prerequisite for a well-functioning credit market (WB, 2008). Given that reforming institutions is an overwhelmingly long-term task, with the notable exception of introducing credit information registries, one may ask whether there are effective short-term actions to improve access to finance. Apart from some improvements in the payment and settlement systems to reduce transaction costs, there seems to be a consensus backed by a large body of evidence that direct government interventions into the credit market through, for example, state-owned banks, taxes or

Based on these findings from previous research, we test in a regression framework whether stronger legal creditor protection in the case of non-loan repayment and faster legal debt enforcement improve access to external finance in order to import capital goods. The time duration to resolve a debt dispute before court is used as a proxy for the efficiency of legal debt enforcement. In addition, we examine the importance of institutions aimed at reducing informational asymmetries between lenders and borrowers, such as accounting standards and the presence of credit information registries. These information sharing institutions should make firms more transparent and may thus enhance the lenders' willingness to grant credit.[66] [67]

In sum, we employ a set of credit market institutions in the analysis that has been shown in previous academic research to be beneficial to the availability of external finance and whose importance has been recognized by policy institutions and practitioners. As a result, improving these institutions may help importers of capital goods overcome potential financing obstacles at the extensive and intensive capital import margin.

3.4 Theoretical Framework

This section develops a simple monopolistic competition model of domestic production to show that a firm's adoption of a more efficient foreign technology can be constrained by the scarce availability of credit in an economy. The model is similar to Bustos (2011)

subsidies are in many cases not desirable because of its inefficiencies and unintended consequences (WB, 2008, 2009).

[66] In a robustness check, an additional rule of law indicator will be included that accounts for the positive effect of property rights institutions on the availability of external finance found by Acemoglu and Johnson (2005).

[67] Some researchers have argued that the decline of trade finance practices and poor credit conditions during the recent financial crises had severe deteriorating effects on trade flows (Auboin, 2009; Chor and Manova, 2012). In addition, the problem seems to persist in particular for import financing in poorer countries (Auboin, 2010). Since the outburst of the crisis, policy programs by regional development banks, the International Finance Corporation and local export credit agencies have supported trade finance by basically co-financing trade finance with banks and by implementing credit guarantee schemes (Auboin, 2009, 2010). Antras and Foley (2011), however, provide evidence that improvements in contractual institutions in the country of the importer may result in a higher value of imports financed on more favorable open account terms without bank involvement, while importers in countries with poorer institutions have to resort to cash in advance or to more costly letters of credit provided by bank intermediation. Given that a large part of trade transactions do occur without bank intermediation on open account terms, according to survey evidence by the International Chamber of Commerce (ICC, 2010), improving the contractual and enforcement environment in poorer countries may be complementary to the policy actions taken and is likely to make international trade more resilient to future crises.

except that credit constraints can arise and firms produce only for the domestic market.[68] Firms within a country differ in their ex ante productivities φ and wealth ω, along the lines of Melitz (2003) and Chaney (2005). Firms that want to import capital goods must incur an additional technology adoption cost f_h in addition to the fixed production cost f, as in Yeaple (2005). As a consequence, only more productive firms find it profitable to import capital goods. Due to imperfect capital markets stemming from the limited pledgeability of future (expected) operating profits, profitability alone is not a sufficient condition to upgrade technology and a firm's credit constraint condition must be overcome as well. In this second dimension, wealthier and more productive firms should be less credit constrained. The model also implies that the importance of credit constraints is negatively related to institutional characteristics of the credit market, such as the existence of creditor rights, the efficiency of debt contract enforcement or the availability of reliable information of a firm's balance sheet and credit history.

Demand Side

Consumers have Dixit & Stiglitz preferences over a continuum of differentiated goods $q(i)$.[69] These CES preferences deliver the following revenue function $r(i) = EP^{\sigma-1}p(i)^{1-\sigma}$ for each variety i supplied to the domestic market, where $p(i)$ is the price of variety i in the domestic market, $P = \left[\int_0^N p(i)di\right]^{\frac{1}{1-\sigma}}$ represents the (ideal) price index, N corresponds to the number of existing varieties and E denotes aggregate spending for the differentiated goods.

Supply Side

Labor is the only factor of production. Labor is assumed to be supplied elastically and wages are treated as numeraire and thus normalized to one.[70] In addition, a single firm is considered to be in a continuum of firms that produces a differentiated good under increasing return to scale. The production technology for every variety i, manufactured each by a single firm, involves a constant marginal cost $1/(\gamma_j\varphi)$ that depends on the ex ante firm productivity φ, a productivity-shifter γ_j related to the technology choice, where

[68] See Bas and Berthou (2011a) for a similar theoretical derivation of the decision to import capital goods when credit constraints are present.

[69] Therefore, preferences of the representative consumer are of the following CES form $U = \left(\int_0^N q(i)^\rho di\right)^{\frac{1}{\rho}}$, with a constant elasticity of substitution, $\sigma = 1/(1-\rho) > 1$, between any two varieties i within and across industries.

[70] The theoretical assumption of fixed wages across countries can be rejected in our heterogenous country sample. Introducing country-specific wages would however complicate the analysis without changing the central hypotheses of the theoretical part. In addition, we take into account different wage levels across countries and industries through fixed effects in the empirical part.

$j = \{l, h\}$ denotes either the low domestic technology l or the high imported technology h, and a fixed production cost f. If a firm adopts a more efficient foreign technology, it has to cover an additional cost f_h, but marginal production costs decline as indicated by $\gamma_h > \gamma_l = 1$.[71] The total costs in terms of required labor to produce $q(\varphi)$ units of variety i are as follows:

$$TC_l(\varphi) = f + \frac{q(\varphi)}{\gamma_l \varphi}, \qquad j = l \tag{9}$$

$$TC_h(\varphi) = f + f_h + \frac{q(\varphi)}{\gamma_h \varphi}, \qquad j = h \tag{10}$$

From (9) and (10), note that the low technology l firms feature lower fixed costs, but exhibit higher marginal costs compared to firms employing the advanced foreign technology h.

Optimal Pricing, Revenues and Profits

Given CES preferences for differentiated goods and monopolistic competition, the optimal price is a constant markup over marginal costs. A firm with productivity φ hence charges the price

$$p_j(\varphi) = \frac{1}{\rho \gamma_j \varphi}, \qquad j = \{l, h\} \tag{11}$$

Thus, the optimal price is lower for firms using the more productive ($\gamma_h > \gamma_l = 1$) imported technology. Firm revenues and profits can then be written as

$$r_j(\varphi) = EP^{\sigma-1}(\rho \gamma_j \varphi)^{\sigma-1}, \qquad j = \{l, h\} \tag{12}$$

$$\pi_l(\varphi) = \frac{1}{\sigma} r_l(\varphi) - f, \quad j = l \qquad \pi_h(\varphi) = \frac{1}{\sigma} r_h(\varphi) - f - f_h, \quad j = h \tag{13}$$

[71] Two intertwined assumptions are made. The fixed costs of importing machinery and equipment is higher than for buying domestic machinery and the foreign technology is more advanced, which is reflected in their lower marginal production costs, $\gamma_h > \gamma_l = 1$. On the one hand, fixed costs increase because importing machinery involves collecting information about a potential foreign supplier and technology, establishing and maintaining a relationship with a foreign firm, as highlighted in Bas and Berthou (2011a). Although no information about the quality of foreign capital or its source country is available, we nonetheless assume that imported machinery and equipment is technologically more advanced than domestic capital goods in our developing countries sample. As argued in Eaton and Kortum (2001), world production of capital equipment is concentrated among a small number of R&D intensive countries. Furthermore, trade figures from the UN Comtrade database conveys that 75% to 97% of machinery & equipment imports (in 2000) come from high-income OECD countries in our sample of developing countries. As a result, the adoption of foreign capital equipment requires the workforce, management and the organization as a whole to adapt to the more advanced technology which further increases fixed costs by f_h.

The revenue and operating profit equations (12) and (13) make clear that revenues are unambiguously higher for high technology firms since the demand elasticity σ is greater than one, whereas the effect of technology on profits depends on the ex ante productivity φ, the efficiency gap between the two technologies, $\gamma_h - \gamma_l$, and the fixed technology adoption cost f_h, as we see in more detail below.

Import Decision under Perfect Credit Market Institutions

A potential producer will enter the domestic market if it earns nonnegative profits using the less productive domestic technology l. More formally, the minimum required ex ante productivity draw φ^* for market entry must be such that the zero profit condition $\pi_l(\varphi^*) = 0$ is met. In this case, the operating profits of a low technology firm l cover exactly the fixed production cost: $\frac{1}{\sigma} r_l(\varphi^*) = f$ and $\varphi^* = \frac{1}{P\rho}\left(\frac{\sigma f}{E}\right)^{\frac{1}{\sigma-1}}$. Next, it is only profitable for a fraction of more productive firms to adopt the more efficient foreign technology because it involves incurring an additional fixed cost f_h that outweighs the efficiency gains, $\gamma_h > 1$, for unproductive firms.[72] As a result, firms will only install the foreign technology if the increase in operating profits compensates for the higher fixed costs. This leads to the following profitability condition:

$$\pi_h(\varphi_h^*) = \pi_l(\varphi_h^*) \iff (\gamma_h^{\sigma-1} - 1)\frac{1}{\sigma} r_l(\varphi_h^*) = f_h, \tag{14}$$

while φ_h^* denotes the threshold productivity to employ the foreign technology. The benefit of using the advanced technology embodied in the imported capital goods (LHS of 14) is increasing in firm productivity φ because more efficient firms are better at exploiting the foreign technology in terms of generating operating profits (see also equation 12). This is why firms above the productivity level φ_h^* self-select into importing capital goods. We get the closed-form solution for the threshold productivity φ_h^* by solving the equation (14) for firm productivity:

$$\varphi_h^* = \frac{1}{P\rho}\left(\frac{\sigma f_h}{E(\gamma_h^{\sigma-1} - 1)}\right)^{\frac{1}{\sigma-1}}. \tag{15}$$

The higher the additional fixed cost f_h and the less pronounced the efficiency gap, $\gamma_h^{\sigma-1} - 1$, between the two technologies is, the higher the initial productivity of the firm must be to gain an advantage by using the imported technology.

[72] More precisely, the result that only a fraction of the domestic firms adopt the foreign technology holds if the parameter restriction $\frac{f_h}{f} > \gamma_h^{\sigma-1} - 1$ is introduced. This also corresponds to the empirically relevant scenario according to Bustos (2011).

Credit Constraints

We introduce credit constraints in a simple manner that capture the essence of a poor financial contracting and enforcement environment, as in Matsuyama (2005). As a result of imperfect credit market institutions, a firm can only credibly pledge up to a fraction, $\theta \in [0, 1]$, of the operating profits generated from selling differentiated goods. The weaker the credit market institutions are, the lower the fraction θ is. The fraction θ of operating profits also represents the maximum level of external financing the firm obtains to cover the fixed costs, f and f_h.

Matsuyama (2005) argues that several agency cost theories could explain and justify the assumption of limited profit pledgeability, $\theta \in [0, 1]$. For instance, Tirole (2006) and Egger and Keuschnigg (2009) propose a moral hazard approach in which a high enough profit stake must be given to a borrower in order to avoid the firm's appropriation of private benefits from the investment. Assuming that private benefits are positively correlated to the level of (expected) operating profits would then automatically lead to a pledgeability of future operating profits of less than one in order to meet the firm's incentive compatibility constraint. The quality of credit market institutions, such as creditor rights, the efficiency of legal contract enforcement and accounting standards, are reflected in the level of profit pledgeability θ. These credit market institutions are intended to restrict the ability of entrepreneurs to extract private benefits (θ goes up) by directly empowering creditors or by lowering information asymmetries between lenders and borrowers and thus should increase the availability of external funds (see also Section 3.3.2). Consequently, we also refer to θ as the state of credit market institutions or institutional quality.

Import Decision under Imperfect Credit Market Institutions

Because of imperfect credit market institutions, firms cannot entirely pledge their (expected) operating profits of an innovation. Therefore, the profitability of introducing the advanced technology does not suffice to evaluate whether a firm can finance a foreign technology upgrade. In this imperfect institutional environment, a second credit constraint condition and with it the firm's wealth ω become relevant. As a result, only firms that meet the following profitability (16) and credit constraint condition (17) will become importers of more advanced capital goods:

$$(\gamma_h^{\sigma-1} - 1)\frac{1}{\sigma} r_l(\varphi_h^*) \geq f_h \tag{16}$$

$$\theta \left[\frac{1}{\sigma} r_h(\varphi) \right] \geq f + f_h - \omega \tag{17}$$

The equation (16) states the profitability condition already explained above. In addition, the new credit constraint condition expressed in (17) says that pledgeable operating profits (LHS of 17) must be higher than demanded or collateral-adjusted credit (RHS of 19) to obtain credit. Demanded credit equals the difference between the fixed production and technology adoption cost, $f + f_h$, and the firm's wealth ω. As opposed to the environment with perfect credit market institutions, a firm's wealth ω becomes important since it lowers demanded credit and also increases the share of credit backed by collateral. Next, solving the credit constraint condition (17) for productivity φ yields the minimum productivity $\bar{\varphi}_h$ to be granted credit for importing capital goods.

$$\overline{\varphi}_h(\omega, \theta) = \frac{1}{P\gamma_h\rho} \left(\frac{\sigma(f + f_h - \omega)}{\theta E} \right)^{\frac{1}{\sigma-1}} \tag{18}$$

Firms having a productivity $\varphi \geq max\left[\varphi_h^*, \bar{\varphi}_h(\omega, \theta)\right]$ can profitably adopt the foreign technology and access the necessary external finance.[73] But more interestingly, there may exist a subset of credit constrained firms in the productivity range $\overline{\varphi}_h(\omega, \theta) > \varphi \geq \varphi_h^*$ that are prevented from profitably upgrading technology only because they lack the required external finance. The following proposition ensures that this subset of firms is non-empty:

Proposition: *If* $\frac{\gamma_h^{\sigma-1}-1}{\gamma_h^{\sigma-1}} \left(\frac{f}{f_h} + 1 \right) > \theta$ *holds, then there exists a subset of credit constrained firms in a specific country that could profitably import capital goods, but do not obtain the required external finance.*

(See the Appendix 3.11.1 for a simple derivation of this proposition.)

In the following, we assume that this proposition holds and some firms have no access to the local credit market. Ultimately, this is the empirical question this paper examines, namely whether credit constraints matter for the decision to import capital goods. To derive the testable hypothesis, we rewrite the credit constraint condition (17) as the probability that a firm overcomes potential credit constraints. This probability is formulated as a

[73] The corresponding minimum productivity to secure finance for the domestic market entry using the low technology l is obtained by solving the condition $\theta \left[\frac{1}{\sigma} r_l(\varphi) \right] = f - \omega$ for productivity φ: $\overline{\varphi}(\omega, \theta) = \frac{1}{P\rho} \left(\frac{\sigma(f-w)}{\theta E} \right)^{\frac{1}{\sigma-1}}$. It is clear that $\overline{\varphi}_h > \overline{\varphi}$ for all ω as long as $\frac{f_h}{f} > \gamma_h^{\sigma-1} - 1$ holds. In words, this means that credit constraints are tighter for potential innovators than for firms serving the home market with the low technology l.

linear expectation given firm i's productivity φ_i , wealth ω_i, and the state of credit market institutions θ_c in country c as follows:

$$E(\frac{1}{\sigma}r_h(\varphi_i) \geq \frac{1}{\theta_c}(f + f_h - \omega_i) \mid \varphi_i, \omega_i) = \frac{1}{\sigma}r_h(\varphi_i) + \frac{1}{\theta_c}(\omega_i - f - f_h) \tag{19}$$

In light of equation (19), a higher firm productivity φ_i reduces credit constraints directly through higher profits. In the model setup, the firm's wealth ω_i is exogenous and lowers the probability of a binding credit constraint condition if credit market institutions are imperfect. In perfect credit markets, a firm's wealth ω should not be a significant determinant of importing capital goods. As a consequence, the firm's wealth ω is predicted to be particularly relevant for firms located in countries with poor credit market institutions (low θ_c), as can be observed from the interaction between wealth and institutions in (19), $\frac{1}{\theta_c}\omega_i$. In a more formal way, the interaction effect between a firm's wealth ω_i and the institutional quality θ_c is given by

$$\frac{\partial^2 E(\frac{1}{\sigma}r_h(\varphi_i) \geq \frac{1}{\theta_c}(f + f_h - \omega_i))}{\partial \omega_i \partial \theta_c} = -\frac{1}{\theta_c^2} \leq 0, \quad \theta \in [0, 1] \tag{20}$$

The cross-partial derivative (20) implies that the the positive impact of an increase in the firm's wealth ω on overcoming the credit constraint condition (17) is higher in countries with underdeveloped credit market institutions. The lower the profit pledgeability θ_c, the more important the firm's wealth ω becomes because it substitutes for a poor institutional setting.

Hypothesis 1: *The positive effect of a marginal increase in the firm's wealth on the likelihood of importing capital goods is greater in countries with weaker credit market institutions.*

Hypothesis 1 summarizes the theoretical discussion. Weaker credit market institutions translate into a lower profit pledgeability θ_c, which increases the need for firm collateral to access external finance or for internal funds that replace loans. Hence, a firm's wealth becomes a more important determinant of the decision to import capital goods when institutions are weak. A firm's wealth is inversely related to its leverage. A less levered firm can provide more collateral, which matters more where investors are less protected and corporate governance is weaker. On the other hand, the firm's wealth can also be interpreted as internal funds that substitute for the limited availability of external finance.

3.5 Data

3.5.1 Firm-level database

This paper employs the standardized firm level data compiled by the World Bank's Enterprise Surveys in the 2002 to 2005 waves.[74] The surveys use a stratified sampling methodology in order to create a representative sample of a country's sectoral composition. In addition, firm size and geographic locations within countries are used as complementary stratifying variables.[75] Within each strata, the firms are picked randomly. The data contains the needed information to construct the firms' wealth indicators and other firm characteristics included as control variables and the dependent variables. Firms that report an inconsistent current over total assets ratio above one are deleted from the sample. Furthermore, we also restrict the sample in most specifications to solvent firms with non-negative equity.[76] The motivation behind this decision is that we believe that the domain of the theory applies primarily to solvent firms and that insolvent firms are entirely excluded from formal credit markets.[77] Applying these selection rules and considering only firms with information about capital goods imports leaves us with a sample of 3405 firms from 7 developing countries.[78]

3.5.2 Dependent variable

The dependent variable is an indicator equalling one for a firm that imported new machinery and equipment in a specific year. In other specifications, the dependent variable changes and is defined as the share of capital imports to total capital goods expenses to investigate whether firms tend to switch to imported machinery when credit constraints become less binding. Finally, we also study the impact of credit constraints on the intensive import margin, that is the imported value of capital goods.

[74] The covered survey years differ across countries in the data sample.

[75] Consequently, the sampling methodology leads to an oversampling of larger firms.

[76] Non-negative equity means a total debt over total assets ratio of lower than or equal to 1.

[77] We relax this assumption in Section 3.9 and test how sensitive the results are to this selection rule.

[78] The sample used in the regressions with the probability of importing intermediate goods as a dependent variable is larger (see Table 29).

3.5.3 Independent variables

As the empirical counterpart of the firm's wealth ω, *Leverage* calculated as total debt over total assets is used. More indebted firms have a lower equity stake, can provide less collateral and have a higher risk of bankruptcy. Hence, highly levered firms are less likely to obtain external finance. *Liquidity ratio,* defined as current assets over total assets, is employed as an alternative proxy for firm-level credit constraints. It measures the availability of internal funds required in the case of limited access to external finance. In further robustness tests, the *Property ratio* and *Log firm age* are included as credit constraints variables.

In the Melitz-type framework presented in Section 3.4, more productive firms set lower prices resulting in higher operating profits; therefore, they are less likely to be credit constrained. We measure firm productivity by the log value added per worker, *Log productivity.* Another important firm characteristic in this framework is the firm size defined as the log number of employees, *Log employment.* To control for the possibility that more capital intensive firms are more likely to import capital and intermediate goods, *Log capital intensity,* measured by the logarithm of total assets per worker, is employed. The dummy variable *Foreign*, which equals one for foreign-owned firms and zero otherwise, is also included in all specifications. Foreign-owned firms may be less prone to credit constraints and have a higher likelihood of importing capital goods.

In robustness checks, we add firm characteristics related to the skill-level of the production workers and the educational background of the employees and the management. This is potentially important because a certain threshold level of human capital is probably required to fully exploit an advanced technology. Lastly, we also control for the share of foreign in total inputs (*Foreign input share*) and include a dummy that equals one if a firm has a *ISO certification*, which may also capture firm aspects linked to organizational and productive efficiency.

3.5.4 Credit market institutions

The paper considers several indicators intended as proxies for the institutional development of a country's credit market. For instance, we employ *Creditor rights* drawn from Djankov et al. (2007). It is an index ranging from 0 (weak creditor rights) to 4 (strong creditor rights) and is meant to capture the investor protection dimension of the credit

market institutions.[79] More specifically, it can be interpreted as a measure of a creditor's legal power to recoup his investment in a firm on the verge of bankruptcy. The variable *Enforcement days* also comes from Djankov et al. (2007) and is defined by the log number of days it takes to enforce an unhonored debt contract worth 50% of the country's GDP per capita. This measure was constructed as of January 2003. It reflects the important legal enforcement dimension of the financial infrastructure. Even in economies with strong creditor rights, investors may be reluctant to lend money because of slow contract enforcement in the case of a firm default. A further institutional variable employed is the widely used *Accounting standards* indicator from the Center for International Financial Analysis and Research (CIFAR) and taken from Bushman et al. (2004) for the year 1995 (see also La Porta et al., 1998).[80] It is a measure for the transparency of a firm's financial disclosure in a country, or more generally for a country's corporate governance standards. In other words, the reduction of informational asymmetries between investors and borrowers as a result of better accounting standards should increase the likelihood of obtaining credit. Finally, the conventional outcome based measure *Private credit,* which is taken from Beck et al. (2009) and defined as the credit volume from banks and other financial institutions extended to the domestic sector over GDP, is also used in some specifications.[81]

(For a more detailed description of the independent variables, credit market institutions,

[79]Both indicators *Private credit* and *Creditor rights* are averaged over the period 1999-2003.

[80]This accounting standards indicator is highly correlated over time, as shown by Rajan and Zingales (1998) and Manova (2008b), so that the country ranking in this indicator is unlikely to be different for the sample period that begins later. In addition, this accounting standards indicator is of high quality and accurate as confirmed in Hope (2003) and is the only indicator that is available for six out of the seven countries in the sample.

[81]The choice of institutional data sources in Chapter 2 and 3 was governed by two criteria : data quality and firm-level sample coverage with regard to included countries and time periods. We have employed financial indicators whose methodology of construction is transparent and which capture important aspects of a country's credit market institutions (see also Section 3.3.2). Furthermore, all indicators were used in academic studies published in highly-ranked journals and are also widely cited and employed in more policy-oriented publications (see Section 3.3.2 for details). Apart from accounting standards, for which there is no better alternative (see also Section 3.5.4 and footnote 80), all indicators are available for most countries in the sample within the investigated time periods. Other popular databases such as the World Economic Forum data or the World's Bank Doing Business database started collecting data after our sample time period ended for most countries. In addition, some of the indicators of the Doing Business data are based on updated creditor rights and enforcement data from Djankov et al. (2007) exploited in this thesis. Another shortcoming of these two databases is the relatively more limited country availability. To the best of our knowledge, institutional data at lower levels of aggregation are not widely available since credit market institutions predominantly vary at the national level. However, please remember that we exploit variation at the country-firm level to test our hypothesis on the interaction between a firm's financial situation and a country's credit market institutions. This should also mitigate concerns about the level of aggregation of the institutional variables.

country characteristics and their data sources see the Appendix 3.11.2)

3.6 Descriptive Statistics and Empirical Specification

This section offers a descriptive statistical overview of the the country- and firm-level data employed later in the regression analysis. In addition, the baseline empirical specification of the regression equation is presented.

3.6.1 Descriptive statistics

Table 16 shows the country distribution of the firms included in the study. The sample covers 3405 firms unevenly distributed across 7 developing countries.[82] For instance, firms from Brazil and Thailand together make up more than 50% of the sample. Consequently, we must check that the results are not affected by overrepresented countries in the sample - this is performed in the robustness Section 3.9. In addition, the values and averages of our main four institutional variables across countries are presented.

Table 17 displays the descriptive statistics of all the lagged firm characteristics. In line with the firm-level empirical literature on the import and export determinants, importers are larger, employ a better educated workforce and CEO, have more skilled production workers and are more likely to be foreign-owned (Bernard et al., 2007). Capital importers also use a higher share of foreign inputs and are more likely to be an ISO certified company. Interestingly, productivity, capital and R&D intensity do not differ significantly by capital importer status in these preliminary statistics.[83] With regard to leverage, importers have on average a statistically significant lower leverage than non-importers, whereas non-capital importers seem to be, a bit surprisingly, more liquid than capital importers.[84] Finally, importers are on average older, but non-capital importers own more property.

[82] Only countries with at least 100 firms were selected.
[83] Value added per worker is, however, an arguably imperfect proxy for productivity
[84] Despite using lagged values, reverse causality may be a reason for this finding.

Table 16: Country sample and credit market institutions

			Credit market institutions			
Country	No. of firms	% tot. firms	Creditor rights	Enforcement days	Accounting standards	Private credit
Brazil	773	22.70	1	6.34	56	0.30
India	155	4.55	2	6.05	61	0.28
Indonesia	521	15.30	2	6.35		0.21
Philippines	201	5.90	1	5.94	64	0.40
South Africa	246	7.22	3	5.63	79	1.24
Sri Lanka	360	10.57	2	6.09	74	0.27
Thailand	1149	33.74	2	5.97	66	1.10
Total	3405	100				
Mean			1.86	6.05	66.67	0.54

Table 17: Mean equality tests of firm characteristics

	Non-Capital Importer	Capital Importer	Mean equality t-test
Number of firms (n=3405)	2212	1193	
Credit constraints proxies:			
Leverage	0.50	0.44	5.61[a]
	(0.29)	(0.30)	
Liquidity ratio	0.54	0.52	3.02[a]
	(0.28)	(0.25)	
Property ratio	0.19	0.14	4.22[a]
	(0.20)	(0.14)	
Log firm age	2.65	2.76	-3.83[a]
	(0.77)	(0.76)	
Firm characteristics:			
Log productivity	1.02	1.93	0.12
	(1.29)	(1.58)	
Log employment	4.48	5.40	-17.02[a]
	(1.35)	(1.59)	
Log capital intensity	2.19	2.26	-1.22
	(1.42)	(1.73)	
Foreign	0.09	0.23	-11.25[a]
	(0.-9)	(0.42)	
Share workforce with university degree	15.06	25.67	-11.66[a]
	(18.45)	(32.44)	
Log R&D spending/sales	-5.37	-5.55	1.22
	(1.87)	(2.22)	
CEO graduate degree	0.10	0.17	-5.60[a]
	(0.30)	(0.38)	
Skilled share of production workers	0.35	0.49	-10.32[a]
	(0.35)	(0.39)	
Foreign input share	15.24	36.47	-15.85[a]
	(28.14)	(37.20)	
ISO certification	0.32	0.41	-4.74[a]
	(0.47)	(0.49)	

Notes: Mean values of credit constraints proxies and firm characteristics are reported by import status and the t-statistics of the mean equality test. Significance levels: [a]1%, [b]5%, [c]10%.
Standard deviations in parentheses.

3.6.2 Empirical Specification

We estimate the following baseline pooled probit model in the empirical section:

$$\begin{aligned} Pr(Imp_{ickt} = 1) &= Pr(\alpha + \beta Z_{it-1} + (\gamma_1 + \gamma_2\theta_c) \times \omega_{it-1} + \lambda_c + \nu_k + \mu_{ck} + \eta_t + \epsilon_{ickt} > 0) \\ &= \Phi(\alpha + \beta Z_{it-1} + (\gamma_1 + \gamma_2\theta_c) \times \omega_{it-1} + \lambda_c + \nu_k + \mu_{ck} + \eta_t), \end{aligned} \tag{21}$$

where Imp_{ickt} is a dummy that equals one if a firm i in sector k from country c imports machinery and equipment (capital goods) in the period t.[85] $\Phi(..)$ represents the standard normal distribution. θ_c denotes the level of institutional development of a country's credit market (see Section 3.5.4). ω_{it-1} is the one year lag of the firm's wealth. *Leverage(t-1)* and *Liquidity ratio(t-1)* proxy for ω_{it-1}. We conjecture that less leveraged and more liquid firms are less credit constrained, as explained in Section 3.3. We thus expect the following coefficient signs: negative for leverage, $\gamma_1 < 0$, and positive for the liquidity ratio, $\gamma_1 > 0$. However, the importance of the firm's financial position should be higher when the country's institutions governing financial contracting and enforcement are non-existent or underdeveloped. This implies that the coefficient of the leverage interaction should be positive[86], $\gamma_2 > 0$, and that of the liquidity interaction negative[87], $\gamma_2 < 0$. Z_{it-1} is a lagged vector of firm characteristics controlling for differences in productivity, size, ownership and physical and human capital. It is expected that larger and more productive firms have a higher import propensity. Foreign-owned firms, as well as those that are skill or capital intensive, may also be more inclined to employ technologically advanced capital goods from abroad.

We estimate equation (21) including interactions between a country and a sector μ_{ck} and their main effects λ_c, ν_k. The country dummy λ_c soaks up the main effects of differences in credit market institutions and other country characteristics affecting the capital import probability; for instance, the distance to capital good producers, the amount of human capital in a country or exchange rate changes affecting import prices. The sectoral dummy ν_k captures the differential impact of sectoral characteristics such as capital, skill or R&D intensity, whereas the country-sector dummy μ_{ck} is intended to pick up determinants at the country and sector level, such as the import tariff structure and prices, other non-

[85] The analysis contains 36 sectoral dummies at the three- and four-digit ISIC level.
[86] Except for the Interaction *Leverage(t-1) x Enforcement* days, which is predicted to be negative.
[87] Except for the Interaction *Liquidity ratio(t-1) x Enforcement* days, which is predicted to be positive.

tariff protectionist measures for capital goods, sectoral exchange rate pass-through rates, the size of the market for domestic second-hand capital goods, industrial policies and the differential impact of a country's institutions across industries. The time fixed effect μ_t absorbs changes in the global economic environment that affect all firms similarly in the sample, for example, the world business cycle.

Apart from pooled probit estimations, we also estimate panel versions of specification (21) with fixed effects to account for unobserved heterogeneity at the firm-level. For instance, heterogenous managerial ability and corporate strategies may affect firms' financial wealth and result in different technology choices contemporaneously. Therefore, we include firm fixed effects in a probit specification as follows:

$$Pr(Imp_{it} = 1) = \Phi(\beta Z_{it-1} + (\gamma_1 + \gamma_2\theta_c) \times \omega_{it-1} + \eta_t + c_i), \tag{22}$$

where firm fixed effects c_i in (22) are modeled using the Mundlak-Chamberlain-Wooldridge device (see Mundlak, 1978, Chamberlain, 1982 and Wooldridge, 2002). Fixed effect c_i for firm i is defined as

$$c_i = \psi + \xi \bar{Z}i + (\phi_1 + \phi_2\theta_c) \times \bar{\omega}_i + a_i, \quad \left(a_i \mid \bar{Z}_i, \theta_c, \bar{\omega}_i\right) \sim N\left(0, \sigma_a\right), \tag{23}$$

where $\bar{Z}_i$ correspond to a vector of time-averaged firm characteristics $\bar{Z}_i = T^{-1}\sum_{t=1}^{T} z_{it}$ and $\bar{\omega}_i$ to time-averaged financial proxies $\bar{\omega}_i = T^{-1}\sum_{t=1}^{T}\omega_{it}$ for firm i. σ_a is the conditional variance of a_i. Plugging (23) back into (22) yields the specification

$$Pr(Imp_{it} = 1) = \Phi(\beta Z_{it-1} + (\gamma_1 + \gamma_2\theta_c) \times \omega_{it-1} + \xi \bar{Z}i + (\phi_1 + \phi_2\theta_c) \times \bar{\omega}_i + a_i), \tag{24}$$

whose parameters of interest γ_1, γ_2 and β can be estimated by conventional random effects probit software including the additional regressors $\bar{Z}_i$ and $\bar{\omega}_i$.[88] $\bar{Z}_i$ also subsumes different sets of country- and industry dummies depending on the specific model.[89] We also estimate dynamic (pooled) probit specifications to check whether firms with a past experience of

[88] Another possible choice would have been to estimate an adjusted equation (24) using pooled MLE. The coefficients would have been identified only up to a scalar $(1+\sigma_a)^{-1/2}$, but in turn the assumption needed for the random effects probit estimation that binary responses Imp_{it} are independent over time conditional on (x_{it}, c_i) could have been dropped (see Wooldridge, 2002 for more details). However, unpublished regressions (available upon request) show that pooled MLE estimations do not alter our conclusions based on estimation of equation (24).

