An economic theory of country membership policies

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The President:

Prof. Dr. Thomas Bieger

To my wife and daughter, for their continuous support and for letting me steal precious family time for writing this dissertation,

and

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Abstract

This thesis sets out to provide an economic theory of country membership policies. Assuming membership provides joint ownership and user rights over a county's public capital, the model derives the equilibrium minimum membership fee that the native population should require from prospective new members. The analysis focuses on the trade-offs between the benefits from economies of scale in the provision of public goods, the ownership dilution of public capital and the potential economic externalities generated by a new member.

The model implies that the membership fee is increasing with the amount of public capital stock and inversely related to its degree of *publicness*. Crowding effects in publicly provided goods caused by a new entrant increase the required contribution. Additionally, the membership fee is decreasing with the overall degree of social homogeneity in the native population, although changes in the latter caused by a new member cause the fee to rise. Productivity or human capital increases induced by a new member reduce the membership fee for temporary membership, whilst its effect when membership is permanent depends on whether the return on capital is endogenously or exogenously determined, as well as the type of productivity modeled. Further, when assuming that private and public capital are complementary factors of production, the membership fee is increasing with the private capital endowments per capita of the native population and decreasing with those of the new member.

This dissertation also analyzes the political economy implications arising from different wealth endowments, heterogeneous skills, social homogeneity, and government preferences within the native population, and how they alter the membership fee.

Empirical data from immigrant investor programs points towards public and private capital stocks in the host country being positively related to those asked to an applicant, but the relationship is weak and hampered by data availability and estimating assumptions. Evidence from the acquisition of citizenship by naturalization also indicates a positive relationship between public capital and the number of years of legal residence requested, whilst results are mixed when using a broader measure like the MIPEX Access to Nationality index.

The country membership model maintains its explanatory power after altering some of its main assumptions – return on capital, factor complementarity, and degree of economic openness – effectively building a bridge between the economic literature on immigration that stems from the areas of Labor Economics, International Trade and Public Finance.

Abstrakt

Diese Doktorarbeit ist darauf ausgerichtet, eine ökonomische Theorie von Richtlinien für Ländermitgliedschaften zu erstellen. Unter der Annahme, dass eine solche Mitgliedschaft ein gemeinsames Eigentums- und Benutzungsrecht des öffentlichen Kapitals eines Landes beinhaltet, leitet das Modell davon einen ausgeglichenen minimalen Mitgliedschaftsbeitrag ab, den die einheimische Bevölkerung von neuen Mitgliedern verlangen sollte. Die Analyse fokussiert sich darauf, wie sich neue Mitglieder auf die Vorteile von Skaleneffekten bei öffentlichen Gütern, die breitere Verteilung von öffentlichem Kapital, sowie die potentiellen ökonomischen Externalitäten auswirken.

Das Modell besagt, dass der Mitgliederbeitrag parallel zur Höhe des öffentlichen Kapitals steigt und dass er umgekehrt proportional zum Ausmass von Öffentlichkeit ist. Durch Neuzugänger verursachte Ueberbevölkerungseffekte bei öffentlich zur Verfügung gestellten Gütern erhöhen den Zugangsbeitrag. Er sinkt jedoch mit steigender allgemeinen sozialen Homogenität der einheimischen Bevölkerung, wobei durch neue Mitglieder verursachte Änderungen dieser Homogenität den Mitgliederbeitrag wieder steigen lässt. Die durch ein neues Mitglied erhöhte Produktivität oder das vergrösserte Humankapital senken den Mitgliederbeitrag bei einer temporären Mitgliederschaft, während der Effekt, wenn die Mitgliedschaft permanent ist, sowohl davon abhängt, ob der Kapitalrendite endogen oder exogen bedingt ist, als auch vom Typ der modellierten Produktivität. Unter der Annahme, dass das private und öffentliche Kapital komplementäre Faktoren sind, zeigt das Modell des Weiteren, dass der Mitgliederbeitrag mit zunehmendem privaten pro Kopf Kapital der einheimischen Bevölkerung steigt während er mit jenem des neuen Mitgliedes sinkt.

Diese Doktorarbeit analysiert auch die politischen und wirtschaftlichen Auswirkungen abhängend von unterschiedlichem Kapital, den heterogenen Fertigkeiten, der soziale Homogenität und der Vorliebe der Regierung innerhalb der einheimischen Bevölkerung und wie sie die Eintrittsgebühr verändert.

Empirische Daten von Immigranteninvestorenprogrammen deuten darauf hin, dass öffentliches und privates Kapital im Gastland positiv mit dem Beitrag korreliert, das man von einem Bewerber verlangt. Diese Korrelation ist jedoch schwach und beeinträchtigt durch die Datenverfügbarkeit und getroffenenAnnahmen. Hinweise vom Erwerb der Einwohnerschaft durch Einbürgerung deuten auf ein positives Verhältnis von öffentlichem Kapital und der Anzahl Jahren von verlangtem rechtlichen Aufenthalt hin. Diese Resultate jedoch unterschiedlich, wenn ein breiteres Mass wie der MIPEX access to Nationality Index angewendet wird.

Das Modell behält seine erklärende Aussagekraft, auch wenn man verschiedenen Grundannahmen verändert, und schlägt eine Brücke zwischen den folgenden Gebieten der ökonomischen Literatur über Immigration: Arbeitsmarkttheorie, internationaler Handel und öffentliche Finanzwissenschaft.

1. Research question

1.1. The case of country membership

Despite living in an increasingly globalized world, country membership understood as the right to freely live and settle in a country and benefit from its public capital, remains heavily restricted. Membership can take different forms, depending on whether the length of the stay is limited or permanent, as well as on the degree of associated rights. Citizens usually enjoy full rights, whilst legal residents are excluded from some of them, for example, the right to vote or the possibility to transmit membership to descendants. For simplicity, throughout this dissertation, country membership will be assumed to provide equal rights to both old and new members. A differentiation will be exclusively made between temporary membership (over one period of production) and permanent membership (over infinite periods of production). Hence, permanent membership could be seen as homologous to full citizenship, whilst temporary membership could be deemed equivalent to temporary residence with full rights, except ownership of public capital.

Governments set the requirements for temporary or permanent establishment through immigration policies, whilst the requisites to be a citizen are typically embedded in the national constitutions, and usually confer nationality upon descent from a member ("jus sanguinis"), birth in the country's soil ("jus solis") or marriage. In addition, most countries grant citizenship by so-called "naturalization" to residents which have lived for a number of uninterrupted years in the country, have shown exemplary conduct and a can prove a high degree of assimilation into the country's culture. This linkage between residence and citizenship de facto extends the reach of immigration policies to the institution of citizenship. Lastly, certain countries confer citizenship upon the payment or the investment of a large sum of money into the country – the so-called *"citizenship by investment"* programs.

Membership policies diverge widely but all seem to pursue a certain economic gain, in Ireland for example one can obtain citizenship by making an endowment of more than EUR 500,000 in a project of public benefit or by making a recoverable investment of more than EUR 1 Million, whilst in the tiny island of Dominica it only takes a payment of USD 75,000 to the government to become a citizen. Spain offers permanent residence for those who make a real estate investment in excess of EUR 500,000, whilst offers EUR 1,600 to unemployed immigrants for leaving the country. Alternatively, gaining citizenship by naturalization in Madagascar takes only one year of residence whilst it takes 30 years in the resource rich United Arab Emirates. The US spends about USD 20 billion per year[1] in controlling its Southern border with Mexico, but also runs a visa program to attract highly skilled individuals.

This dissertation will set out to address two related questions that naturally follow when looking at the diversity of contemporary immigration policies: What is the economic rationale for countries to restrict membership that much? And what type of economic gains do countries seek when determining their membership policies?

1.2. Some facts about country membership

1.2.1. Attitudes to newcomers change over time

As the purpose of this thesis is to study membership policies from an economic perspective, the analysis needs to exclude large periods of time across history when country membership was not a consequence of an act of free will.[2] However, there is a long enough period, starting approximately with the emergence of the nation state in the nineteenth century up to the present times, when new members have joined a country on their own will and when, in the case of democratic countries, the rules determining country membership have been to a large degree decided by the incumbent population. Interestingly, a wide variation in country membership policies can be observed during this period, particularly immigration policies.[3]

As described by Goldin et. al. (2011)[4] three characteristic periods of global migration can be observed, the first is the so-called "age of mass migration" which started from the mid nineteenth century until the First World War and which was characterized by open border regimes, and led to millions of immigrants from Europe to America, but also within Europe.[5]

[1] "Secure enough". The Economist, June 22, 2013.

[2] Coercion has often been involved in determining both the country of membership, as a result of wars, invasions, etc., as well as the degree of membership, be it free citizen, noble vassal or slave.

[3] As immigration policies are the most observable membership policies, throughout the thesis the terms " immigration" and " immigrant" will be often used as a substitute for "country membership" and "new member" respectively.

[4] Goldin, Cameron and Balarajan (2011) pp. 57-85.

[5] Borjas (1997) shows that only in the US more than 23 million immigrants arrived to the country between 1881 and 1920.

This period had an abrupt end after the advent of the First World War, and was followed by the protectionist era characterizing the inter-war period. During this time, passports, which had not been previously required, became ubiquitous and immigration was severely curtailed. The increase in border restrictions was partly driven by national security measures, but also by the rise of mercantilism and nationalism. Moreover, the economic depression that started in 1929 triggered protests in many countries against foreign workers and immigration policies became increasingly restrictive.

The third period encompasses the end of the Second World War up to the oil crisis in the late 70s, characterized by the reconstruction efforts in Europe and the subsequent acceleration in economic growth, which generated a transfer of manpower from the South of Europe to the North. These immigration programs were supposed to be of a temporary nature – as reflected in the German name: *"Gastarbeiter"* which means guest worker –, however, in reality they turned out to be permanent. The oil crisis and the subsequent rise in unemployment in Europe coincided with an abrupt change in perception towards immigration, and a return to restrictive policies.

I would add to these three periods a fourth one, which starts when immigration changed from being considered a taboo topic in the political debate, to become part of the mainstream political agenda. This shift occurred in the late nineties when right-wing anti-immigration parties, most prominently the FN in France, started to attract votes from a population increasingly concerned about the impact of immigration in their countries. Nowadays, immigration features prominently in the political agenda of most developed countries, and even in those countries that have been traditionally receptors of immigration, like the US or Australia, the political stance towards immigration has turned increasingly restrictive. In some ways, new immigration policies seem to retrace steps; a good example of this is can be found in the EU where despite the accord on the free movement of people embedded in the Schengen agreement, the UK Prime Minister has recently argued for stopping immigration from poorer EU countries,[6] and Germany recently announced plans to expel EU immigrants who do not find a job during three months.[7]

[6] "Stop unrestricted immigration from poor EU countries, David Cameron suggests". The Telegraph, December 13, 2013.

[7] "Rechtsfragen und Herausforderungen bei der Inanspruchnahme der sozialen Sicherungssysteme durch Angehörige der EU-Mitgliedstaaten". Bundesministerium des Innern and Bundesministerium für Arbeit und Soziales, March 2014.