[89] However, unpublished regressions (available upon request) show that the robustness of the results does not depend on the inclusion of country- or industry dummies in the parametrization of c_i.

importing are more likely to be capital importers in the present. This could be the case if some fixed costs of importing capital, such as finding an appropriate foreign technology and establishing a commercial relationship with foreign technology suppliers, are sunk costs and occur at the time when machinery and equipment were previously imported. Moreover, using again the Mundlak-Chamberlain-Wooldridge device proposed by Wooldridge (2005) we incorporate fixed effects c_i into a dynamic probit specification that can be written as

$$Pr(Imp_{it} = 1) = \Phi(\rho Imp_{it-1} + \beta Z_{it-1} + (\gamma_1 + \gamma_2\theta_c) \times \omega_{it-1} + \eta_t + c_i), \qquad (25)$$

In equation (25) the import probability in t, $Pr(Imp_{it} = 1)$ can depend on the one-period lag of the import status Imp_{it-1}. The firm fixed effect c_i in (25) has the form

$$c_i = \psi + \xi_0 Imp_{io} + \xi \bar{Z}i + (\phi_1 + \phi_2\theta_c) \times \bar{\omega}_i + a_i, \quad \left(a_i \mid Imp_{i0}, \bar{Z}_i, \theta_c, \bar{\omega}_i\right) \sim N\left(0, \sigma_a\right), \quad (26)$$

In addition to (23), in (26) c_i is also allowed to be correlated with the initial import status Imp_{i0}. Estimation can again be carried out in the random effects probit framework including $\bar{Z}_i$, $\bar{\omega}_i$, Imp_{i0} and Imp_{it-1} as additional regressors. To check the sensitivity to distributional assumptions of the probit specifications, a linear probability with fixed effects will be estimated. An advantage of the linear model compared to probit models (22) and (25) is that firm fixed effects can correlate with time-varying explanatory variables such as financial wealth.[90] To estimate a dynamic linear model, we employ the GMM estimator introduced by Arellano and Bond (1991). Moreover, in cross-sectional regressions we use 2SLS to instrument our financial variables to control for the possibility of omitted firm characteristics that may confound the consistent estimation of the coefficients of interest γ_1, γ_2.[91] We correct standard errors for serial dependence in pooled probit models and for heteroskedasticity in linear probability models.

[90] Of course, a well-known disadvantage of the linear probability model is that response probabilities are not bounded between zero and one.

[91] The set of instruments used is described in detail in Section 3.7.3, where the 2SLS results are presented.

3.7 Results

3.7.1 The effect of credit market institutions on the capital import probability

Table 18 presents the results concerning our main hypothesis about the interaction between credit market institutions and the firm's financial position. The coefficients of the traditional firm determinants of exporting and importing goods all display the expected signs in line with Bernard et al. (2007): Larger, more productive and capital intensive firms have a higher probability of importing capital goods, albeit productivity surprisingly does not enter the regression significantly in the specifications 1 to 4 and 7. However, value added per worker may only capture part of firm productivity. Foreign-owned firms also have a significantly higher capital import propensity. This probably indicates reduced credit constraints because of the foreign owner's co-financing of investments (see also Manova et al., 2009) or the use of more advanced production technologies of foreign-owned firms.

The estimations show a consistent picture with respect to a firm's leverage and its interactions with the credit market institutions. A more levered firm has a lower capital import probability, but its marginal effect is decreasing in the quality of a country's financial contracting and enforcement, which is in line with hypothesis 1 (see columns 1 to 4). In countries with more creditor rights, faster enforcement of debt contracts and higher accounting standards, the negative impact of a firm's leverage on the decision to adopt a more advanced foreign technology is sharply diminished. This suggests that a firm's leverage plays a less harmful role in access to external finance in countries with more developed credit market institutions. Interestingly, the presence of private and public credit registries for potential lenders does not reduce the importance of a firm's debt situation. In contrast, public registries seem to have a detrimental effect on the capital import propensity (see the interaction in column 4). This counterintuitive result may capture some peculiarity in the small country sample and will be further explored in Section 3.7.2.

In columns 5 to 8, the leverage variable is replaced with the liquidity ratio as our second proxy for firm-level credit constraints. This set of estimations with the firm's liquidity ratio and its interactions with the institutional measures are mostly statistically insignificant.[92] One possible explanation is that the costs related to the decision to import capital goods are substantial. As a consequence, the level of external financing required would be high irrespective of the level of available internal finance. This would make the capital import

[92] In the columns 5 and 7, a firm's liquidity unexpectedly displays a larger negative effect on the capital import propensity in countries with weaker credit market institutions.

Table 18: Credit market institutions, the firm's financial position and the capital import probability

Dependent variable	Dummy=1 if firm imports capital goods in t							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log productivity(t-1)	0.014	0.017	0.013	0.016	0.018[c]	0.018[c]	0.016[c]	0.018[c]
	(0.011)	(0.011)	(0.009)	(0.011)	(0.011)	(0.011)	(0.009)	(0.010)
Log employment(t-1)	0.082[a]	0.082[a]	0.075[a]	0.082[a]	0.081[a]	0.080[a]	0.074[a]	0.081[a]
	(0.007)	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)
Log capital intensity(t-1)	0.030[a]	0.028[a]	0.032[a]	0.029[a]	0.027[a]	0.027[a]	0.(29[a]	0.027[a]
	(0.010)	(0.010)	(0.009)	(0.010)	(0.010)	(0.010)	(0.009)	(0.010)
Foreign	0.095[a]	0.096[a]	0.086[a]	0.095[a]	0.094[a]	0.095[a]	0.083[a]	0.095[a]
	(0.030)	(0.030)	(0.027)	(0.030)	(0.030)	(0.030)	(0.027)	(0.030)
Leverage(t-1)	-0.283[a]	3.278[a]	-0.792[a]	0.007				
	(0.096)	(0.882)	(0.259)	(0.046)				
Liquidity ratio(t-1)					-0.323[a]	0.908	-0.807[a]	-0.056
					(0.110)	(1.040)	(0.303)	(0.053)
Leverage(t-1) x Creditor rights	0.151[a]							
	(0.050)							
Leverage(t-1) x Enforcement d.		-0.545[a]						
		(0.146)						
Leverage(t-1) x Accounting st.			0.012[a]					
			(0.004)					
Leverage(t-1) x Private bureau				0.064				
				(0.067)				
Leverage(t-1) x Public registry				-0.236[a]				
				(0.077)				
Liquidity ratio(t-1) x Creditor rights					0.130[b]			
					(0.059)			
Liquidity ratio(t-1) x Enforcement d.						-0.167		
						(0.172)		
Liquidity ratio(t-1) x Accounting st.							0.011[b]	
							(0.005)	
Liquidity ratio(t-1) x Private bureau								-0.001
								(0.079)
Liquidity ratio(t-1) x Public registry								-0.159[c]
								(0.089)
Observations	5,128	5,128	4,871	5,128	5,128	5,128	4,871	5,128
Pseudo-R-squared	0.264	0.265	0.188	0.264	0.264	0.263	0.189	0.264

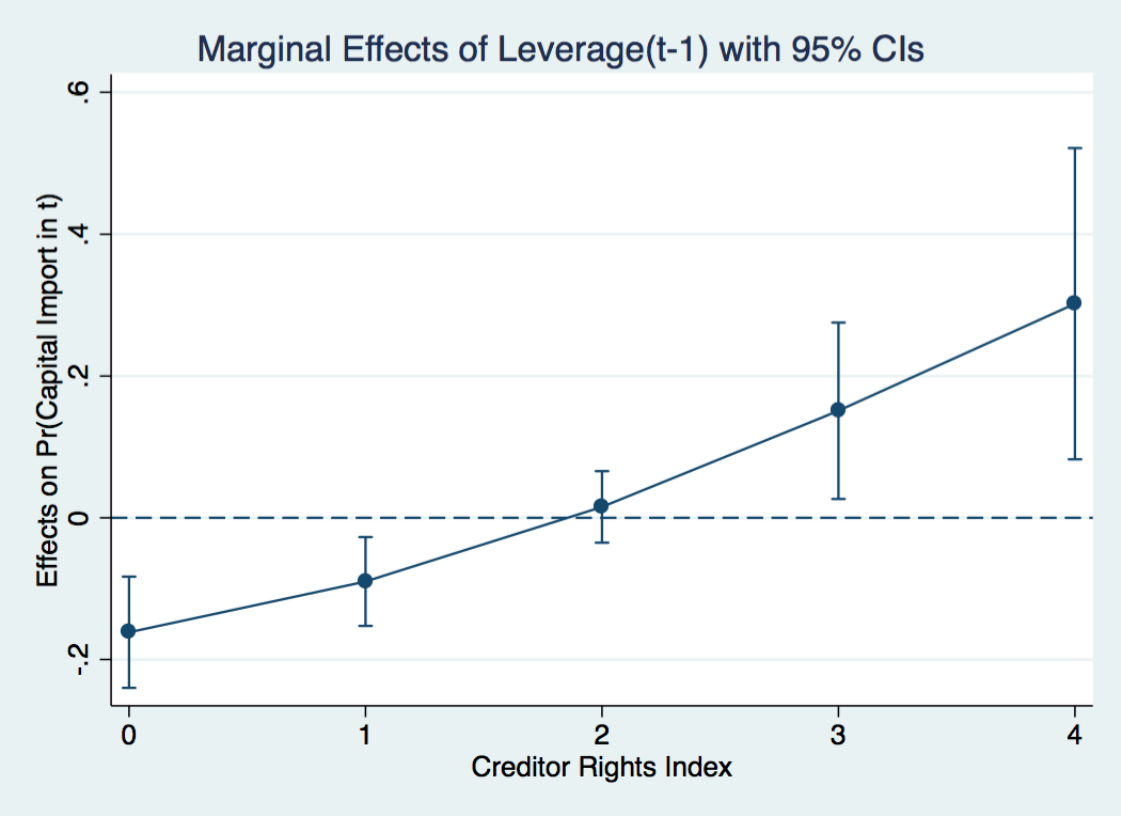
Notes: Estimation: Pooled Probit. Marginal effects at means are reported. Significance levels: [a]1%, [b]5%, [c]10%.

Firm-level cluster- and heteroskedastic-robust standard errors in parentheses.

All specifications include country-industry, country, industry and year dummies.

probability insensitive to a change in the firm's liquidity. Put differently, collateral measures such as the firm's leverage are more appropriate to approximate credit constraints if firm financing must rely to a large extent on external finance.

Figure 5: The marginal effect of a unit-increase in the firm's leverage



Based on the baseline specification in the first column of Table 18, we assess the economic importance of our results. Figure 5 depicts the marginal effect of a unit-increase in the firm's leverage on the capital import probability as a function of the creditor rights index. In accordance with hypothesis 1, Figure 5 shows that a higher firm leverage reduces the probability of importing capital goods, particularly for firms located in countries with weak creditor rights. To arrive at a more meaningful interpretation of the quantitative impact, the depicted marginal effects are multiplied by a sample standard deviation in the firm's leverage equal to 0.29. Then, a standard deviation increase in the leverage decreases the capital import probability by about 5 percentage points for firms in countries with a creditor rights index of zero. Given an average import probability of 0.27, this corresponds to a 17% lower capital import probability. Furthermore, in countries with no creditor rights (index value= 0), a 10% decrease in the leverage has about the same effect as a 10%-increase in the firm size, namely a rise of about 3% in the average import propensity. In countries with a creditor rights index of 1, like Brazil or the Philippines, the negative

marginal effect gets smaller to slightly over minus 2 percentage points or to a 9% lower capital import probability for the average firm. There is no effect of leverage on importing technology in countries with an index value of 2 (for instance Thailand, Sri Lanka or Indonesia). Consequently, the firm's financial position becomes less important in countries with stronger financial institutions confirming hypothesis 1. The marginal effect of leverage then unexpectedly turns positive for firms operating in countries with strong creditor rights (index of 3 or 4). One possible explanation is that potential investors interpret the firm's leverage as a signal of the ability to generate future profits in countries with strong financial institutions as these firms have enjoyed the faith of other investors - at least in the past. More generally, this quantification shows that higher creditor rights are associated with lower credit constraints inferred from the substantially smaller negative impact of a firm's leverage in financially more developed countries.

3.7.2 Which credit market institutions matter most?

It is relevant to determine which credit market institutions may have the highest leverage to reduce firm-level credit constraints, in particular from a policy perspective. To start, it is important to bear in mind that two intertwined features of the data make a statistical horse race of the country-level credit market institutions difficult to accomplish: Several indicators are highly correlated and the number of countries included in the estimation sample is fairly small. Nonetheless, this section sheds some light on this question by entering the institutions two by two and simultaneously in order to see which institutions retain a significant effect.

We are primarily interested in the interaction terms of Table 19. In the first column one can note that an efficient legal enforcement of debt contracts seems to dominate the provision of *de jure* creditor rights in the environment of a developing country. The enforcement days interaction (see column 1) enters significantly and almost unchanged compared to its equivalent in Table 18 as opposed to the insignificant creditor rights interaction. Although the interaction terms in the second column are imprecisely estimated, the results suggest that creditor rights and accounting standards may be both important in a similar manner. In the third column almost perfect collinearity prevents us from drawing conclusions on the importance of legal debt enforcement compared to accounting standards. The availability of bank credit matters as can be seen from the estimated coefficients of the firm's leverage and its private credit interaction in column 4. When we control for private credit over GDP in columns 5 and 6, creditor rights still exerts a positive but insignificant influence

Table 19: The importance of different credit market institutions

Dependent variable	Dummy=1 if firm imports capital goods in t							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log productivity(t-1)	0.016	0.013	0.014	0.015	0.015	0.017	0.015	0.017
	(0.010)	(0.009)	(0.009)	(0.011)	(0.011)	(0.011)	(0.010)	(0.011)
Log employment(t-1)	0.082^a	0.075^a	0.076^a	0.082^a	0.082^a	0.082^a	0.082^a	0.082^a
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Log capital intensity(t-1)	0.028^a	0.031^a	0.030^a	0.028^a	0.029^a	0.028^a	0.029^a	0.028^a
	(0.010)	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Foreign	0.096^a	0.085^a	0.086^a	0.094^a	0.094^a	0.096^a	0.095^a	0.097^a
	(0.030)	(0.027)	t.027)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
Leverage(t-1)	2.942^c	-0.492	1.746	-0.156^b	-0.272^a	3.376^b	-0.203	3.221^b
	(1.595)	(0.403)	(1.750)	(0.062)	(0.097)	(1.431)	(0.144)	(1.568)
Leverage(t-1) x Creditor rights	0.022	0.094			0.110		0.102	
	(0.084)	(0.095)			(0.071)		(0.066)	
Leverage(t-1) x Enforcement d.	-0.496^b		-0.337			-0.560^b		-0.539^b
	(0.244)		(0.228)			(0.226)		(0.263)
Leverage(t-1) x Accounting st.		0.005	0.004					
		(0.008)	(0.007)					
Leverage(t-1) x Private credit				0.201^a	0.090	-0.010		
				(0.073)	(0.105)	(0.113)		
Leverage(t-1) x Public registry							-0.151	-0.016
							(0.098)	(0.135)
Leverage(t-1) x Private bureau							0.077	0.042
							(0.067)	(0.068)
Observations	5,128	4,871	4,871	5,128	5,128	5,128	5,128	5,128
Pseudo-R-squared	0.265	0.188	0.188	0.263	0.264	0.265	0.264	0.265

Notes: Estimation: Pooled Probit. Marginal effects at means are reported. Significance levels: ^{a}1%, ^{b}5%, ^{c}10%.

Firm-level cluster- and heteroskedastic-robust standard errors in parentheses.

All specifications include country-industry, country, industry and year dummies.

on firm-level credit constraints (see column 5), while enforcement days remains highly significant with an almost unchanged magnitude in column 6. In the last two columns, 7 and 8, we check whether the presence of public and private credit registries reduces the negative impact of a firm's debt position on obtaining credit for importing capital goods. Somewhat surprisingly, this cannot be confirmed from the estimations in columns 7 and 8 in which we control for creditor rights and the time it takes to enforce a debt contract. This finding is consistent with the estimations of Table 18 (column 4), but contrasts with the results from Djankov et al. (2007). It may be reasonable to conclude that the number of countries is too small to test the effect of an institution that enters the regression as a dummy variable.

Although the results of this section must be interpreted with caution, the importance of the legal enforcement of debt contracts clearly emerges from the analysis. One possible interpretation is that creditor rights matter, but the weak legal enforcement in many developing countries is complementary and constitutes the binding firm constraint for access to external finance and the subsequent technology upgrade.

3.7.3 Panel specifications, instrumental variables and subsample estimations

Using various tests, this section aims to check the robustness of the evidence regarding the importance of finance for the decision to import capital goods. For this purpose, columns 1 to 4 of Table 20 report the estimations of binary outcome models with firm fixed effects. The employed unbalanced panel only consists of two time periods; nonetheless, the available degrees of freedom allow us to include firm fixed effects to control for unobserved heterogeneity at the firm level. Columns 1 and 2 include firm fixed effects in a probit model by applying the so-called Mundlak-Chamberlain-Wooldridge (M-C-W) device as detailed in Section 3.6.2. In addition, to check model sensitivity we also estimate a linear probability model with firm fixed effects in the subsequent columns 3 and 4. Apart from significant negative signs of capital intensity in columns 1 and 2, firm fixed effects capture the entire effect of productivity and size as the corresponding estimates in columns 1 to 4 have reduced magnitudes and are not significant anymore. In contrast, leverage has a significant negative marginal effect on the capital import probability, but providing more creditor rights weakens this adverse relationship between leverage and import propensity substantially, as columns 1 and 3 display. Similar but insignificant results are obtained in columns 2 and 4 - in which one can read that faster legal enforcement may reduce the negative impact of firm leverage on capital imports through credit constraints. The

Table 20: Panel specifications, 2SLS and R&D intensity

Dependent variable	Dummy=1 if firm imports capital goods in t									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
R&D Intensity							*Low*	*High*	*Low*	*High*
Log productivity(t-1)	-0.002	-0.030	0.003	0.004	0.008	0.010	0.017	0.010	0.020	0.011
	(0.010)	(0.011)	(0.013)	(0.013)	(0.008)	(0.008)	(0.014)	(0.016)	(0.014)	(0.016)
Log employment(t-1)	-0.019	-0.027	0.013	0.013	0.059[a]	0.061[a]	0.077[a]	0.089[a]	0.078[a]	0.089[a]
	(0.027)	(0.031)	(0.032)	(0.032)	(0.009)	(0.009)	(0.009)	(0.011)	(0.009)	(0.011)
Log capital inten.(t-1)	-0.040[b]	-0.048[b]	-0.029	-0.029	0.022[a]	0.021[a]	0.023[c]	0.046[a]	0.021	0.044[a]
	(0.019)	(0.021)	(0.020)	(0.020)	(0.007)	(0.007)	(0.013)	(0.015)	(0.013)	(0.015)
Foreign	0.082[a]	0.068[a]			0.085[a]	0.086[a]	0.084[c]	0.072[b]	0.088[c]	0.073[b]
	(0.016)	(0.018)			(0.026)	(0.025)	(0.051)	(0.034)	(0.051)	(0.034)
Liquidity ratio(t-1)(=LR)	0.203	-0.296	0.137	-0.049						
	(0.163)	(1.604)	(0.136)	(1.314)						
Leverage(t-1) (=Lev)	-0.258[c]	1.416	-0.420[b]	2.964	-0.225[b]	3.058[b]	-0.220[c]	-0.444[a]	3.133[a]	3.784[a]
	(0.149)	(1.515)	(0.180)	(1.879)	(0.102)	(1.420)	(0.122)	(0.152)	(1.185)	(1.296)
LR x Creditor rights	-0.022		0.010							
	(0.083)		(0.070)							
LR x Enforcement days		0.081		0.034						
		(0.267)		(0.218)						
Lev x Creditor rights	0.138[c]		0.226[b]		0.112[c]		0.119[c]	0.226[a]		
	(0.078)		(0.104)		(0.057)		(0.066)	(0.076)		
Lev x Enforcement days		-0.237		-0.493		-0.506[b]			-0.519[a]	-0.633[a]
		(0.251)		(0.310)		(0.232)			(0.196)	(0.216)
Model (Estimation)	Probit M-C-W		LPM (Within)		LPM (2SLS)		Pooled Probit (MLE)			
Observations	5292	5268	5,305	5,305	2,681	2,681	3,220	1,908	3,220	1,908
Firm fixed effects	yes	yes	yes	yes	no	no	no	no	no	no
Hansen J statistic					0.809	0.862				
Hansen J p-value					0.667	0.6499				
Kleinbergen-Paap (KP)					1303.043	81.341				
KP statistic value (5%)					11.04	11.04				

Notes: Marginal effects at means are reported in columns 3 to 10. In columns 1 and 2 average marginal effects are reported. Significance levels: [a]1%, [b]5%, [c]10%. Firm-level cluster- and heteroskedastic-robust standard errors in parentheses. Error correction for correlation at the country-industry level in columns 5 and 6. The probit model using the M-C-W device and the linear probability model (columns 1 to 4) contain firm fixed effects and year dummies. 2SLS and pooled probit specifications include country-industry, country, industry and year dummies. Leverage (t-1), its interaction with Creditor rights and Enforcement days are instrumented by Leverage (t-2), a second lag of Leverage x Creditor rights, an external auditor dummy and the log age of the firm. KP statistic value (5%) indicate the threshold for rejecting weak identification (H_0) allowing for 5% relative 2SLS bias.

leverage and the related interaction with the enforcement variable are at the margin of the 10%-significance level in the linear model reported in column 4, which is remarkable given that the other firm characteristics are far from being significant. It should be noted that we also control for the firm's liquidity situation and the associated institutional interactions in these panel specifications. In sum, the panel models in the first four columns show that the significance and magnitudes of the estimated impacts of the financial variables are comparable to the effects from pooled probits (see columns 1 and 2 of Table 18). Furthermore, probit (columns 1 and 2) and linear (columns 3 and 4) specifications give qualitatively equal results. Overall, the presented panel specifications strengthen the case for a positive effect of strong credit market institutions on access to finance.

We employ instrumental variable estimations in the linear probability model of columns 5 and 6 to further mitigate the concern that our results are driven by omitted third factors. The lagged leverage variable and its interaction with *Creditor rights* (in column 3) and *Enforcement days* (in column 4) are instrumented by the two period lag of the current period leverage and the *Leverage(t-2) x Creditor rights* interaction. Furthermore, we also use the log age of the firm and a dummy that equals one for a firm that employs an external auditor to review its financial statements as additional instruments. The null of valid instruments in the overidentifying restriction test cannot be rejected as indicated by the heteroskedastic and clustered errors consistent Hansen J statistic and the p-value. In addition, the reported Kleinbergen-Paap statistic, which is a robust F-statistic of the first-stage regression, confirms that weak identification is not a problem. This suggests that our chosen set of instruments is adequate. Using 2SLS estimations, we obtain the estimated coefficients of the instrumented financial variables in columns 3 and 4. The results are encouraging and in line with hypothesis 1 because their magnitudes are almost the same as the corresponding marginal effects in the baseline regressions of Table 19, despite their higher standard errors from 2SLS estimations.

The following identification of the unobservable firm credit constraints relies upon the higher riskiness of investments in firms belonging to R&D intensive industries. Egger and Keuschnigg (2010) point out that R&D intensive firms use more intangible and not collateralizable assets such as human capital and specialized equipment. In terms of the theoretical model in Section 3.3, these firm characteristics increase agency problems and thus reduce the fraction θ of operating profits lenders accept as credibly pledgeable (see also Matsuyama, 2005). Empirically, one should therefore observe a greater importance of a firm's balance sheet conditions and a country's credit market institutions for firms

operating in R&D intensive sectors. This expectation is met by the data presented in columns 7 to 10 of Table 20 in which we divide the sample according to the sample median of the R&D intensity variable (R&D spending over sales) from Kroszner et al. (2007). The firm's financial situation, which is proxied by leverage, and the financial interaction terms exert a larger and more significant effect on the capital import probability in sectors with a high R&D intensity as opposed to less innovative sectors (compare columns 8 to 7 and 10 to 9). As a consequence, more R&D intensive firms seem to particularly benefit from the development of credit market institutions.

3.7.4 The importance of sunk importing costs

Firms that import capital goods for the first time are likely to incur higher fixed (sunk) costs compared to incumbent capital importers. First-time importers must first find an adequate foreign supplier, negotiate a contract, adapt the production process to the new foreign technology, learn to use the new technology efficiently and so on. Follow-up purchases of capital goods may involve lower fixed costs as incumbents already have experience with upgrading technology along with lower costs due to established relations with foreign suppliers. As a result, credit constraints may be more severe for first-time capital importers. This is what we test in this section and is presented in Table 21.

For this purpose, we include the lagged importer status in all specifications. Indeed, in all specifications having been a capital importer in the previous year significantly increases the probability of capital imports a year later (columns 1 to 9). The inclusion of the lagged importer status halves the size of the effects of the financial variables in the first two columns compared to the corresponding results. In addition, significance reduces remarkably. In the next step, the financial variables are interacted with the lagged importer status. The results are displayed in columns 3 to 5. Although relatively imprecisely estimated, the results suggest that improved financial conditions at the firm- and country-level matter most for firms that are new importers of specific capital goods. Consequently, this evidence supports the idea that credit constraints are more prevalent among new capital importers implying that institutional development is especially beneficial for this subset of firms.

In the next step, we estimate a dynamic probit model that controls for the initial and lagged importer status and, importantly, represents firm fixed effects by following the Mundlak-Chamberlain-Wooldridge device. The results are reported in columns 6 and 7. The lagged

Table 21: Controlling for past capital importer status

Dependent variable	Dummy=1 if firm imports capital goods in t								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Imp(t-1)	0.705[a]	0.705[a]	0.730[a]	0.728[a]	0.723[a]	0.231[a]	0.231[a]	0.218[b]	0.217[b]
	(0.017)	(0.017)	(0.033)	(0.034)	(0.035)	(0.014)	(0.014)	(0.917)	(0.910)
Log productivity(t-1)	0.000	0.001	-0.001	0.002	-0.000	-0.004	-0.004	-0.005	-0.006
	(0.009)	(0.009)	(0.010)	(0.009)	(0.009)	(0.012)	(0.012)	(0.018)	(0.018)
Log employment(t-1)	0.049[a]	0.049[a]	0.049[a]	0.049[a]	0.050[a]	-0.061[b]	-0.063[b]	-0.025	-0.025
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.030)	(0.030)	(0.042)	(0.042)
Log capital intensity(t-1)	0.019[b]	0.019[b]	0.022[a]	0.018[b]	0.019[b]	-0.062[a]	-0.063[a]	-0.027	-0.027
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.021)	(0.022)	(0.030)	(0.030)
Foreign	0.038	0.039[c]	0.040	0.040[c]	0.037	0.019[c]	0.020		
	(0.024)	(0.024)	(0.025)	(0.024)	(0.025)	(0.011)	(0.011)		
Leverage(t-1)	-0.153[c]	1.471[c]	-0.211[b]	1.086	-0.108	-0.210	1.919	-0.308	1.571
	(0.088)	(0.875)	(0.107)	(0.939)	09.074)	(0.209)	(1.783)	(0.287)	(3.116)
Leverage(t-1) x Importer(t-1)			0.073	0.764	0.175				
			(0.133)	(1.000)	(0.107)				
Leverage(t-1) x Creditor rights	0.088[c]		0.121[b]			0.163		0.177	
	(0.047)		(0.055)			(0.109)		(0.173)	
Leverage(t-1) x Cred. rights x Imp(t-1)			-0.065						
			(0.056)						
Leverage(t-1) x Enforcement days		-0.242[c]		-0.175			-0.302		-0.258
		(0.145)		(0.156)			(0.295)		(0.512)
Leverage(t-1) x Enforcement x Imp(t-1)				-0.136					
				(0.166)					
Leverage(t-1) x Private credit					0.154[b]				
					(0.078)				
Leverage(t-1) x Priv. cred. x Imp(t-1)					-0.275[a]				
					(0.088)				
Model/Estimation	Pooled Probit					Probit M-C-W		Dynamic GMM	
Observations	4,566	4566	4,667	4,566	4,566	4726	4726	1,954	1,954
Firm fixed effects	no	no	no	no	no	yes	yes	yes	yes
Pseudo-R-squared	0.538	0.538	0.552	0.538	0.540				

Notes: Marginal effects at means are reported in columns 1 to 5 and 8 and 9. In columns 6 and 7 average marginal effects are reported. Significance levels: [a]1%, [b]5%, [c]10%. Firm-level cluster- and heteroskedastic-robust standard errors in parentheses. Pooled probit specifications include country-industry, country, industry and year dummies, while probit using the Mundlak-Chamberlain-Woodridge device (M-C-W) and Dynamic GMM contain firm fixed effects and year dummies. Dynamic GMM estimations (Arellano-Bond) employ second order lags of regressors to instrument for first-differences of all regressors and the lagged importer status denoted by Imp(t-1) .

importer status remains a very strong and highly significant predictor of the capital import probability (compare columns 6/7 to columns 1 to 5). However, its size is only about a third of the pooled probit specifications (compare columns 6/7 to columns 1 to 5). This implies that including firm fixed effects absorbs some of the effects previously attributed to sunk importing costs. Fixed effects also decrease the impact of other time-varying firm characteristics. For instance, larger and more capital intensive firms now have a lower import propensity after considering unobserved firm heterogeneity and lagged importer status. The estimations of average marginal effects of the financial variables are, however, not affected by the inclusion of firm fixed effects. The effect of firm leverage as a function of creditor rights or legal enforcement is not significant in columns 6 and 7, but marginal effects display the expected signs and have a similar magnitude to previous regressions. As a result, dynamic probit models provide further evidence in favor of an easier access to financial funds in institutionally more developed credit markets, which is in line with hypothesis 1.

Columns 8 and 9 show Arellano-Bond GMM estimations of a linear dynamic specification that includes the lagged importer status and also allows for firm fixed effects. The instrument vector for the first-differenced regressors contains the second order lags of current regressors, as customary for this GMM framework. The appropriate overidentifying restriction tests are implemented and the null hypothesis, which states that the moment conditions are correct, cannot be rejected. Unfortunately, we cannot test the no second order error autocorrelation condition needed for consistent estimates due to limited sample periods. Taking this into account, the point estimates of the financial variables remain consistent with hypothesis 1 despite being non-significant like all of the other regressors, except the lagged importer status. This strengthens the robustness of our results since in this framework we control for unobserved heterogeneity and endogeneity of all regressors and past importer experience.[93]

[93]Furthermore, unreported results show that *Leverage(t-1)* and the *Leverage(t-1) x Creditor rights* interaction are the only regressors (except the lagged importer status) that achieve significance at the 10%-level if the regressors are not instrumented and thus are more accurately estimated.