1.2.2. Membership is proactively managed

At the same time as immigration policies are becoming increasingly restrictive in terms of the number of immigrants that are admitted, they are turning more selective in the skills and qualifications requirements asked to prospective new members. The establishment of *points based systems* (PBS) for granting residence visas is one of the most important trends in international migration policies according to the OECD Migration Report 2011. Moreover, some countries are proactively seeking to attract new members who possess certain highly wanted skills, as is the case with the H1-B visa program in the United States, and similar other programs.[8]

Selectivity however does not only apply to skills but also to other characteristics like culture or religion. Examples of the former are Commonwealth countries, which facilitate immigration or naturalization to individuals who belong to other member states, or the lower entry requirements that ex-colonial countries like UK, Spain or The Netherlands demand to members of their former colonies. Another example of filtering by cultural affinity can be found in the US "national-origins quota system" which was in place in the country from 1920 to 1965 and that aimed to maintain the ethnic equilibrium in the country.[9] The state of Israel is an extreme case, as the country has pursued the attraction of a very large number of new members of Jewish descent, and to minimize flows from individuals of other origins.[10]

Another observable trend is that an increasing number of countries are offering permanent residence and/ or citizenship, in exchange for an investment into the country. This investment typically entails one or a combination of the following: (1) making a deposit in a local bank (2) buying domestic financial assets (3) acquiring real estate or (4) starting a business that creates a certain number of jobs. In some instances, it requires an explicit non-refundable financial contribution in the form of a monetary donation to a government fund or to a designated non-profit organization. These so-called "investment programs" were initially offered by some small island states like Dominica or Saint-Kitts and Nevis, as well as by countries traditional receptors of immigration, like the US, Canada, UK, Germany or Australia. However, in the last decade, several Eastern European countries have set up their own programs, like those of Bulgaria, Latvia, Montenegro, Slovakia and Hungary. In addition, since the start of the sovereign debt crisis, several countries in Europe's periphery have followed, and Ireland, Portugal, Cyprus, Hungary, Spain and Malta now all offer their own programs.

[8] Hong Kong, Singapore, Russia and China have also established visa programs for highly-skilled professionals.

[9] This system restricted the annual flow from Eastern Hemisphere countries to 150,000 immigrants, and allocated the visas according to the ethnic composition of the US population in 1920 (see Borjas (1994)).

[10] As will be explained in detail in Chapter 7, Israel offers unrestricted citizenship to all Jews, and the definition of what is consider to be a Jew has evolved over time to facilitate the entrance of a larger number of Jewish descendants. At the same time, it has increased the hurdles for immigrants of Arab origin to become citizens of the state via family reunification.

Coincidentally, some of the countries offering investment visas to rich individuals like the UK, Spain or Malta, have also set up at the same time so-called "pay-to-go" programs to incentivize unemployed or illegal immigrants to leave the country by offering them a lump-sum payment, stipends covering travel expenses, or an up front payment of their accumulated unemployment benefits.

1.2.3. Requirements depend on the degree of membership

Membership policies differentiate not only amongst types of individuals but also between degrees of membership. Some countries like the Gulf States have very relaxed immigration policies, which translate into a very large share of immigrant population, whilst at the same time erect high barriers to become a citizen by naturalization. In Bahrain for example immigrants account for 76% of the total population but they are required to live 20 years uninterruptedly in the country to be naturalized. In Kuwait the share of immigrants is 62% but citizenship cannot be obtained via naturalization.

Other differences amongst membership levels are the requirements to prove a certain degree of cultural affinity to become a citizen by naturalization, which typically are not asked for acquiring a resident visa, with the exception of a certain command of the country's language in some cases.

Lastly, countries that offer investment programs usually ask for different monetary amounts for obtaining temporary visa, permanent residence or for becoming a citizen.[11] The Cayman Islands for example require an investment of KYD 2.4 million and proving wealth in excess of KYD 6 million for a permanent residence permit. However, for temporary residence, it demands annual contributions to be paid by the employer which depend on the type of job, and that can amount up to KYD 32,400 per annum. In Saint-Kitts and Nevis permanent residence can be acquired by making a refundable investment of USD 400,000, whilst citizenship is granted by making a non-refundable donation of USD 200,000. These data points seem to indicate countries apply a certain "discounting" mechanism when pricing different degrees of membership.

1.2.4. What can be inferred from these facts?

The first insight that can be derived from the above facts is that country membership is a multidimensional problem, which leads to a wide range of immigration policies that may seem conflicting at first sight. Spain is a good example of asymmetric policies, on the one hand

[11] See tables A.2-A.4 in the Appendix for a detailed description of the different investment programs by country

it spends large amounts of money in protecting its borders from illegal immigrants and offers a monetary sum to immigrants for leaving the country, whilst on the other hand it offers unrestricted membership to those who invest large sums of money in the country, or as it recently announced, offers full citizenship to the descendants of Sephardic Jews, which are estimated to amount up to 3.5 million worldwide.[12]

A second related inference is that immigration seems not to be perceived as good or bad in absolute terms. On the contrary, attitudes towards immigration appear to depend on the historic and economic context, and particularly on the individual characteristics of the prospect immigrant in terms of skills, wealth and culture. In fact, an increasing number of countries are using immigration as a tool to externalize some costs, like those arising from labor shortages[13] or alternatively, to internalize some benefits by monetizing the attractiveness of a country as residence for wealthy individuals. At the moment, immigration policies in most rich countries pursue to prevent an inflow of low-skilled immigrants, and to attract in small numbers only the highly skilled and the wealthy ones.

Lastly, countries generally are more reluctant to confer citizenship than settlement into the country, even if residence can be acquired permanently. Here several factors seem to be at play, first the importance of cultural assimilation, second the ability to transfer membership to the progeny and third the right to vote and to influence public choice.

1.3. What do we know about country membership?

1.3.1. The economics of country membership

Belonging to a country is often associated to culture, traditions and heritage. However, membership also carries significant economic benefits to its members by entitling them to receive the returns of the nation's public capital.[14] These can be both of a tangible and intangible nature. Public infrastructure, natural resources, healthcare or education are examples of the first, whilst security, law and order, institutions, and internal markets are examples of the latter. Some publicly provided goods, like defense, can be considered purely non-rival, but the large majority of goods are subject to a certain degree of rivalry and hence crowding effects appear when increasing the number of members. On the other hand, as the provision of most

[12] http://www.ft.com/intl/cms/s/0/72faf212-9333-11e3-8ea7-00144feab7de.html#axzz2ymod44ZW

[13] This applies for both high-skill and low-skill individuals.

[14] In the particular case of citizenship, a new member becomes co-owner of the nation's publicly provided goods, and hence entitled to receive a part of its returns, either from its exploitation (e.g., mineral resources) or in case of a disposal.

public goods entails fixed costs, a new member will help decrease the per capita costs. As a consequence, there is a trade-off between economies of scale in the provision of public goods and the crowding effects of increasing the number of individuals in the country.

Moreover, building on Putnam's (1993) notion of *social capital*, culture and customs have also an economic value as they help in increasing the amount of societal coordination and trust which results in a higher degree of economic efficiency.[15] Thus, all things being equal, increasing social heterogeneity by admitting a foreign new member is likely to come at a cost. Additionally, different individuals have different views on how taxes should be spent and consequently influence the amount and nature of publicly provided goods.[16] On the other hand, different individuals may possess skills or assets that the incumbent population lacks or that are in short supply, and admitting new members would result in an increase in productivity and income. Hence, there is a second trade-off influencing country membership, the one between heterogeneity costs in the provision of public goods and the benefits from heterogeneity in the production function.

When looking back at Sec. 1.2 through an economic lens, it is easier to understand the motivation behind the diversity of membership policies. In times when economies of scale are large, like in periods of rapid industrialization or national construction, mass immigration is welcome and usually encouraged. However, in periods when crowding prevails over scale effects, like when unemployment is high or public services are overstretched, immigration is in general severely restricted. At this point membership becomes selective and individuals are only admitted when they minimize the costs of heterogeneity and/ or generate positive externalities due to their wealth or skills.

1.3.2. Literature review

Different strands in the economic literature have addressed the basic trade-offs behind country membership. For simplicity, they will be grouped here in two broad areas: the literature on immigration and the literature on jurisdictions and local public goods.

[15]Knack, S., and Keefer, P. (1997) argue Putnam's measure of social capital (as the degree of membership in social groups) is not correlated with trust or economic performance. Instead they find trust and civic norms are stronger in nations with higher and more equal incomes, with institutions that restrain predatory actions of chief executives, and with better-educated and ethnically homogeneous populations. Either way, heterogeneity is expected to have a negative effect on income.

[16]Alesina and Spoalore (2003) consider an optimal nation size to result from a trade-off between size and heterogeneity costs, where the latter is a function of two dimensions, geography (i.e., how distant is an individual from a public good) and ideology (i.e., how close publicly provided goods are to the representative individual's preferences).

Literature on immigration A vast amount of literature can be found on the determinants and effects on immigration. The determinants of immigration have been analyzed from several angles. At a macro level international trade theories have postulated international migration to be caused by wage differentials between countries, and different rates on return on labor for high-skill and low skill workers (see Arango et al. (1996) pp. 433-436 for a review on theories on international migration). These models explain immigration as a result of a personal decision of the immigrants by factoring in expected returns, costs and risks.

At a micro level, *push* and *pull* models that explain migratory flows by looking at the immigrant's incentives have been developed (see for example Ortega and Peri (2009), Grogger and Hanson (2007) and Arango et al. (1993)). The potential economic effects of further liberalizing labor flows have been also largely studied, Klein and Ventura (2007) for example estimate a potential increase in the world's GDP of 150% over 50 years if immigration were liberalized, and by using a calibrated one-sector model Benhabib and Jovanovic (2012) find that the level of migration that would maximize welfare far exceeds the levels observed today. This result may appear contradictory with the observed restrictions to the free movement of people, but as Prichett (2006) well explains, this is not so much surprising when taking into consideration that most of the benefits accrue to the immigrants themselves and only a small part to the incumbent populations of rich countries.

In fact, assuming there is a large enough supply of individuals who want to be members of a country, analyzing the effects that immigration has on the incumbent population is crucial to understanding membership policies. The first micro-founded model of immigration demand was advanced by Berry and Soligo (1969). Their model explains that immigration is always beneficial as long as the capital per capita of immigrants is different than that of the incumbent population due to the resulting allocative efficiency gains.[17] As it can happen that not all individuals in the host country may benefit equally from the overall economic gains of a better allocation of resources due to unequal capital endowments, Benhabib (1996) presents a model of immigration demand that, preserving the overall average gains for the host country (from a representative individual perspective), incorporates the political economy dimension by modeling an heterogeneous wealth distribution. Furthermore, Usher (1977) showed that the benefits from allocative efficiency benefits might be dwarfed by the dilution in public capital caused by the immigrants whenever the latter is large enough as a proportion of the total capital in the economy. This is an important result that implies that, from a receiver country perspective, the benefits from increased labor mobility are not so clear, and that helps to explain the

[17] The authors point that their model is an *"analogue of the theorem in international trade that whenever the trade between two previously closed economies is made possible, the income of each economy is increased provided that factor proportions were not the same in the two economies before trade"* (p 783*)*.

general restrictive stance rich countries have towards mass immigration. Usher's model will be one important starting point for deriving a model of country membership, however, as will be explained in detail later in Chapter 3, it fails to capture the economies of scale in publicly provided goods that help to mitigate the dilution in public capital created by new entrants.