3.8 Additional Results

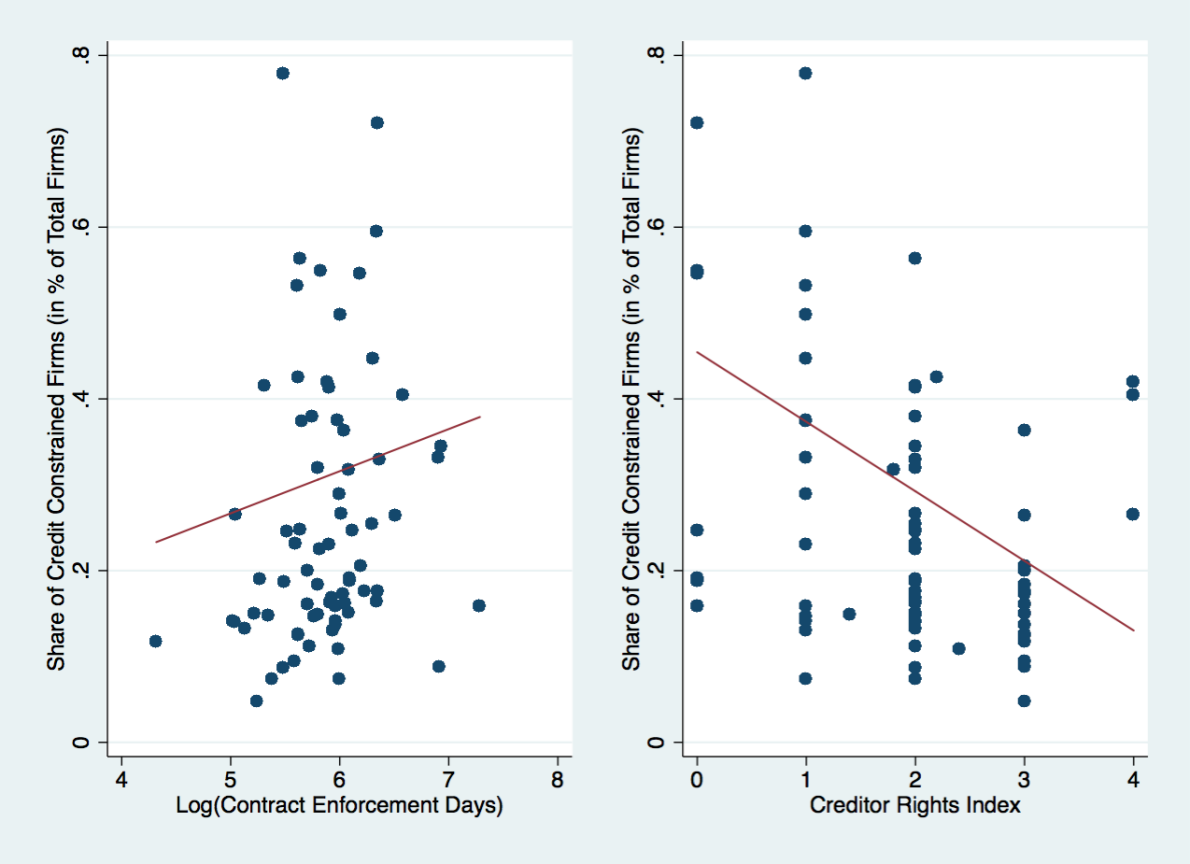
3.8.1 Perceived credit constraints and capital imports

In this section, we assess the importance of self-reported credit constraints on capital import propensity. Beforehand, we also check whether firms' financial situations affect perceived credit constraints. Thus, the results reported in this section also test the validity of financial measures as proxies for limited access to finance. The response to the question: *"How problematic for the operation and growth of the firm's business is access to financing?",* from the World Bank Enterprise Surveys 2002- 2005 was used to construct a binary indicator of credit constraints. Specifically, answers range from zero (no problem) to four (very severe obstacle). In a first step, only firms that perceive restricted financing to be a *very severe obstacle* have been labeled as credit constrained. In our sample of low and lower-middle income countries these include about 13% of all manufacturing firms. A disadvantage of using a survey questionnaire to infer on the presence of credit constraints is the potential endogeneity due to omitted variables or justification bias, as explained below. On the other hand, self-reported credit constraints are certainly a more direct measure of financing difficulties than liquidity or leverage ratios. For a large sample of developing countries, Figure 6 plots the relationship between a country's level of financial institutional development and the corresponding country's share of firms reporting credit constraints. The left plot displays a negative fitted relationship between the duration of enforcing a debt contract before court and the share of credit constrained firms, while the right plot shows that countries with a higher level of creditor protection tend to have proportionately less firms that perceive credit constraints as a very severe obstacle for firm growth (see Figure 6).

Table 22 displays the marginal effects of probit regressions that include potential determinants of self-reported credit constraints. The average probability of being credit rationed is about 16% in the estimation samples.[94] Foreign-owned firms report about a 30% lower probability to perceive access to finance as a severe problem compared to the domestic average firm throughout specifications 1 to 8. Larger, more productive and older firms appear to have a slightly improved subjective availability of funding, while capital intensity has no effect. With respect to productivity, this seems at least to be the case in specifications 7 and 8 that include country and industry fixed effects. Turning to our financial measures,

[94]The average probability of being credit constrained is just the sample frequency of firms reporting being credit constrained.

Figure 6: Credit market institutions and share of firms reporting credit constraints



a standard deviation (0.33) increase of firms' own internal liquidity decreases self-reported financing problems by about -0.016 or 10% in column 6 in relation to the average firm. Similar liquidity effects hold in all specifications. A higher firm's leverage deteriorates the subjective availability of financing substantially, in particular in countries that have underdeveloped financial institutions (see column 1 to 8). This is also confirmed by the Wald tests below whose null hypotheses that leverage and its interactions with credit market institutions equal jointly zero can always be rejected at least at the 10%-significance level. Thus, these set of estimations are consistent with our main hypothesis, namely that the importance of a low leverage is a more important determinant of access to credit in financially underdeveloped countries. Moreover, from the Wald tests we also infer that the quality of countries' financial institutions (and private credit/GDP) reduce perceived credit constraints through lowering the adverse effect of firms' leverage or by raising the potential availability of external funding directly; the null hypotheses that financial development and their interactions with leverage are jointly zero are always rejected.

Next, it is examined whether our binary indicator of self-reported measure of credit constraints, *Credit Constraints (CC),* has an impact on the probability of importing machinery and equipment, after controlling for productivity, size, capital intensity and foreign ownership. In specifications 1 and 2 of Table 23 probit models are estimated that differ by the set of included industry (1 and 2), country dummies (1 and 2) and their interactions (only in 2). In both models the variable *Credit Constraints* is negative, as expected, but does not significantly affect the capital import probability.

However, the estimations could be biased because of the potential endogeneity of our binary indicator of credit constraints due to omitted variables. For instance, financial funding may be demanded predominantly by firms that have identified and developed investment opportunities. In imperfect credit markets there can be an excess demand of funds even though the proposed projects may be profitable. This would result in perceived limited access to finance. At the same time, this set of firms could be characterized by a relatively high degree of unobserved managerial, organizational and technological abilities that also increase the propensity to use foreign capital goods. Consequently, a positive correlation between unobserved firm abilities and perceived credit constraints may lead to an understated- upward biased - negative impact of our credit constraint variable. A positive error term correlation with the finance indicator could also arise if potential lenders observe that firms employing a foreign technology are also more risk-loving. As a result, the loan applications of these firms could be rejected more often. In contrast, firms that report

Table 22: Determinants of perceived credit constraints

Dependent variable	Dummy=1 if firm perceives access to finance as a very severe investment constraint							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log productivity(t-1)	-0.009	-0.009	-0.008	-0.007	-0.004	-0.007	-0.013^{c}	-0.014^{c}
	(0.007)	(0.008)	(0.011)	(0.005)	(0.008)	(0.008)	(0.008)	(0.008)
Log employment(t-1)	-0.016^{a}	-0.017^{a}	-0.008^{b}	-0.014^{a}	-0.016^{a}	-0.015^{a}	-0.008^{b}	-0.011^{b}
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
Log capital intensity(t-1)	0.004	0.004	-0.002	-0.001	0.000	-0.001	-0.001	-0.002
	(0.009)	(0.010)	(0.011)	(0.005)	(0.009)	(0.009)	(0.009)	(0.008)
Log firm age	-0.014	-0.014	-0.013^{c}	-0.018^{a}	-0.014	-0.017^{c}	-0.014	-0.014^{b}
	(0.011)	(0.011)	(0.007)	(0.006)	(0.010)	(0.010)	(0.008)	(0.007)
Foreign	-0.059^{a}	-0.059^{a}	-0.073^{a}	-0.059^{a}	-0.061^{a}	-0.060^{a}	-0.056^{a}	-0.059^{a}
	(0.015)	(0.015)	(0.013)	(0.015)	(0.014)	(0.016)	(0.015)	(0.018)
Liquidity ratio(t-1)	-0.062^{a}	-0.059^{a}	-0.072^{a}	-0.050^{a}	-0.063^{a}	-0.051^{a}	-0.039^{b}	-0.041^{b}
	(0.021)	(0.021)	(0.027)	(0.018)	(0.021)	(0.019)	(0.016)	(0.019)
External revisor dummy	-0.086^{a}	-0.080^{a}	-0.031^{c}	-0.032^{b}	-0.045^{b}	-0.030	-0.013	-0.021
	(0.020)	(0.020)	(0.017)	(0.014)	(0.020)	(0.022)	(0.020)	(0.018)
Leverage(t-1)	0.145^{b}	-0.733^{b}	0.122	0.035	0.108^{c}	0.096	0.083^{c}	0.087^{c}
	(0.060)	(0.313)	(0.179)	(0.029)	(0.058)	(0.058)	(0.047)	(0.045)
Leverage(t-1) x Creditor rights	-0.053^{b}				-0.027	-0.019	-0.007	-0.008
	(0.025)				(0.025)	(0.028)	(0.022)	(0.023)
Leverage(t-1) x Enforcement days		0.130^{b}						
		(0.053)						
Leverage(t-1) x Accounting standards			-0.001					
			(0.003)					
Leverage(t-1) x Private credit/GDP				0.068				
				(0.054)				
Creditor rights	0.007				-0.039^{c}	-0.002		
	(0.013)				(0.020)	(0.017)		
Enforcement days		-0.003						
		(0.030)						
Accounting standards			-0.009^{a}					
			(0.002)					
Private credit/GDP				-0.284^{a}		-0.216^{a}		
				(0.038)		(0.030)		
Rule of law						-0.064^{a}		
						(0.023)		
GNI	0.000^{a}	0.000^{a}	0.000^{a}	0.000^{a}	0.000^{a}	0.000^{a}		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
Observations	4,578	4,578	3,555	4,403	4,403	4,403	4,578	4,245
Country/Industry dummies	No	No	No	No	No	No	Yes	Yes
Country-industry dummies	No	No	No	No	No	No	No	Yes
Pseudo-R-squared	0.145	0.146	0.203	0.179	0.168	0.180	0.204	0.201

Table 22: continued

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Leverage(t-1) =Leverage(t-1) x Creditor rights=0	5.54^c				8.15^b	9.54^a	10.55^a	11.93^a
$Prob > \chi^2$	0.063				0.017	0.009	0.005	0.003
Leverage(t-1) x Creditor rights=Creditor rights=0	5.69^c				22.47^a			
$Prob > \chi^2$	0.058				0.000			
Leverage(t-1) =Leverage(t-1) x Enforcement d.=0		7.01^b						
$Prob > \chi^2$		0.030						
Leverage(t-1) x Enforcement d. = Enforcement d.=0		25.45^a						
$Prob > \chi^2$		0.000						
Leverage(t-1) =Leverage(t-1) x Accounting st.=0			8.48^b					
$Prob > \chi^2$			0.0144					
Leverage(t-1) x Accounting st.=Accounting st.=0			70.33^a					
$Prob > \chi^2$			0.000					
Leverage(t-1) =Leverage(t-1) x Priv. cred./GDP=0				16.82^a				
$Prob > \chi^2$				0.000				
Leverage(t-1) x Priv. cred./GDP= Priv. cred./GDP=0				88.81^a				
$Prob > \chi^2$				0.000				

Notes: Estimation: Probit. Marginal effects at means are reported. Significance levels: ^{a}1%, ^{b}5%, ^{c}10%. Robust standard errors in parentheses. Error correction for correlation at the industry-level in columns (1) to (7). Error correction for correlation at the country-industry-level in column (8). All specifications include year dummies.

a lack of credit as a very severe obstacle may be those that have been unsuccessful for other reasons. This would lead to a negative correlation between unobserved firm abilities captured in the error term and perceived credit constraints. In this case, the estimated negative effect of credit constraints would turn out to be larger- downward biased- than the true effect.

To take into account the potential endogeneity of our binary financial access indicator due to the possibility of omitted variables, we write the empirical model as follows:

$$Pr(Imp_i = 1) = Pr(\alpha + \beta Z + \gamma CC_i + \epsilon_i > 0) = \Phi(\alpha + \beta Z + \gamma CC_i), \tag{27}$$

$$Pr(CC_i = 1) = Pr(\alpha + \beta Z + \delta I + \nu_i > 0) = \Phi(\alpha + \beta Z + \delta I), \tag{28}$$

where $\Phi(..)$ denotes the standard normal distribution that leads to a bivariate probit specification. Z contains the same firm characteristics as in the baseline specification, country, industry and year dummies (see Section 3.6.2). The error terms (ϵ_i, ν_i) are assumed to have a bivariate normal distribution with mean zero and unit variance. Crucially, the two error terms are allowed to be correlated, $\rho = corr(\epsilon_i, \nu_i)$. Omitted variables that affect both the capital import propensity, $Pr(Imp_i = 1)$ in (27), and the probability to report credit constraints, $Pr(CC_i = 1)$, in (28), clearly result in a non-zero correlation $\rho \neq 0$.[95] After considering the potential endogeneity of access to finance, we expect a negative effect of credit constraints $\gamma < 0$ on the capital import probability due to lack of funding. The coefficient γ in equation (27) is identified from the probit model (28). However, it is usually not advisable to rely solely on the nonlinearity of the bivariate probit model for identification. Thus, we also employ instruments I to increase exogenous variation in perceived credit constraints CC_i. The identification of the finance effect is achieved from the following empirical strategy. First, we defend the validity of instruments on theoretical grounds and by referring to previous literature. Second, alternative sets of instruments are employed to test the sensitivity of the results. Third, equations (27) and (28) are estimated by 2SLS in a linear probability model. This allows us to apply formal weak identification and overidentifying restriction tests on the instrument set. Fourth, by comparing 2SLS estimates of the linear model to those from the bivariate probit model, we can assess the robustness of the results to strong distributional assumptions of the bivariate probit model.[96] Fifth,

[95] Equations (27) and (28) are estimated jointly by maximum likelihood.

[96] The error terms in (27) and (28) are assumed to be jointly normally distributed and to be homoskedastic.

we implement a two-step estimation procedure on modified equations (27) and (28) that is also consistent in the case of a misclassified binary indicator of credit constraints. Lastly, we generalize the results to wider definitions of self-perceived credit constraints.

Our main set of instruments include a firm's leverage and its interaction with private credit over GDP. As outlined in the theoretical Section 3.4 and backed up by an extensive literature, firms' financial situations and countries' supply of credit should affect only firms' investment behavior through changing the availability of external funding, in particular after controlling for firm productivity.[97] Moreover, as a third instrument we employ the country-sector mean value of the credit constraint indicator, *Mean CC*. This variable is strongly correlated with the credit constraint indicator as required, but unlikely to be related to unobserved firm characteristics such as managerial skills that influence both finance constraints and capital import propensity. This holds as long as firms' abilities are similarly distributed and largely uncorrelated across sectors within a specific country, which is highly probable. The strong correlation is likely to be driven by the interaction of the countries' financial institutions and sectoral characteristics, for example, the external finance intensity of firm expenditures (Rajan and Zingales, 1998) or the tangible assets share (Braun, 2003), that shape lending decisions and affect perceived credit constraints.[98] Stated differently, while our credit constraint indicator is probably related to unobserved firm characteristics, its sectoral mean is likely to be mainly influenced by exogenous sector- and country-level financial characteristics. In other specifications the instrument set includes the share of customer payments that are overdue, *Share overdue*. The higher this share, the less liquidity a firm owns to finance the fixed costs related to capital imports. Thus, this variable captures exogenous liquidity shocks to firms that are presumably independent of omitted variables. Another instrument used is a dummy - *External revisor* - that equals one if a firm employs an external revisor to review its financial statements and zero otherwise. An external revisor should make the firms financial situation more transparent and thus potentially improve access to external funding. The last instrument is the log age of the firm since an older firm may have established closer relationships to potential lenders. Moreover, the age of the firm should not be a direct determinant of its capital import propensity. For instance, learning effects over time are captured by

[97] See for instance Love (2003); Modigliani and Miller (1958); Whited (1992) for the theoretical and empirical relationships between firms' financial situations and countries' domestic credit on firms' financing constraints and investments.

[98] We do not use directly the interaction of countries' financial institutions and sector characteristics as instruments to avoid weak identification problems.

a higher firm productivity or are reflected empirically in a larger firm size. This is also consistent with a Melitz (2003)-type framework.[99] Nonetheless, different instrument sets are employed because a remaining correlation with omitted firm characteristics can never be completely excluded.

Columns 3 to 12 of Table 23 display the estimated marginal effects and their standard errors from the bivariate probit model. Apart from one specification in columns 5 and 6, one can note that the error terms of the equations (27) and (28) have a strong positive correlation with a lower bound of 0.8 and are significant at least at the 10%-level. This indicates that omitted factors affecting the probability of credit constraints and capital imports move simultaneously in the same direction. It also implies that we can reject exogeneity of credit constraints. The estimated marginal effect of credit constraints on the capital import probability ranges between -0.36 and -0.40 at the 1%-significance-level, after taking into account its endogeneity. Given that estimated import probabilities for the average firm also lie within this value range, these results imply that very severe financing obstacles reduce the import propensity to almost zero. Comparing the credit constraint effect of the bivariate probit model (columns 3 to 12) with the simple probit results (column 1 and 2), we note that not considering endogeneity of self-reported constraints results in a heavily upward biased estimate. In light of the positively correlated error terms, one explanation could be that firms with a lot of investment opportunities are more likely to report credit constraints. The effects of the other firm characteristics display all the expected signs and are in line with previous results in this chapter concerning magnitudes and significance. Also controlling for the availability of internal liquidity and ISO certification, a proxy for the organizational efficiency, does not significantly alter the estimated effects (see columns 11 and 12).

How much trust should we put in these results? On the one hand, the credit constraint effect does not seem to rely on a particular instrument or a specific combination of instruments. Replacing instruments does not change the estimated magnitude of the effect much, which may be interpreted as a comforting sign. However, we also observe that even when the instrument set employed does not differ significantly from zero, as in the specification shown in columns 9 and 10 (see the according p-value of the χ^2-statistic in the Table 23), the marginal effect does not vary much. This suggests that the identification of the credit constraint effect may be driven largely by the nonlinearity of the bivariate probit model. As

[99] As a consequence, firm-level empirical studies of trade determinants based on the Melitz-framework do not usually include a firm age variable.

Table 23: Relationship between perceived credit constraints and capital imports

Dependent variables	Imp	Imp	Imp	CC	Imp	CC	Imp	CC	Imp	CC	Imp	CC
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Log productivity(t-1)	0.021^{c}	0.025	0.005	-0.010	0.014	-0.007	0.012	-0.006	0.011	-0.004	0.003	-0.007
	(0.012)	(0.015)	(0.015)	(0.007)	(0.017)	(0.007)	(0.016)	(0.007)	(0.016)	(0.006)	(0.017)	(0.009)
Log employment(t-1)	0.096^{a}	0.097^{a}	0.074^{a}	0.008^{b}	0.073^{a}	-0.007^{c}	0.071^{a}	-0.007^{c}	0.070^{a}	-0.003	0.058^{a}	-0.005^{b}
	(0.010)	(0.011)	(0.013)	(0.003)	(0.015)	(0.004)	(0.013)	(0.004)	(0.013)	(0.004)	(0.012)	(0.002)
Log capital int.(t-1)	0.038^{a}	0.034^{a}	0.032^{a}	-0.000	0.029^{a}	-0.001	0.028^{b}	-0.002	.0276644	-0.003	0.012	-0.006
	(0.009)	(0.013)	(0.010)	(.006)	(0.011)	(0.007)	(0.012)	(0.008)	.01234	(0.008)	(0.012)	0.007
Foreign	0.111^{a}	0.103^{a}	0.063^{b}	-0.060^{a}	0.078^{b}	-0.056^{a}	0.076^{b}	-0.056^{a}	.0736573	-0.055^{a}	0.061^{c}	-0.060^{a}
	(0.025)	(0.028)	(0.028)	(0.007)	(0.038)	(0.006)	(0.035)	(0.006)	.03452	(0.008)	(0.033)	(0.006)
Credit Constr. (CC)	-0.040	-0.038	-0.364^{a}		-0.382^{a}		-0.395^{a}		-0.400^{a}		-0.404^{a}	
	(0.035)	(0.033)	(0.041)		(0.059)		(0.035)		(0.036)		(0.027)	
Liquidity ratio(t-1)											-0.227^{a}	-0.043^{b}
											(0.057)	(0.022)
ISO certification											0.098^{a}	0.001
											(0.023)	(0.014)
Instruments:												
Leverage(t-1)				0.045^{a}		0.032^{a}		0.032^{a}				0.038^{b}
				(0.014)		(0.006)		(0.006)				(0.016)
Leverage(t-1)xPr. cred.				-0.015								-0.001
				(0.014)								(0.015)
Mean CC				0.434^{a}		0.608^{a}						0.566^{a}
				(0.103)		(0.151)						(0.158)
Share overdue						0.0002		0.0002		0.0003		
						(0.0003)		(0.0003)		(0.0003)		
External revisor										-0.010		
										(0.019)		
Log firm age										-0.009^{c}		
										(0.006)		
Model	Probit		Bivariate Probit									
Observations	3,681	3,531	3,264	3,264	2,969	2,969	2,969	2,969	2,986	2,986	2,557	2,557
Pseudo-R-squared	0.399	0.387	.	.	.	.	.	.	.	.	.	.
χ^2-stat (Instr.=0)				63.83^{a}		23.67^{a}		21.44^{a}		5.30		42.49^{a}
$Prob > \chi^2$				0.000		0.000		0.000		0.151		0.000
$Corr(\epsilon_i, \nu_i)$	.	.	0.817^{b}		0.840		0.884^{b}		0.905^{c}		0.902^{a}	

Notes: Marginal effects at means are reported. Significance levels: ^{a}1%, ^{b}5%, ^{c}10%. Robust standard errors in parentheses.

Error correction for correlation at the industry-level. All specifications include country, industry and year dummies.

Column 2 also contains country-industry dummies and errors are corrected at the country-industry level.

a consequence, we test the robustness of our credit effect by estimating identically specified linear models with 2SLS. In this linear framework identification of the endogenous variable must come from the instruments. The comparison between the results from the linear and nonlinear models is displayed in Table 24. In line with the bivariate probit model, the endogeneity of credit constraints can be assumed according to most p-values of the heteroskedastic-robust Hausman test (see *endog stat.* and *endog. p-value*). It is also very reassuring that the Hansen J statistics, which test the null hypotheses of the joint validity of the instruments, cannot be rejected in all specifications. Moreover, the heteroskedastic- and cluster-robust Kleinbergen-Paap statistics suggests that weak identification is not a major problem except for the specification using instruments *External revisor*, *Log firm age* and *Share overdue* (see columns 8 and 9 of Table 24). From columns 1 and 2, we see that the linear model and the bivariate probit model give rise to about the same negative marginal effect of having severe financing obstacles: firms reporting very severe financing obstacles are about -0.36 less likely to import capital goods. This also corresponds to our preferred specification since the employed instruments seem to contribute strongest here on the identification of credit constraints according to χ^2- and Kleinbergen-Paap (KP) statistics- and the observation number is highest. Furthermore, the comparisons in Table 24 suggest that the magnitude of the marginal effect does not depend on the normality and homoskedasticity assumption imposed in the bivariate probit model. Remarkably, the effect of credit rationing is estimated much more precisely in the bivariate probit than in the linear model, in particular in the case of weak identification for the linear case displayed in column 8.

Another issue is that unsuccessful firms may tend to overstate their financial difficulties in order to justify their underperformance. This may lead to the misclassification of firms with respect to their true status of credit constraints. From an economic point of view, we may define a firm truly credit constrained if it does not obtain financing for a certain project although the marginal return to this investment would be higher than the (opportunity) cost to capital. Therefore, a firm whose loan application has been turned down because of having (expected) returns below market rates should not be classified as credit constrained. A misclassified binary indicator leads to a non-classical measurement error that is negatively correlated with true credit constraints and results in biased estimates.[100] As a consequence, a linear 2SLS estimator does not constitute a solution since instruments will

[100]If a firm is truly credit constrained and misclassified as zero, the measurement error is +1. In turn, if a firm is not truly credit constrained and misclassified as one, the measurement error is -1.

Table 24: Comparison between bivariate probit and linear probability models

Dependent variable	Dummy=1 if firm imports capital goods in t									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Model	Biv. Probit	LPM	Biv. Probit	LPM	Biv. Probit	LPM	Biv. Probit	LPM	Biv. Probit	LPM
Estimation	MLE	2SLS	MLE	2SLS	MLE	2SLS	MLE	2SLS	MLE	2SLS
Credit Constraints	-0.364^a	-0.356^c	-0.382^a	-0.245	-0.395^a	-0.420^b	-0.400^a	0.180	-0.404^a	-0.608^a
	(0.041)	(0.206)	(0.059)	(0.171)	(0.035)	(0.206)	(0.036)	(0.542)	(0.027)	(0.204)
Observations	3,264	3,264	2,969	2,969	2,969	2,969	2,986	2,986	2,557	2,557
$Corr(\epsilon_i, \nu_i)$	0.817^b		0.840		0.884^b		0.905^c		0.902^a	
endog. stat.		5.319^a		5.337^a		6.757^a		0.076		12.254^a
endog. p-value		0.021		0.021		0.009		0.783		0.000
Hansen J stat.		1.085		2.010		0.605		0.223		0.789
Hansen J p-value		0.581		0.3660		0.437		0.894		0.674
χ^2-stat (Instr.=0)	63.83^a		23.67^a		21.44^a		5.30		42.49^a	
$Pr > \chi^2$	0.000		0.000		0.000		0.151		0.000	
KP stat.		10.835		10.839		8.896		3.019		9.004
KP stat. value		9.08 (10%)		9.08 (10%)		n.a.		5.39 (30%)		9.08(10%)
Instruments:	*Leverage(t-1)*		*Leverage(t-1)*		*Leverage(t-1)*		*External revisor*		*Leverage(t-1)*	
	Leverage(t-1) x Private credit		*Share overdue*		*Share overdue*		*Share overdue*		*Leverage(t-1) x Private credit*	
	Mean CC		*Mean CC*				*Log firm age*		*Mean CC*	
Additional variables									ISO cert. & Liquidity ratio(t-1)	

Notes: Marginal effects at means are reported. Significance levels: [a]1%, [b]5%, [c]10%. Heteroskedastic- and cluster-robust standard errors in parentheses. Error correction for correlation at the industry-level. Heteroskedastic-robust Hausman tests of the endogeneity of the credit constraint indicator are provided: endog. stat and endog. p-value. Hansen J statistics test the joint validity of the instruments. Kleinbergen Paap (KP) and χ^2- statistics test for weak identification. KP stat. values are the threshold values for rejecting weak identification (H_0) allowing for the relative 2SLS bias in percentage indicated in parentheses (...%). n.a. means the critical values were not applicable (see Stock and Yogo, 2002 for details).

also be correlated with the measurement error by construction. The bivariate probit model also does not produce consistent results in the case of misclassification (see Wooldridge, 2002). Furthermore, the 2SLS estimator inflates the magnitude of an instrumented binary indicator that is misclassified, while OLS would lead to attenuated effects as derived by Kane et al. (1999).[101] Therefore, as the marginal effects of financing obstacles are very high in absolute terms from either bivariate probit and 2SLS estimation, a robustness check that takes into account the possibility of misclassification is required. We employ the two-step estimator proposed by Brachet (2008) and adapt it to our binary capital import decision. In the first step, we estimate the fitted probabilities of being truly credit constrained from the misclassification-corrected probit model developed by Hausman et al. (1998). In the second step, we plug the fitted values into a linear probability model. Formally, we can write the two-step procedure as follows:

$$Pr(Imp_i = 1) = \alpha + \beta Z + \gamma Pr(\widehat{CC_i = 1}) + \epsilon_i, \tag{29}$$

$$Pr(CC_i = 1) = \alpha_0 + (1 - \alpha_0 - \alpha_1)\Phi(\alpha + \beta Z + \delta I), \tag{30}$$

where equation (30) denotes the first step probit that corrects for the misclassification probabilities α_0 and α_1. The misclassification probability α_0 is the probability of reporting credit constraints $CC_i = 1$ when true credit constraints in a economic sense are absent $\widetilde{CC_i} = 0$, $\alpha_0 = Pr(CC_i = 1 \mid \widetilde{CC_i} = 0)$; in the opposite case, α_1 is the probability that we observe CC_i=0 in the data, while these firms should be coded as credit constrained $\widetilde{CC_i} = 1$, $\alpha_1 = Pr(CC_i = 0 \mid \widetilde{CC_i} = 1)$. The parameters $(\alpha_0, \alpha_1, \beta, \delta)$ are estimated jointly by maximum likelihood. The fitted probabilities $Pr(\widehat{CC_i = 1})$ are then used in (29) to estimate the credit constraints coefficient γ by OLS. We bootstrap standard errors in the second step to account for the fact that we employ estimated values as a regressor. This two-step procedure can be described as the best linear projection of a "true" underlying probit model. The linearity of the second step is critical to the consistency of this estimator.[102] For instance, replacing (29) with a non-linear probit specification would yield a inconsistent estimator, which is sometimes referred to as a forbidden regression. Furthermore, if the first step regression in (30) were to be linear, misclassification probabilities would not be identified and fitted probabilities $Pr(\widehat{CC_i = 1})$ would be biased in most cases, as pointed out by Hausman et al. (1998) and Meyer and Mittag (2012).

[101] Consequently, 2SLS and OLS estimates represent the upper and lower bound of the true effect .

[102] See Brachet (2008) for a consistency proof.

Table 25 shows the result of the two-step procedure. Although the misclassification probabilities are significantly different from zero, their magnitudes are very small and negligible. As a consequence, there is poor evidence for misclassification of our credit constraint indicator in the first step estimation. Nonetheless, in the second step we employ the fitted values as unbiased estimates of the firm probabilities of being credit constrained. The estimated marginal effect of credit constraints is -0.094 and greatly reduced compared to the results from the bivariate probit model or 2SLS. However, the effect is estimated imprecisely and is insignificant. This is not surprising since support for misreporting is scant. This implies that the applied two-step procedure is still consistent, but inefficient, in particular for estimating the effect of the binary credit constraint indicator.

In Table 26 , we generalize our findings to wider definitions of credit constraints. Specifically, we treat firms that have reported access to finance to be a major investment obstacle as credit constrained in addition to those already included before, namely those firms having classified financial access as a very severe obstacle. This means that we include firms having a 3 or 4 assigned to the financial access question, which ranges from 0 (no problem) to 4 (very severe problem). This new variable is called weaker credit constraints*, Weaker CC*. Consequently, the share of credit constrained firms in our sample increases from 13% to 29%. In columns 1 and 2 the estimated marginal effect of *Weaker CC* is negative at the 10%-significance level.[103] However, as before we consider potential endogeneity of our variable of interest by re-estimating the effect in a bivariate probit model (see columns 5 and 6). Indeed, the correlation structure between the errors is significantly positive and indicates that we can reject the exogeneity of *Weaker CC*. The marginal effect turns out to be almost as large as previous estimates of the more narrowly defined credit constraint variable (compare column 5 with column 3 in Table 23). In the next step, we further weaken the definition of credit constraints by coding firms reporting access to finance as a moderate problem as being credit constrained*, Weak CC*. As expected, the finance effect becomes smaller, but it still remains significant as can be seen from the probit specification 3 and the bivariate probit model in columns 7 and 8. Insignificant error correlation (slightly below the 10%-level) in columns 7 and 8 suggests that the specification in column 3 may be appropriate. Surprisingly, however, the effect of *Weak CC* is estimated much more precisely in the model that takes into account the endogeneity in column 7. Therefore, it is not so clear-cut which estimate of the marginal effect of *Weak CC* we should

[103]Column (2) also includes the ISO certification dummy and the liquidity ratio as additional control variables.

Table 25: Two-step estimation allowing for misclassification

Dependent variables	$Pr(Imp_i = 1)$ second-step:	$Pr(CC_i = 1)$ first-step:
Log productivity(t-1)	0.011	-0.038
	(0.008)	(0.027)
Log employment(t-1)	0.055[a]	-0.071[a]
	(0.005)	(0.019)
Log capital intensity(t-1)	0.022[a]	0.009
	0.007	(0.023)
Foreign	0.088[a]	-0.431[a]
	(0.024)	(0.114)
Liquidity ratio(t-1)	-0.081[a]	-0.186[b]
	(0.020)	(0.088)
Credit Constraints ($Pr(\widehat{CC_i} = 1)$)	-0.094	
	(0.169)	
Instruments:		
Leverage(t-1)		0.008
		(0.012)
Mean credit constraints		3.891[a]
		(0.351)
Misclassification probabilities:		
α_0		0.000[a]
		(0.000)
α_1		0.000[a]
		(0.000)
Observations	3281	4918
Model	LPM	Probit
Estimation	OLS	MLE

Notes: Coefficient estimates are reported. Significance levels: [a]1%, [b]5%, [c]10%. Standard errors in parentheses Bootstrap errors are used in the second-step. The second-step includes country, industry and year dummies. The first-step controls for creditor rights, private credit/GDP, rule of law, gross national product per capita and sectoral R&D intensity.