There is also a large body of empirical research devoted to ascertain whether the impact of immigration on the host country is positive due to productivity increases (For a prominent example of this view see Peri (2002, 2007) and Ottaviano and Peri (2003)), or if on the contrary substitution effects predominate over displacement effects, thus imposing job losses and/ or lower salaries in the incumbent working population (As defended by Borjas (1994, 1999, 2003)). Alesina and La Ferrara (2005) provide a model that shows the theoretical underpinnings of the relationship between ethnic diversity and economic performance.[18] Overall, empirical evidence is limited in terms of countries analyzed (most of the research is based on the US) and not conclusive.

Economies of scale and crowding effects are indirectly treated by the literature on immigration when assessing the effect of immigration on welfare programs, and whether or not immigrants have a negative fiscal impact (see Nannestad (2007) for a survey). Besides, the adverse impacts on the wages or the employment of the natives previously described can be also considered a sort of crowding. Once again here, empirical evidence is mixed in quite some instances.

A more recent alternative strand of research has started to look at the economic determinants of the legal institution of citizenship, including the economic costs and benefits of the acquisition of citizenship by naturalization, both for the immigrants themselves and for the native population (see Bevelander and DeVoretz (2008) for a survey). Bertocchi and Strozzi (2010) propose a political economy model that accounts for the trade off between costs of exclusion of participation and higher taxes, and test it against changes in the adoption of a "jus solis" or "jus sanguinis" principle. Even if this is a new promising field of research, the theoretical foundation behind these models results very much ad-hoc and falls short of explaining the different membership policies across countries, as well as the link between residence and citizenship requirements.

In summary, the question of whether immigration brings more benefits than costs to the host population remains inconclusive from both an empirical and theoretical perspective as the economic literature tends to look to the economic tradeoffs associated to immigration in isolation. As Borjas (1994, p. 1693) summarizes in his survey paper on immigration *"the literature does not yet provide a systematic analysis of the factors that generate the host country's demand*

[18] In the same article they provide a survey of the literature on the positive and negative effects of ethnic diversity on economic policies and outcomes.

function for immigrants".

Literature on jurisdictions and local public goods There is a diverse body of literature around jurisdictions and local public goods that addresses many of the issues revolving around country membership. Samuelson's (1954) seminal definition of *public goods* as non-rival and non-excludable set the theoretical basis for treating jointly owned community assets. However, the assets of a country are excludable for non-nationals/ residents, whilst its assets are a mixed-bag of *pure* non-rival goods (e.g., defense, institutions or its cultural or social capital), *impure* public goods which are subject to crowding and congestion (e.g.; roads, hospitals, etc.) and commons (e.g., state-owned natural resources). Buchanan's (1965) seminal work provides a framework for analyzing the conditions under which it is advantageous to admit a new member to a club, and advances that new members should be admitted as long as the marginal benefits of admitting a new member exceed its marginal costs. The club literature has been divided between a *within club* perspective (the Buchanan club) and a *total economy* perspective, devoted to the study of the optimal number of clubs (see Sandler and Tschirhart (1980) for a survey). Making the parallel with the literature on immigration, the total economy view provides a macro optimization of club membership whereby open borders will result in a higher degree of overall welfare. However, modeling country membership nowadays requires of acceptance that existing borders, population and capital endowments of countries have been defined by history as opposed to a *greenfield* approach. Therefore, the economic rationale for letting a prospective immigrant join is from an economic point of view similar to that of a club accepting a new member. In both cases there is an existing pool of jointly owned assets whose ownership will be diluted (and its usage congested) by increasing the number of members, whilst on the other hand average running costs will be lowered. A significant literature has been devoted to studying the optimality of *mixed* clubs as opposed to *homogeneous* clubs, touching this upon the benefits and costs of heterogeneity as well as discrimination and variations in the utilization rate of the public good (see Sandler and Tschirhart (1980) for a survey). Overall, the club framework is ideally attuned for modeling the economic trade-offs involved in country membership, in particular when complemented with the intuition provided by Usher's model. In fact, Straubhaar (1992) proposes the club framework as a guide for defining immigration policies as a function of the marginal benefits and costs for the incumbent population, although he neither includes economies of scale amongst its marginal benefits nor does he formalize a micro-founded model for calculating the equilibrium conditions. A related area of research that starts with Olson (1965) deals with the asymmetric incentives individuals face in the presence of public goods, and to the management of the commons pioneered by Ostrom (2000). Both yield important insights on the political economy of publicly owned assets, but do not address the enlargement of the group.

The literature on *jurisdictions,* which started with the *voting with the feet* hypothesis by Tiebout (1956) also touches upon the idea of community membership. However, this type of model lacks explanatory power when it comes to describing a nation, as they rely upon the notion of free mobility, which in the case of countries is severely curtailed. Furthermore, they do not consider dilution in public capital caused by new members as migration entails the movement of citizens *within* the country.[19]

The club model on the contrary, presents two main shortcomings when analyzing jurisdictions. First, it typically considers a single public good, thus accounting for economies of scale but ignoring economies of scope in bundling different publicly provided goods; and second, it lacks *geography*, as an individual, could in principle belong to as many overlapping clubs as he or she would wish for consuming different bundles of publicly provided goods. These shortcomings are not a problem though when modeling entry into a country from the point of view of the native population, as in this case the country's public goods can be considered to be bundled to geography. Furthermore, the club model can address the case when the new entrant belongs to several countries by pricing different congestion effects or scale economies.[20]

An attempt to bridge externality pricing and geography can be traced to the relatively recent literature on *economic geography*, which analyzes the positive externalities brought by agglomeration economies (see Gill and Goh (2010) for a survey). Usually, the unit of analysis consists of a city, an industry or a region, but a particularly interesting strand corresponds to the study of the *optimal size of nations* pioneered by Alesina and Spolaore (1997). They advance a micro-founded model to calculate optimal country size that incorporates the trade-off between economies of scale in the consumption of public goods and heterogeneity costs. As determining an optimal population size is equivalent to deriving an optimal country size when assuming a constant population density, the optimization problem could be considered closely related to that of determining optimal membership conditions. However, country size is optimized from a total-economy perspective and does not account for different existing levels of public capital endowments. Hence, it is very insightful to understand why borders are formed from a *greenfield* approach (i.e., what are the optimal borders so that global welfare is maximized), but does not serve us to model immigration once borders and capital endowments are given (i.e., how much public capital or positive externalities should a prospective new member bring

[19] As Scotchmer (2002, p. 2036) succinctly puts it*: "At the level of nations themselves, migration is severely restricted. None of the models [of local public goods] explains why this should be so. Is there an efficiency reason that the intra-country rules for migration should be different from the inter-country rules for migration?*

[20] In fact most countries impose the obligation to live in the country to grant a residence permit. Additionally, a majority of countries request to renounce to other citizenship before granting citizenship via naturalization (only 36% out of a sample of 180 analyzed in Chapter 8 allow for double citizenship)

to the country to compensate for crowding and dilution in public capital).

Finally, a last strand of research relevant for understanding country membership relates to the study of secessions and unions, as they entail allowing a group of members of a country to depart with a fraction of the country's public capital and set up a new country in the case of secessions, or to unite population and public capital in the case of a union. In the economic literature about secessions there are two main theories.[21] Bolton and Roland (1997) argue that, unions should always be more efficient than splits, as the same redistributive results brought by a split can be achieved with fiscal transfers, whilst larger economies of scale can be attained. Alesina and Spolaore (2003) argue on the contrary that the underlying driver is geography, as location is generally positively correlated with cultural homogeneity, first due to the increasing costs of administering distant locations, and second, by a lengthy process of sorting, identity formation and active policies aimed at increasing the degree of homogeneity. In both models the basic trade-offs behind country membership appear, although they do not account for different endowments in public capital per capita pre and post the union or split.

1.4. Contribution of the thesis

Taking stock of what the economic literature explains, it is apparent that the basic elements (the pieces of the puzzle) determining the costs and benefits of adding a new member to the country are largely known but there is a need for a comprehensive economic model of country membership (putting together the pieces of the puzzle) that accounts for the different costs and benefits that admitting a new member may have for the incumbent population, the different levels of membership offered, as well as the different ways in which membership can be *financed* (e.g., capital contributions, investments, productivity gains, externalities or efficiency gains). The main contribution of this thesis will be to fill this gap by advancing a micro-founded model of country membership demand that derives the equilibrium entry requirements accounting for all the economic trade-offs involved. Further, the explanatory power of the model will be assessed by contrasting its empirical implications against two novel datasets associated to country membership policies and several case studies.

It is important to outline that despite the intent of this research is positive – to derive a model that explains membership policies – there is a certain underlying normative component that cannot be ignored, as the model formulation could be interpreted as if countries should design membership policies to exclusively maximize their economic interests. However, there may be

[21] See Bolton, Roland, and Spolaore (1996) for a survey

other non-economic aspects of immigration that influence the utility of the native population and which are not considered by the model, for example: solidarity, (dis)like for diversity or large populations, geostrategic advantages of large countries, etc. This is particularly important to keep in mind when deriving policy implications from the model.

Besides non-economic factors, there are a number of issues that the model will not set out to address, like the economic trade-offs behind endogenous population growth, the impact of country membership policies on international trade and the implications for optimal taxation, and which will be left for the Discussion section.

1.5. Organization of the thesis, and brief synopsis

The thesis will be organized as follows. Chapter 2 will review the main models of immigration demand and assess their merits as potential models of country membership. It will show that due to the strict divisibility of capital these models require, they fail to capture the (partially) non-rival nature of most publicly provided goods.

Chapter 3 will introduce a micro-founded club model of country membership that derives the equilibrium membership requirements as a trade off between the benefits of economies of scale and the redistributional costs associated to a larger population. The model will be extended further to cater for crowding impacts or changes in scale economies generated by the new members. This chapter will also show there is an equivalence between the club model and the immigration models described in Chapter 2.

Chapter 4 will extend the model to include the costs associated with the heterogeneity of preferences between the native population and the new members, as well as the benefits from heterogeneity of skills between them. Same as in the previous chapters, the classic immigration models will be extended in order to cater for heterogeneity of tastes and skills, and its implications will be compared with those of the club model.

Chapter 5 will critically bring back to the model the potential allocative efficiency gains associated with differences in factor proportions between the incumbent and immigrant populations. A more comprehensive version of the model will be introduced by incorporating private capital, assuming that positive spillovers associated to population size are exclusively circumscribed to publicly provided goods. It will be demonstrated how unequal private capital endowments amongst the native and the immigrant population can have a significant impact on the determination of the membership fee, and that the direction will critically depend on whether there are complementarities between public and private capital, as well as on whether the optimization problem considers only one period or infinite periods. The extended model will also prove very useful when looking at empirical data, taking into consideration that investment programs typically require a combination of both public and private capital contributions. Further, in this chapter it will be mathematically proved that the income optimization problem that lies at the foundation of the thesis is equivalent to the classic income approximation approach mostly seen in the literature. Lastly, it will be critically proved that the only necessary assumption for the production function is to be homogeneous of degree one, being all the results valid independently of the value of the elasticity of substitution. This will confer generality to the results obtained by the Cobb-Douglas production function specification widely used throughout the thesis.

Chapter 6 will analyze economies of scale associated to population size when these depend exclusively on the size of the public sector, and the impact the latter can have on the membership fee. All things being equal, the larger the pubic sector the lower the membership fee. The chapter also analyzes the trade-off between economies of scale and government size, and the optimum level of government size. Lastly, a simple model will be used to describe the impact that income taxation can have on the membership fee.