Table 26: Robustness of generalized perceived credit constraints and capital imports.

Dependent variable	Imp				Imp	CC	Imp	CC	Imp	Imp	CoC
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Log productivity(t-1)	0.021^{c}	0.012	0.021^{c}	0.021^{c}	0.005	-0.024^{c}	0.009	-0.043^{a}	0.001	0.001	-0.012^{b}
	(0.012)	(0.016)	(0.012)	(0.012)	(0.015)	(0.013)	(0.014)	(0.011)	(0.015)	(0.009)	(0.005)
Log employment(t-1)	0.096^{a}	0.069^{a}	0.096^{a}	0.096^{a}	0.077^{a}	-0.018^{a}	0.086^{a}	-0.007	0.078^{a}	0.073^{a}	-0.003
	(0.010)	(0.012)	(0.010)	(0.010)	(0.013)	(0.008)	(0.013)	(0.010)	(0.013)	(0.011)	(0.006)
Log capital intensity(t-1)	0.038^{a}	0.020^{c}	0.038^{a}	0.038^{a}	0.034^{a}	0.004	0.037^{a}	0.016	0.036^{a}	0.034^{a}	0.003
	(0.009)	(0.011)	(0.009)	(0.009)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.005)
Foreign	0.110^{a}	0.112^{a}	0.110^{a}	0.109^{a}	0.054^{c}	-0.122^{a}	0.075^{a}	-0.140^{a}	0.037	0.043	-0.056^{a}
	(0.026)	(0.030)	(0.026)	(0.026)	(0.032)	(0.024)	(0.029)	(0.034)	(0.030)	(0.029)	(0.016)
Weaker CC	-0.036^{c}	-0.047^{c}			-0.334^{a}						
	(0.019)	(0.027)			(0.072)						
Weak CC			-0.033^{c}				-0.202^{a}				
			(0.018)				(0.098)				
CC (ordinal from 1-4)				-0.011^{c}					-0.146^{a}		
				(0.007)					(0.049)		
Cost of credit (CoC)										-0.430^{a}	
										(0.021)	
ISO		0.116^{a}									
		(0.021)									
Liquidity ratio(t-1)		-0.193^{a}									
		(0.048)									
Leverage(t-1)						0.142^{a}		0.178^{a}			0.078^{a}
						(0.044)		(0.049)			(0.020)
Leverage(t-1)xPr. cred.						-0.077^{c}		-0.109^{b}			-0.052^{b}
						(0.045)		(0.049)			(0.023)
Mean CC						0.877^{a}		1.269^{a}			0.490^{a}
						(0.216)		(0.119)			(0.168)
Observations	3,681	2,545	3,681	3,681	3264		3264		3250	3232	
Model	Probit				Bivariate Probit				IV-Probit	Bivariate Probit	
Pseudo-R-squared	0.400	0.364	0.400	0.400							
$Corr(\epsilon_i, \nu_i)$					0.611^{b}		0.309		0.470^{b}	0.907^{a}	

Notes: Marginal effects at means are reported. Significance levels: ^{a}1%, ^{b}5%, ^{c}10%. Robust standard errors in parentheses.

Error correction for correlation at the industry-level. All specifications include country, industry and year dummies.

trust more. In the probit specification 4 and in the second-stage IV probit estimation displayed in column 9 we also employ the ordinal measure of credit constraints that ranges from 0 to 4. A significant correlation $Corr(\epsilon_i, \nu_i)$ (see column 9) hints that the IV probit model in column 9 should be preferred over the probit specification 4. Column 9 displays an adverse effect of credit constraints that is firmly negative at the 1%-significance level. Taken together, this set of results of weaker definitions of credit constraints implies that access to finance is a widespread and relevant problem for a large share of firms located in low- and middle-income countries.

Finally, we replace our *limited access to finance* measure of *credit constraints (CC)* with an alternative indicator based on *perceived cost of finance (CoC)* as a potential investment obstacle. Specifically, firms reporting cost of finance as a very severe obstacle were coded as credit constrained. This measure is obviously interrelated with our previous indicator capturing more broadly access to finance, but it is arguably more narrowly defined. Columns 10 and 11 show the results with respect to this cost of finance measure *(CoC).* Significant and large error correlation again indicates that the use of a bivariate probit model is recommended to deal with the endogeneity of the cost of finance. Moreover, the size of the negative marginal effect of the cost of finance on the capital import probability remains similar to the effect related to the lack of financial access.

In sum, this section shows that a country's financial institutional development and a firm's financial health reduce the incidence of self-reported credit constraints. In addition, this perceived lack of access to finance has an economically large and significant negative effect on the probability of foreign technology upgrading for firms in developing countries. The presented set of results corroborate our previous findings from Section 3.7 and hold after controlling for a variety of firm characteristics and taking into account potential endogeneity due to omitted variables and misclassification.[104]

[104] Although the previous results do not hinge on a particular country (see robustness checks in Section 3.9 and Table 32), this section contains an enlarged country sample and the identification strategy does not rely on firm-country interactions. As a consequence, the findings presented in this section, which are consistent with the previous results, show again that the conclusions drawn so far do not depend on country selection.

3.8.2 Additional credit constraints proxies and firm characteristics

Table 27 presents a set of results using two additional credit constraints proxies; *Property ratio* defined as the share of land and property of total assets and the *Log firm age.* Property is arguably the best collateral a firm can offer to a potential lender, so firms owning more property should be less credit constrained. Similarly, older firms have had time to build up a reputation and to establish relationships with investors, which arguably leads to better access to external finance. While firms owning more property seem to be less constrained by credit markets, particularly in countries with weaker institutions, the imprecisely estimated results do not convincingly support the view of a relationship between firm age, financing and capital import probability.[105]

Next, we test the sensitivity of our results to the inclusion of additional firm characteristics. In particular, we include characteristics related to the level of human capital embodied in the production workers and management as well as the ISO certification dummy and the foreign input share. Importantly, Table 28 shows that the main conclusions drawn previously in the paper are not altered by the additional firm characteristics. The estimated coefficients of the finance variables remain almost unaffected in size and significance. Somewhat surprisingly, the human capital variables do not have a significant influence on the capital import probability, whereas ISO certified firms and firms with a higher share of foreign inputs are more likely to source capital goods from abroad.

3.8.3 Do credit market institutions also play a role for intermediate imports?

Limited access to specialized inputs is an important characterization of the business environment of poorer countries. In addition, those inputs are often only available at an extra cost from abroad, as Tybout (2000) argued.[106] This extra cost certainly involves shipping and tariff expenses on a regular basis, but also an additional fixed cost related to quality upgrading, such as the adaption of the production process, learning how to use the new input and the like (Kugler and Verhoogen, 2012). An important part of this fixed cost accrues shortly before or at the time the firm starts importing intermediate goods. Thus, credit constraints could also matter for intermediate imports.

Table 29 reports the marginal effects regarding the relationship between the probability

[105]Nonetheless, the log firm age variable and their institutional interactions display the expected coefficients signs.

[106]Recent firm-level evidence also suggests that imported intermediate goods on average are of higher quality than domestic inputs for firms located in developing countries (Kugler and Verhoogen, 2009).

Table 27: Alternative credit constraints proxies and the capital import probability

Dependent variable	Dummy=1 if firm imports capital goods in t					
	(1)	(2)	(3)	(4)	(5)	(6)
Log productivity(t-1)	-0.012	-0.014	-0.013	0.014	0.014	0.012
	(0.018)	(0.018)	(0.018)	(0.011)	(0.011)	(0.009)
Log employment(t-1)	0.085[a]	0.085[a]	0.085[a]	0.080[a]	0.080[a]	0.074[a]
	(0.012)	(0.012)	(0.012)	(0.008)	(0.008)	(0.007)
Log capital intensity(t-1)	w.038[b]	0.036[b]	0.037[b]	0.029[a]	0.029[a]	0.030[a]
	(0.018)	(0.017)	(0.017)	(0.010)	(0.010)	(0.009)
Foreign	0.157[a]	0.157[a]	0.156[a]	0.097[a]	0.096[a]	0.088[a]
	(0.045)	(0.045)	(0.045)	(0.030)	(0.030)	(0.028)
Property ratio(t-1)	0.995[a]	-10.663[b]	3.913[b]			
	(0.324)	(5.032)	(1.543)			
Log firm age				0.025	-0.154	0.168[c]
				(0.033)	(0.299)	(0.087)
Property ratio(t-1) x Creditor rights	-0.545[a]					
	(0.165)					
Property ratio(t-1) x Enforcement days		1.796[b]				
		(0.848)				
Property ratio(t-1) x Accounting standards			-0.059[b]			
			(0.023)			
Log firm age x Creditor rights				-0.016		
				(0.017)		
Log firm age x Enforcement days					0.025	
					(0.049)	
Log firm age x Accounting standards						-0.003[b]
						(0.001)
Observations	1,894	1,894	1,891	5,125	5,125	4,870
Pseudo-R-squared	0.186	0.181	0.181	0.261	0.261	0.186

Notes: Estimation: Pooled Probit. Marginal effects at means are reported. Significance levels: [a]1%, [b]5%, [c]10%.

Firm-level cluster- and heteroskedastic-robust standard errors in parentheses.

All specifications include country-industry, country, industry and year dummies.

Table 28: Additional firm characteristics and the capital import probability

Dependent variable	Dummy=1 if firm imports capital goods in t			
	(1)	(2)	(3)	(4)
Log productivity(t-1)	0.009	0.009	0.009	0.008
	(0.011)	(0.011)	(0.011)	(0.011)
Log employment(t-1)	0.058[a]	0.058[a]	0.058[a]	0.058[a]
	(0.008)	(0.008)	(0.008)	(0.008)
Log capital intensity(t-1)	0.020[b]	0.020[b]	0.020**	0.021[b]
	(0.010)	(0.010)	(0.010)	(0.010)
Foreign	0.077[b]	0.077[b]	0.078[b]	0.076[b]
	(0.032)	(0.032)	(0.032)	(0.032)
Leverage(t-1)	-0.290[a]	2.754[a]	-0.964[a]	-0.188[b]
	(0.091)	(0.796)	(0.278)	(0.073)
Leverage(t-1) x Creditor rights	0.165[a]			
	(0.048)			
Leverage(t-1) x Enforcement days		-0.454[a]		
		(0.132)		
Leverage(t-1) x Accounting standards			0.015[a]	
			(0.004)	
Leverage(t-1) x Private credit				0.228[a]
				(0.078)
Liquidity ratio(t-1)	-0.097[a]	-0.097[a]	-0.099[a]	-0.093[a]
	(0.036)	(0.036)	(0.036)	(0.036)
Share workforce with university degree	-0.001[b]	-0.001[b]	-0.001[b]	-0.001[a]
	(0.001)	(0.001)	(0.001)	(0.001)
CEO graduate degree	-0.003	-0.003	-0.003	-0.004
	(0.028)	(0.028)	(0.028)	(0.028)
Skilled share of production workers	-0.015	-0.014	-0.015	-0.012
	(0.027)	(0.027)	(0.027)	(0.027)
ISO certification	0.085[a]	0.085[a]	0.085[a]	0.086[a]
	(0.022)	(0.022)	(0.022)	(0.022)
Foreign input share	0.001[a]	0.001[a]	0.001[a]	0.001[a]
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	3,433	3,433	3,433	3,433
Pseudo-R-squared	0.177	0.177	0.177	0.176

Notes: Estimation: Pooled Probit. Marginal effects at means are reported.

Significance levels: [a]1%, [b]5%, [c]10%.

Firm-level cluster- and heteroskedastic-robust standard errors in parentheses.

All specifications include country-industry, country, industry and year dummies.

Table 29: Credit market institutions and the probability to import intermediate goods

Dependent variable	Dummy=1 if firm imports intermediate goods in t					
	(1)	(2)	(3)	(4)	(5)	(6)
Log productivity(t-1)	0.050[a]	0.051[a]	0.049[a]	0.048[a]	0.048[a]	0.047[a]
	(0.010)	(0.010)	(0.010)	(0.009)	(0.009)	(0.010)
Log employment(t-1)	0.113[a]	0.114[a]	0.113[a]	0.115[a]	0.115[a]	0.115[a]
	(0.012)	(0.012)	(0.012)	(0.011)	(0.012)	(0.012)
Log capital intensity(t-1)	0.043[a]	0.042[a]	0.045[a]	0.045[a]	0.044[a]	0.046[a]
	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Foreign	0.231[a]	0.232[a]	0.239[a]	0.230[a]	0.231[a]	0.238[a]
	(0.043)	(0.043)	(0.043)	(0.042)	(0.042)	(0.043)
Leverage(t-1)	0.030	0.761	0.140[c]			
	(0.087)	(0.532)	(0.073)			
Liquidity ratio(t-1)				-0.037	0.892	0.137
				(0.104)	(0.637)	(0.099)
Leverage(t-1) x Creditor rights	0.027					
	(0.044)					
Leverage(t-1) x Enforcement days		-0.113				
		(0.086)				
Leverage(t-1) x Private credit			-0.117			
			(0.090)			
Liquidity ratio(t-1) x Creditor rights				0.072		
				(0.050)		
Liquidity ratio(t-1) x Enforcement days					-0.133	
					(0.106)	
Liquidity ratio(t-1) x Private credit						-0.111
						(0.132)
Observations	4,150	4,150	3,996	4,150	4,150	3,996
Pseudo-R-squared	0.245	0.245	0.249	0.245	0.245	0.249

Notes: Estimation: Probit. Marginal effects at means are reported.

Significance levels: [a]1%, [b]5%, [c]10%. Robust standard errors in parentheses.

All specifications include country-industry, country, industry and year dummies.

Error correction for correlation at the country-industry level.

of importing intermediate goods and the interaction between the firm's financial position and the credit market institutions. Firstly, firms with a higher lagged productivity, which employ more people and are more capital intensive, have a significantly higher probability to import intermediate goods in all specifications (see columns 1 to 8). This supports the recent idea that more efficient firms may self-select into importing inputs, as asserted by Kugler and Verhoogen (2009), although the direction of causality is admittedly difficult to establish. Not surprisingly, foreign-owned firms are much more likely to source their inputs from abroad.

The estimations in Table 29 show that neither a firm's liquidity ratio or leverage nor their associated interactions with the financial institutions are determinants of the probability of importing intermediates. The results suggest that credit constraints for imported inputs play a minor role and are in line with the results from Bas and Berthou (2011a) for India. This evidence is probably explained partly by a lower fixed cost of importing inputs than for the adoption of a foreign production technology. Another explanation is that supplier credit or even more informal short-term lending, which are pervasive in countries with weak financial institutions, substitute for a lack of formal credit (IFC, 2010; Fisman and Love, 2003).

It is important to point out that the data only allowed us to determine whether a firm imported inputs at a specific point in time, but does not contain a history about imported inputs.[107] We are therefore not able to detect import starters with a potentially higher fixed or sunk cost that are more likely to be subject to financing constraints. This data limitation must be taken into account when reading our empirical evidence.

3.8.4 The impact of credit market institutions on the intensive import margin

In this section we assess the importance of the firm's leverage and financial institutions on the intensive import margin, which we define as the value of imported capital goods over the total expenses on capital goods as a percentage number (*Capital import share* in columns 1 and 2). In columns 3 to 6 we use the log value of capital goods imports as our dependent variable (*Log(Capital import value)*). This issue deserves attention particularly from a policy point of view. Theoretically, credit constraints may matter less for the intensive import margin. The reason is that at least part of the associated fixed costs have already been borne and financed once a firm is already importing a positive amount of capital. In

[107]Furthermore, the database does not contain any information about the inputs origins.

turn, if firms are credit constrained with respect to the intensive import margin, firms also have problems financing the variable trade costs associated with importing capital goods, and government interventions promoting trade finance also may be appropriate.

Table 30 presents the results of the intensive import margins. In columns 1 and 2 we estimate a two-limit tobit model including a lagged dependent variable that allows for dependence on past behavior stemming, for instance, from established linkages with capital exporters.[108] Indeed, the lagged capital import variable is highly significant. Turning next to financial factors, a lower leverage increases the capital import share, which suggests that financial constraints influence the import of capital goods, but affect domestic capital purchases less strongly. Domestic capital goods might be better known and less risky from the viewpoint of domestic investors. The estimations in columns 1 and 2 indicate that firms substitute capital imports for domestic capital goods when credit constraints become less severe.

The evidence in favor of a significant effect of financial factors and institutions does not, however, carry over to columns 3 to 6 in which the capital import share is replaced with the log value of capital imports as the dependent variable. This model is first estimated by OLS in columns 3 and 4 and afterwards by the Heckman two-step procedure to account for non-random selection into importing capital goods. In the Heckman model the excluded variable is a dummy variable that equals one for firms that have a ISO certification and zero otherwise.[109] The fairly significant Heckman's lambda in columns 5 and 6 provides some evidence for selection into capital importing. However, the financial variables are not significant throughout columns 3 to 6, which casts doubt on the idea that credit constraints also are important for the intensive capital import margin.

More generally, the results presented in Table 30 are ambiguous with regard to financial variables, whereas the size, capital intensity and productivity proxies have mostly a significant positive impact on the intensive import margin. This implies that the amount invested in imported capital goods may depend more on efficiency or profitability of the foreign technology adoption than on credit constraints. From a policy perspective, cutting import tariffs for more advanced capital goods may be a better option than extending

[108] A dynamic specification including a lagged dependent variable does not invalidate consistent estimation of the pooled tobit model (Wooldridge, 2002).

[109] The assumption is thus that an ISO certification affects the decision to import capital goods, but it should not have a significant effect on the imported value of capital goods. Indeed, this is what preliminary intensive and extensive margin regressions and the first-stage results confirm, which are available upon request.

Table 30: Credit market institutions and the intensive import margin: capital import share and value

Dependent variable	Capital import share		Log(Capital import value)			
	(1)	(2)	(3)	(4)	(5)	06)
Capital import share(t-1)	3.054[a]	3.044[a]				
	(0.022)	(0.022)				
Log productivity(t-1)	-2.433[a]	-1.740[b]	0.314[a]	0.308[a]	0.336[a]	0.329[a]
	(0.729)	(0.734)	(0.088)	(0.089)	(0.079)	(0.077)
Log employment(t-1)	18.949[a]	19.542[a]	0.863[a]	0.854[a]	1.011[a]	0.979[a]
	(0.411)	(0.411)	(0.060)	(0.061)	(0.095)	(0.095)
Log capital intensity(t-1)	8.130[a]	7.679[a]	0.422[a]	0.425[a]	0.491[a]	0.485[a]
	(0.677)	(0.678)	(0.111)	(0.111)	(0.077)	(0.075)
Foreign	21.400[a]	21.875[a]	0.336	0.338	0.595[b]	0.560[b]
	(2.055)	(2.048)	(0.252)	(0.253)	(0.234)	(0.231)
Leverage(t-1)	-31.352[a]	1,010.506[a]	-0.568	-4.356	-1.063	-0.859
	(3.491)	(3.499)	(0.910)	(6.480)	(0.925)	(7.786)
Leverage(t-1) x Creditor rights	13.847[a]		0.463		0.676	
	(1.782)		(0.474)		(0.503)	
Leverage(t-1) x Enforcement days		-167.777[a]		0.746		0.160
		(0.579)		(1.069)		(1.265)
Heckman's lambda					1.194[b]	1.015[c]
					(0.540)	(0.535)
Estimation	Two-limit Tobit		OLS		Heckman Model	
Observations	4,702	4,702	681	681	2,135	2,135
Excluded variable					ISO certification	
R-squared			0.579	0.579		

Notes: Marginal effects at means are reported. Significance levels: [a]1%, [b]5%, [c]10%. Robust standard errors in parentheses. All specifications include country-industry, country, industry and year dummies. Error correction for correlation at the country-industry level and for firm-level cluster correlation in the pooled tobit estimations. First-stage Probit estimates in the Heckman Model are not reported, but can be made available upon request.

trade finance when the goal is to increase the imported value of capital goods. On the other hand, credit constraints and the quality of financial institutions strongly matter for the decision to import capital goods in the first place. This suggests that fixed costs of technology adoption play a decisive role in this case.

3.9 Robustness checks

In this section we conduct further robustness checks along various dimensions. The corresponding Tables can be found in the Appendix 3.11.3.

In Table 31 we shed some light on whether foreign ownership affects financial constraints along the lines of Manova et al. (2009) and whether larger firms have better access to financial resources. Although the coefficients of the variables of interest enter the regressions with the expected signs, they are not statistically significant.

We also check whether the results depend on the inclusion of a specific country. Consequently, in every regression we successively excluded one country. Table 32 is reassuring because the size and significance of the displayed coefficients are not driven by a particular country. Even dropping overrepresented countries such as Thailand or Brazil does not substantially affect the estimates, which remain remarkably similar to the benchmark results.

In the next robustness check, displayed in Table 33, further interactions terms between country characteristics - which are likely to be correlated with credit market institutions - and firm leverage are added to the estimating equation. Specifically, in these additional interaction terms we control for the rule of law, the average years of schooling and for proxies related to the level of economic development and performance, such as GNI per capita, GDP per capita growth and the average inflation rate. Although the coefficients of the leverage variables in the regressions with creditor rights in columns 1 to 4 become expectedly less precise, the coefficient signs stay unaffected. Furthermore, aside from column 2, in which the schooling level does indeed somewhat reduce the impact of creditor rights on credit constraints, the magnitudes of the *Leverage(t-1) x Creditor rights* coefficients are not affected much. The results in columns 5 to 8 with *Leverage(t-1) x Enforcement days* are even more convincing as the significance and size of the coefficients of interests do not considerably change.

Table 34 presents the probit regressions including the effectively applied MFN import tariffs for machinery & equipment in every country taken from the UNCTAD-TRAINS database. Controlling for capital import tariffs is potentially important since lower import tariffs may coincide with strong institutions within a country and thus bias the institutions' effect on credit constraints upward. This hypothesis, however, is not supported by the estimations shown in Table 29. The coefficients of the interaction terms are only slightly affected by

adding import tariffs.[110]

Next, all firm characteristics are interacted with the credit market institutions simultaneously. Nonetheless, the size and significance of the leverage interaction remain unchanged, while in the vast majority of cases the other interactions are insignificant (see Tables 35 and 36). This indicates that credit constraints are mainly driven by firm leverage in our baseline specification, as theoretically derived.

Table 37 shows sample sensitivity tests with regard to the liquidity ratio and leverage. In the first column the full sample is used, which also contains insolvent firms and firms with inconsistent liquidity ratios above one. As a result, the importance of finance and institutional variables is dramatically reduced, but they still exert a significant effect on the capital import propensity. Restricting the sample to firms with liquidity ratios under one does not alter the picture, as one can note from the second column. Despite also using observations with liquidity ratios above one, column 3 employs only solvent firms[111] and column 4 a weighting scheme inversely related to the leverage for insolvent firms. Importantly, these regressions convey that the magnitude of the leverage coefficients crucially depend on the exclusion of still operating but insolvent firms. This is intuitively appealing in the sense that there is no reason that the leverage and financial institutions should affect credit constraints or the probability of obtaining credit for already insolvent firms. In the next regressions, displayed in columns 5 to 7, *Creditor rights* is replaced by *Enforcement days*, but the key insight that marginal changes of a firm's financial situation and of interactions with institutions may only play a role within certain value ranges still holds.

Next, the additional control variable *Size of second-hand market* is added to control for the availability of used capital goods within a country and sector. As expected, the main results remain unaffected because the principal variation of this factor at the sectoral level within a country is already picked up by the time-invariant country-sector dummies (see Table 38).

Finally, we use another set of fixed effects. Specifically, we add a time dimension to country-industry fixed effects in the pooled probit regressions. This controls for sharp changes in exchange rates that are not entirely captured by the previous set of fixed effects employed in the baseline specification. However, the results are not influenced by these additional dummy variables, as can be inferred from Table 39.

[110] As stated in Section 3.6.2, the main effect of capital import tariffs on the capital import probability is taken into account by the country-sector dummies.

[111] This substantially reduces the sample by about 10%.

3.10 Conclusions

The results indicate that a country's institutional development of the credit market matters mainly for the extensive import margin, i.e., for the decision to import capital goods. In particular, first-time capital importers seem to benefit from stronger credit market institutions, which suggests that fixed and sunk costs of capital imports are considerable. Similarly, credit constraints are found to be more severe among firms belonging to R&D intensive sectors. In turn, this means again that reforming credit market institutions improves access to external finance, especially for this subset of innovative firms. This finding corroborates the view that our financial variables capture credit constraints and the (potential) availability of funding. This is because R&D intensive firms should be more sensitive to the firm leverage and the quality of institutions as a result of higher agency costs. The extensive margin results are impervious to various robustness tests, such as 2SLS estimation, controlling for unobserved firm heterogeneity, past importer status and additional country characteristics among others. In addition, the results are not driven by a particular country. Furthermore, there is no one institution that clearly emerges as the most important, but the analysis suggests that legal investor protection and the efficiency of debt enforcement before court complement each other to be fully effective at reducing credit constraints. Additional results also suggest that financial institutional development lowers the probability of reporting credit constraints, which in turn exert a substantial negative impact on the capital import propensity. This finding also holds after correcting for the potential endogeneity and misclassification of self-reported credit constraints measures.

This paper is the first to empirically support the argument that providing legal investor protection, a more efficient enforcement of debt contracts and higher accounting standards reduce firm-level credit constraints for adopting a foreign technology embodied in capital goods imports. This is an important policy finding because importing advanced foreign machinery and equipment is likely to increase the productivity of firms located in developing countries. Moreover, development countries may also benefit from positive externalities stemming from the adoption of more advanced foreign technologies

Concerning the intensive import margin, the results are more ambiguous. While financial limitations are not found to play an important role for the absolute amount invested in capital imports, the regressions show that firms located in countries with stronger credit market institutions devote a higher share of their capital spendings to imports. This

subtle finding may also point to the importance of the additional fixed costs involved with sourcing capital goods from abroad, which prevents firms from entry into foreign markets for machinery and equipment. Next, this paper does not find an effect of finance on the import propensity of intermediate goods whose fixed costs of importing are assumed to be lower. This implies that cutting import tariffs is a more appropriate policy measure to increase intermediate and capital goods imports, while institutional development of the credit market allows firms to finance the fixed costs of technology upgrade associated with capital goods imports.

The robustness check regarding the sample selection sensitivity suggests that the relationship between credit constraints, institutional development and innovation activities may be nonlinear and dependent on the level of financial and institutional variables at the firm- and country-level. This could be a fruitful area for theoretical research. However, in future empirical research the precise estimation of such nonlinear effects would require larger samples with more firms and countries; especially to increase the variation of the institutional indicators at the country-level.

3.11 Appendix

3.11.1 Credit constrained innovators

Proposition: *If* $\frac{\gamma_h^{\sigma-1}-1}{\gamma_h^{\sigma-1}}\left(\frac{f}{f_h}+1\right)>\theta$ *holds, then there exists a subset of credit constrained firms (denoted by* Ω*) in a specific country, that could profitably import capital goods, but do not obtain the required external finance.*

Proof. *This proposition is proved by substituting equation (11) into the left-hand side of inequality* $\overline{\varphi}_h(\theta,\omega)>\varphi_h^*=\frac{1}{P\rho}\left(\frac{\sigma f_h}{E(\gamma^{\sigma-1}-1)}\right)^{\frac{1}{\sigma-1}}$ *and setting firms' wealth* ω *to zero.* $\overline{\varphi}_h(\theta,\omega=0)>\varphi_h^*$ *is a necessary and sufficient condition for* Ω *to be non-empty and will hold if the above condition in the proposition is met.*

It is assumed that these conditions are satisfied.

3.11.2 Data

Variable	Description
Credit constraints proxies:	
Liquidity ratio	Current assets over total assets.
Leverage	Total debt over total assets.
Property ratio	Share of land and property of total assets.
Log firm age	Logarithm of the firm age.
Firm characteristics:	
Log productivity	Logarithm of value added per employee.
Log employment	Logarithm of the number of employees.
Log capital intensity	Logarithm of total assets per employee.
Foreign	A dummy variable that equals one if at least 50% of the firm is owned by foreigners and zero otherwise.
Share workforce with university degree	Percentage share of the workforce with a university degree.
Log R&D spending/sales	Logarithm of R&D spending over total sales.
CEO graduate degree	A dummy variable that equals one if the CEO of the firm obtained a post graduate degree (PhD, Masters) and zero otherwise.
Skilled share of production workers	Share of production workers reported as skilled to total production workers.
Foreign input share	Percentage share of the use of foreign inputs to total inputs.
ISO certification	A dummy variable that equals one if the firm has a ISO certification and zero otherwise.
	Source of firm variables: World Bank Enterprise Surveys (2002-2005).
Credit market Institutions:	
Creditor rights	An index ranging from 0 (weak creditor rights) to 4 (strong creditor rights). A score of one is given if the following rights are legally adopted by a country: *(I)* There are restrictions, such as creditor consent or minimum dividends, to file for bankruptcy. *(II)* Secured creditors are able to seize their collateral if a firm reorganization is approved (no automatic stay or asset freeze). *(III)* Secured creditors are the first to be paid out of the liquidated assets of a bankrupt firm. *(IV)* If the debtor does not retain the management of the firm during the reorganization. Data is averaged over the from 1999 to 2003. *Source:* Djankov et al. (2007).

(continued)

Variable	Description
Enforcement days	The logarithm number of days it takes to enforce a debt contract worth 50% of a country's GDP per capita before court, constructed as of January 2003. *Source:* Djankov et al. (2007).
Accounting standards	Index from 1 to 90 created by the Center for International Financial Analysis and Research (CIFAR), constructed by rating a cross-section of a country's firms' 1995 annual reports on the inclusion and omission of 90 items that fall into 7 categories such as general information, income statement, balance sheets, funds flow statement, accounting standards, stock data and special items. *Source:* Bushman et al. (2004).
Private credit	Private credit volume from banks and other financial institutions extended to the domestic sector over the country's GDP. Data is averaged over the period from 1999 to 2003. *Source:* Beck et al. (2009).
Private bureau	A dummy variable that equals one if a private credit bureau operates in a country and zero otherwise. The credit bureau provides information about a firm's credit history and its current financial situation. *Source:* Djankov et al. (2007).
Public registry	A dummy variable that equals one if a public credit registry operates in a country and zero otherwise. The credit registry ran by public authorities provides information about a firm's credit history and its current financial situation. *Source:* Djankov et al. (2007).
Country characteristics:	
Rule of law	A composite index from -2.5 to +2.5 that captures perceptions of the extent to which citizens have confidence in a country's rule of law, in particular the efficiency of contract enforcement, property rights enforcement, the police, the courts, as well as the probability of crime and violence. Average from the biannual data from 1998 to 2002. *Source:* Government IV database (1996-2002) from the World Bank (Kaufmann et al., 2003).

(continued)

Variable	Description
Average years of schooling	Average years of schooling of people older than 25 within a country for the year 2000. *Source:* Barro and Lee (2001).
Log average GNP per capita	The logarithm of the gross national product averaged from 2001 to 2003. *Source:* World Development Indicators.
Mean GDP per capita growth	Average growth rate of the gross domestic product per capita from 1999 to 2003. *Source:* World Development Indicators.
Average inflation rate	Average inflation rate over the period from 1999 to 2003. *Source:* World Development Indicators.
Sectoral characteristics:	
Capital import tariffs	The effectively applied most favored nation (MFN) import tariffs for the machinery and other equipment sector in a country (SITC Rev. 3 code 7). *Source:* UNCTAD-TRAINS database.
Size of second-hand market	Total sectoral expenses on domestic second-hand capital goods over sectoral revenues of a country's sector. It is a proxy for the availability of used domestic capital goods and the size of the sectoral second-hand market for capital goods within a country. *Source:* World Bank Enterprise Surveys (2002-2005).

3.11.3 Tables

Table 31: Foreign ownership, employment and the capital import probability

Dependent variable	Dummy=1 if firm imports capital goods in t					
	(1)	(2)	(3)	(4)	(5)	(6)
Log productivity(t-1)	0.014	0.014	0.012	0.013	0.014	0.011
	(0.011)	(0.011)	(0.009)	(0.010)	(0.011)	(0.009)
Log employment(t-1)	0.080[a]	0.081[a]	0.074[a]	0.108[a]	-0.076	0.908[a]
	(0.007)	(0.007)	(0.006)	(0.022)	(0.219)	(0.063)
Log capital intensity(t-1)	0.030[a]	0.030[a]	0.032[a]	0.030[a]	0.030[a]	0.031[a]
	(0.010)	(0.010)	(0.009)	(0.010)	(0.010)	(0.009)
Foreign	0.172[c]	0.081	0.472[c]	0.096[a]	0.097[a]	0.089[a]
	(0.094)	(0.864)	(0.286)	(0.030)	(0.030)	(0.027)
Leverage(t-1)	-0.017	-0.017	-0.010	-0.019	-0.020	-0.013
	(0.031)	(0.031)	(0.028)	(0.031)	(0.031)	(0.028)
Foreign x Creditor rights	-0.035					
	(0.041)					
Foreign x Enforcement days		0.002				
		(0.130)				
Foreign x Accounting standards			-0.004			
			(0.003)			
Log employment(t-1) x Creditor rights				-0.015		
				(0.012)		
Log employment(t-1) x Enforcement days					0.026	
					(0.036)	
Log employment(t-1) x Accounting standards						-0.002[b]
						(0.001)
Observations	5,128	5,128	4,871	5,128	5,128	4,871
Pseudo-R-squared	0.262	0.261	0.185	0.262	0.262	0.187

Notes: Estimation: Pooled Probit. Marginal effects at means are reported. Significance levels: [a]1%, [b]5%, [c]10%.

Firm-level cluster- and heteroskedastic-robust standard errors in parentheses.

All specifications include country-industry, country, industry and year dummies.

Table 32: Dropping countries one by one

Dependent Variable	Dummy=1 if firm imports capital goods in t							
	full sample	W/O THA	W/0 BRA	W/O IND	W/O IDN	W/O PHI	W/O RSA	W/O SRI
(1) Leverage(t-1)	-0.283[a]	-0.303[a]	-0.225	-0.281[a]	-0.260[a]	-0.351[a]	-0.222[c]	-0.278[a]
	(0.096)	(0.111)	(0.154)	(0.095)	(0.086)	(0.104)	(0.116)	(0.094)
Leverage(t-1) x Creditor rights	0.151[a]	0.170[a]	0.126[c]	0.150[a]	0.143[a]	0.179[a]	0.107	0.153[a]
	(0.050)	(0.060)	(0.074)	(0.050)	(0.045)	(0.053)	(0.067)	(0.050)
(2) Leverage(t-1)	3.278[a]	3.715[a]	3.962[a]	3.245[a]	2.749[a]	3.303[a]	3.022[b]	3.284[a]
	(0.882)	(1.072)	(1.429)	(0.876)	(0.807)	(0.863)	(1.195)	(0.874)
Leverage(t-1) x Enforcement days	-0.545[a]	-0.614[a]	-0.660[a]	-0.539[a]	-0.457[a]	-0.548[a]	-0.504[b]	-0.546[a]
	(0.146)	(0.176)	(0.240)	(0.145)	(0.134)	(0.143)	(0.196)	(0.145)
(3) Leverage(t-1)	-0.792[a]	-0.882[a]	-0.654	-0.789[a]	-0.792[a]	-0.777[a]	-0.599[c]	-0.983[a]
	(0.259)	(0.299)	(0.436)	(0.257)	(0.259)	(0.246)	(0.314)	(0.277)
Leverage(t-1) x Accounting standards	0.012[a]	0.013[a]	0.010	0.012[a]	0.012	0. T2[a]	0.009[c]	0.015[a]
	(0.004)	(0.004)	(0.006)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)

Notes: Marginal effects at means are reported. Significance levels: [a]1%, [b]5%, [c]10%. Robust standard errors in parentheses. Specifications (1) to (3) are pooled probit estimations including firm characteristics (Log productivity, Log employment, Log capital intensity and Foreign) but suppressed in the Table. All specifications include country-industry, country, industry and year dummies. Error correction for firm-level cluster correlation. W/O= without, THA=Thailand, BRA=Brazil, IND=India, IDN=Indonesia, PHI=Philippines, RSA= Republic of South Africa SRI=Sri Lanka.

Table 33: Additional country characteristics

Dependent variable	Dummy=1 if firm imports capital goods in t							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log productivity(t-1)	0.015	0.016	0.014	0.015	0.017	0.017	0.017	0.017
	(0.011)	(0.011)	(0. 11)	(0.010)	(0.011)	(0.011)	(0.011)	(0.010)
Log employment(t-1)	0.082[a]	0.082[a]	0.082[a]	0.082[a]	0.083[a]	0.082[a]	0.082[a]	0.082[a]
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Log capital intensity(t-1)	0.030[a]	0.029[a]	0. 030[a]	0.029[a]	0.028[a]	0.028[a]	0.028[a]	P.028[a]
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Foreign	0.094[a]	0.096[a]	0.095[a]	0.095[a]	0.095[a]	0.096[a]	0.096[a]	0.097[a]
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
Leverage(t-1)	-0.191	-0.565[a]	-0.302[b]	-0.076	2.719[b]	4.378	3.234[a]	3.455[a]
	(0.121)	(0.180)	(0.129)	(0.186)	(1.102)	(2.771)	(0.893)	(0.986)
Leverage(t-1) x Creditor rights	0.101	0.089	0.150[a]	0.167[a]				
	(0.065)	(0.063)	(0.050)	(0.055)				
Leverage(t-1) x Enforcement days					-0.452[b]	-0.695[c]	-0.543[a]	-0.568[a]
					(0.182)	(0.387)	(0.146)	(0.164)
Leverage(t-1) x Rule of law	0.197				0.131			
	(0.165)				(0.156)			
Leverage(t-1) x Average years of schooling		0.065[c]				-0.032		
		(0.037)				(0.077)		
Leverage(t-1) x Log average GNI per capita			0.000				0.000	
			(0.000)				(0.000)	
Leverage(t-1) x Mean GDP p. cap. growth				-0.056				-0.012
				(0.046)				(0.044)
Leverage(t-1) x Average inflation rate				-0.019				-0.001
				(0.015)				(0.015)
Observations	5,128	5,128	5,128	5,128	5,128	5,128	5,128	5,128
Pseudo-R-squared	0.264	0.264	0.264	0.264	0.265	0.265	0.265	0.265

Notes: Estimation: Pooled Probit. Marginal effects at means are reported. Significance levels: [a]1%, [b]5%, [c]10%.

Firm-level cluster- and heteroskedastic-robust standard errors in parentheses.

All specifications include country-industry, country, industry and year dummies.

Table 34: Controlling for import tariffs

Dependent variable	Dummy=1 if firm imports capital goods in t		
	(1)	(2)	(3)
Log productivity(t-1)	0.015	0.016	0.013
	(0.011)	(0.010)	(0.009)
Log employment(t-1)	0.082[a]	0.082[a]	0.075[a]
	(0.007)	(0.007)	(0.006)
Log capital intensity(t-1)	0.029[a]	0.028[a]	0.031[a]
	(0.010)	(0.010)	(0.009)
Foreign	0.095[a]	0.096[a]	0.086[a]
	(0.030)	(0.030)	(0.027)
Leverage(t-1)	-0.196	3.755[a]	-0.764[c]
	(0.147)	(1.070)	(0.402)
Leverage(t-1)x Capital import tariffs	-0.008	0.009	-0.001
	(0.010)	(0.012)	(0.011)
Leverage(t-1) x Creditor rights	0.138[a]		
	(0.053)		
Leverage(t-1) x Enforcement days		-0.636[a]	
		(0.187)	
Leverage(t-1) x Accounting standards			0.012[b]
			(0.005)
Observations	5,125	5,125	4,871
Pseudo-R-squared	0.263	0.264	0.188

Notes: Estimation: Pooled Probit. Marginal effects at means are reported. Significance levels: [a]1%, [b]5%, [c]10%. Firm-level cluster- and heteroskedastic-robust standard errors in parentheses. All specifications include country-industry, country, industry and year dummies.

Table 35: Firm characteristics interactions with Creditor rights and Enforcement days

Dependent Variable	Dummy=1 if firm imports capital goods in t		
	(1)		(2)
Independent Variables		*Independent Variables*	
Log productivity(t-1)	0.044	Log productivity(t-1)	-0.510[c]
	(0.032)		(0.302)
Log employment(t-1)	0.115[a]	Log employment(t-1)	-0.157
	(0.023)		(0.226)
Log capital intensity(t-1)	-0.021	Log capital intensity(t-1)	0.377
	(0.P28)		(0.274)
Foreign	0.132	Foreign	0.367
	(0.096)		(0.957)
Leverage(t-1)	-0.246[b]	Leverage(t-1)	3.366[a]
	(0.098)		(0.900)
Liquidity ratio(t-1)	-0.284[b]	Liquidity ratio(t-1)	0.445
	(0.114)		(1.063)
Liquidity ratio(t-1) x Creditor rights	0.110[c]	Liquidity ratio(t-1) x Enforcement Days	-0.090
	(0.061)		(0.176)
Leverage(t-1) x Creditor rights	0.133[a]	Leverage(t-1) x Enforcement days	-0.559[a]
	(0.051)		(0.149)
Log productivity(t-1) x Creditor rights	-0.016	Log productivity(t-1) x Enforcement days	0.087[c]
	(0.017)		(0.050)
Log employment(t-1) x Creditor rights	-0.018	Log employment(t-1) x Enforcement days	0.040
	(0.012)		(0.038)
Log capital intensity(t-1) x Creditor rights	0.030[c]	Log capital intensity(t-1) x Enforcement days	-0.058
	(0.015)		(0.045)
Foreign x Creditor rights	-0.021	Foreign x Enforcement days	-0.037
	(0.042)		(0.131)
Observations	5,128		5,128
Pseudo-R-squared	0.268		0.268

Notes: Estimation: Pooled Probit. Marginal effects at means are reported. Significance levels: [a]1%, [b]5%, [c]10%. Firm-level cluster- and heteroskedastic-robust standard errors in parentheses. All specifications include country-industry, country, industry and year dummies.

Table 36: Firm characteristics interactions with Accounting standards

Dependent variable	Dummy=1 if firm imports capital goods in t
	(1)
Log productivity(t-1)	0.108
	(0.082)
Log employment(t-1)	0.230[a]
	(0.064)
Log capital intensity(t-1)	-0.144[c]
	(0.075)
Foreign	0.388
	(0.311)
Leverage(t-1)	-0.774[a]
	(0.260)
Liquidity ratio(t-1)	-0.739[b]
	(0.312)
Liquidity ratio(t-1) x Accounting standards	0.010[b]
	(0.005)
Leverage(t-1) x Accounting standards	0.012[a]
	(0.004)
Log productivity(t-1) x Accounting standards	-0.001
	(0.001)
Log employment(t-1) x Accounting standards	-0.002[b]
	(0.001)
Log capital intensity(t-1) x Accounting standards	0.003[b]
	(0.001)
Foreign x Accounting standards	-0.003
	(0.003)
Observations	4,871
Pseudo-R-squared	0.195

Notes: Estimation: Pooled Probit. Marginal effects at means are reported. Significance levels: [a]1%, [b]5%, [c]10%. Firm-level cluster- and heteroskedastic-robust standard errors in parentheses. All specifications include country-industry, country, industry and year dummies.

Table 37: Sample selection sensitivity tests

Dependent variable	Dummy=1 if firm imports capital goods in t							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log productivity(t-1)	0.014	0.013	0.017	0.014	0.014	0.014	0.014	0.018^{c}
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Log employment(t-1)	0.083^{a}	0.079^{a}	0.084^{a}	0.079^{a}	0.083^{a}	0.083^{a}	0.079^{a}	0.085^{a}
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Log capital intensity(t-1)	0.034^{a}	0.034^{a}	0.029^{a}	0.033^{a}	0.033^{a}	0.034^{a}	0.033^{a}	0.028^{a}
	(0.009)	(0.009)	(0.010)	(0.010)	(0.009)	(0.009)	(0.009)	(0.010)
Foreign	0.090^{a}	0.086^{a}	0.095^{a}	0.091^{a}	0.094^{a}	0.090^{a}	0.086^{a}	0.096^{a}
	(0.026)	(0.027)	(0.029)	(0.027)	(0.027)	(0.026)	(0.027)	(0.029)
Leverage(t-1)	-0.074^{b}	-0.084^{b}	-0.240^{a}	-0.116^{b}	-0.106^{b}	0.357^{b}	0.477^{b}	3.229^{a}
	(0.032)	(0.035)	(0.092)	(0.046)	(0.045)	(0.163)	(0.201)	(0.821)
Leverage(t-1) x Creditor rights	0.024^{b}	0.027^{b}	0.128^{a}	0.043^{a}	0.040^{b}			
	(0.011)	(0.012)	(0.048)	(0.016)	(0.016)			
Leverage(t-1) x Enforcement days						-0.066^{b}	-0.085^{b}	-0.537^{a}
						(0.029)	(0.036)	(0.136)
Sample selection rule	No	Liquid <=1	Leverage<=1	Weights & Liquid<=1	Weights	No	Liquid <=1	Leverage<=1
Observations	6,171	5,896	5,516	5,896	6,171	6,171	5,896	5,516
Pseudo-R-squared	0.273	0.263	0.272	0.260	0.271	0.273	0.263	0.274

Notes: Estimation: Pooled Probit. Marginal effects at means are reported. Weights correspond to 1 for observations with non-negative equity and (1/ Leverage(t-1)) for observations with negative equity defined as Leverage(t-1)>1, Liquid=Liquidity ratio (t-1) variable.
Significance levels: ^{a}1%, ^{b}5%, ^{c}10%. Robust standard errors in parentheses. All specifications include country-industry, country, industry and year dummies. Error correction for firm-level cluster correlation.

Table 38: Controlling for the size of the second-hand capital goods market

Dependent variable	Dummy=1 if firm imports capital goods in t		
	(1)	(2)	(3)
Log productivity(t-1)	0.015	0.017	0.013
	(0.011)	(0.011)	(0.009)
Log employment(t-1)	0.082 [a]	0.083[a]	0.075[a]
	(0.007)	(0.007)	(0.006)
Log capital intensity(t-1)	0.029[a]	0.028[a]	0.031[a]
	(0.010)	(0.010)	(0.009)
Foreign	0.095[a]	0.096[a]	0.086[a]
	(0.030)	(0.030)	(0.027)
Size of second-hand market	0.003	0.003[b]	0.002[b]
	(0.001)	(0.001)	(0.001)
Leverage(t-1)	-0.283[a]	3.281[a]	-0.792[a]
	(0.096)	(0.883)	(0.259)
Leverage(t-1) x Creditor rights	0.151[a]		
	(0.050)		
Leverage(t-1) x Enforcement days		-0.545[a]	
		(0.146)	
Leverage(t-1) x Accounting standards			0.012[a]
			(0.004)
Observations	5,128	5,128	4,871
Pseudo-R-squared	0.264	0.265	0.188

Notes: Estimation: Pooled Probit. Marginal effects at means are reported. Significance levels: [a]1%, [b]5%, [c]10%. Firm-level cluster- and heteroskedastic-robust standard errors in parentheses. All specifications include country-industry, country, industry and year dummies.

Table 39: Adding country-industry-year dummies

Dependent variable	Dummy=1 if firm imports capital goods in t			
	(1)	(2)	(3)	(4)
Log productivity(t-1)	0.013	0.015	0.012	0.014
	(0.011)	(0.011)	(0.009)	(0.011)
Log employment(t-1)	0.081***	0.082***	0.075***	0.082***
	(0.007)	(0.007)	(0.006)	(0.007)
Fog capital intensity(t-1)	0.030***	0.028***	0.032***	0.029***
	(0.010)	(0.010)	(0.009)	(0.010)
Foreign	0.096***	0.098***	0.087***	0.096***
	(0.030)	(0.030)	(0.028)	(0.030)
Leverage(t-1)	-0.263***	3.071***	-0.745***	-0.152**
	(0.097)	(0.897)	(0.262)	(0.062)
Leverage(t-1) x Creditor rights	0.137***			
	(0.051)			
Leverage(t-1) x Enforcement days		-0.511***		
		(0.149)		
Leverage(t-1) x Accounting standards			0.011***	
			(0.004)	
Leverage(t-1) x Private credit/GDP				0.189**
				(0.074)
Observations	5,095	5,095	4,841	5,095
Pseudo-R-squared	0.264	0.265	0.189	0.264

Notes: Estimation: Pooled Probit. Marginal effects at means are reported. Significance levels: [a]1%, [b]5%, [c]10%. Firm-level cluster- and heteroskedastic-robust standard errors in parentheses. All specifications include country-industry, country, industry and year dummies.

4 Natural hedging of exchange rate risk - the role of imported input prices[112]

Abstract

Recent empirical trade literature on the role of imported inputs in exchange rate adjustments of exports implicitly assumes full exchange rate pass-through (ERPT) into imported input prices, which is a rather strong assumption. In this paper, we use self-constructed indices of intermediate input prices to investigate the effect of exchange rate fluctuations using disaggregated quarterly trade data for Switzerland over 2004-2011. While our results indicate high ERPT into imported input prices in all sectors, we do not find evidence of full pass-through for all sectors either in the short- or long-run. We also find strong sectoral ERPT heterogeneity on the export side in both the short- and long-run. Our results also suggest the use of "natural hedging" as an effective strategy to reduce exchange rate risks. Moreover, Swiss exporters may not have adjusted export pricing and "natural hedging" practice in response to a strong CHF in the wake of the Euro crisis.

Keywords: exchange rates, exchange rate pass-through, international trade, prices

JEL classification: F31, F41

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4.1 Introduction

Exploring the role of imported inputs in exchange rate adjustments of exports has a relatively long tradition in the empirical trade literature (see for example sector-level studies by Athukorala and Menon, 1994 and Goldberg and Campa, 2010, or more recently, firm-level studies by Greenaway et al., 2010 and Berman et al., 2012). The rationale for studying this channel is the potential role of exchange rate appreciation/depreciation not just in raising/lowering the foreign export prices of traded goods and services, but also in lowering/raising the prices of imported inputs. Domestic firms exporting abroad may thus have the means to offset some of the adverse effect of exchange rate appreciations on profit margins through cheaper imported inputs ("naturally hedge" exchange rate risks). However, this rationale only holds if exchange rate pass-through (ERPT) into imported input prices and/or export prices is non-zero.

It turns out that the recent empirical literature mainly focuses on (semi-)final goods price adjustments and investigates the cost effect due to imported inputs only indirectly using measures such as the share of imported intermediate inputs in total intermediate inputs (Greenaway et al., 2010), or in studies with firm data, the ratio of total imports to total sales (Berman et al., 2012). These studies however do not look at actual price developments of imported inputs as a result of exchange rate shocks. Thus, they implicitly assume full ERPT into imported input prices,[113] which is a rather strong assumption, given the overwhelming existing evidence of partial ERPT into import prices in general (see for instance Campa and Goldberg, 2005).

In a significant departure from this literature, we study ERPT into imported input prices using bilateral and disaggregated unit values as proxies for import prices. We then use these unit values to calculate indices of average imported input prices that are faced by each sector over time and investigate their role in the price setting behavior of exporters. To the best of our knowledge, this paper is the first (i) to investigate in detail how imported input prices faced by each (exporting) industry develop over time and (ii) to study the effectiveness of "natural hedging" of exchange rate risk by quantifying the effect of exchange rate fluctuations on these imported input prices. Finally, (iii) we examine total pass-through effects on export prices; that is, the combined effect of pricing-to-market behavior (the simple effect of exchange rate movements on export prices) and the cost-changing effects of exchange rate changes through imported inputs. The last step is also used to

[113] To the best of our knowledge, the only exception to this are Athukorala and Menon, 1994 but they do not use disaggregated indices for imported input prices as we do.

identify whether exporters used "natural hedging" to stabilize profit margins (mark-ups) in a specific export market. In other words, the paper's main contribution is to take into account the effect of price fluctuations of imported inputs on the exporters' pricing decisions and profit margins.

We use monthly/quarterly product level trade data at the 8-digit level for Switzerland between 2004 and 2011. Analyzing imported input prices in Switzerland is particularly interesting as the Swiss economy has high ratios of imported intermediate inputs relative to total intermediate inputs, especially in the manufacturing sector (see Table 40), and about half of total imports are processed and re-exported (see Seco, 2011). In the event of significant "natural hedging" it is thus a relevant question whether Swiss exporters are (at least to some extent) spared from losing competitive advantage despite the strong appreciation of the Swiss Franc (CHF). Last but not least, investigating this issue with Swiss data also contributes to the on-going debate on the "strong" CHF. According to a recent study by the State Secretariat for Economic Affairs (Seco, 2011), imported goods prices fell by 40 percent three or four quarters after the appreciation. However, the prices did not fall as much as the CHF appreciated. While the focus of the on-going discussion is more related to imported consumer goods, it might be that prices of imported inputs did not - or not yet - fully adjust as well, which provides another motivation for this study and a reason to also investigate the recent "Strong Franc" period separately.

The paper proceeds as follows. Section 4.2 provides a brief review of the relevant literature. Section 4.3 introduces the theoretical framework which forms the basis for the empirical set up in Section 4.5. Section 4.4 presents the recent evolution of imported input prices and describes the data. Section 4.6 describes the results from estimation and Section 4.7 concludes.

4.2 Related literature

This section highlights results and empirical issues from previous work closely related to our study. A complete overview of the extensive pass-through literature is beyond the scope of this brief review (for more extensive literature reviews see for example Goldberg and Knetter, 1997 and Greenaway et al., 2010).

Athukorala and Menon (1994) examine the pricing behavior of Japanese exporters by taking into account the aggregate changes of intermediate costs arising from exchange rate

movements. Their investigation of quarterly export prices reveals that if the cost-saving effect of exchange rate appreciations is considered the pass-through rate into foreign currency prices for total manufacturing exports declines from 0.78 to 0.67. Separate estimations for seven manufacturing sub-industries reveal a substantial upward aggregation bias: At the disaggregated level, total ERPT ranges from 0.04 for textiles to 0.53 for transport equipment. All estimates are thus lower than 0.67 at the aggregated level. In this essay, we go a step further by investigating average ERPT into export prices for 15 goods sectors using price data (unit values) at a highly disaggregated (HS 8-digit) and bilateral level. Moreover, we explicitly include disaggregated proxies of imported input prices faced by exporting industries in each period. Finally, we also estimate how these intermediate import prices react to exchange rate changes (again using highly disaggregated data) to investigate whether "natural hedging" is effective.

In a recent study using a panel of French firms, Berman et al. (2012) find a positive net "natural hedging" effect (defined as the interaction between the real exchange rate and firm intermediate imports over sales) on EUR export prices, and thus - in line with Athukorala and Menon (1994) - smaller ERPT into foreign currency prices when taking the cost adjustment into account. Similarly, Greenaway et al. (2010) investigate a panel of UK manufacturing firms and suggest that the negative effect of an exchange rate appreciation on firm exports is lower in industries that import a greater share of inputs. According to Greenaway et al. (2010), their imported-input-weighted exchange rate, which varies at the sectoral-level, should account for import price changes resulting from exchange rate changes. They implicitly assume that an appreciation of the domestic currency would lower import prices. A shortcoming of both studies is that they draw conclusions on the behavior of import prices without actually studying them.

As indicated by Athukorala and Menon (1994) and Greenaway et al. (2010), industry variation in the pass-through rates are likely to reflect differences in the cost structures across industries. Along the same line, Campa and Goldberg (1997) and Hummels et al. (2001) point to the increasingly important role of global supply chains, and accordingly to the share of imported inputs as an important determinant of industry cost structure. Acknowledging the cost contribution of imported inputs, we emphasize the cost sensitivity of imported inputs to exchange rate movements and its subsequent effect on export pricing. The sensitivity of prices at the importer side also influences the ERPT at the exporter side, but this interconnection has surprisingly not received adequate attention in the empirical ERPT literature. Aksoy and Riyanto (2000) formalize this issue and show that ERPT

in the downstream export market depends on the pricing behavior of foreign upstream suppliers. Finally, Ihrig et al. (2006) argue that the decline of pass-through rates into domestic prices experienced in all G-7 countries over the last two decades may also be a consequence of the steady rise of cross-border production arrangements.

In other related work, Goldberg and Campa (2010) calibrate a model of the CPI sensitivity to exchange rates with data from 21 OECD countries. They find that the goods cost shares of imported inputs are the dominant channel through which exchange rate shocks are transmitted into consumer prices. For the calibration exercise, they use the strong assumption that an exchange rate change is completely passed through into imported input prices. This contrasts, for instance, with the low pass-through rate of 0.22 into US import prices reported by Gopinath and Rigobon (2008). Campa and Gonzalez Minguez (2006) show that differences of ERPT into domestic prices in the euro area countries may be explained by the degree of openness to non-euro imports of each country. Campa and Goldberg (1995) and Campa and Goldberg (1999) provide evidence for the US, UK, Japan and Canada that suggests that sectoral investment rates respond to exchange rate fluctuations depending primarily on a sector's exposure to imported inputs and export markets. Their empirical findings suggest that a depreciation of the domestic currency tends to reduce investments particularly in competitive sectors that employ a large fraction of imported inputs, whereas high mark-up sectors with lower imported input shares are less affected by exchange rates. A possible explanation is again that the sensitivity of imported input prices to exchange rates differs across sectors, probably reflecting distinct competitive environments. Yet the issue remains unresolved in all the cited studies. Our study fills this gap in the pass-through literature by recognizing explicitly in the empirical framework that the exporters' pricing decisions have become inextricably intertwined with the pricing behavior of foreign suppliers.

4.3 Theoretical framework

This section develops the analytical framework from which we derive our pass-through estimating equations with regard to imported input prices in 4.5.1 and export prices in 4.5.2. More details on the empirical strategy and econometric techniques are discussed in Section 4.5.

4.3.1 Import price equation

We assume an exporting sector s specific Cobb-Douglas production function with the share α_s corresponding to imported inputs and the share $1-\alpha_s$ to domestic inputs including labour services.

$$Q_s = (K^*)^{\alpha_s} \cdot (K)^{1-\alpha_s}, \tag{31}$$

The marginal cost function dual to (31) is given by :

$$MC_s(W, W^*(E), \alpha_s, E) = A_s \cdot W^{1-\alpha_s} \cdot (EW^*(E,Z))^{\alpha_s}, \qquad A_s = \alpha_s^{-\alpha_s} \cdot (1-\alpha_s)^{\alpha_s - 1}, \tag{32}$$

where W is the price of domestic inputs, W^* denotes the price of imported inputs denominated in the foreign currency and E is the bilateral exchange rate between Switzerland and the import source country defined as CHF per unit of the foreign currency. Z includes all factors that affect the foreign currency price of imported inputs W^*; such as the state of the business cycle or increases in producer prices due to changes in foreign wages or commodity prices. Taking logs and then totally differentiating (32) leads to the following expression:

$$\tilde{MC}_s = \widetilde{A} + (1-\alpha_s)\widetilde{W} + \alpha_s \left(\tilde{E} + \frac{\partial w^*}{\partial W^*} \frac{\partial W^*}{\partial e} \tilde{E} + \frac{\partial w^*}{\partial W^*} \frac{\partial W^*}{\partial z} \tilde{Z} \right) \tag{33}$$

where a "$\backsim$" over a variable denotes percentage changes and small letters denote the log of the variables. It is clear from (33) that a higher share of imported inputs, α_s, results in a higher sensitivity of marginal costs to exchange rate fluctuations. Price changes of imported inputs in CHF can be decomposed into the direct effect $\widetilde{E}$ on the Swiss price of imported inputs and the indirect consequence of an exchange rate change on the pricing behavior of foreign suppliers, $\tilde{W}^* = \frac{\partial w^*}{\partial W^*} \frac{\partial W^*}{\partial e} \tilde{E}$. An interesting limiting case is local currency pricing (LCP) in which the pass-through rate is zero or formally:

$$\widetilde{E} + \frac{\partial w^*}{\partial W^*} \frac{\partial W^*}{\partial e} \tilde{E} = 0 \tag{34}$$

The price reducing effect of an appreciation is here completely offset by the price increases of the foreign suppliers. More generally, percentage changes of imported input prices in

CHF, $\tilde{P_s^m}$, due to exchange rates movements, which corresponds to the term in brackets in (33), can be defined as follows:

$$\tilde{P_s^m} = \left(1 + \frac{\partial w^*}{\partial e}\right) \cdot \tilde{E} + \frac{\partial w^*}{\partial z} \cdot \widetilde{Z}, \tag{35}$$

Thus the effect of a percentage change in the bilateral exchange rate $\tilde{E}$ depends on the elasticity of the foreign currency input prices to exchange rates or equivalently on the elasticity of mark-ups to exchange rates, $\frac{\partial w^*}{\partial e}$. If this elasticity equals zero, we obtain full pass-through. Conversely, if foreign suppliers adjust foreign prices and mark-ups when the exchange rate fluctuates, pass-through will be less than complete, $\frac{\partial w^*}{\partial e} < 0$, or amplified, $\frac{\partial w^*}{\partial e} > 0$. In line with equation (35), the simplified empirical equation takes the following logarithmic specification using first-differences and adding time dimension t (see more details in 4.5.1):

$$dp_{t,s}^m = \theta_t + \lambda_s + \beta_s de_t + \epsilon_{t,s} \tag{36}$$

where d is the first-difference operator, β_s corresponds to the sector-specific pass-through coefficient. $\beta_s = 1$ would mean that this sector is characterized by full pass-through or producer currency pricing (PCP). In contrast, $\beta_s = 0$ indicates zero pass-through or local currency pricing (LCP) of foreign input suppliers in the Swiss market as illustrated in equation (34).[114] In the intermediate case, $\beta < 1$, we have incomplete pass-through, which suggests that foreign input suppliers raise their prices and mark-ups when the CHF appreciates. Knetter (1989) points out that this occurs when foreign input suppliers' perceived elasticity of demand rises with the local price (CHF). Then, a depreciation of the supplier's currency, $\tilde{E} < 0$, induces foreign suppliers to increase their profit margins. This relationship would be reflected in the negative elasticity between the foreign input price and the exchange rate in equation (35), $\frac{\partial w^*}{\partial e} < 0$. Conversely, a $\beta > 1$ shows that exchange rate changes are transmitted into imported input prices in an amplified manner. This could indicate that the foreign input suppliers' demand elasticity may fall with the Swiss price of foreign inputs resulting in $\frac{\partial w^*}{\partial e} > 0$. Full pass-through, $\frac{\partial w^*}{\partial e} = 0$, indicates that the perceived demand elasticity does not change with the local price.[115] A set of fixed effects $\theta_t + \lambda_s$ in (36) captures changes in foreign input prices in a specific sector s and over time t that can be attributed to changes in the economic conditions, the production costs ($\tilde{Z}$ in equation 35) in the exporting country, demand conditions in the importing country

[114] All exchange rate movements are fully absorbed in the mark-ups of foreign suppliers in this case.
[115] This would be the case with a CES demand function.

or changes in commodity prices.