Chapter 7 will study a number of political economy implications arising from the country membership model. In a first step Benhabib's (1996) political economy model of immigration will be revisited to cater for dilution in public capital. Further, the impact that diverging preferences for government size can have on membership policies will be analyzed. The chapter will end looking at several case studies that illustrate how preferences for social homogeneity can play an important role in defining country membership policies.

Chapter 8 will discuss the challenges in empirically testing the implications of the model and advance some datasets for the key variables of the model. Regression analysis will be conduced for three different datasets associated to country membership: immigrant investor programs, citizenship by naturalization requirements and a sub-index of the MIPEX index that caters for access to nationality

Chapter 9 will close the book by discussing a number of assumptions, modeling alternatives and further research implications. Particularly relevant is the analysis of the different discount rates used to analyze the effects of membership policies in the long run, and how the latter differ in the case of an open or closed economy.

Chapter 10 will conclude.

2. Review of existing economic models of immigration demand

This chapter will review the most relevant models of immigration demand and assess their merits as potential models of country membership. It will conclude that due to the strict divisibility of capital imposed by these models, they fail to capture the (partially) non-rival indivisible nature of most publicly provided goods.

Existing models of immigration demand set out to assess the change in income for the native population caused by an influx of immigrants. If post immigration income is higher than pre-immigration income, immigration is deemed to be positive and hence there will be a demand for immigrants. On the contrary, if income is decreased, immigration will be curtailed.

2.1. Income effects of immigration in a model with no public capital (Berry and Soligo)

The seminal model by Berry and Soligo (1969) analyzes the impact of an inflow of immigrants on the host population's income, when defined as the sum of wages and return on capital for a representative individual.[1] According to their model, the change in income can be approximated by (see sec. A.2 in the Appendix for a detailed calculation):

$$I_1 - I_0 \approx -\frac{1}{2} f''(k_0) \left(k_1 - k_0\right)^2 \gtrapprox 0 \tag{2.1}$$

Where k_0 and k_1 are the pre and post immigration capital per capita, and $f(k)$ the per capita production function.

[1] Their model assumes perfect markets, no external effects, constant returns to scale, independent utility functions and a two-factor economy. Further, factors are continuously substitutable and prices are flexible so that factor markets are always cleared. The marginal utility of income is assumed to be equal for all owners of factors of production.

If the production function $f(k)$ exhibits constant returns to scale, immigration should always have a positive impact on the existing population as long as the capital per capita of the immigrant is different from that of the average individual. In the particular case when they are equal, there is no gain or loss.

According to this result, countries should proactively seek immigration as it results overall beneficial for the income of the host population. However, when the population is not equally endowed in terms of capital and/ or skills[2] there may be winners and losers, which can explain the observed resistance to immigration despite the overall economic gains.

2.2. Income and redistribution effects in the presence of public capital (Usher)

Berry and Soligo's model describes an economy in which all capital is in private hands. In most developed countries however, there is a significant stock of public capital whose ownership and returns gets diluted with an increasing population. Usher (1977) showed how in the presence of public capital, immigration does not result to be unconditionally beneficial. On the contrary, if the public capital stock is large compared to the private one, immigration will have an overall negative impact on the host population's income.

Defining δ_p as the net dilution in public capital per capita caused by the flow of immigrants, the change in income per capita for a representative individual of the incumbent population will be (see sec. A.3 in the Appendix for a detailed calculation):

$$I_1 - I_0 \approx -\frac{1}{2} f''(k_0)\,(k_1 - k_0)^2 - f''(k_0)\delta_p\,(k_1 - k_0) - f'(k_0)\delta_p \tag{2.2}$$

Which corresponds to a quadratic equation in $k_1 - k_0$ with discriminant:

$$\triangle = \left[f''(k_0)\,(k_1 - k_0)\,\delta_p\right]^2 - 2f''(k_0)\,(k_1 - k_0)^2\,f'(k_0)\delta_p \tag{2.3}$$

The sign of the discriminant is positive assuming a production function with diminishing marginal returns and a net dilution in public capital per capita ($\delta_p > 0$). Which implies there

[2] Chapter 7 will describe Benhabib's (1996) extension for a non-homogeneous capital distribution in the host population.

is a range of values for $k_1 - k_0$ for which $I_1 - I_0$ is negative. Or in other words, equation (2.2) shows that the net effect of immigration on income is a trade-off between the efficiency gains provided by a change in factor proportions and the redistributional losses caused by the dilution of public capital per capita.[3] However, when changes in public capital per capita are larger than those in private capital,[4] the last term in the equation are of a higher order of magnitude, and immigration has an overall negative impact on the income of the host population.

The maximum income loss occurs for values in post-immigration capital per capita in the vicinity of the pre-immigration ones (i.e., whenever redistribution effects predominate) and will be equal to:

$$I_1 - I_0 \approx -f'(k_0)\delta_p \tag{2.4}$$

The former loss corresponds to a one-period calculation of the income change. Assuming an infinite lifetime of individuals, the total impact will be given by the *capitalized* income loss:

$$\frac{I_1 - I_0}{f'(k_0)} \approx -\delta_p \tag{2.5}$$

This result implies that the total income loss for the average member is equal to the change in public capital per capita after immigration. Or alternatively, if immigrants had to compensate the incumbent population[5] for their multi-period income loss, they would need to pay an amount of public capital per immigrant p^* equal to the existing public capital per capita p_0:

$$\triangle L \cdot p^* = \delta_p L_1 = \left(P_0 \frac{\triangle L}{L_1 \cdot L_0} \right) L_1 \Rightarrow \tag{2.6}$$

$$p^* = \frac{P_0}{L_0} = p_0 \tag{2.7}$$

[3]To be precise the first term in the equation is always positive but the second tells us that whenever there is a dilution of public capital ($\delta_p > 0$) there are efficiency gains only when $k_1 > k_0$. However, this term is not really relevant as can be seen by centering the Taylor approximation in $k_1$instead of k_0, which results in the following approximation: $I_1 - I_0 \approx \frac{1}{2} f''(k_0)\,(k_1 - k_0)^2 - f'(k_0)\delta_p$

[4]It is worth noting that changes in private capital have a lower boundary as immigrants cannot bring negative capital, whilst there is no upper boundary. This may help to explain why we observe much less restrictions to the inflow of capital-rich immigrants as opposed to that of poor ones.

[5]In fact as new members will contribute in the form of public capital that they will also enjoy, the contribution needs to cater for the dilution of the total population post entry L_1

How large can the dilution in public capital be? For the calculation of the break-even contribution of new entrants we have assumed that redistribution effects predominate over income effects. However, the actual income change will depend on the existing stock of public capital and the per capita differences between the native and immigrant populations as given by equation (2.2). The following graph illustrates the post-immigration income for different levels of immigrant capital per capital, and public capital as a proportion of total capital; assuming immigrants are 1% of the native population and total capital per capita is USD 50,000.

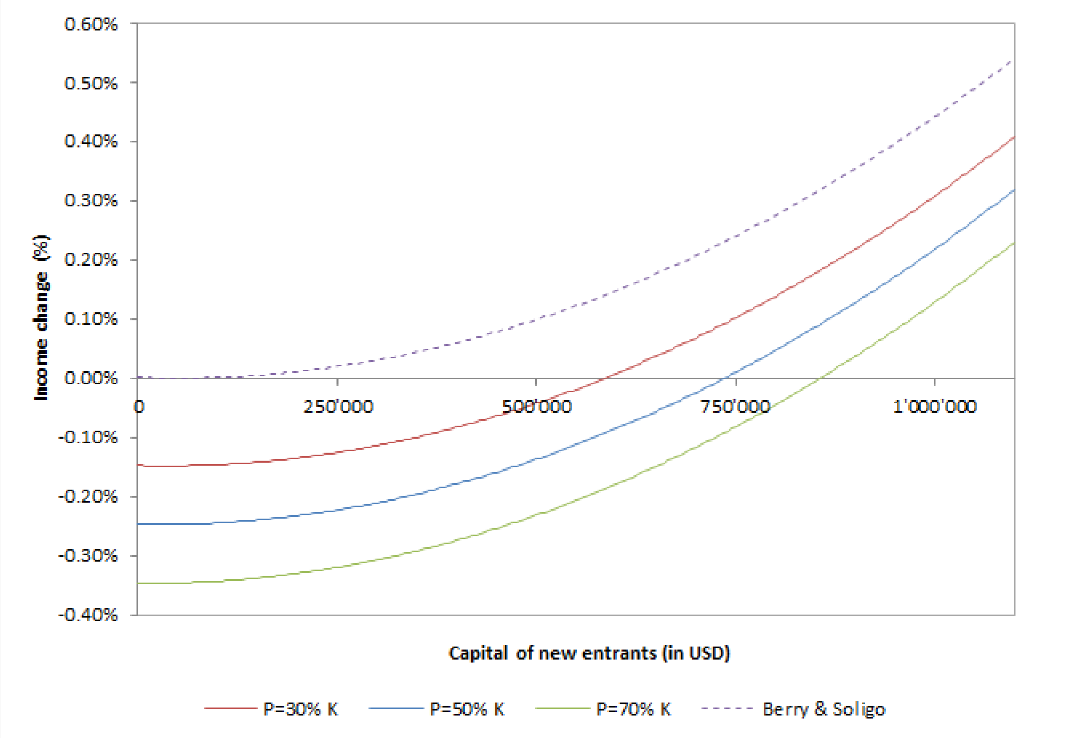

Figure 2.1.: Income change vs. immigrant capital per capita

It can be observed that when public capital is ignored as Berry and Soligo do (dotted line), natives always benefit of immigration.[a] However, when public capital is taken into consideration, immigration can only be beneficial when the immigrants are significantly wealthier than the incumbent population. Furthermore, as capital per capita has a lower boundary at zero, the benefits of immigration are potentially much larger for admitting wealthy individuals than poor individuals. Two conditions are necessary for low capital immigration to have a significant

[a]Except for the case when immigrant capital is exactly USD 50,000 when they break-even.

positive impact in the income of native population, in the first place the influx of immigrants needs to be very large in order to constitute a real *drag* in the capital per capital, and second, the stock of public capital per capita needs to be relatively small. The following graph shows the income change when the influx of immigrants is equal to 200% of the native population. It can be seen that when public capital is low (5% of private capital) immigration can be beneficial. However, even for modest levels of public capital per capita, it quickly turns detrimental from a native's income perspective.