4.3.2 Export price equation

In an imperfectly competitive environment such as the popular monopolistic competition framework, economic agents are price setters and their first order conditions from profit maximization can be stated in the following way:

$$P^e_{j,s} = MK_{js}\left(\frac{P^*_{js}(E)}{P_j}, Z_j, MC_s(E,W)\right)\cdot MC_s(E,W), \qquad MK_{js} = \frac{P^e_{js}}{MC_s}, \quad P^*_{j,s} = \frac{P^e_{j,s}(E)}{E}, \tag{37}$$

where $P^e_{j,s}$ is the FOB average export price in CHF of sector s delivering to country j, $P^*_{j,s}$ is the corresponding price in local currency, MC_s denotes the sector-specific marginal cost (see also equations 32 and 33) and $MK_{j,s}$ represents the sector-destination specific mark-ups. Taking logs and totally differentiating (37) with respect to the bilateral exchange rate in terms of CHF per unit of the destination currency E, the destination price index P_j, the demand-shifter Z_j and the domestic input prices W we obtain:

$$\tilde{P}^e_{j,s} = \left(\frac{\partial mk_{j,s}}{\partial P^*_{j,s}}\frac{\partial P^*_{j,s}}{\partial e}\right)\cdot\tilde{E} + \left(\frac{\partial mk_{j,s}}{\partial MC_s}\frac{\partial MC_s}{\partial e} + \frac{\partial mc_s}{\partial e}\right)\cdot\tilde{E} + \tag{38}$$

$$+\frac{\partial mk_{j,s}}{\partial p_j}\cdot\tilde{P}_j + \left(\frac{\partial mk_{j,s}}{\partial MC_s} + 1\right)\cdot\frac{\partial mc_s}{\partial w}\cdot\tilde{W} + \frac{\partial mk_{j,s}}{\partial z_j}\cdot\tilde{Z}_j,$$

$$\frac{\partial mk_{j,s}}{\partial MC_s} \leq 0, \quad \frac{\partial mc_s}{\partial e} \geq 0, \quad \frac{\partial mk_{j,s}}{\partial P_j} > 0, \quad \frac{\partial mk_{j,s}}{\partial Z_j} > 0, \quad \frac{\partial mc_s}{\partial W} > 0$$

The exporter's price equations (37) and (38) show that the mark-up is a function of the ratio between the price of the Swiss export good price in local currency, $P^*_{j,s}$, divided by an average price index, P_j, that encompasses close substitutes available in market j. The export price reaction to exchange rate changes depends on the reaction of the mark-ups to currency movements, $\frac{\partial mk_{j,s}}{\partial P^*_{j,s}}\frac{\partial P^*_{j,s}}{\partial e}$. As on the import side, this elasticity depends on how exporters perceive the demand schedule in a specific export market. For instance, a

positive relationship between a CHF depreciation and the mark-up, $\frac{\partial mk_{j,s}}{\partial P^*_{j,s}} \frac{\partial P^*_{j,s}}{\partial e} > 0$, holds whenever a firm is confronted with a residual demand that exhibits an increasing elasticity with the price - this is the case for demand functions that are less convex than in the CES case - irrespective of the form of imperfect competition as highlighted by Knetter (1989) and illustrated by Yang (1997) and Dornbusch (1987) for extended Dixit-Stiglitz and Cournot frameworks.[116] [117] With such a perceived demand function, exporters that face an appreciated currency , $\tilde{E} < 0$, try to remain competitive by reducing mark-ups. A mark-up elasticity of one, $\frac{\partial mk_{j,s}}{\partial P^*_{j,s}} \frac{\partial P^*_{j,s}}{\partial e} = 1$, corresponds to local currency pricing (LCP) wherein the mark-up fully absorbs exchange rate movements. If the demand curve is more convex than in the CES case, it could occur that exporters increase the mark-up when the exporter's currency appreciates leading to an overreaction of local prices to exchange rate changes. The second term in (38) illustrates the effect of exchange rate changes on marginal costs and mark-ups working through imported input prices.[118] Contingent on the imported input price reactions (see equations 35 and 36), exporters may benefit from lower marginal costs through cheaper foreign inputs when their currency appreciates, $\frac{\partial mc_s}{\partial e} \geq 0$, and may also increase profit margins, $\frac{\partial mk_{j,s}}{\partial MC_S} \frac{\partial MC_s}{\partial e} \leq 0$. The mark-up adjustment depends again on the perceived demand elasticity. Furthermore, as in Melitz and Ottaviano (2008), more competitive export markets are characterized by lower local prices, P_j, for similar goods, and thus higher demand elasticities which force exporters to reduce export prices, $\frac{\partial mk_{j,s}}{\partial p_j} > 0$. From (38) one can also note that controlling for differences and changes of marginal costs, preferably at the product level, is important due to their direct impact on export prices and through their effect on the price-cost margins since sectors with lower marginal costs MC_j are able to set higher mark-ups, $\frac{\partial mk_{j,s}}{\partial MC_s} \leq 0$.[119] Z_j is a demand shifter related to destination-specific preferences for a good but also on general economic conditions in market j. Stronger preferences and better conditions both increase the exporters' ability to raise export prices and margins, $\frac{\partial mk_{j,s}}{\partial z_j} > 0$.

Equation (38) leads us directly to our simplified empirical specification (see more details

[116] In the extended Dixit-Stiglitz framework of Yang (1997) based on Dornbusch (1987), firms take into account their non-negligible effect of quantity decisions on the aggregate industry price index. Atkeson and Burstein (2008) show that the endogenous mark-up in our sense, $\frac{\partial mk_{j,s}}{\partial e} > 0$, that leads to incomplete pass-through can be even introduced in a CES-framework with small modifications.

[117] Our derivation of the exporter's pricing and pass-through in (37) and (38) is therefore not limited to monopolistic competition frameworks but holds more generally as well.

[118] Please note that the bilateral exchange rate variable, $\tilde{E}$, in the first and second term of (38) can differ according to the origins of the imported inputs used and the specific destination of an export good.

[119] This holds again for demand curves that are less convex than in the CES case (i.e. elasticity increases with price).

in 4.5.2):

$$dp^{e}_{t,j,s} = \theta_{t,j} + \eta_s + \gamma_1 * de_{t,} + \gamma_2 * dp^{m}_{t,s} + \varepsilon_{t,j,s}, \tag{39}$$

where γ_1 denotes the pricing-to-market coefficient (PTM) and corresponds to the mark-up elasticity to exchange rates in equation (38), $\gamma_1 = \frac{\partial mk_{js}}{\partial P^{*}_{js}} \frac{\partial P^{*}_{js}}{\partial e}$. A PTM coefficient equalling one, $\gamma_1 = 1$, represents local currency pricing (LCP) in the sense that export prices in CHF and mark-ups move one-to-one with exchange rates. As a consequence, a CHF appreciation erodes profit margins. Exchange rate pass-through into local prices (in FCU) would then be zero. More specifically, the pass-through effects (in local/foreign prices) are calculated as $1 - \gamma_1$, and therefore are negatively related to PTM behavior. γ_2 corresponds to the cost-adjustment coefficient and shows how export prices change when imported input prices change. As a result, it should be clear that not accounting for the cost-effect of exchange rate movements on the prices of imported inputs may create a bias in the pass-through estimations on the export side - as also argued by Goldberg and Knetter (1997). The remaining variables affecting export prices as emphasized in equation (38) are captured by a set of fixed effects $\theta_{t,j} + \eta_s$ to account for changes of marginal costs, demand conditions at destination and product-specific differences of competitive pressure, preferences and production costs.

4.4 Data

Sub-section 4.4.1 documents the extent to which Swiss goods industries use imports of intermediate inputs, among other things, as a means to lower exchange rate risks ("natural hedging"), explains the calculation of our sectoral input price indices and traces the evolution of imported input prices that Swiss industries have faced since 2005 compared to that of nominal effective exchange rates and crude oil prices. In 4.4.2, we discuss the data used in the empirical estimations and provide descriptive statistics.

4.4.1 Calculation and evolution of imported input price indices

Prima facie, our data suggest that Swiss industries practiced considerable "natural hedging". The first column of Table 40 shows ratios of imported inputs relative to the sum of total inputs and total compensation to employees (or total production costs) while the

Table 40: Share of imported inputs of total production costs in Switzerland by sector

		(Imported inputs) / (Total inputs + Compensation of employees)	(Imported inputs) / (Total inputs)
1	Agriculture	0.18	0.22
2	Mining & quarrying	0.09	0.13
3	Food & beverages	0.14	0.17
4	Textiles	0.27	0.38
5	Wood products	0.11	0.18
6	Paper products	0.14	0.21
7	Chemicals & pharmaceuticals	0.24	0.29
8	Rubber & plastics products	0.19	0.27
9	Mineral products	0.18	0.27
10	Iron & steel	0.25	0.35
11	Fabricated metal products	0.21	0.35
12	Machinery & equipment	0.17	0.25
13	Electrical machinery	0.25	0.31
14	Communication equipment	0.21	0.32
15	Precision instruments	0.16	0.22

Source: OECD

second column shows ratios of imported inputs relative to total inputs. Data and the sector classification are taken from the 2001 input-output table (I-O table) for Switzerland published by the OECD. As Table 14 highlights, imported inputs make up more than 10 percent of total production costs in all Swiss sectors and are particularly high in some manufacturing sectors (e.g. Textiles 27 percent, or Electrical machinery 25 percent). By construction, these figures are even higher when looking at the simple ratios of imported relative to total intermediate inputs (e.g. Textiles 38 percent, or Electrical machinery 31 percent).

"Natural hedging" is only an effective tool to lower exchange rate risks if imported input prices react to exchange rate fluctuations. To gain more insight into the price and exchange rate developments, we calculate indices of imported input prices faced by Swiss industries and plot them against the nominal effective exchange rate index (calculated by the Bank of International Settlement) over January 2005-September 2011 (see Figure 7). Imported input price indices are calculated using unit values at the 8-digit level and for each month and each trading partner separately. Solely imported intermediate 8-digit goods are considered in these calculations, for which the WTO classification of intermediate goods (published by UN Comtrade[120]) is used. We then construct import-weighted unit values for each 2-digit ISIC product group, and aggregate them to the I-O table sector-level using import volume shares.[121] To calculate the average imported intermediate input prices (or unit values) faced by Swiss industries, the constructed sector price averages are re-weighted according to the share of imports from each input sector in each output sector. These weights are taken from the 2001 I-O table for Switzerland.[122]

Despite their well-known shortcomings, using unit values as proxies for import or export

[120] http://wits.worldbank.org/wits/data_details.html

[121] Each I-O table sector consists of one up to five 2-digit ISIC product groups.

[122] More formally, these price indices are constructed as follows:

$$P^m_{t,so} = \left[\sum_{t,so,si,isic2}\left\{\left[\sum_{t,isic2,k,i}\left(\left(\frac{IV_{t,isic2,k,i}}{IV_{t,isic2}}\right)(UV_{t,isic2,k,i})\right)\right]_{t,isic2} * \left(\frac{IV_{t,si,isic2}}{IV_{t,si}}\right) * \left(R^{si}_{so}\right)\right\}\right]_{t,so},$$

where t is the time period (month), i is the source country of imports, k is the HS 8-digit input product, $isic2$ is the ISIC 2-digit sector, si is the I-O imported input sector and so is the I-O output sector. IV stands for import volumes in CHF, UV are unit values (or import volumes divided by weight of imported goods in kg) and R^{si}_{so} is the share of imported inputs from I-O input sector si in I-O output sector so. A limiting feature of our data is that these I-O weights do not vary over time, and thus are assumed to remain constant across the whole study period. Finally, $P^m_{t,so}$ is the average imported intermediate input price faced by each (output) sector io in each period t. In Figure 2 these price indices are set to 100 for January 2005 and correspond to averages over the previous 12 months. In the export side estimations in Section 4.5.2, these imported input price indexes are again used as an independent variable.

Figure 7: Development of imported input prices faced by output sectors: 2005-2011

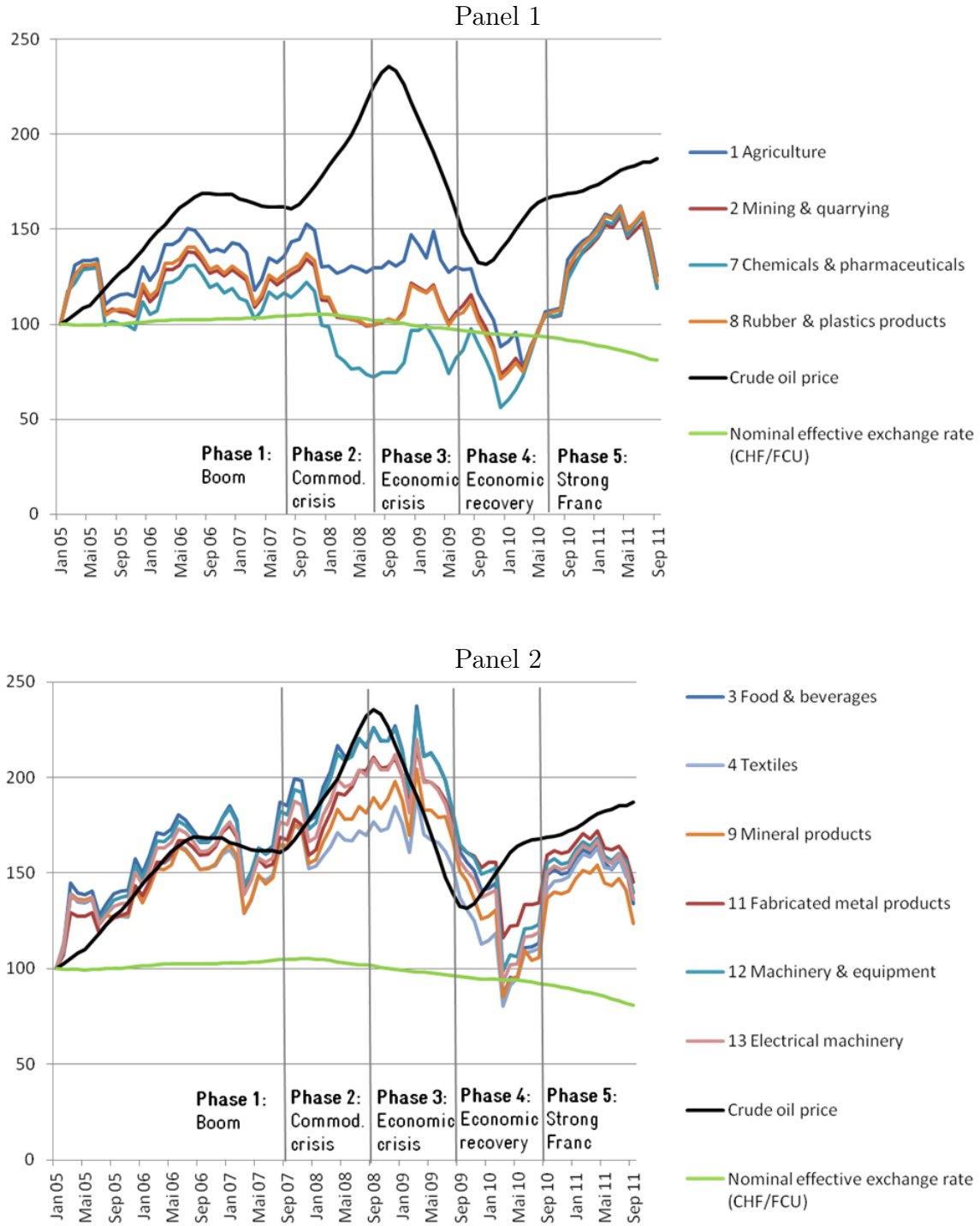
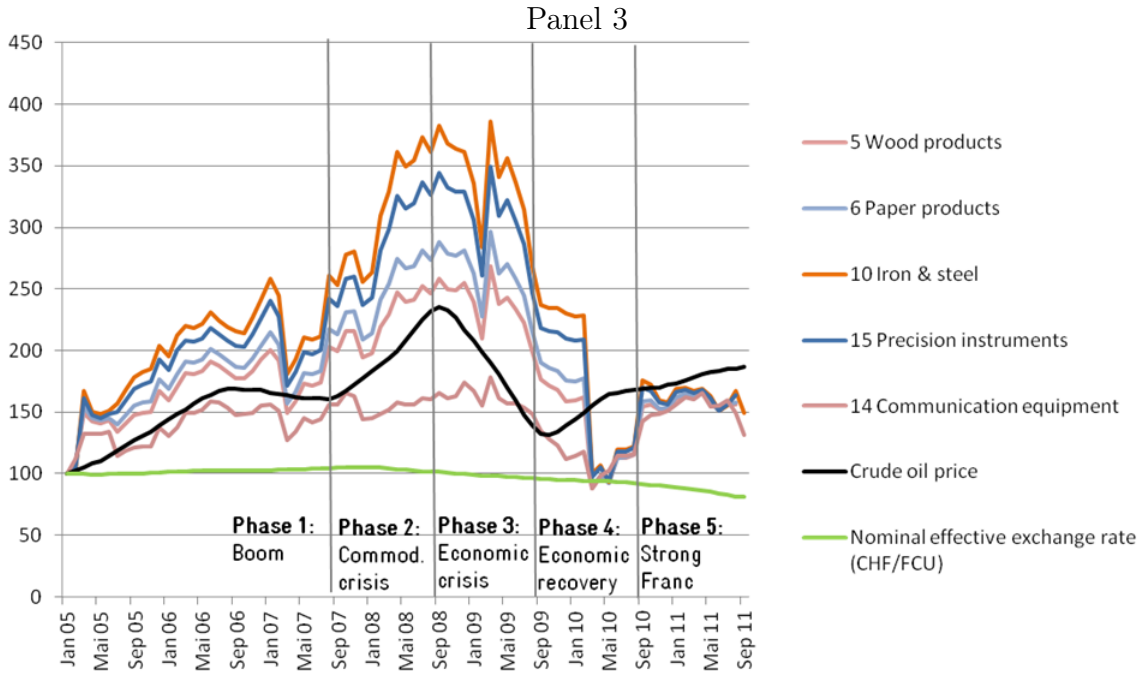


Figure 7: continued



Notes: Figures are averages of the last 12 months; all price indexes are based on prices in CHF; FCU denotes foreign currency units.
Source: Swiss Federal Customs Administration, Bank for International Settlements

prices is standard in the exchange rate pass-through literature because of their relatively wide availability (see for example Berman et al., 2012). Compared to most earlier studies, unit values in this paper more accurately reflect prices as products are highly disaggregated (8-digit level) and separate unit values are calculated for imports of each trading partner. Furthermore, unit values allow us to discriminate between intermediate and consumer goods. This enabled us to be the first to construct industry-level imported input price indexes as genuine price indexes are not available either at the aggregate or at the sectoral level.

Trade data is obtained from the Swiss Federal Customs Administration. As energy prices are likely to make up a significant amount of production costs, imported input prices faced by Swiss industries are likely to be correlated with energy prices. To visualize this relationship, Figure 2 also includes a line for a crude oil price index (calculated as the simple average of three spot crude oil prices in CHF; Dated Brent, West Texas Intermediate, and the Dubai Fateh). All indices are set to 100 in January 2005. To eliminate seasonal fluctuations, all reported figures correspond to averages of the last 12 months (e.g. the oil price index for March 2005 corresponds to the average oil price index between April 2004 and March 2005).

The figure is divided into three panels (1-3). Each panel looks at imported input price developments for sectors facing a similar pattern. The time axis is roughly divided into five phases: boom, commodity crisis, economic crisis, economic recovery, strong Franc. Panel 1 sectors import intermediates with the least price fluctuations and are at first sight the least responsive to oil price shocks, in particular from January 2008 to May 2009. During the commodity crisis, imported input prices even decreased slightly while crude oil prices almost doubled. Panel 2 and Panel 3 sectors clearly show the expected positive relationship between oil prices and imported input prices. Panel 3 sector prices are relatively more volatile (in both directions) than Panel 2 sectors. For some Panel 3 sectors (e.g. Iron & steel) imported input prices increased by a factor of four between January 2005 and September 2008, which is a considerably larger price hike compared to the oil shock during the same period.

Figure 7 also shows that the nominal effective exchange rate index is relatively stable from January 2005 to January 2009, and is followed by a steady appreciation of the CHF over 2009 and a sharp appreciation in 2010 and 2011. Interestingly, during 2009 input prices show a decline during the period of steady CHF appreciation but a rise in the "strong" CHF phase up until May 2011; this suggests that these prices were more correlated with

oil prices during this period (with approximately a six month lag). It was only after May 2011 that the price decreasing impulse of the strong Franc seemed to overcompensate for the price increasing tendencies of the oil price hike, thereby providing preliminary evidence for the effectiveness of "natural hedging" as a tool to lower exchange rate risks. Thus, in the course of continued CHF appreciation, prices of imported inputs started to fall, which is likely to have decreased the exposure of Swiss exporters to the adverse exchange rate.

4.4.2 Descriptive statistics

This section describes the two datasets used in the import and export price equations, respectively. We use quarterly and bilateral trade data based on HS 8-digit products between Q4-04 and Q3-11 taken from the Swiss Federal Customs Administration. The dataset is reduced to the 37 most important trading parters for Switzerland (including all OECD countries and the BRICS and accounting for more than 90 percent of import and exports, respectively). On the import side (Table 41), the dependent variable, imported input price, is constructed as the first-difference of log imported input unit values (CHF/kg). The main independent variable, exchange rate, is constructed as the first-difference of bilateral log nominal exchange rates. Similarly, on the export side (Table 42), the dependent variable, export price, corresponds to the first-difference of log export product unit values (CHF/kg) and the exchange rate variable is constructed in the same way as on the import side. Additionally, the export side dataset includes imported input price indices introduced in Section 4.4.1 and constructed for the empirical estimations as the first-difference of log indices of sectoral imported input unit values, which are faced by exporters in each sector (see Table 42). Thus, the variables of interest in both datasets correspond to growth rates (that is, first-differences of logs) of the underlying level variables. The dependent variables in both datasets are on average (almost) zero in each sector. The growth rates of exchange rates have naturally no variation across sectors and are also zero on average. The price indices of imported inputs are weighted averages at the sectoral level (that is, they vary only across time and not across products within sectors). Average growth rates of these indices are more heterogeneous across sectors than the other variables, for example -2 percent for Chemicals & pharmaceuticals or +6 percent in the Iron & steels sector. The standard deviation and the minimum and maximum bounds are however lower compared to those of the dependent variables in both datasets.

Table 41: Descriptive statistics of data used in import price equation

Dependent variable: Imported input price

Formula: $dp^m_{t,i,k}$
Description: First-difference of log imported input unit value (CHF/kg)
Dimensions: Time t (28 quarters, Q4-04 to Q3-11), Geography i (37 source countries), Product k (2'366 HS 8-digit intermediate input products)
Source: Swiss Federal Customs Administration

		Mean	Std. Dev.	Min.	Max.
1	Agriculture (3'378)	-0.00	0.62	-3.97	3.83
2	Mining & quarrying (279)	-0.02	1.51	-5.15	6.09
3	Food & beverages (17'918)	-0.00	0.60	-6.10	6.08
4	Textiles (53'111)	-0.00	0.74	-5.51	6.63
5	Wood products (4'572)	0.01	0.I4	-4.52	5.41
6	Paper products (16'495)	0.00	0.78	-6.25	6.78
7	Chemicals & pharmaceuticals (104'450)	-0.00	1.19	-11.77	10.33
8	Rubber & plastics products (13'408)	-0.00	0.88	-7.36	6.75
9	Mineral products (6'895)	-0.00	1.03	-7.04	6.31
10	Iron & steel (50'285)	0.00	0.81	-8.78	8.44
11	Fabricated metal products (16'567)	0.00	0.97	-7.42	8.16
12	Machinery & equipment (2'754)	-0.01	0.99	-6.19	6.35
13	Electrical machinery (3'634)	0.00	0.99	-5.00	5.74
14	Communication equipment	..	..	..	..
15	Precision instruments (9'125)	0.01	1.09	-7.57	8.56

Independent variable: Nominal exchange rate

Formula: $de_{t,i}$
Description: First-difference of log nominal exchange rate
Dimensions: Time t (28 quarters), Geography i (37 source countries)
Source: Swiss National Bank

	Mean	Std. Dev.	Min.	Max.
All sectors	-0.01	0.03	-0.24	0.19

Notes: Figures in parentheses correspond to the number of observations in the respective sectors; reported statistics for the nominal exchange rate variable are equal across different sectors and are therefore not reported separately; figures missing for input sector 14 as no *hs8* input product classified within sector 14.

Table 42: Descriptive statistics of data used in export price equation

Dependent variable: Export product price

Formula: $dp^{e}_{t,j,f}$
Description: First-difference of log export product unit value (CHF/kg)
Dimensions: Time t (28 quarters), Geography j (37 destination countries), Product f (5'505 HS 8-digit intermediate and final products)
Source: Swiss Federal Customs Administration

		Mean	Std. Dev.	Min.	Max.
1	Agriculture (10'944)	0.00	0.97	-8.90	10.13
2	Mining & quarrying (9'403)	0.00	1.14	-10.95	10.83
3	Food & beverages (73'240)	0.00	0.57	-7.58	8.17
4	Textiles (185'355)	-0.00	0.84	-8.51	9.35
5	Wood products (10'457)	-0.01	0.95	7.11	8.11
6	Paper products (47'404)	-0.00	0.98	-11.42	8.80
7	Chemicals & pharmaceuticals (190'038)	0.00	0.98	-12.10	12.32
8	Rubber & plastics products (58'638)	0.00	0.90	-9.29	10.24
9	Mineral products (36'427)	-0.00	1.07	-9.93	9.82
10	Iron & steel (60'706)	0.01	0.96	-9.28	9.34
11	Fabricated metal products (133'608)	0.00	0.92	-8.74	9.14
12	Machinery & equipment (209'033)	-0.00	1.00	-10.91	11.87
13	Electrical machinery (97'780)	-0.00	0.98	-10.35	10.35
14	Communication equipment (27'876)	0.00	1.21	-11.67	12.51
15	Precision instruments (103'826)	0.00	0.93	-8.43	9.64

Independent variable: Nominal exchange rate

Formula: $de_{t,i}$
Description: First-difference of log nominal exchange rate
Dimensions: Time t (28 quarters), Geography i (37 destination countries)
Source: Swiss National Bank

	Mean	Std. Dev.	Min.	Max.
All sectors	-0.01	0.04	-0.24	0.19

Notes: Figures in parentheses correspond to the number of observations in the respective sectors; reported statistics for the nominal exchange rate variable are equal across different sectors and therefore not reported separately for each sector.

Table 42: continued

Independent variable: Imported input price

Formula: dp_t^m
Description: First-difference of log of sectoral imported input price index (CHF/kg)
Dimensions: Time t (28 quarters), Geography (37 source countries), Product (variation across sector 1-15, but not within sectors)
Source: Swiss Federal Customs Administration

		Mean	Std. Dev.	Min.	Max.
1	Agriculture (10'944)	0.00	0.65	-1.61	1.09
2	Mining & quarrying (9'403)	-0.01	0.70	-1.61	1.33
3	Food & beverages (73'240)	0.03	0.68	-1.58	1.35
4	Textiles (185'355)	0.02	0.65	-1.60	1.15
5	Wood products (10'457)	0.03	0.72	-1.59	1.48
6	Paper products (47'404)	0.04	0.76	-1.59	1.60
7	Chemicals & pharmaceuticals (190'038)	-0.02	0.83	-1.85	1.96
8	Rubber & plastics products (58'638)	-0.01	0.71	-1.61	1.39
9	Mineral products (36'427)	0.02	0.63	-1.58	1.15
10	Iron & steel (60'706)	0.06	0.92	-1.56	1.93
11	Fabricated metal products (133'608)	0.03	0.49	-1.19	1.03
12	Machinery & equipment (209'033)	0.03	0.60	-1.41	1.25
13	Electrical machinery (97'780)	0.02	0.61	-1.48	1.22
14	Communication equipment (27'876)	0.01	0.58	-1.48	1.04
15	Precision instruments (103'826)	0.05	0.84	-1.54	1.79

Notes: Figures in parentheses correspond to the number of observations in the respective sectors; reported statistics for the nominal exchange rate variable are equal across different sectors and therefore not reported separately for each sector.

4.5 Empirical strategy and econometric issues

Our theoretical derivations in Section 4.3 directly lead to estimations in first differences in line with equations (36) and (39). Most other studies in the ERPT literature, however, introduce theoretical considerations that require estimations in levels (see for example, Campa and Goldberg, 2005 or Gaulier et al., 2008). These studies often perform unit root tests and generally cannot reject the null of unit roots in price and exchange rate series. To avoid the problem of spurious regression in dealing with potentially non-stationary time series, these researchers estimate their empirical models in first differences.[123]

To be consistent with the existing literature and to emphasize the need for estimations in first differences not only from a theoretical but also from an econometric point of view, we perform panel unit root tests on our import and export price as well as exchange rate series. Taking account of cross-sectional dependence (particularly important in our exchange rate series) and seasonalities (particularly important in our price series), we cannot decisively reject the null of unit roots and thus the non-stationarity of our time series. Appendix 4.8 describes these preliminary diagnostics in greater detail.

The stationarity tests convince us even more to estimate first-difference models, which will be further described in this section. Section 4.5.1 introduces the empirical strategy for ERPT into imported input prices and Section 4.5.2 for ERPT into export prices taking into account the cost adjustments through imported inputs. This two-step approach allows us to investigate on the one hand whether exporters potentially benefit from "natural hedging" practice (i.e. whether imported input prices adjust with exchange rates) and on the other hand whether exporters use such input cost/price adjustments to stabilize profit margins in the export markets.

4.5.1 ERPT into imported input prices

The empirical equation (36) for ERPT into imported input prices is estimated for each I-O input sector si separately. The HS 8-digit input product dimension k and partner

[123]Previous ERPT studies often test and reject the existence of theory-grounded co-integration relationships (see for instance Campa and Goldberg, 2005 and Campa and Gonzalez Minguez, 2006). Aside from the generally low power of panel co-integration tests, additional severe testing and aggregation difficulties arise in large cross-sectional heterogeneous panels as ours in order to establish a robust sector-level co-integration relationship (see for instance Trapani and Urga, 2010). Moreover, our theoretical framework does not lead to an equation in levels on which a co-integration relationship is usually based. For these reasons, we decided against testing for co-integration.

country dimension i are introduced and lagged exchange rate terms are added to allow for the possibility of gradual adjustment of these prices. Thus, we estimate regressions based on bilateral import data at the HS 8-digit level and the estimated parameters are pooled at the I-O input sector level si, as follows:

$$dp^m_{t,i,k} = \theta_{p,i} + \lambda_{hs6} + \sum_{t=0}^{-2}(\beta_t * de_{t,i}) + u_{t,i,k}. \tag{40}$$

where the index si is omitted, d is the first-difference operator, t is the time component defined as one quarter, p is time phase including four quarters (Q4 of one year to Q3 of the next year), i is the foreign supplier and k refers to the intermediate product. Notations are consistent with the previous section, where lower case letters designate logarithms. Namely, $p^m_{t,i,k}$ is the log of imported input price indexes defined as unit values (import value in CHF per kg, which are set to 100 in Q1-2004) and $e_{t,i}$ is the log of the nominal bilateral exchange rate index defined as CHF per unit of the foreign supplier i's currency. The average short-run relationship between exchange rates and the imported input prices in each si is given by the estimated coefficient β_0. The long-run elasticity is given by the sum of the coefficients on the contemporaneous exchange rate and two lags of exchange rate terms $\sum_{t=0}^{-2}\beta_t$.[124] Finally, the set of fixed effects $\theta_{p,i}+\lambda_{hs6}$ capture all other factors affecting intermediate input prices. In particular, $\theta_{p,i}$ capture aggregate changes in production costs (including commodity price changes) in source country i as well as the evolution of demand conditions in the importing country, Switzerland.[125] It is thereby assumed that the time- and supplier-varying fixed effects are homogeneous across all $hs8$ products of a given si sector, so that the k dimension can be neglected. Marginal costs and demand conditions are difficult to measure - especially at the product level. As a remedy, other researchers have used aggregate measures such as consumer-price-, producer-price- or labour-cost-indices as marginal cost proxies and GDP as proxies for demand conditions (see for example Campa and Goldberg, 2005 or Auer and Chaney, 2009). Given that our data includes the product dimension, we add fixed effects for each HS 6-digit product group, λ_{hs6}, to control for time

[124] Variable deletion F-tests have confirmed that these high sectoral long-run pass-through rates are mostly achieved within three quarters. In the benchmark specifications, we thus only used two lags for the long-run analysis.

[125] The time component is pooled to phase p including four quarters. Each phase corresponds to a time period in which crude oil prices have on average either hiked, remained relatively constant or decreased during the 12 previous months (see Section 4.4.1 and Figure 7). Thus, the underlying assumption is that marginal costs of inputs, which are captured by the fixed effects and are likely to be driven by energy prices or crude oil prices, have changed in each of these phases but remained constant within a phase.

and supplier invariant determinants of price adjustments within a product group $hs6$.

In order to see to what extent I-O output sectors so face imported input price adjustments when exchange rates change, the estimated short- and long-run ERPT effects on imported input prices have to be re-weighted according to each si's share of each so's total imported inputs. These shares are calculated from the I-O table 2001 for Switzerland and are denoted as R_{so}^{si}, where $\sum_{si}[R_{so}^{si}] = R_{so}$. Average short-run ERPT effects on imported input prices per I-O output sector so are thus given as follows:[126]

$$\beta_0^{so} = \sum_{si} \left[R_{so}^{si} * \beta_0^{si} \right]; \tag{41}$$

and the long-run effects as follows:

$$\sum_{t=0}^{-2} \beta_t^{so} = \sum_{si} \left[R_{so}^{si} * \sum_{t=0}^{-2} \beta_t^{si} \right]. \tag{42}$$

After estimating (40), we calculated the standard errors of the linear combinations (41) and (42) that take into account the variance-covariance structure of the estimated coefficients β_t^{si}.

4.5.2 ERPT into export prices

Our export regressions estimate ERPT on export prices in line with our theoretical considerations and equation (39). Similar to the estimation strategy applied for the import side, first-difference equations, based on bilateral export data at the HS8-digit level with lagged exchange rate terms to allow for the possibility of gradual adjustment of export prices, are estimated separately for each I-O output sector level so, as follows:

$$dp_{t,j,f}^{e} = \theta_{p,j} + \lambda_{hs6} + \sum_{t=0}^{-2} (\gamma_{1,t} * de_{t,j}) + \sum_{t=0}^{-2} (\gamma_{2,t} * dp_t^m) + v_{t,j,f}, \tag{43}$$

where index j stands for export destination, f for export product at the $hs8$ level and

[126] As I-O tables are not updated each period, it is assumed that the import structure of inputs per so is not varying over time, which is a necessary but restrictive limitation of our analysis. Comparisons of Swiss I-0 tables between 2001 through 2008 show that the import structure of inputs in fact remains relatively stable over time.

so is omitted.[127] Letters or expressions already used in equation (39) have the same interpretation; lower case letters still designate logarithms. The variable $p^e_{t,j,f}$ is the log of the export price index, $e_{t,j}$ is the nominal and bilateral exchange rate index defined as CHF per unit of export destination j's currency and p^m_t is the log of the imported input price index in time t. Section 4.4.1 explains in detail how p^m_t is constructed.[128] The fixed effects $\theta_{p,j}$ control for phase and destination dependent demand shifts, for instance, due to changes in general economic conditions. As in the import side equation (40), these fixed effects absorb all relative cost and demand changes between Switzerland and one specific destination country.[129] Fixed effects λ_{hs6} capture variations in domestic marginal costs for different export products at the *hs6*-level.

Short-run total exchange rate pass-through, TPT, (on foreign currency export prices) per *so* is in line with our theoretical framework defined as:

$$1 - \left[\gamma^{so}_{1,0} + \gamma^{so}_{2,0}\right]; \tag{44}$$

and for the long-run it is defined as:

$$1 - \left[\sum_{t=0}^{-2} \left[\gamma^{so}_{1,t} + \gamma^{so}_{2,t}\right]\right], \tag{45}$$

where the first terms within the brackets in (44) and (45) correspond to mark-up adjustments due to exchange rate changes, or PTM effects. The second terms show the cost-adjustment effects through imported inputs, CAE.[130]

[127]Note that $f = k$ if the input k is exported by Swiss exporters and $j = i$ if source country i is also a destination country for Swiss exports.

[128]Notice that the imported intermediate input price indexes for each I-O output sector have been used in Section 4.4 and have only variation over time for each *io* sector and not variation across products. This data shortcoming requires the assumption that input price developments faced by different producers/products within a *so* are the same.

[129]As an example, if domestic sourcing becomes more expensive for whatever reason (e.g. domestic agricultural intermediates get more expensive for the food sector), this changes the relative demand and cost conditions for Swiss exporters vs. foreign producers and are hence captured by the $\theta_{p,j}$ dummies. In robustness checks, we also estimated models with *(non-time varying) destination country dummies* but *time-varying product dummies* instead. The ERPT coefficients turned out to be similar.

[130]It should be noted that the theoretically derived CAE term is defined as follows: $\gamma^{so}_{2,t} * \beta^{so}_t$. These beta and gamma coefficients are however estimated in two different samples, the imported input price sample and the export price sample. As a result, obtaining the appropriate standard errors for these estimates (i.e. the product of the estimates) is a non-trivial task and cannot be accomplished with conventional bootstrapping methods. One possible remedy is to construct firstly all variables needed for the import

4.6 Results

Table 43 presents sectoral ERPT coefficients for imported input prices. The first two columns display average short- and long-run elasticities in each input sector, while the the last two columns report the responses of imported input prices faced by each output/export sector. These latter figures are calculated as weighted averages of pass-through coefficients across input sectors according to their import weight in a respective output sector. The weights are taken from Swiss 2001 I-O-tables (see equation 41 and 42). To account for possible auto-correlation in the errors within trading partner countries, we report robust-clustered standard errors using the partner country as the clustering unit. The argument for this clustering strategy is that nominal exchange rates are country-pair-specific but not product-specific. Unless the pricing of products differs greatly in terms of which currency it is denominated in, partner country is the preferred clustering unit.[131] This strategy is followed in all regressions reported in this paper.

Looking firstly at the results in column 1 and 2, we find high ERPT into imported input prices in all sectors. However, contrary to assumptions made in the recent empirical literature, we do not find evidence of full pass-through for all sectors either in the short- or long-run, though we are able to reject zero ERPT in a majority of sectors. There is some sectoral heterogeneity in the short-run, but the estimated long-run coefficients are not significantly different from one in 7 out of 14 sectors and statistically above one in 3 sectors (Wood products, Iron & steel and Fabricated metal products). With regard to imported input prices faced by each output sector in the third and fourth column, the picture remains unchanged with complete pass-through or exchange rate amplification (coefficients above one) being the appropriate characterization of the input price reactions to exchange rate movements.[132]

The magnitudes of the pass-through coefficients into imported input prices may be surpris-

regression within the export price sample, which does however substantially reduce variation in the data. Secondly, the new import regression and the export regression is estimated through seemingly unrelated equations (SUR) in order to apply new post-estimation simulations to calculate non-linear combinations and their standard errors. We estimated such models and came to the same conclusions as with the simpler and straightforward approach described in the main text. Not least, estimates from the two alternatives do not substantially differ as the $\gamma^{so}_{2,t}$ coefficients are not significantly different from zero for most sectors and/or the magnitude is close to zero. The combined effects $\gamma^{so}_{2,t} * \beta^{so}_{t}$ are thus also close to zero. We are grateful to Giovanni Mellace for important suggestions on these issues.

[131] Our results are robust to estimations using (partner country)*(hs8-product) as the clustering unit. The results can be received upon request.

[132] For instance, a coefficient of 1.33 for the Textiles sector in the long-run (column 2 of Table 18) indicates that foreign suppliers increase CHF prices by about 13.3 percent when the CHF depreciates by 10 percent.

Table 43: ERPT into imported input prices (in CHF)

		By input sector		By output sector*	
		Short-run	Long-run	Short-run	Long-run
1	Agriculture	0.49	0.71	$0.50^{a/b}$	1.34^{a}
		(0.35)	(0.63)	(0.20)	(0.51)
2	Mining & quarrying	2.78	6.54	1.09	3.09^{a}
		(3.78)	(4.04)	(1.05)	(1.21)
3	Food & beverages	0.72^{a}	1.51^{a}	0.61^{a}	1.18^{a}
		(0.24)	(0.49)	(0.20)	(0.43)
4	Textiles	0.79^{a}	1.33^{a}	$0.71^{a/b}$	1.45^{a}
		(0.12)	(0.32)	(0.12)	(0.38)
5	Wood products	1.13^{a}	1.71^{a}	0.97^{a}	1.79^{a}
		(0.20)	(0.37)	(0.15)	(0.40)
6	Paper products	$0.58^{a/b}$	1.37^{a}	$0.61^{a/b}$	1.60^{a}
		(0.11)	(0.38)	(0.15)	(0.41)
7	Chemicals & pharmaceuticals	0.18^{b}	1.79^{a}	0.75	$2.65^{a/b}$
		(0.45)	(0.81)	(0.72)	(0.90)
8	Rubber & plastics products	$0.72^{a/b}$	1.56^{a}	0.34^{b}	1.81^{a}
		(0.11)	(0.32)	(0.33)	(0.68)
9	Mineral products	0.86^{a}	1.62^{a}	1.46	3.48^{a}
		(0.326)	(0.38)	(1.36)	(1.48)
10	Iron & steel	1.12^{a}	$2.32^{a/b}$	1.18^{a}	$2.65^{a/b}$
		(0.28)	(0.57)	(0.43)	(0.63)
11	Fabricated metal products	$0.73^{a/b}$	$1.99^{a/b}$	1.03^{a}	$2.27^{a/b}$
		(0.12)	(0.45)	(0.22)	(0.52)
12	Machinery & equipment	0.55	1.85	0.68^{a}	$1.88^{a/b}$
		(0.98)	(1.13)	(0.30)	(0.41)
13	Electrical machinery	0.30	1.59^{a}	0.61^{a}	$1.84^{a/b}$
		(0.49)	(0.44)	(0.24)	(0.32)
14	Communication equipment	..	..	0.73^{a}	$1.89^{a/b}$
		..	..	(0.15)	(0.39)
15	Precision instruments	0.88^{a}	0.92	0.85^{a}	1.76^{a}
		(0.38)	(0.87)	(0.13)	(0.39)

Notes: *Weighted average ERPT faced by each output sector [weights from I-O table]; by input sector: short-run = β_0^{si}, long-run = $\sum_{t=0}^{-2}\beta_t^{si}$; by output sector: short-run = β_0^{so}, long-run = $\sum_{t=0}^{-2}\beta_t^{so}$; $^{a/b}$H0 of zero/full pass-through rejected at the 95%-level; estimated with WLS [weight = import value], robust-clustered standard errors in parentheses [cluster unit = source country]; phase-source varying fixed effects as well as $hs6$ varying fixed effects; coefficients missing for input sector 14 as no *hs8* input product classified within sector 14.

ingly high, but they are in line with the existing evidence of high pass-through into Swiss import prices. For instance, Campa and Goldberg (2005) estimate a long-run pass-through rate of 0.94, which is not significantly different from one, for the Swiss manufacturing sector as a whole. Gaulier et al. (2008) estimate ERPT for each HS 4-digit product line separately and obtain an average ERPT of 0.7 for Switzerland. Only about 30 percent of the estimated pass-through coefficients are statistically different from one. For countries in the euro area, Campa and Gonzalez Minguez (2006) conclude that industry-specific pass-through rates into import prices are on the order of 0.8 and that many industries within a country reach full pass-through after only four months. Furthermore, Campa and Gonzalez Minguez (2006) show that pass-through into producer price indexes is more than double the size of transmission into consumer prices suggesting higher pass-through into imported input goods compared to consumer goods. However, our results somewhat contradict the recent study conducted by the State Secretariat for Economic Affairs (Seco, 2011) that estimated fairly low average ERPT into Swiss import price indexes of 0.4 after three to four quarters.[133]

How can this high pass-through rate at the upper bound of prior estimates be explained? It is important to bear in mind that we only included input (intermediate) goods in the import regressions, while studies employing more aggregate price indexes are likely to be biased towards consumer goods. In line with equation 35 in Section 4.3, high ERPT can be explained by a input demand elasticity that changes little with local prices (in CHF). This is reasonable for highly customized input goods tailored to specific needs of firms. Recent theoretical advances complement the imperfect competition model of mark-up pricing from Section 4.3 with distribution costs in the local market in order to explain ERPT (see for example, Corsetti and Dedola, 2005 in a general-equilibrium framework or in Berman et al., 2012 in a Melitz-type model). According to Goldberg and Campa (2010) and Berman et al. (2012), 30-60 percent of local consumer goods prices are made up by distribution costs as opposed to a much lower distribution cost share for intermediate goods. This is important because a lower share of distribution costs incurred in local currency lowers the incentive for pricing-to-market (PTM), and thus increases pass-through rates in all models emphasizing distribution costs.[134] Our import side results support this class of models and suggest that prices of imported inputs faced by Swiss output/export industries are mainly invoiced

[133]Stulz (2007) also obtains an ERPT of 0.4.

[134]Previous empirical studies come to similar conclusions: Using French firm-level data, Berman et al. (2012) show that ERPT is substantially higher for intermediate goods than for consumer goods. Gaulier et al. (2006) reach the same conclusion using disaggregated trade data.

in currencies of the foreign suppliers (PCP). As a consequence, Swiss industries highly benefit from exchange rate appreciations through cheaper imported inputs, in particular in those industries with a higher share of foreign inputs. Hence, exporters can potentially benefit from "natural hedging" practices in times of currency appreciations if imported price changes are not transmitted to foreign consumers. Moreover, variable deletion F-tests confirmed that these high sectoral long-run pass-through rates are mostly achieved within three quarters, therefore, we used only two lags for the long-run analysis.[135]

As a robustness check, we performed the same estimations adding interaction terms for each exchange rate variable with a dummy that equals one for all observations during the "strong Franc" period (Q1 2010 - Q3 2011, or since the nominal CHF/EUR exchange rate reached a level below 1.25 for the first time). This was done in order to study the pricing behavior during this exceptional time. However, we could not find statistical evidence that the pricing strategies of foreign suppliers changed during the strong CHF period in the wake of the euro crisis.

Table 44 displays the short-run PTM and pass-through coefficients as well as cost-adjustment effects due to imported input price changes on the export side. We find substantial sectoral heterogeneity indicating along the lines of Knetter (1993) that sectoral differences are important factors in explaining ERPT. The results for direct ERPT (DPT, column 4) show that 6 sectors out of 15 report partial ERPT (Food & beverages, Textiles, Rubber & plastics products, Fabricated metal products, Mineral products and Electrical machinery), 4 sectors are characterized by full pass-through (Paper products, Iron & steel, Machinery & equipment and Precision instruments) and ERPT for 2 sectors is not statistically different from zero (Wood products and Chemicals & pharmaceuticals).

According to Yang (1997), sectors with differentiated goods, which have no close substitutes available that prevent foreign costumers from switching to other products when local prices in foreign currency units (FCU) rise, should attain higher ERPT rates. As displayed in Supposition 1 of Table 45, this is the case in the short-run for sectors containing a high share of differentiated and customized products such as Precision instruments, Machinery & equipment, Fabricated metal and Rubber & plastics products. In contrast, more competitive sectors with less product differentiation according to Rauch (1999) classification, for example Textiles or Wood products, are less able to pass-through exchange rate changes to foreign customers. In the short-run, the supposition is confirmed in 9 sectors and rejected in 6 sectors. This indicates that the degree of firm rivalry within a sector in home

[135] We also estimated equations with four lags which yielded similar results.

Table 44: ERPT into export prices (in CHF and in foreign currency units, FCU) - short-run

		In CHF			In FCU	
		Direct (PTM)	Indirect (CAE)	Total (1-TPT)	Direct (DPT)	Total (TPT)
1	Agriculture	0.59	-0.00^{b}	0.59	0.41	0.41
		(0.67)	(0.02)	(0.68)	(0.67)	(0.68)
2	Mining & quarrying	0.70	-0.01^{b}	0.69	0.30	0.31
		(0.47)	(0.01)	(0.47)	(0.47)	(0.47)
3	Food & beverages	0.33$^{a/b}$	-0.01$^{a/b}$	0.32$^{a/b}$	0.67$^{a/b}$	0.68$^{a/b}$
		(0.12)	(0.00)	(0.12)	(0.12)	(0.12)
4	Textiles	0.62$^{a/b}$	0.02$^{a/b}$	0.65^{a}	0.38$^{a/b}$	0.35^{b}
		(0.18)	(0.01)	(0.18)	(0.18)	(0.18)
5	Wood products	1.08^{a}	-0.00^{b}	1.08^{a}	-0.08^{b}	-0.08^{b}
		(0.34)	(0.01)	(0.35)	(0.33)	(0.35)
6	Paper products	0.18^{b}	0.01^{b}	0.19^{b}	0.82^{a}	0.81^{a}
		(0.22)	(0.01)	(0.22)	(0.22)	(0.23)
7	Chemicals & pharmaceuticals	0.69^{a}	-0.02^{b}	0.67^{a}	0.31^{b}	0.33^{b}
		(0.32)	(0.03)	(0.30)	(0.32)	(0.30)
8	Rubber & plastics products	0.44$^{a/b}$	0.00^{b}	0.44$^{a/b}$	0.56$^{a/b}$	0.56$^{a/b}$
		(0.10)	(0.00)	(0.10)	(0.10)	(0.10)
9	Mineral products	0.52$^{a/b}$	-0.02^{b}	0.49$^{a/b}$	0.48$^{a/b}$	0.51$^{a/b}$
		(0.21)	(0.01)	(0.22)	(0.21)	(0.22)
10	Iron & steel	-0.14^{b}	-0.03$^{a/b}$	-0.17	1.14^{a}	1.17
		(0.49)	(0.01)	(0.49)	(0.49)	(0.419)
11	Fabricated metal products	0.30$^{a/b}$	-0.01^{b}	0.29$^{a/b}$	0.70$^{a/b}$	0.71$^{a/b}$
		(0.12)	(0.00)	(0.12)	(0.12)	(0.12)
12	Machinery & equipment	0.27^{b}	-0.00^{b}	0.26^{b}	0.73^{a}	0.74^{a}
		(0.22)	(0.01)	(0.22)	(0.22)	(0.22)
13	Electrical machinery	0.62$^{a/b}$	-0.02^{b}	0.60$^{a/b}$	0.38$^{a/b}$	0.40$^{a/b}$
		(0.16)	(0.02)	(0.17)	(0.16)	(0.16)
14	Communication equipment	0.73	-0.03^{b}	0.70	0.27	0.30
		(0.40)	(0.02)	(0.40)	(0.40)	(0.40)
15	Precision instruments	0.16^{b}	-0.00^{b}	0.16^{b}	0.84^{a}	0.84^{a}
		(0.19)	(0.01)	(0.20)	(0.19)	(0.20)

Notes: PTM (pricing to market coefficient) = $\gamma^{so}_{1,0}$, CAE (cost-adjustment effect) = $\gamma^{so}_{2,0}$, 1-TPT = $\gamma^{so}_{1,0} + \gamma^{so}_{2,0}$, DPT = $1 - \gamma^{so}_{1,0}$, TPT (total pass-through coefficient) = $1 - \left(\gamma^{so}_{1,0} + \gamma^{so}_{2,0}\right)$; $^{a/b}$H0 of zero/one PTM, CAE or pass-through (DPT and TPT) rejected at the 95%-level, respectively; estimated with weighted least squares [weight = import value], robust-clustered standard errors in parentheses [cluster unit = partner country]; phase-source varying fixed effects as well as *hs6* varying fixed effects.

and foreign markets may be indeed an important determinant of the pricing behavior of exporters. This hypothesis is also confirmed when comparing average sectoral profit margins - as an indicator for firm rivalry within a sector - and ERPT rates. Supposition 2 that sectors with higher average profits are more able to pass through exchange rate changes into prices holds again in 9 out of 15 sectors in the short-run (see Table 45). It is further assumed that sectors in which differentiation and thus specialized skills and equipment are relatively more important (e.g. Precision instruments and Machinery & equipment) are also those sectors paying higher average wages to their employees. Sectors with higher average hourly wages should thus also be those having higher ERPT rates; and vice versa. However, this supposition is not well supported in our data (see Supposition 3, Table 45).

An alternative explanation for sectoral heterogeneity would be that distribution costs (incurred in the local currency) as a share of marginal costs are higher in some sectors increasing the incentives to set prices directly in the local currency (LCP) (see Corsetti and Dedola, 2005). Also, this second rationalization of sectoral ERPT heterogeneity holds remarkably well in the short-run (see Supposition 4 in Table 45). Having lower distribution costs, the Machinery & equipment, Fabricated metal and Rubber & plastics products sectors also have higher ERPT rates. In opposition, sectors with low ERPT rates, such as Mineral products and Textiles, also report higher distribution cost shares according to Supposition 4. Overall, this supposition is confirmed in 11 sectors and rejected in 4 sectors.[136]

The cost-adjustment effects denoted by Indirect (CAE) in the second column of Table 44 are overwhelmingly insignificant meaning that exporters do not pass on imported input price changes to foreign consumers. Given full pass-through rates in almost all sectors on the imported input side (see Table 43), these insignificant CAE coefficients imply that an appreciation of the exporter currency (CHF) leads to higher profit margins. This supports the view of imported inputs as a natural means for hedging exchange rate risks.

Table 46 shows the corresponding long-run results and gives additional insights with regard to PTM and cost-adjustment behavior at the sectoral level. Consistent with the short-run results and in line with Yang (1997), the Machinery & equipment and Precision instruments

[136]However, one should be cautious in the interpretation of all suppositions in Table 20 because the number of sectors included in the analysis is too small (15 sectors) for proper statistical inference. The small number of sectors means that the aggregation level is probably too high, and covers the underlying heterogeneity in terms of distribution costs and product differentiation of more disaggregated product groups within a sector. One would thus need more observations for a regression analysis that controls for other confounding factors (see for instance Campa and Goldberg, 2005 and Gaulier et al., 2008). This was, however, not our main research focus and thus beyond the scope of this study.

Table 45: Descriptive analysis of sectoral ERPT heterogeneity

Supposition 1:
Sectors exporting more differentiated products have higher ERPT rates; and vice versa

	Confirmed	Rejected
Short-run ERPT (see Table 44, Direct DPT)		
High ERPT rates (>50%); high share of differentiated goods exported (>80%)	Precision instruments[a]; Fabricated metal products[a/b]; Machinery & equipment[a]; Rubber & plastics products[a/b]	Electrical machinery[a/b]; Mineral products[a/b]; Communication equipment
Low ERPT rates (<50%); low share of differentiated goods exported (<80%)	Textiles[a/b]; Wood products; Chemicals & pharmaceuticals; Agriculture; Mining & quarrying	Food & beverages[a/b]; Paper products[a]; Iron & steel[a]
Long-run ERPT (see Table 46, Direct DPT)		
High ERPT rates (>50%); high share of differentiated goods (>80%)	Precision instruments[a]; Machinery & equipment[a]	Fabricated metal products[a/b]; Electrical machinery[b]; Mineral products; Rubber & plastics products[b]; Communication equipment
Low ERPT rates (<50%); low share of differentiated goods (<80%)	Textiles[a/b]; Wood products[b]; Mining & quarrying	Food & beverages[a/b]; Paper products; Chemicals & pharmaceuticals; Agriculture; Iron & steel

Notes: Share of differentiated goods = Share of differentiated goods according to Rauch (1999) exported of all goods exported in a sector; supposition is confirmed if sectors in the group of high shares of differentiated goods are also in the group of high ERPT rates, and vice versa; [a/b]H0 of zero/full ERPT rejected at the 95%-level

Table 45: continued

Supposition 2:
Sectors with sectors with higher profit margins have higher ERPT rates; and vice versa

	Confirmed	Rejected
Short-run ERPT (see Table 44, Direct DPT)		
High ERPT rates (>50%); high profit margins (>3%)	Precision instruments[a]; Fabricated metal products[a/b]; Machinery & equipment[a]; Rubber & plastics products[a/b]	Chemicals & pharmaceuticals; Electrical machinery[a/b]; Communication equipment
Low ERPT rates (<50%); low profit margins (<3%)	Textiles[a/b]; Wood products; Agriculture; Mining & quarrying; Mineral products[a/b]	Food & beverages[a/b]; Paper products[a]; Iron & steel[a]
Long-run ERPT (see Table 46, Direct DPT)		
High ERPT rates (>50%); high profit margins (>3%)	Chemicals & pharmaceuticals; Precision instruments[a]; Machinery & equipment[a]	Fabricated metal products[a/b]; Electrical machinery[b]; Rubber & plastics products[b]; Communication equipment
Low ERPT rates (<50%); low profit margins (<3%)	Textiles[a/b]; Wood products[b]; Mining & quarrying; Mineral products;	Food & beverages[a/b]; Paper products; Agriculture; Iron & steel

Notes: Swiss average sectoral profit margins between 2005-2010 taken from Accenture (2012); supposition is confirmed if sectors in the group of high profit margins are also in the group of high ERPT rates, and vice versa; [a/b]H0 of zero/full ERPT rejected at the 95%-level

Table 45: continued

Supposition 3:
Sectors with higher hourly wages have higher ERPT rates; and vice versa

	Confirmed	Rejected
Short-run ERPT (see Table 44, Direct DPT)		
High ERPT rates (>50%); high hourly wages (> 27 USD)	Iron & steel[a]; Precision instruments[a]; Machinery & equipment[a];	Mining & quarrying; Chemicals & pharmaceuticals; Electrical machinery[a/b]; Communication equipment
Low ERPT rates (<50%); low hourly wages (< 27 USD)	Textiles[a/b]; Wood products; Agriculture; Mineral products[a/b]	Food & beverages[a/b]; Paper products[a]; Rubber & plastics products[a/b]; Fabricated metal products[a/b]
Long-run ERPT (see Table 46, Direct DPT)		
High ERPT rates (>50%); high hourly wages (> 27 USD)	Chemicals & pharmaceuticals; Precision instruments[a]; Machinery & equipment[a]; Iron & steel	Mining & quarrying; Electrical machinery[b]; Communication equipment
Low ERPT rates (<50%); low hourly wages (< 27 USD)	Textiles[a/b]; Wood products[b]; Mineral products; Rubber & plastics products[b]; Fabricated metal products[a/b];	Food & beverages[a/b]; Paper products; Agriculture;

Notes: Average sectoral hourly wages in the US between 2005-2010 taken from the Bureau of Labor Statistics; supposition is confirmed if sectors in the group of high hourly wages are also in the group of high ERPT rates, and vice versa; [a/b]H0 of zero/full ERPT rejected at the 95%-level

Table 45: continued

Supposition 4:
Sectors exporting products with smaller shares of distribution costs have higher ERPT rates; and vice versa

	Confirmed	Rejected
Short-run ERPT (see Table 44, Direct DPT)		
High ERPT rates (>50%); low share of distribution costs (10-14%)	Iron & steel[a]; Rubber & plastics products[a/b]; Paper products[a]; Fabricated metal products[a/b]; Machinery & equipment[a]	Electrical machinery[a/b]; Wood products
Low ERPT rates (>50%); high share of distribution costs (14-27%)	Communication equipment; Agriculture; Chemicals & pharmaceuticals; Mineral products[a/b]; Mining & quarrying; Textiles[a/b]	Food & beverages[a/b]; Precision instruments[a]
	Long-run ERPT (see Table 46, Direct DPT)	
High ERPT rates (>50%); low share of distribution costs (10-14%)	Iron & steel; Paper products; Machinery & equipment[a]	Electrical machinery[b]; Wood products[b]; Rubber & plastics products[b]; Fabricated metal products[a/b]
Low ERPT rates (>50%); high share of distribution costs (14-27%)	Communication equipment; Mineral products; Mining & quarrying; Textiles[a/b]	Agriculture; Chemicals & pharmaceuticals; Food & beverages[a/b]; Precision instruments[a]

Notes: Share of distribution costs = Distribution cost share of final price (taken from Goldberg and Campa, 2010); supposition is confirmed if sectors in the group of low shares of distribution costs are also in the group of high ERPT rates, and vice versa; [a/b]H0 of zero/full ERPT rejected at the 95%-level

Table 46: ERPT into export prices (in CHF and in foreign currency units, FCU) - long-run

		In CHF			In FCU	
		Direct (PTM)	Indirect (CAE)	Total (1-TPT)	Direct (DPT)	Total (TPT)
1	Agriculture	0.31	-0.05^{b}	0.26	0.69	0.74
		(0.83)	(0.06)	(0.85)	(0.83)	(0.85)
2	Mining & quarrying	0.99	-0.14$^{a/b}$	0.85	0.01	0.15
		(0.75)	(0.04)	(0.78)	(0.75)	(0.78)
3	Food & beverages	0.35^{b}	-0.02$^{a/b}$	0.33^{b}	0.65^{a}	0.67^{a}
		(0.19)	(0.01)	(0.19)	(0.19)	(0.12)
4	Textiles	0.71^{a}	0.05$^{a/b}$	0.76^{a}	0.29^{b}	0.24^{b}
		(0.23)	(0.01)	(0.23)	(0.23)	(0.23)
5	Wood products	1.40^{a}	0.01^{b}	1.41^{a}	-0.40^{b}	-0.41^{b}
		(0.41)	(0.03)	(0.43)	(0.41)	(0.43)
6	Paper products	0.33	0.04^{b}	0.37	0.67	0.63
		(0.44)	(0.03)	(0.46)	(0.44)	(0.46)
7	Chemicals & pharmaceuticals	0.49	-0.09^{b}	0.40	0.51	0.60
		(0.58)	(0.07)	(0.53)	(0.58)	(0.53)
8	Rubber & plastics products	0.85^{a}	-0.02^{b}	0.83^{a}	0.15^{b}	0.17^{b}
		(0.32)	(0.01)	(0.33)	(0.31)	(0.33)
9	Mineral products	0.55	-0.01^{b}	0.53	0.45	0.47
		(0.37)	(0.03)	(0.39)	(0.37)	(0.39)
10	Iron & steel	0.47	-0.04^{b}	0.43	0.53	0.57
		(0.63)	(0.02)	(0.63)	(0.63)	(0.63)
11	Fabricated metal products	0.55$^{a/b}$	-0.03^{b}	0.52$^{a/b}$	0.45$^{a/b}$	0.49$^{a/b}$
		(0.16)	(0.02)	(0.16)	(0.16)	(0.16)
12	Machinery & equipment	-0.04^{b}	0.01^{b}	-0.02^{b}	1.04^{a}	1.02^{a}
		(0.34)	(0.03)	(0.34)	(0.34)	(0.34)
13	Electrical machinery	0.94^{a}	-0.07^{b}	0.87^{a}	0.06^{b}	0.13^{b}
		(0.38)	(0.05)	(0.35)	(0.38)	(0.35)
14	Communication equipment	0.73	0.01^{b}	0.74	0.27	0.26
		(0.73)	(0.05)	(0.73)	(0.73)	(0.73)
15	Precision instruments	-0.09^{b}	-0.00^{b}	-0.09^{b}	1.09^{a}	1.09^{a}
		(0.29)	(0.02)	(0.30)	(0.29)	(0.30)

Notes: PTM (pricing to market coefficient) $=\sum_{t=0}^{-2}\gamma_{1,t}^{so}$, CAE (cost-adjustment effect) $=\sum_{t=0}^{-2}\gamma_{2,t}^{so}$, 1-TPT $=\sum_{t=0}^{-2}\left(\gamma_{1,t}^{so}+\gamma_{2,t}^{so}\right)$, DPT $=1-\sum_{t=0}^{-2}\gamma_{1,t}^{so}$, TPT (total pass-through coefficient) $=1-\sum_{t=0}^{-2}\left(\gamma_{1,t}^{so}+\gamma_{2,t}^{so}\right)$; $^{a/b}$H0 of zero/one PTM, CAE or pass-through (DPT and TPT) rejected at the 95%-level, respectively; estimated with weighted least squares [weight = import value], robust-clustered standard errors in parentheses [cluster unit = partner country]; phase-source varying fixed effects as well as *hs6* varying fixed effects.

sectors are able to keep profit margins stable by passing on exchange rate shocks completely to foreign clients. Conversely, the average exporter in the Wood products, Textiles or the Food & beverages sectors engages at least partly in PTM (see column 1, Table 46), thereby stabilizing local prices and absorbing some of the exchange rate movements in the mark-up. Overall, our explanation of the sectoral ERPT heterogeneity based on product competition and distribution margins is, however, less supported in the long-run (see again Table 45 for more details).

The cost-adjustment coefficients CAE in the second column of Table 46 have no statistical significance and/or small magnitudes confirming the corresponding short-run CAE results described above. In sum, the cost-savings accrued on the inputs from the recent CHF appreciation period compensate for the partly squeezed profit margins on the export side.

Tables 47 and 48 report the results of export price regressions in which imported input prices are replaced with an imported input weighted exchange rate for the short- and long-run. This set of regressions is intended to check the robustness of the results concerning the responsiveness of export prices to imported input price adjustments. The CAE results reported in Table 47 and 48 corroborate the general finding about small or non-responsiveness of export and local prices to imported input price changes. The magnitudes of the CAE coefficients are generally higher, but except for three (mostly commodity intensive) sectors in the short- and long-run, the CAE are not statistically significant. It is therefore safe to conclude that in the vast majority of the investigated goods sectors firms do not adjust export prices in response to exchange rate driven changes of production costs. As price adjustments are costly and a large bulk of the production costs is likely to be incurred in CHF (including compensation of employees, see Table 40), Swiss exporters optimally choose to absorb changes of the imported input prices in their mark-ups. Put differently, looking at direct (DPT) and total (TPT) pass-through coefficients in Table 44 and 46, we recognize that imported input price changes are not passed on to foreign consumers and do hence not significantly change ERPT behavior. This finding differs with the results of Athukorala and Menon (1994) and Berman et al. (2012) which report diminished ERPT coefficients when imported inputs are considered. As a consequence, their results imply that "natural hedging" of exchange rate risks is less pronounced.