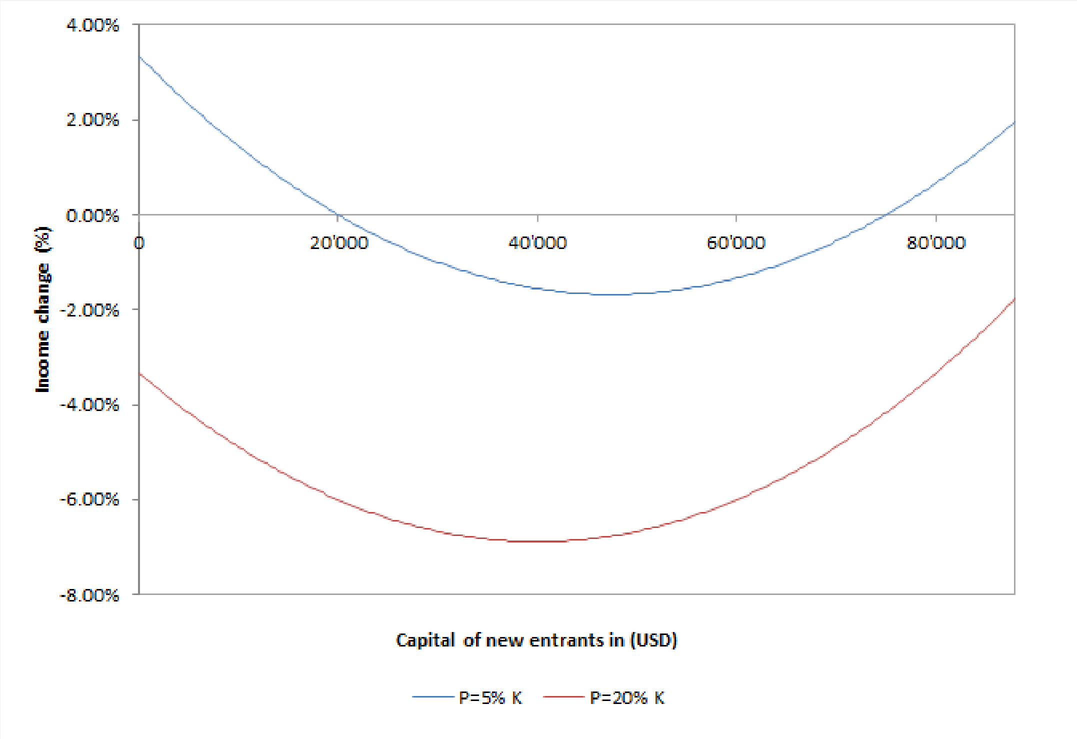

Figure 2.2.: Income change vs. immigrant capital per capita

Estimates of public capital per capita are scarce and difficult to obtain. Kamps (2004) provides internationally comparable government capital stock estimates for 22 OECD countries. According to these estimates, in 2000 Japan had the highest ratio of net government capital stock to GDP was 117.1%, whilst Ireland had the lowest with 35.2%. Madison (1995) estimates the capital stock is generally between two and three times the size of GDP for a range of industrialized countries.[a] As an example, in the case Japan total capital stock to GDP is estimated to be 3.02 in 1992, which would imply public capital to be about 40% of total capital.

[a]Table 2.1 Maddison (1995), Monitoring the World Economy: 1820–1992.

These estimates however do not include government debt.[a] As public debt will be served by both existing and new members, dilution in public capital will be smaller in the presence of high levels of public debt. Bova et. al (2013) look at the composition of financial assets, non-financial assets and public debt for OECD countries. Despite the many data gaps and problems of comparability,[b] the data they provide help in getting an idea of the order of magnitude of the net public capital stock, and hence the importance of its dilution in the case of admitting new members.

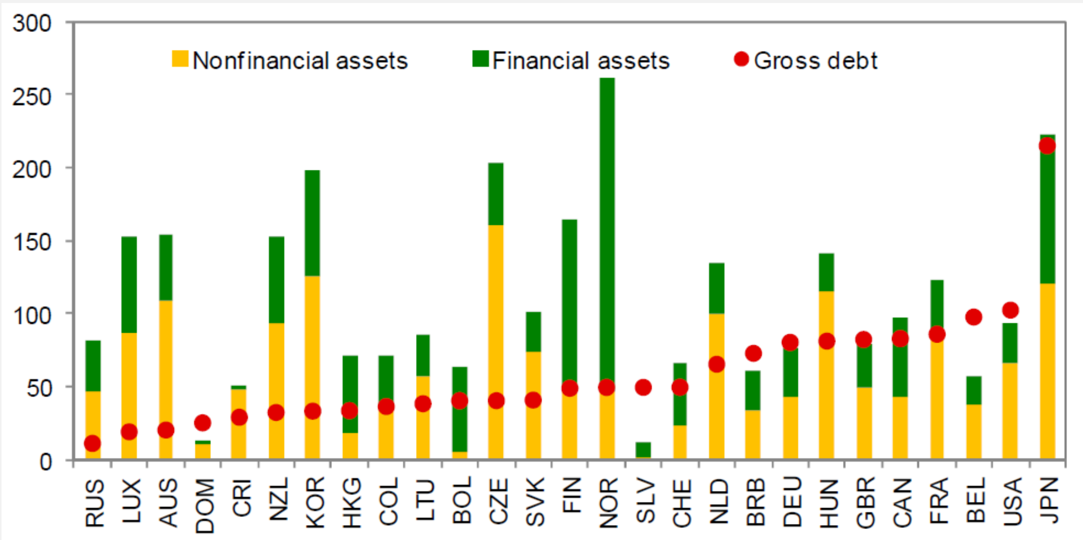

Figure 2.3.: General Government Assets and Liabilities in % of GDP. Source: Bova et. al (2013)

For some countries that are rich in natural resources, the amount of public capital can be actually very large. An illustrative case is Saudi Arabia. Aramco, its national petroleum and natural gas company has estimated reserves of more than 300,000 million barrels, which, according to The Financial Times, makes it worth USD 7 trillion at 2010 market prices and exploitation costs.[c] Taking into consideration that there are 21 million Saudi nationals, this would result in USD 333,333 per capita, which is more than 10 times current GDP per capita.

[a]Kamps uses the classic definition of net capital stock which accounts for depreciation and hence the word *"net"*, but this does not include net government financial assets.

[b]Most countries do not report certain assets (e.g., subsoil assets) or record assets at book value therefore underestimating the real value of government assets. For example Norway and Russia have large reserves of oil and gas which are not included in the government assets. In the case of Norway, there are large financial assets reported consequence of the sovereign wealth fund where the surplus wealth produced by Norwegian petroleum income is deposited.

[c]"Big Oil, bigger oil". FT, February 4, 2010.

In Qatar the numbers are even more dazzling. The value of the Qatar Petroleum corporation is half of that of Aramco, but population is only 2.1 million, which if distributed would result in USD 7.3 million per capita, or more than 70 times current GDP per capita.

2.3. Conclusions

Summarizing, in the presence of public capital, capital dilution costs are typically of a larger order of magnitude than allocative efficiency benefits. The latter can only have a positive influence in the native population's income when the wealth of the new members is significantly higher than the average capital per capita. The lower the amount of public capital and the larger the share of immigrants, the bigger the impact. On the contrary, poorly endowed new members will in most cases have a negative impact on the host population income. These findings help to explain why nowadays immigration policies are skewed towards facilitating access to wealthy individuals but heavily restricting entry to poorly endowed ones.

These models however fail to capture the partially non-rival nature of publicly provided goods, which help mitigate the dilution in public capital. In principle, if all goods were perfectly public, adding a new member to the club should cause no dilution in the returns of public capital, and thus allocative efficiency considerations should then prevail. The next section will introduce a model of membership that accounts for the trade-off between economies of scale in the provision of public goods and public capital dilution effects.

3. The trade-off between economies of scale and public capital dilution

This section will introduce a micro-founded club model of country membership that derives the equilibrium membership conditions as a trade off between the benefits of economies of scale and the redistribution costs associated to a larger population. Economies of scale arising from population size will be found better represented by modeling non-rivalry associated to publicly provided goods in the utility function as opposed to increasing returns to scale to public capital in the production function. In a second step an equivalence between the club model and the immigration models described in Chapter 2 will be established. Lastly, the model will be further extended to cater for crowding impacts or changes in scale economies brought by the new entrants. The relevance of crowding effects will be discussed with the help of several case studies.

3.1. Modeling economies of scale

If Berry and Soligo's model of immigration appears to be too benign by overseeing some of the disadvantages of granting free entrance at new members, Usher's model results too restrictive as it ignores the benefits associated to larger populations, which can act as a mitigant to the dilution in public capital. Allison and Spolaore (1997) enumerate some of the most relevant spillovers associated to population size: larger internal markets, exposure to uninsurable shocks, security considerations, and, most importantly, the benefits of scale in the provision of public goods. Contrary to their model, the formulation here proposed will be broad enough to consider all sort of possible spillovers associated with population size, and not only the economies of scale in publicly provided goods.

Scale effects can be modeled along two dimensions, either by assuming increasing returns to scale in public capital in the production function or by incorporating non-rival consumption of publicly provided goods (or of the returns public capital provides) in the individual's utility function.

Economies of scale in the production function The non-rival nature of public capital implies that the role of public capital in the production should be different than that of the private one. Following the tradition of Barro (1990), it will be assumed that public capital enters the production capital separately, i.e., $f = f(k, p)$.

The second order Taylor approximation of the change in income per capita in this case will be given by (see sec. A.4 in the Appendix for a detailed calculation):

$$I_1 - I_0 \approx f_p\left(p_1 - p_0\right) + \frac{1}{2} f_{pp}\left(p_1 - p_0\right)^2 - \frac{1}{2} f_{kk}\left(k_1 - k_0\right)^2 \tag{3.1}$$

Assuming decreasing marginal returns on private capital, the formula above shows that the change in income is positive related to changes in private capital per capital, as in the model of Berry and Soligo. The effect of the change in public capital needs of further analysis. If immigrants do not contribute with any public capital, $p_1 < p_0$ and the first term in the equation will be negative. The sign of the second term depends on whether there are increasing or decreasing marginal returns. Thus, if economies of scale in public capital bring increasing marginal returns ($f_{pp} > 0$), they will partially compensate for public capital dilution.

The question however is how large can scale effects be. In order to assess the relative importance of both factors, a Cobb-Douglas production function similar to Barro's will be used: $f = k^{\alpha_K} p^{\alpha_P}$. The capitalized income differential in this case can be expressed as:

$$\frac{I_1 - I_0}{f_p} \approx -p_0 \frac{\triangle L}{L_1}\left(1 + (1 - \alpha_P)\frac{\triangle L}{L_1}\right) \tag{3.2}$$

Similar as happens with the factors proportions, for small changes of population the dilution in public capital trumps the other benefits. Therefore, to compensate for the income loss new entrants should still have to contribute with an amount of public capital p^* almost equal to the existing public capital per capita p. This result is somehow intuitive as the fact that public capital brings increasing production gains simply makes a share of public capital more valuable.

Economies of scale in the utility function The first approach does not provide a model in which scale effects can compensate capital dilution costs in a significant manner. The reason is that public capital is modeled just as a mere pool of divisible capital of a rival nature. In order to capture the partially non-rival nature of publicly provided goods, it is necessary to model the utility function of a representative individual in a way that this is unaffected by the total number of individuals. However, most publicly provided goods in a country are not completely *pure* and congestion effects will kick in at a certain point. As a consequence, the utility of the representative individual needs to be dependent on the number of members in the country, even if not proportionally (i.e., dilution can be partial).

Buchanan's (1965) model provides the basic intuition for the optimization problem at hand, that consists in maximizing the representative individual's utility – which on the one hand is negatively related to the number of club members due to congestion effects but on the other hand is positively influenced due to cost-sharing – subject to the constraint defined by the production function. Buchanan's basic optimization problem caters for the *maintenance* of the club, thus the trade-off is only one between economies of scale in the provision of public goods and crowding. Accordingly, any new member would be welcomed as long as the synergies brought in the provision of the club good are bigger than the crowding generated. However, when treating immigration, a distinction has to be made between temporary immigration – which mostly affects crowding – and permanent immigration – which also causes a dilution in public capital.

In fact the club model lends itself nicely to model country membership from a conceptual point of view. Accepting that history has determined the borders and riches of present countries, a modern nation-state can be conceptualized from an economic perspective as an asset-rich club with broadly speaking two types of capital, privately and publicly owned. Entry to the club and usage of its public assets is in principle reserved to its members. Existing members decide on the optimal number and nature of new members to be admitted according to what is more beneficial to them from an economic perspective.

The utility of a representative member of the native population of a country can be described as the sum of the income generated from the production function of the economy $I(K, P, L)$ plus any other non income-related factors which may affect the individual's utility, like solidarity, compassion, (dis)like for diversity, etc.:

$$U(K, P, L) = I(K, P, L) + \Omega(L) \tag{3.3}$$

Similar to the immigration models described above, when modeling the utility of the host population this research will circumscribe itself to the income of the representative individual, leaving aside any other on income-related factors potentially affecting his/her utility ($\Omega(L) = 0$).[1]

[1] In Chapter 4 the role of social heterogeneity will be analyzed but exclusively from a pure economic perspective,

3.2. A club optimization problem

The club framework allows us to derive the equilibrium conditions for admitting new members under the different economic trade-offs at play. The basic intuition of the club model is that new members will be admitted as long as the marginal benefits of admitting a new member are higher than the marginal costs. In the case of country membership, marginal costs will be determined by the dilution of public capital (or its returns) and the potential crowding effects (reduction in economies of scale). Marginal benefits on the other hand are determined by the reduced average costs in the provision of public goods.[2]

The club model would imply that no new members should be admitted when economies of scale are not sufficient to compensate for the dilution in public capital. However, when this is the case the new entrant could compensate the host population for the difference between marginal costs and benefits by contributing with a certain amount of public capital to the country. The optimization problem will then turn from optimizing the number of members in the club to deriving the minimum entry fee required to new members. The idea of building on the club parallel to derive an entry fee to new immigrants has also been sketched at high-level by Straubhaar (1992) although his framework does not include economies of scale amongst the marginal benefits and does not advance a model for calculating the fee.

In order to keep the model as simple as possible, an stylized version of the club model which treats the total economy as a club good will be presented. Besides its simplicity, this formulation has one further advantage versus a more specified alternative, as it allows to incorporate the broad benefits associated to population size (i.e., including externalities, economies of scope, larger markets, etc.), and not only the economies of scale in the provision of public goods. In Chapter 5 a more disaggregated formulation will be presented breaking down the different sources of income and restricting economies of scale to public capital only.

3.2.1. A one-period calculation: temporary membership

Generic production function Assuming there are two types of capital, one public which is jointly owned and thus dilutable when increasing the number of members and a second which is private and individually owned, the production function will be given by $F(K, P, L)$, where K and P represent the private and public capital stock respectively, and L the population of

leaving aside subjective tastes for heterogeneity.

[2]At this point all individuals are considered equal. Some further benefits and costs associated to the individual characteristics of prospective new members will be developed further in this chapter.

the country. The income of the representative individual over one period will be defined as:

$$I(K,P,L)=\frac{F(K,P,L)}{L^{\beta}} \tag{3.4}$$

where $\beta \in [0,1])$ is a parameter[3] related to the degree of economies of scale in the economy associated to population size, or in a more narrow interpretation, the degree of *publicness* inherent to the goods and services produced in the economy.[4]

The economic rationale behind is clear, one unit in total production per capita *yields* more than one unit of utility per capita due to the presence of club goods (mainly publicly provided goods) in the economy that allow for simultaneous consumption.

The club optimization problem is equivalent in this case to finding the minimum contribution of public capital a new member should make in order for the income per capita of the incumbent population to stay invariant.[5] Taking into consideration that prospective new members can bring both private and public capital to the country ($K=K(L)$ and $P=P(L)$):

$$\frac{\partial I}{\partial L}=\left(\frac{\partial F}{\partial K}\cdot\frac{\partial K}{\partial L}+\frac{\partial F}{\partial P}\cdot\frac{\partial P}{\partial L}+\frac{\partial F}{\partial L}\right)L^{\beta}-\beta F L^{\beta-1} \tag{3.5}$$

$$\frac{\partial I}{\partial L}=0\Rightarrow\frac{\partial P}{\partial L}=\frac{1}{\frac{\partial F}{\partial P}}\left[\beta\frac{F}{L}-\frac{\partial F}{\partial L}-\frac{\partial F}{\partial K}\cdot\frac{\partial K}{\partial L}\right] \tag{3.6}$$

Defining the per capita output, private and public capital as: f, k and p, and the marginal productivity of labor, private and public capital as w, r_K and r_P, the amount of public capital that should be brought by a new member and denoted as p^* should be equal to:

$$p^*=\frac{\partial P}{\partial L}\Big|_{\frac{\partial I}{\partial L}=0}=\frac{1}{r_P}\left[\beta f-w-r_K\cdot\frac{\partial K}{\partial L}\right] \tag{3.7}$$

Assuming the economy is in equilibrium before the influx of new members ($f=w+r_K\,k+r_P\,p$), the previous equation can be rewritten as:

[3] In reality, β is on itself a variable dependent on L. Typically β should increase with the population size as congestion effects will appear. However, this does not necessary have to be the case, particularly whenever there are labor shortages. In Sec. 3.4 this assumption will be relaxed and changes in ere β will be analyzed.

[4] If all goods in the economy were public $\beta=0$, whilst if all them were private $\beta=1$

[5] The exhibition of the optimization problem has been simplified for avoiding the readers the need to be familiar with the club model formulation. A classic club model optimization is shown in the Appendix sec. A.5 for a Cobb-Douglas specification

$$p^* = \frac{1}{r_P}\left[f\,(\beta - 1) + r_P\,p + r_K\left(k - \frac{\partial K}{\partial L}\right)\right] \tag{3.8}$$

Taking into consideration that in the presence of significant public capital, redistribution effects are of first order whilst allocative efficiency gains are of second order,[6] it will be helpful to assume that the immigrant brings an amount of private capital exactly equal to the existing per capita one ($\frac{\partial K}{\partial L} = \frac{K}{L} = k$). This will allow us to keep the model to be as parsimonious and tractable as possible by not differentiating between different sources of income from labor and capital.[7] Nonetheless, this assumption will be removed in Chapter 5 where income effects will be analyzed in detail.

Accordingly, the equilibrium *minimum entry fee*[8] can be expressed as:

$$p^* \geq \frac{1}{r_P}\left[f\,(\beta - 1) + r_P\,p\right] \tag{3.9}$$

The intuition of the result is clear, economies of scale have to compensate for the dilution in the *returns* on public capital created by the new entrants. Eventually, if economies of scale are large ($\beta < 1 - r_P\frac{p}{f}$) the amount of public capital required could be zero or even negative. If there are no economies of scale in the economy ($\beta = 1$) the result is similar to that derived from Usher's model,[9] and every new immigrant should contribute with an amount equal to the existing public capital per capita p. However, in the case when there are some economies of scale ($\beta < 1$) the new entrant should contribute with a lower amount. Conversely, the lower the stock of public capital p, the less dilution and the lower the entry fee.

The impact of the return on public capital r_P needs more careful analysis as, on the one hand, the lower its value the less economies of scale are needed (as dilution decreases), whilst on the other hand, a lower value in the denominator of equation 3.9 increases the value of p^*. Furthermore, equation (3.9) assumes the influx of new members alter the existing equilibrium in the economy and bring it to a new equilibrium point.[10]

[6] As shown in Sec. 2.2

[7] It is worth noting that by defining income per capita as a fraction of total output, if there would be a contribution in private capital from the new member larger/smaller than the existing capital per capita, this would be equivalent to a donation from the newcomer and vice-versa, which would only serve to represent an egalitarian society.

[8] Any fee paid above this level will result in a net profit for the native population.

[9] See equation (2.7).

[10] In Chapter 9 the modeling implications of assuming endogenously determined vs. exogenously given marginal returns of labor and capital will be discussed

Cobb-Douglas production function In order to assess the relative importance of the return on public capital r_P, the model will be specified by means of a Cobb-Douglas production function $F(K, P, L) = K^{\alpha_K} P^{\alpha_P} L^{1-\alpha_K-\alpha_P}$, where K and P represent the private and public capital stock respectively, α_K and α_P their respective shares of production, and L the population of the country. This specification will also later be of help to extend the model further in a tractable form. Furthermore, Chapter 5 will show that the only necessary assumption on the production function for the results to hold is that this is homogeneous of degree one, and hence there is no loss of generality by using such a functional specification.

The income of the representative individual over one period will be defined as:

$$I(K, P, L) = \frac{F(K, P, L)}{L^{\beta}} = K^{\alpha_K} P^{\alpha_P} L^{1-\alpha_K-\alpha_P-\beta}$$

And the minimum required contribution in public capital p^* to the new entrant will then be:

$$p^* \geq p \cdot \left(1 + \frac{\beta - 1}{\alpha_P}\right) \tag{3.10}$$

Once again, if there are no economies of scale in the economy $p^* = p$. However, if economies of scale are large, and the share of public capital in production is low $(\beta + \alpha_P < 1)$ the entry fee could be zero or even negative. The lower the share of output of public capital α_P is, the lower will be the public capital contribution p^* in absolute terms. Thus, countries that exhibit large returns of public capital have a higher incentive to avoid its dilution and consequently should have a higher resistance to immigration and vice-versa.

3.2.2. Permanent membership

The per capita income optimized in the previous section corresponded to a one-period calculation. If new members were to stay in the country permanently – or pass the right of residence to further generations – income would need to be capitalized and expressed as present values, which is equivalent to discounting the one-period utility as if it were a perpetuity.[11] As we are interested in the dilution of public capital returns,[12] the appropriate discount rate will be[13]

[11] As shown in Sec. 2.2 Usher (1977) follows a similar approach.

[12] In fact, as we assume that the new entrants are equally endowed in terms of private capital, we could remove K from all the equations.

[13] Discounting by r_K leads to an equation invariant to P and hence an indeterminated result, as will be further discussed in Sec. 9.2.3.

$r_P = \frac{\partial F(K,P,L)}{\partial P}$. The income of the representative individual will then be $I = \frac{F(K,P,L)}{r_P L^\beta} = \frac{P}{\alpha_P L^\beta}$, and the required minimum public capital contribution for new members will be:

$$p^* \geq \beta p \tag{3.11}$$

Thus, according to this result, when accounting for permanent settlement the entry can never be for free (unless all goods are perfectly non-rival and $\beta = 0$), as opposed to the result in the previous section for temporary membership. Economies of scale related to population size can only mitigate public capital dilution, but not eliminate it completely. Furthermore, in this case the output share of public capital α_P turns to be irrelevant for the required capital contribution.

The reason for the difference between the one-period and the permanent residence calculation lies in the degree of consumption of public capital. In the first case immigrants receive a per capita share of the *return* on public capital, whilst in the second they receive a per capita share of the public capital itself. Or in other words, the incumbent population may have an incentive to accept immigration for free in the short-term when economies of scale are large and the return on private capital is low. In the long-term however, immigration entails the dilution of public capital and not only of its returns, and a certain contribution of public capital is always necessary in order to avoid an income loss.