As with the import estimations, we also tested whether pricing behavior on the export side differed during the "strong Franc" period and again found no convincing support for this hypothesis. Thus, our results also hold for the period of the recent CHF appreciation.

Table 47: ERPT into export prices (in CHF and in foreign currency units, FCU) - short-run (with import weighted exchange rates)

		In CHF			In FCU	
		Direct (PTM)	Indirect (CAE)	Total (1-TPT)	Direct (DPT)	Total (TPT)
1	Agriculture	0.21	0.47	0.69	0.79	0.32
		(1.34)	(1.28)	(0.36)	(1.34)	(0.36)
2	Mining & quarrying	-0.02^{b}	2.78$^{a/b}$	2.76$^{a/b}$	1.02^{a}	-1.76$^{a/b}$
		(0.13)	(0.32)	(0.29)	(0.13)	(0.29)
3	Food & beverages	0.42$^{a/b}$	-0.04^{b}	0.38$^{a/b}$	0.58$^{a/b}$	0.62$^{a/b}$
		(0.14)	(0.15)	(0.13)	(0.14)	(0.13)
4	Textiles	0.75^{a}	-0.65$^{a/b}$	0.10^{b}	0.25^{b}	0.90^{a}
		(0.24)	(0.30)	(0.17)	(0.24)	(0.17)
5	Wood products	0.52	0.94^{a}	1.46$^{a/b}$	0.48	-0.46$^{a/b}$
		(0.29)	(0.37)	(0.22)	(0.29)	(0.22)
6	Paper products	-0.04^{b}	0.11^{b}	0.07^{b}	1.04^{a}	0.93^{a}
		(0.31)	(0.46)	(0.20)	(0.31)	(0.20)
7	Chemicals & pharmaceuticals	0.64^{a}	0.31	0.95	0.36^{b}	0.05
		(0.25)	(0.52)	(0.62)	(0.25)	(0.62)
8	Rubber & plastics products	0.40$^{a/b}$	0.41^{b}	0.81^{a}	0.60$^{a/b}$	0.19^{b}
		(0.19)	(0.24)	(0.11)	(0.19)	(0.11)
9	Mineral products	0.62$^{a/b}$	0.06^{b}	0.69^{a}	0.38$^{a/b}$	0.31^{b}
		(0.17)	(0.25)	(0.24)	(0.18)	(0.24)
10	Iron & steel	-0.54^{b}	1.61^{a}	1.07^{a}	1.54^{a}	-0.07^{b}
		(0.43)	(0.32)	(0.37)	(0.43)	(0.37)
11	Fabricated metal products	0.25^{b}	0.32^{b}	0.57$^{a/b}$	0.75^{a}	0.43$^{a/b}$
		(0.16)	(0.21)	(0.16)	(0.16)	(0.16)
12	Machinery & equipment	0.26^{b}	-0.05^{b}	0.21^{b}	0.74^{a}	0.79^{a}
		(0.24)	(0.34)	(0.28)	(0.24)	(0.28)
13	Electrical machinery	0.51$^{a/b}$	0.60	1.11^{a}	0.49$^{a/b}$	-0.11^{b}
		(0.20)	(0.36)	(0.35)	(0.20)	(0.35)
14	Communication equipment	0.87^{a}	-0.24	0.64	0.13^{b}	0.36
		(0.41)	(0.71)	(0.71)	(0.41)	(0.71)
15	Precision instruments	0.20^{b}	-0.14^{b}	0.06^{b}	0.80^{a}	0.94^{a}
		(0.15)	(0.32)	(0.36)	(0.15)	(0.36)

Notes: PTM (pricing to market coefficient) = $\gamma^{so}_{1,0}$, CAE (cost-adjustment effect) = $\gamma^{so}_{2,0}$, 1-TPT = $\gamma^{so}_{1,0} + \gamma^{so}_{2,0}$, DPT = $1 - \gamma^{so}_{1,0}$, TPT (total pass-through coefficient) = $1 - \left(\gamma^{so}_{1,0} + \gamma^{so}_{2,0}\right)$; $^{a/b}$H0 of zero/one PTM, CAE or pass-through (DPT and TPT) rejected at the 95%-level, respectively; estimated with weighted least squares [weight = import value], robust-clustered standard errors in parentheses [cluster unit = partner country]; phase-source varying fixed effects as well as *hs6* varying fixed effects.

Table 48: ERPT into export prices (in CHF and in foreign currency units, FCU) - long-run (with import weighted exchange rates)

		In CHF			In FCU	
		Direct (PTM)	Indirect (CAE)	Total (1 - TPT)	Direct (DPT)	Total (TPT)
1	Agriculture	-0.47	1.50	1.02	1.47	-0.03
		(1.40)	(1.23)	(0.94)	(1.40)	(0.95)
2	Mining & quarrying	0.05^{b}	$7.70^{a/b}$	$7.75^{a/b}$	0.95^{a}	$-6.75^{a/b}$
		(0.30)	(0.72)	(0.91)	(0.30)	(0.91)
3	Food & beverages	$0.48^{a/b}$	0.08^{b}	0.56	$0.52^{a/b}$	0.45
		(0.12)	(0.33)	(0.33)	(0.12)	(0.32)
4	Textiles	0.78^{a}	-0.38^{b}	0.40	0.22^{b}	0.60
		(0.27)	(0.43)	(0.38)	(0.27)	(0.39)
5	Wood products	0.69	1.25^{a}	$1.94^{a/b}$	0.31	$-0.95^{a/b}$
		(0.36)	(0.44)	(0.31)	(0.36)	(0.31)
6	Paper products	-0.23	0.33	0.11^{b}	1.23	0.89^{a}
		(0.68)	(0.87)	(0.34)	(0.68)	(0.34)
7	Chemicals & pharmaceuticals	0.54	-0.70	-0.15	0.46	1.15
		(0.45)	(1.44)	(1.43)	(0.47)	(1.43)
8	Rubber & plastics products	0.32^{b}	$2.20^{a/b}$	$2.52^{a/b}$	0.68^{a}	$-1.52^{a/b}$
		(0.28)	(0.33)	(0.31)	(0.28)	(0.31)
9	Mineral products	0.63	0.43	1.06^{a}	0.37	-0.06^{b}
		(0.36)	(0.54)	(0.45)	(0.36)	(0.45)
10	Iron & steel	0.51	-1.48^{b}	-0.97^{b}	0.49	1.97^{a}
		(0.60)	(0.62)	(0.88)	(0.61)	(0.88)
11	Fabricated metal products	0.32^{b}	1.18^{a}	1.50^{a}	0.68^{a}	-0.50^{b}
		(0.18)	(0.32)	(0.30)	(0.18)	(0.30)
12	Machinery & equipment	0.02^{b}	-0.46	-0.44^{b}	0.98^{a}	1.44^{a}
		(0.38)	(0.73)	(0.66)	(0.38)	(0.66)
13	Electrical machinery	0.72	1.37	2.10^{a}	0.28	-1.10^{b}
		(0.43)	(0.87)	(0.95)	(0.43)	(0.95)
14	Communication equipment	0.96	-0.75	0.21	0.04	0.79
		(0.64)	(1.24)	(1.54)	(0.64)	(1.54)
15	Precision instruments	0.06^{b}	-0.85^{b}	-0.79^{b}	0.94^{a}	1.79^{a}
		(0.19)	(0.84)	(0.84)	(0.19)	(0.84)

Notes: PTM (pricing to market coefficient) $=\sum_{t=0}^{-2}\gamma_{1,t}^{so}$, CAE (cost-adjustment effect) $=\sum_{t=0}^{-2}\gamma_{2,t}^{so}$, 1-TPT $=\sum_{t=0}^{-2}\left(\gamma_{1,t}^{so}+\gamma_{2,t}^{so}\right)$, DPT $=1-\sum_{t=0}^{-2}\gamma_{1,t}^{so}$, TPT (total pass-through coefficient) $=1-\sum_{t=0}^{-2}\left(\gamma_{1,t}^{so}+\gamma_{2,t}^{so}\right)$; $^{a/b}$H0 of zero/one PTM, CAE or pass-through (DPT and TPT) rejected at the 95%-level, respectively; estimated with weighted least squares [weight = import value], robust-clustered standard errors in parentheses [cluster unit = partner country]; phase-source varying fixed effects as well as *hs6* varying fixed effects.

4.7 Conclusions

This study uses highly disaggregated trade data for Switzerland over 2004-2011 to examine at length whether Swiss exporters systematically respond to exchange rate changes by adjusting their prices. Given the high share of imported intermediates in total intermediate inputs in Swiss manufacturing, of underlying significance is the impact of exchange rate changes on the prices of these imported inputs. This could be due to the possibility that the latter may serve as a "natural" channel by which exporters can maintain their competitive advantage despite an appreciation of the CHF.

Our empirical results, that are impervious to various robustness checks, firstly indicate high ERPT into imported input prices in all sectors. However, contrary to assumptions made in the recent empirical literature, we do not find evidence of full pass-through for all sectors either in the short- or long-run, though we are able to reject zero ERPT in a majority of sectors. The high magnitudes of pass-through coefficients into imported input prices are in line with related literature, but depart from Stulz (2007) and SECO (2011) who study ERPT into import prices more generally (not only intermediate imports). This difference could be due to low input demand elasticities with respect to local prices and/or a low share of distribution costs for inputs.

On the export side, our results indicate strong sectoral ERPT heterogeneity in both the short- and long-run. It is shown that differentiated and customized products such as Machinery & equipment or Rubber & plastics products generally have higher ERPT rates. This is consistent with Yang's (1997) argument that sectors with differentiated goods should attain higher ERPT rates. Our results also hold remarkably well with recent ERPT explanations based on distribution costs by Corsetti and Dedola (2005). Sectors with high distribution costs shares (incurred in the local currency) such as Mineral products and Textiles, tend to have low ERPT rates and to engage more in local currency pricing (LCP).

Moreover, the cost-adjustment effects are found to be overwhelmingly insignificant implying that exporters do not pass on imported input price changes to foreign consumers. Thus, an appreciation of the CHF leads to higher profit margins through the import channel and imported inputs act as a natural means for hedging exchange rate risks.

The appreciation of the CHF began in 2009 and progressed steadily until the middle of 2010 after which it accelerated in response to the ensuing euro crisis. In the last year the Swiss National Bank (SNB) has intervened to assuage Swiss exporters of the adverse effects of this appreciation. However, our final empirical result suggests that the pricing

strategies of Swiss exporters may not have changed in response to the strong CHF in wake of the euro crisis. Significantly, a similar result at the extensive margin would strongly question the SNB's intervention during this period.

Future research could elaborate on some limitations of our study. Firstly, we proxied export and import prices by unit values. Compared to most earlier studies, unit values in our study more accurately reflect prices as products are highly disaggregated (8-digit level) and separate unit values are calculated for each trading partner. Nevertheless, measurement error and aggregation issues may be a problem. Secondly, our matching of imported input prices faced by each exporting industry is done with relatively aggregated I-O table data. This may be a constraint in identifying the cost-adjustment effect on the export side. Future studies may improve on both of these caveats using firm-level panel data, which would ideally include export revenues and prices of firms as well as the share and price of their imported inputs. Thirdly, while we could not identify changes in the pricing strategy during the recent strong CHF period, such adjustment may be observed over a longer time period. Therefore, one can reach a deeper understanding of the recent challenges of Swiss exporters once data on a strong CHF become available over a longer time period. Fourthly, we did not directly investigate whether our results of the most recent period are partly driven by extensive margin adjustments - firms that exit the export market or products that are no longer exported. If this is the case, central bank intervention may be appropriate and necessary to avoid irreversible structural damage of the exporting industry as emphasized by hysteresis theories (see for instance Baldwin and Krugman, 1989). Future research could therefore work along the analysis of the extensive margin. Finally, it would be useful to extend this analysis to an enlarged country sample. To the extent that these results hold across countries and at the extensive margin, they would also have significant implications for monetary policy and for the policy debate on the impact of misaligned exchange rates on trade imbalances.

4.8 Appendix

Preliminary diagnostics - unit root tests

Although our theoretical framework leads us to an estimation in first-differences, we reconfirm this approach from an econometric point of view in this appendix section. Our panel data has a significant time series component, which raises the risk of spurious regression when estimating a model in levels. We thus tested our panel series for unit roots/non-stationarity. This is done for consistency with other studies in this field, which are often modeled in levels and therefore had to perform such tests. In general, other ERPT studies find non-stationary series and thus also estimate in first differences.

Recent studies by O'Connell (1998) and Breitung and Das (2005) have highlighted that in the presence of contemporaneous correlation standard panel unit root tests, like those proposed by Maddala and Wu (1999), Levin et al. (2002) and Im et al. (2003), suffer from severe oversize problem. Our panel unit root tests, therefore, needed to be preceded by tests for cross-sectional dependence. We performed these tests for each HS-6 digit product line separately for both the import and the export side. Using the Modified Lagrange Multiplier test for cross-sectional dependence in Pesaran (2004), we found that the null of cross-sectional independence was non-surprisingly rejected in all cases of the nominal exchange rate (NER) series but in only 27 percent of the tests in the case of the import price series. On the export side, we found the null of cross-sectional independence to be decisively rejected in 99 percent of these tests in the case of NER and in 39 percent of the tests in the case of export prices. Our results thus provided evidence of cross-sectional dependence in our data on NER and to a limited extent on import and export prices.

If cross-sectional dependence is weak, literature suggests using robust panel unit root tests such as the one proposed by Im et al. (2003) or Breitung and Das (2005) depending on the data and sample size. However, if cross-sectional dependence is strong, estimation would require either decomposing the time series into common and idiosyncratic factors and testing them separately for the presence of unit roots (e.g. Bai and Ng, 2004) or using cross-sectional demeaned tests such as the IPS test (CIPS) suggested by Pesaran (2007). Unfortunately, though, there seems to be no consensus in the literature on the definition of weak or strong dependence (Sarafidis and Wansbeek, 2010).

In view of the above, the first method used to test for unit roots was the Im et al. (2003) panel unit root test. Once again, we performed these tests at the HS-6 digit level for both

the import and export side. We found that the null of "all panels contain unit roots" was rejected in only 3 percent of the tests for the NER data but in 97 percent of the tests for import prices. On the export side, the null was rejected in only 5 percent of the cases for the NER data but in 95 percent of the tests for export prices. This first set of tests points to our NER data being a random walk and suggests that our import and export prices may be stationary.

Under the assumption of strong cross-sectional dependence, we next used the cross-sectional demeaned version of the IPS test (CIPS) suggested by Pesaran (2007) which accounts for the dynamics in the common factor by using cross-sectional averages and their lagged values (without having to estimate the common factor first). The results from the CIPS corroborated those from Im et al. (2003). The null of unit root was rejected in only 1 percent of the tests for NER; on the export side, the null of unit root was rejected in all of cases for NER but in 72 percent for export prices.

However, it is probably more appropriate to consider long-run data to adjust for seasonal variations. Including four lags for each panel series while performing the CIPS test, we found the the null of unit root was never rejected for NER on both the import and export side and rejected in only 1 percent and 2 percent of the tests for imported input prices and export prices, respectively. Thus, all our panel series seem to be non-stationary when adjusting for seasonalities.

Having performed various unit root tests, we could not rule out non-stationarity in our data; therefore, even from an econometric point of view, we were on the safe side to estimate our empirical models in first-differences.

References

Accenture (2012). *The Swiss Top500 - New opportunities for growth in volatile times.* Accenture.

Acemoglu, D. and Johnson, S. (2005). Unbundling institutions. *Journal of Political Economy*, 113(5):949–95.

Ai, C. and Norton, E. (2003). Interaction terms in logit and probit models. *Economics Letters*, 80(1):123–129.

Aksoy, Y. and Riyanto, Y. (2000). Exchange rate pass-through in vertically related markets. *Review of International Economics*, 8(2):235–251.

Alfaro, L. and Hammel, E. (2007). Capital flows and capital goods. *Journal of International Economics*, 72(1):128–150.

Amiti, M. and Konings, J. (2007). Trade liberalization, intermediate inputs, and productivity: Evidence from indonesia. *American Economic Review*, 97(5):1611–1638.

Antras, P., Desai, M., and Foley, C. (2009). Multinational firms, fdi flows, and imperfect capital markets. *Quarterly Journal of Economics*, 124(3):1171–1219.

Antras, P. and Foley, C. (2011). Poultry in motion: a study of international trade finance practices. *National Bureau of Economic Research Working Paper Series*.

Arellano, M. and Bond, S. (1991). Some tests of specification for panel data: Monte carlo evidence and an application to employment equations. *Review of Economic Studies*, 58(2):277.

Athukorala, P. and Menon, J. (1994). Pricing to market behaviour and exchange rate pass-through in japanese exports. *Economic Journal*, 104(423):271–281.

Atkeson, A. and Burstein, A. (2008). Pricing-to-market, trade costs, and international relative prices. *American Economic Review*, 98(5):1998–2031.

Auboin, M. (2009). *Restoring Trade Finance: What the G20 can do: in The collapse of global trade, murky protectionism and the crisis: Recommendations for the G20, ed. Richard Baldwin and Simon Evenett*. Center for Economic Policy Research.

Auboin, M. (2010). *The G20 mandate on fixing trade finance for low-income countries*. www.voxeu.org.

Auer, R. and Chaney, T. (2009). Exchange rate pass-through in a competitive model of pricing-to-market. *Journal of Money, Credit and Banking*, 41:151–175.

Bai, J. and Ng, S. (2004). A panic attack on unit roots and cointegration. *Econometrica*, 72(4):1127–1177.

Baldwin, R. and Krugman, P. (1989). Persistent trade effects of large exchange rate shocks. *Quarterly Journal of Economics*, 104(4):635–654.

Barro, R. and Lee, J. (2001). International data on educational attainment: updates and implications. *Oxford Economic Papers*, 53(3):541.

Bas, M. and Berthou, A. (2011a). The decision to import capital goods in india: Firms' financial factors matter. *World Bank Economic Review forthcoming*.

Bas, M. and Berthou, A. (2011b). Financial reforms and foreign technology upgrading: firm level evidence from india. *Working Paper*.

Beck, T. (2003). Financial dependence and international trade. *Review of International Economics*, 11(2):296–316.

Beck, T., Demirgüc-Kunt, A., Laeven, L., and Maksimovic, V. (2006). The determinants of financing obstacles. *Journal of International Money and Finance*, 25(6):932–952.

Beck, T., Demirguc-Kunt, A., and Levine, R. (2009). *Financial institutions and markets across countries and over time-data and analysis*. World Bank.

Bellone, F., Musso, P., Nesta, L., and Schiavo, S. (2010). Financial constraints and firm export behaviour. *World Economy*, 33(3):347–373.

Berman, N. and Héricourt, J. (2010). Financial factors and the margins of trade: Evidence from cross-country firm-level data. *Journal of Development Economics*, 93:206–217.

Berman, N., Martin, P., and Mayer, T. (2012). How do different exporters react to exchange rate changes? *Quarterly Journal of Economics*, 127(1):437–492.

Bernard, A. and Jensen, B. (2004). Why some firms export. *Review of Economics and Statistics*, 86(2):561–569.

Bernard, A., Jensen, J., Redding, S., and Schott, P. (2007). Firms in international trade. *Journal of Economic Perspectives*, 21(3):105–130.

Bond, S. and Van Reenen, J. (2007). Microeconometric models of investment and employment. *Handbook of Econometrics*, 6:4417–4498.

Brachet, T. (2008). Maternal smoking, misclassification, and infant health. *MPRA Paper 21466*.

Braun, M. (2003). Financial contractibility and asset hardness. *Harvard University, Department of Economics Working Paper*.

Breitung, J. and Das, S. (2005). Panel unit root tests under cross sectional dependence. *Statistica Neerlandica*, 52:1–20.

Bushman, R., Piotroski, J., and Smith, A. (2004). What determines corporate transparency? *Journal of Accounting Research*, 42(2):207–252.

Bustos, P. (2011). Trade liberalization, exports and technology upgrading: Evidence on the impact of mercosur on argentinean firms. *American Economic Review*, 101(1):304–340.

Campa, J. and Goldberg, L. (1995). Investment in manufacturing, exchange rates and external exposure. *Journal of International Economics*, 38(3-4):297–320.

Campa, J. and Goldberg, L. (1997). The evolving external orientation of manufacturing industries: evidence from four countries. *National Bureau of Economic Research Working Paper Series*.

Campa, J. and Goldberg, L. (1999). Investment, pass-through, and exchange rates: a cross-country comparison. *International Economic Review*, 40(2):287–314.

Campa, J. and Goldberg, L. (2005). Exchange rate pass-through into import prices. *Review of Economics and Statistics*, 87(4):679–690.

Campa, J. and Gonzalez Minguez, J. (2006). Differences in exchange rate pass-through in the euro area. *European Economic Review*, 50(1):121–145.

Carpenter, R. E. and Petersen, B. C. (2002). Capital market imperfections, high-tech investment, and new equity financing. *Economic Journal*, 112(477):F54–F72.

Chamberlain, G. (1982). Multivariate regression models for panel data. *Journal of Econometrics*, 18(1):5–46.

Chaney, T. (2005). Liquidity constrained exporters. *University of Chicago mimeo*.

Chor, D. and Manova, K. (2012). Off the cliff and back? credit conditions and international trade during the global financial crisis. *Journal of International Economics*, 87:117–133.

Corsetti, G. and Dedola, L. (2005). A macroeconomic model of international price discrimination. *Journal of International Economics*, 67(1):129–155.

Das, S., Roberts, M., and Tybout, J. (2007). Market entry costs, producer heterogeneity, and export dynamics. *Econometrica*, 75(3):837–873.

Djankov, S., McLiesh, C., and Shleifer, A. (2007). Private credit in 129 countries. *Journal of Financial Economics*, 84(2):299–329.

Dornbusch, R. (1987). Exchange rates and prices. *American Economic Review*, 77(1):93–106.

Drakos, K. and Giannakopoulos, N. (2008). On the determinants of credit rationing: Firm-level evidence from transition countries. *Journal of International Money and Finance*, 30(8):1773–1790.

Eaton, J. and Kortum, S. (2001). Trade in capital goods. *European Economic Review*, 45(7):1195–1235.

Egger, P. and Kesina, M. (2010). Financial constraints and exports: Evidence from chinese firms. *ETH Zürich mimeo*.

Egger, P. and Keuschnigg, C. (2009). Corporate finance and comparative advantage. *Working Paper Series Economics University of St. Gallen*.

Egger, P. and Keuschnigg, C. (2010). Innovation, trade and finance. *Working Paper Series Economics University of St. Gallen*.

Fazzari, S., H.-G. and Petersen, B. . (1988). Financing constraints and corporate investment. *Brookings Papers on Economic Activity*, 1:141–195.

Fisman, R. and Love, I. (2003). Trade credit, financial intermediary development, and industry growth. *Journal of Finance*, 58(1):353–374.

Freitas, K. (2004). The role of financial development and r&d on international trade. *Working Paper*.

Gaulier, G., Lahrèche-Révil, A., and Méjean, I. (2006). Structural determinants of the exchange-rate pass-through. *CEPII Working Papers*.

Gaulier, G., Lahrèche-Révil, A., and Méjean, I. (2008). Exchange-rate pass-through at the product level. *Canadian Journal of Economics/Revue canadienne d'économique*, 41(2):425–449.

Goldberg, L. and Campa, J. (2010). The sensitivity of the cpi to exchange rates: Distribution margins, imported inputs, and trade exposure. *Review of Economics and Statistics*, 92(2):392–407.

Goldberg, P. and Knetter, M. (1997). Goods prices and exchange rates: What have we learned? *Journal of Economic Literature*, 35(3):1243–1272.

Gopinath, G. and Rigobon, R. (2008). Sticky borders. *Quarterly Journal of Economics*, 123(3):531–575.

Gorodnichenko, Y. and Schnitzer, M. (2010). Financial constraints and innovation: Why poor countries don't catch up. *National Bureau of Economic Research Working Paper Series*.

Greenaway, D., Guariglia, A., and Kneller, R. (2007). Financial factors and exporting decisions. *Journal of International Economics*, 73(2):377–395.

Greenaway, D., Kneller, R., and Zhang, X. (2010). The effect of exchange rates on firm exports: The role of imported intermediate inputs. *World Economy*, 33(8):961–986.

Harrison, A. and McMillan, M. (2003). Does direct foreign investment affect domestic credit constraints? *Journal of International Economics*, 61(1):73–100.

Hausman, J., Abrevaya, J., and Scott-Morton, F. (1998). Misclassification of the dependent variable in a discrete-response setting. *Journal of Econometrics*, 87(2):239–269.

Helpman, E., Melitz, M., and Rubinstein, Y. (2008). Estimating trade flows: Trading partners and trading volumes. *Quarterly Journal of Economics*, 123(2):441–487.

Héricourt, J. and Poncet, S. (2009). Fdi and credit constraints: Firm-level evidence from china. *Economic Systems*, 33:1–21.

Himmelberg, C. and Petersen, B. (1994). R&d and internal finance: A panel study of small firms in high-tech industries. *Review of Economics and Statistics*, 76(1):38–51.

Hope, O. (2003). Disclosure practices, enforcement of accounting standards, and analysts' forecast accuracy: An international study. *Journal of Accounting Research*, 41(2):235–272.

Hubbard, R. (1998). Capital-market imperfections and investment. *Journal of Economic Literature*, 36(1):193–225.

Hummels, D., Ishii, J., and Yi, K. (2001). The nature and growth of vertical specialization in world trade. *Journal of International Economics*, 54(1):75–96.

Hur, J., Raj, M., and Riyanto, Y. E. (2006). Finance and trade: A cross-country empirical analysis on the impact of financial development and asset tangibility on international trade. *World Development*, 34:1728–1741.

ICC (2010). *Global 2010 trade finance survey*. International Chamber of Commerce.

IFC (2010). *Scaling-up SME access to financial services in the developing world*. International Finance Corporation (World Bank Group).

Ihrig, J., Marazzi, M., and Rothenberg, A. (2006). Exchange-rate pass-through in the g-7 countries. *FRB International Finance Discussion Paper No. 851*.

Im, K., Pesaran, M., and Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, 115(1):53–74.

Kane, T., Rouse, C., and Staiger, D. (1999). Estimating returns to schooling when schooling is misreported. *National Bureau of Economic Research Working Paper Series*.

Kasahara, H. and Rodrigue, J. (2008). Does the use of imported intermediates increase productivity? plant-level evidence. *Journal of Development Economics*, 87(1):106–118.

Kaufmann, D., Kraay, A., and Mastruzzi, M. (2003). Governance matters iii: Governance indicators for 1996-2002. *World Bank*.

Knetter, M. (1989). Price discrimination by us and german exporters. *American Economic Review*, 79(1):198–210.

Knetter, M. (1993). International comparisons of pricing-to-market behavior. *American Economic Review*, 83(3):473–486.

Kroszner, R., Laeven, L., and Klingebiel, D. (2007). Banking crises, financial dependence, and growth. *Journal of Financial Economics*, 84(1):187–228.

Kugler, M. and Verhoogen, E. (2009). Plants and imported inputs: New facts and an interpretation. *American Economic Review Papers and Proceedings*, 99(2):501–507.

Kugler, M. and Verhoogen, E. (2012). Prices, plant size, and product quality. *The Review of Economic Studies*, 79(1):307–339.

La Porta, R., Lopez-de Silanes, F., Shleifer, A., and Vishny, R. (1997). Legal determinants of external finance. *Journal of Finance*, 52(3):1131–1150.

La Porta, R., Lopez-de Silanes, F., Shleifer, A., and Vishny, R. (1998). Law and finance. *Journal of Political Economy*, 106:1113–1155.

Levin, A., Lin, C.-F., and James Chu, C.-S. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of Econometrics*, 108(1):1–24.

Love, I. (2003). Financial development and financing constraints: International evidence from the structural investment model. *Review of Financial Studies*, 16(3):765.

Maddala, G. S. and Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics*, 61(0):631–52.

Manova, K. (2008a). Credit constraints, equity market liberalizations and international trade. *Journal of International Economics*, 76(1):33–47.

Manova, K. (2008b). Credit constraints, heterogeneous firms and international trade. *Stanford University*.

Manova, K. (2009). Credit constraints and the adjustment to trade reform. Technical report, Working Paper.

Manova, K., Wei, S., and Zhang, Z. (2009). Firm exports and multinational activity under credit constraints. *Working Paper*.

Matsuyama, K. (2005). Credit market imperfections and patterns of international trade and capital flows. *Journal of the European Economic Association*, 3(2-3):714–723.

Mayer, T. and Ottaviano, G. I. (2008). The happy few: The internationalisation of european firms. *Intereconomics*, 43(3):135–148.

Melitz, M. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71(6):1695–1725.

Melitz, M. and Ottaviano, G. (2008). Market size, trade, and productivity. *Review of Economic Studies*, 75(1):295–316.

Meyer, B. and Mittag, N. (2012). Misclassification in binary choice models.

Minetti, R. and Zhu, S. (2011). Credit constraints and firm export: Microeconomic evidence from italy. *Journal of International Economics*, 83:109–125.

Modigliani, F. and Miller, M. (1958). The cost of capital, corporation finance and the theory of investment. *American Economic Review*, 48(3):261–297.

Mundlak, Y. (1978). On the pooling of time series and cross section data. *Econometrica*, pages 69–85.

O'Connell, P. G. J. (1998). The overvaluation of purchasing power parity. *Journal of International Economics*, 44(1):1–19.

Pesaran, M. (2004). General diagnostic tests for cross section dependence in panels. *CESifo Working Paper Series No. 1229; IZA Discussion Paper No. 1240.*

Pesaran, M. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22(2):265–312.

Raddatz, C. (2006). Liquidity needs and vulnerability to financial underdevelopment. *Journal of Financial Economics*, 80(3):677–722.

Rajan, R. and Zingales, L. (1998). Financial dependence and growth. *American Economic Review*, 88(3):559–586.

Rauch, J. E. (1999). Networks versus markets in international trade. *Journal of international Economics*, 48(1):7–35.

Roberts, M. and Tybout, J. (1997). The decision to export in colombia: an empirical model of entry with sunk costs. *American Economic Review*, 87(4):545–564.

Sarafidis, V. and Wansbeek, T. (2010). Cross-sectional dependence in panel data analysis. MPRA Paper 20367, University Library of Munich, Germany.

Seco (2011). Weitergabe von Einkaufsvorteilen aufgrund der Frankenstärke. *Working paper*.

Stiebale, J. (2011). Do financial constraints matter for foreign market entry? a firm-level examination. *World Economy*, 34(1):123–153.

Stock, J. H. and Yogo, M. (2002). Testing for weak instruments in linear iv regression. *National Bureau of Economic Research Working Paper Series*.

Stulz, J. (2007). Exchange rate pass-through in Switzerland: Evidence from vector autoregressions. *SNB Working paper*.

Svaleryd, H. and Vlachos, J. (2005). Financial markets, the pattern of industrial specialization and comparative advantage: Evidence from OECD countries. *European Economic Review*, 49(1):113–144.

Tirole, J. (2006). *The theory of corporate finance*. Princeton University Press Princeton, NJ.

Trapani, L. and Urga, G. (2010). Micro versus macro cointegration in heterogeneous panels. *Journal of Econometrics*, 155(1):1–18.

Tybout, J. (2000). Manufacturing firms in developing countries: How well do they do, and why? *Journal of Economic literature*, 38(1):11–44.

WB (2008). *Finance for all: Pitfalls and policies in expanding acess*. World Bank Washington DC.

WB (2009). *Financial infrastructure: Building access through transparent and stable financial systems*. World Bank Washington DC.

Whited, T. (1992). Debt, liquidity constraints, and corporate investment: Evidence from panel data. *Journal of Finance*, pages 1425–1460.

Wooldridge, J. (2002). *Econometric analysis of cross section and panel data*. The MIT press.

Wooldridge, J. M. (2005). Simple solutions to the initial conditions problem in dynamic, nonlinear panel data models with unobserved heterogeneity. *Journal of applied econometrics*, 20(1):39–54.

Yang, J. (1997). Exchange rate pass-through in us manufacturing industries. *Review of Economics and Statistics*, 79(1):95–104.

Yeaple, S. (2005). A simple model of firm heterogeneity, international trade, and wages. *Journal of International Economics*, 65(1):1–20.

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