When comparing equations (3.10) and (3.11), it becomes clear that if ($\beta < 1$), as it is expected to be in a developed nation, then $p^*_{Permanent} > p^*_{Temporary}$. This result is clearly in line with what we observe in the real world where the requisites for permanent residence, or ultimately, citizenship (e.g., number of years of residence, exemplary civic conduct, certain degree of assimilation to host culture, etc.) are usually much higher than those for temporary migration. It is important to outline that this fact cannot be easily explained by the two models of immigration previously analyzed, in which when immigration is beneficial/ detrimental for one period, more so is the case of permanent residence.

Discounting plays obviously a key role in this result and also the chosen specification with complementarities between labor, private capital and public capital. Moreover, the model assumes interest rates remain constant after the influx of new members, and unaffected by the financing needs of the country or the global level of interest rates. Other alternative model formulations will be discussed in Chapter 5 as well as in the discussion section in Chapter 9. The present formulation has been chosen for its simplicity, which will facilitate the derivations of the model in the next chapters.

Further, Sec. A.23 in the Appendix shows that the Cobb-Douglas specification causes the assumption of equal capital endowments ($\frac{\partial K}{\partial L} = k$) not to be necessary, contrary to the one-period calculation. However, for any other specification with CES $\neq$1 this assumption would be required.

Guest worker programs: An example of temporary membership History provides us with multiple examples of countries adapting policies for temporary versus permanent immigration. During periods of war or strong economic growth, countries have actively recruited foreign workers to alleviate shortages of labor. France was the first country to set up a formal guest worker program in 1924 to compensate for the population decimation after World War I. The Société Générale d'Immigration was managed by the employer's association whilst the state provided bilateral treaties with the countries of origin of the immigrants, mainly Italy, Poland, Spain and Belgium. Whilst initially welcomed, the global economic depression in the 1930s turned immigration very restrictive with new permits reduced dramatically and working foreigners being sent back to their countries.[a]

With the reconstruction efforts in Europe after World War II and the subsequent "economic miracle", several central European countries reinitiated efforts to recruit foreign workers to accommodate the demands of the rapidly expanding industrial sector. Western Germany's *"Gastarbeiter"* program became Europe's largest and most sophisticated one. Similar to that of France, the program entailed the signature of bilateral agreements with several countries (Greece, Italy, Morocco, Portugal, Tunisia, Turkey and Yugoslavia) to recruit unskilled labor. The Federal Labour Office was in charge of supervising the recruitment in the countries by checking skills, medical condition, criminal records and organizing transport, whilst the employers were responsible for providing initial accommodation. However, contrary to its design, immigrants tended to stay in the country and bring their families instead of returning to their countries. With the sudden economic slowdown caused by the "oil crisis", the government stopped all entries from countries outside the European Economic Community, which caused to stop immigration from all sending countries except Italy. Furthermore, the government soon realized that jobless foreign workers had become a burden for social services and passed the *"Rückkehrbereitsschaft"* law (law to advance the willingness to return home) and started paying a so-called *"Rückkehrprämie"* (repatriation grant) or *"Rückkehrhilfe"* (repatriation help) for those who opted for returning home. A person returning home received 10,500 Deutsche Mark, an additional 1,500 Deutsche Mark for his spouse and 1,500 Deutsche Mark for each of his children if they returned to the country of his origin. France set up a similar program in 1977

[a]Goldin et al. pp.80.

offering 10,000 Francs for any non European Community national willing to leave the country and renounce to his claim to French Social Security. The practice of incentivizing the return of immigrants is not a matter of the past. Several countries have recently implemented so-called "golden handshake" or "pay-to-go" programs for immigrants to leave the country. Denmark offers such a program since 1997 to those immigrants who cannot or are not willing to integrate in its society, and in 2010 increased the amount paid almost ten times to close to DKK 100,000. Since 2013 Spain also offers to pay accumulated social security benefits to legal immigrants who chose to return to their country of origin. Monetary incentives have also recently been offered to illegal immigrants or asylum seekers in countries such as, Canada, Italy, Malta, Spain and UK. These examples emphasize how short-term benefits of immigration may be very different from long-term ones, as the temporary consumption of publicly provided goods, that can be initially perceived to be compensated by the benefits associated to population increases, becomes more important once immigration is permanent. In some occasions foreign labor had strictly to be of a temporary nature due to the seasonality or the special circumstances determining the scarcity of labor. The most prominent example was the *"bracero"* program in the US, set up to bring immigrants from Mexico and Central America to work as temporary workers mainly in the agricultural sector. This program started in 1942 as a result of the war efforts during World War II but was extended several times lasting until 1962, when it was finally ended due in large part to the growing opposition by organized labor and welfare groups. During this period 4.6 million braceros were admitted with temporary work permits.

The incentive to tap cheap sources of labor without bearing the cost of granting future entitlements to the immigrants is also behind the "Kafala" guest-worker system in several Gulf States. Under this system unskilled laborers need to have an in-country sponsor, usually their employer, who is responsible for their visa and legal status. This creates easy opportunities for the exploitation of workers, as many employers take away passports and abuse their workers with little chance of legal repercussions.

3.3. Equivalence with classical models (I)

In the previous section the equilibrium conditions for admitting a new member have been derived in a way that economies of scale can be incorporated into the income of the native population. This section will compare the result with an extended Usher model that accounts for economies of scale in the consumption of publicly provided goods.

When public capital is diluted by an increase in the population, but due to its partial non-rival nature this dilution is not one to one proportional to the increase, the change in public capital per capita δ_P can be rewritten as:

$$\delta_P = p_1 - p_0 = \left(\frac{P_0}{L_0 + \beta \triangle L} - \frac{P_0}{L_0} \right) = -P_0 \frac{\beta \triangle L}{L_1 L_0} \tag{3.12}$$

And the capitalized income loss will be given by:

$$\frac{I_1 - I_0}{f_p} \approx -p_0 \frac{\triangle L}{L_0 L_1} \left(\beta + (1 - \alpha_p) \frac{\triangle L}{2L_1} \right) \tag{3.13}$$

Finally, the amount of capital per immigrant to compensate for the loss of income would be:

$$p^* \approx \frac{P_0}{L_0} \left(\beta + (1 - \alpha_p) \frac{\triangle L}{2L_1} \right) = \beta p_0 \tag{3.14}$$

Therefore, when publicly provided goods present a certain degree of non-rivalry, the entry fee gets reduced. If publicly provided goods were completely pure ($\beta = 0$) there would be no entry fee ($p^* = 0$). If publicly provided goods were completely rival ($\beta = 1$) the entry fee would be equal to the existing public capital per capita ($p^* = p$).

This result is equivalent to the one obtained by using the club approach. However, there is a methodological difference as in the case of the club model the entry fee is derived in equilibrium, whilst in the adapted Usher model it is approximated as the difference in income between two equilibrium states before and after immigration. The club model will therefore lend itself better to be extended in a way that can cater for other economic trade-offs that will be developed in the next chapter.

3.4. Crowding effects

In the previous sections we have assumed β is a static parameter representing the degree of economies of scale, which is assumed to be closely related to the degree of *publicness* of the goods in the economy. However, if the number of publicly provided goods remains the same and there is a certain degree of rivalry in its consumption, like is the case with roads, hospitals or schools, an increase in population will inevitably generate certain crowding effects and hence

β to rise. Conversely, new entrants contribute with labor and capital, which can help build public services and infrastructure and hence increase economies of scale. Allowing β to change with L in equations (3.10) and (3.11) leads to the following required contribution for temporary migration:

$$p^* \geq p \cdot \left(1 + \frac{\beta - 1 + LnL \cdot \frac{\partial \beta}{\partial L/L}}{\alpha_P}\right) \tag{3.15}$$

Likewise, in the case of permanent residence, the membership fee would be:

$$p^* \geq p \cdot \left(\beta + LnL \cdot \frac{\partial \beta}{\partial L/L}\right) \tag{3.16}$$

In both cases a positive change in β means that the influx of immigrants increases crowding (reduces economies of scale) which has to be compensated by paying a higher fee, and vice-versa.

Immigration and crowding perception It is worth noting that by construction β has been defined as the degree of economies of scale in the economy. This assumes that individuals will recognize the degree of publicness in the economy and factor it into their utility functions as per equation (3.4). However, in real life individuals will not know the *actual* amount of economies of scale in the economy and inform their utility functions with their *perceived* one. Moreover, how the perceived economies of scale associated to population size inform the utility function may vary from individual to individual depending on their tolerance for crowding. The differences between the economic and perceived crowding can be very large. For example, when the number of immigrants is very small compared to the size of the native population, a small flow of immigrants will probably be unnoticed and the perceived change in crowding may underestimate the real one. However, when an influx of immigrants happens to be difficult to integrate, like happens often with asylum seekers, public perception may overestimate the change in crowding. Conversely, when too many immigrants enter the country in a short period of time and some congestion effects become readily apparent and crowding enters into the public debate, it may become difficult for the native population to disentangle the actual versus the perceived effects.

Measuring crowding on the other hand is a difficult task and when combined with immigration, it becomes a very politically-sensitive topic. A rare example of such an attempt can be found in a 2013 report by the Home Office in the UK based on a survey conducted amongst local authorities and service providers, which found that low-skilled immigrants were creating overcrowding, fueling community tensions and increasing waiting times at the national healthcare system. In the economic literature the closest research can be found in the study of agglomeration economies in the context of industries or cities.[a] The challenge of measuring crowding comes from its partially subjective nature and from the many diverse types of publicly provided goods that are source of economies of scale. Healthcare or education are for example much more prone to crowding than defense or law and order. Some types of publicly owned goods are commons (e.g., mineral reserves) and thus rival. Others are unevenly used, like public infrastructure, or not consumed at all, like natural reserves. The literature developed around the *contingent valuation method* provides an approach for valuing *passive use* of quasi-public goods in the area of environmental economics[b] that could be extended to valuing the whole bundle of publicly provided goods of a country and to derive an estimation of the parameter β. Besides the absence of surveys on crowding effects caused by immigration, the population has rarely the opportunity to directly express their conformity with the immigration policies and their

[a]See Gill and Goh (2010) for a survey.
[b]See Carson et al (1996) for a survey.

impact on the society. Switzerland's direct democracy however has provided such an opportunity in several occasions in the past. Between 1950 and 1973, the number of foreign citizens in the country rose from 6% to 17% as a result of a booming economy. This large influx of immigrants generated social tensions and growing intolerance for foreigners. Two newly created small right-wing parties[a] whose main objective were *"to defend the national identity"* tried to capitalize on the concerns of the population. The two parties had a small representation in the parliament but managed to organize four referendums about *"an excess of foreigners"* and *"overpopulation"*. The first referendum usually referred as the *"Schwarzenbach initiative"*[b] was held in 1970 and aimed at limiting the share of foreigners to 10% of the population, which de facto would have implied the expulsion of a considerable number of immigrants. The proposal obtained a much larger support than the electoral base of the two parties, summing up 46% of the vote with an unusually high turnover of 74%. Three more initiatives followed in the years 1974, 1977 and 1988 with a declining support (34%, 29% and 32%). In 2000 the Radical Party launched a new initiative to limit the number of foreigners to 18%[c] which captured 36% of the vote. From 2000 to 2014 the foreign born population rose dramatically again from 21.9% to 27.3%,[d] mostly fueled by the bilateral treaties with EU countries allowing for the free movement of people. It is within this context of renewed acceleration of immigration that in 2014[e] the Swiss Popular Party (SVP)[f] proposed a new initiative to impose limits to the number of foreigners and put an end to the free movement accord with the EU. The referendum was narrowly approved with 50.3% of the votes despite the lack of support from the major industry associations and the majority of the political parties, with the exception of the SVP. The economic case for immigration was telling, according to the OECD immigration generates a gain of CHF 6.5bn for the government annually[g], which is roughly equivalent to 1% of GDP. The economy has a competitive edge in some high value-added industries that need of highly specialized personnel.[h] Furthermore, according to the OECD[i] 69% of the arrivals between 2010 and 2012 were highly skilled and with unemployment at about 3%, on aggregate it could not

[a] National Action (now the Swiss Democrats) and the Republican Movement.
[b] Named after the head of the Republican Movement James Schwarzenbach (1911-1994).
[c] According to the OECD statistics foreign population in Switzerland was 21.9% in 2000.
[d] OECD (2013).
[e] The referendum took place in February 9, 2014.
[f] The SVP had been moving their political stance on immigration over the years, from initially rejecting the first initiatives to curb immigration, to being adamant of the anti-immigration movement. In fact, the SVP had amongst its members former members of the Republican Movement like Ulrich Schlüer, the former secretary of James Schwarzenbach.
[g] Jauer et. al (2014).
[h] As an example, according to the Science Industries Switzerland, about 45% of employees in its chemical, pharmaceutical and bio-tech industries are foreigners.
[i] OECD (2013).

be seriously argued about labor replacement effects. The anti-immigration campaign however was successful by focusing on the impact of a rapidly growing foreign population on housing, congestion in roads, crowded public transportation, as well as the impact on the social services. Similar to the Schwarzenbach initiative, turnover was very high 55.8%.[a] The result of the vote showed the misalignment between mainstream political parties and their electorate on immigration issues, which is confirmatory of the Freeman (1995) thesis that immigration is dominated by special interest as benefits are concentrated but cost are distributed.

One conclusion that can be taken from the Swiss case is that sudden acceleration of immigration, rather than the overall percentage of immigrant population, tend to be associated with an increased perception of crowding. The reason may lie in the mismatch between the immediate congestion effects and the retarded benefits of larger economies of scale brought by the new population.[b] This leads to the question of whether cases of *positive crowding* can be found. In fact, according to equation (3.16), an expected increase in economies of scale is the only reason why countries would embrace *mass (permanent) immigration*, as otherwise and all things being equal, the entry fee will always be positive for a new (undifferentiated) member. The condition that has to be satisfied for an *open doors* policy is that $p^* \leq 0$ or:

$$\frac{\partial \beta}{\partial L / L} \leq -\frac{\beta}{LnL} \tag{3.17}$$

The mass migration to the new found territories of the US, Canada and Australia can be considered as an example of a free access based on the benefits of scale. In all these new countries land extensions were huge and the benefits of populating the country compensated by far any dilution effects.[c] In the case of the US, immigration went completely unchecked until the establishment of the *Page Act* of 1875. The law was only aimed at prohibiting the entry to immigrants considered "undesirable".[d] The first law that can be considered designed to curtail immigration into the US was the *Emergency Quota Act* of 1921, which restricted the number of immigrants admitted from any country annually to 3% of the number of residents from that same country living in the United States as of the U.S. Census of 1910.[e] This percentage was further reduced to 2% by the *Immigration Act* of 1924. By then, the population in the US had

[a]One of the five highest participation rates ever according to Claude Longchamp, head of pollster gfs.bern.

[b]The inter-temporal dynamics are not captured by the club model, which assumes all benefits and costs are discounted at the point of entry into the country.

[c]Aditionally, public capital stock was lower that in the Old World.

[d]Mostly Asians coming to work as forced laborer and Asian women who would engage in prostitution. See http://library.uwb.edu/guides/usimmigration/1875_page_law.html for the fullt act.

[e]See full text at: http://library.uwb.edu/guides/usimmigration/1921_emergency_quota_law.html

increased from about 17 million in 1840 to 106 million in 1920, a six fold increase to which immigration had greatly contributed with net annual migration rates of up to 10% between 1880-1885.[a] The increase in population was accompanied by rapid urbanization moving from 15% in 1850 to more than 45% in 1910,[b] which is consistent with a positive contribution of immigration to scale economies. It is much more difficult to find an example of a country that welcomes mass permanent immigration in contemporary times, being probably the reasons the absence of new land discoveries and the large stock of public capital countries have already accumulated. The state of Israel however offers a prominent case. As a recently formed state that had fought several wars with its neighbors, in 1970 Israel amended the *"Law of Return"*– which gave the right to any Jew to settle in the country – extending citizenship rights to non-Jews[c] who could prove had a Jewish grandparent, as well as to their spouses. This facilitated the arrival amongst others of more than a million Jews from the former Soviet republics (compared with an existing population of about 5 million at the time when the big exodus induced by the Perestroika began). This no doubt created crowding, particularly in housing and public services, but also brought significant economies of scale, amongst others in one of the purest public good, defense. Israel military expenditure as a percentage to GDP in 1988 was one of the highest in the world, representing 15.57% of the country's economy, a figure that has gradually come down to 6.77% in 2011.[d] Of course in the case of Israel there were other benefits sought after by increasing the Jewish population besides financing defense spending, as the influx helped to maintain a high degree of social homogeneity, which was considered threatened by the higher fertility rates from the Arab population present in the country. This effect will be analyzed in detail in Chapter 7.

[a] See Ward (1987).
[b] See Ward (1987).
[c] According to Jewish tradition only those born from a Jewish mother were considered Jews.
[d] World Bank (2012).

3.5. Conclusions

This chapter has shown that economies of scale in the economy can help mitigate the dilution in public capital per capita. In the short term, scale economies can actually prevail over the dilution in *returns* from public capital and create a net gain for the native population. In the case of permanent membership, the dilution occurs in the *ownership* of public capital, and admitting new members will generally come at a cost, that will have to be compensated by bringing more public capital. An increase in new members can also generate crowding effects when economies of scale have been exhausted, or alternatively, can contribute to create further scale economies. The latter case can help explain why episodes can be found in history when mass permanent migration has been welcomed.

Lastly, this section has shown how the classic immigration models can be extended in order to cater for economies of scale, and how the results are comparable in terms of direction of the relationships between variables with those derived from the club model.

4. The trade-off between heterogeneity of skills and social homogeneity

Immigration policies often go beyond the pure financial requirements and filter out prospective new members by skills and cultural affinity. When doing so they seem to look for individuals who on the one hand are as similar as possible to the native society, but that on the other hand, can bring skills which are wanted, either because they are scarce or because of their complementarity with those possessed by the native workers. In this chapter the club model will be extended to capture this trade-off which, judging by observable policy developments, seems to be of a similar degree of importance as the trade off between scale economies and public capital dilution.

4.1. Economic benefits from social homogeneity

As explained in Chapter 1, a homogeneous society enjoys different economic benefits. First, shared customs, values, language and culture allow for a higher degree of societal coordination which redounds on higher productivity and economic output. Second, different individuals may have different views about the amount and type of goods that the state should provide. Some may prefer fewer goods of a high degree of publicness, like defense and law and order, whilst others may favor a larger government that also provides public healthcare or education.

4.1.1. Extension of the club model[1]

Following Alesina and Spolaore (1997), heterogeneity will be thought to influence the incumbent income in a negative way by reducing the agreement around the nature and extent of goods that the state should provide. This definition excludes other factors that may enter the

[1] The income change approach model can be extended in exactly the same way as the club approach.

production function, like the impact of heterogeneity on social capital and economic performance[2] or the potential productivity gains associated with heterogeneous populations,[3] which will be examined in the next section.

Assuming that the role played by heterogeneity is of a similar nature but different magnitude than that of crowding – as both impact how much utility is ultimately derived by the population from those goods that are publicly provided – the extension of the model is straightforward.

Defining an heterogeneity parameter $\psi \in [0, \infty]$, whereby $\psi = 0$ represents a totally homogeneous society,[4] the income of the representative individual in the club approach will be given by:

$$I(K, P, L) = \frac{F(K, P, L)}{L^{\beta+\psi}} = K^{\alpha_K} P^{\alpha_P} L^{1-\alpha_K-\alpha_P-\beta-\psi} \tag{4.1}$$

and all the previous results can be extrapolated by replacing β for $\beta + \psi$.

For example the entry fee for one-period and permanent membership will be given respectively by:

$$p^* \geq \left(1 + \frac{\beta + \psi - 1}{\alpha_P}\right) \cdot p \tag{4.2}$$

$$p^* \geq (\beta + \psi) \cdot p \tag{4.3}$$

In both formulas, a high homogeneity lowers the entry fee and vice-versa. The explanation is straightforward, a high homogeneity allows for higher economies of scale, and therefore reduce the dilution of a new entrant.

4.1.2. Changes in social homogeneity introduced by the new entrant

The model above is static and assumes heterogeneity remains constant. Accordingly, a country with a very homogeneous population would be less restrictive to new members than a very heterogeneous country. However, in practice when a new entrant joins a given society the

[2]See Putnam (1993) and Knack and Keefer (1997) for two antagonist views.

[3]See Alesina and La Ferrara (2003) for an empirical study of ethnic diversity and economic performance.

[4]There is in principle no upper bound for the parameter ψ, as one can easily imagine some very dire scenarios when new entrants can diminish dramatically the income of the incumbent population, though admittedly not in a peaceful way.

heterogeneity parameter will to a certain degree change. Assuming no changes in crowding, the entry fee for the one-period and permanent cases can be respectively expressed as follows:

$$p^* \geq \left(1 + \frac{\beta + \psi - 1 + LnL \cdot \frac{\partial\psi}{\frac{\partial L}{L}}}{\alpha_P}\right) \cdot p \tag{4.4}$$

$$p^* \geq \left(\beta + \psi + LnL \cdot \frac{\partial\psi}{\frac{\partial L}{L}}\right) \cdot p \tag{4.5}$$

hereby an increase in the heterogeneity parameter will increase the entry fee.

In the case of a highly homogeneous country, the change in homogeneity triggered by the admission of new members will eventually be larger than in the case of an heterogeneous country. The relative proportions of different types of members will be key in determining the *premium* (or discount) that the new entrant should pay over membership entry fee, as will be explained in Chapter 7.

The US National Origins Act: an example of the role of social homogeneity in immigration policies The most prominent case of social homogeneity playing a role in immigration policies can be seen in the US Immigration Act. In the recessionary and nationalistic environment following World War I, social attitudes towards immigration started to change in America. The 1921 Emergency Quota Act restricted immigration to 3% of foreign-born persons of each nationality that resided in the United States in 1910.

The Immigration Act of 1924, also called the National Origins Act, reduced the quota from 3% to 2% and changed the basis for the calculation to the census of 1890 instead of that of 1910. In a period of three years, total immigration from all countries was limited to 150,000, with allocations by country based upon the census of 1920. The 1924 Act also included the Asian Exclusion Act, which limited immigration to persons eligible for naturalization based on the Naturalization Act of 1790. As a result, East Asians, Arabs, and Indians were effectively banned from immigrating. Africans were also subjected to severe restrictions, whilst immigration from within the American continent was not restricted.

The Immigration and Nationality Act of 1952 retained the National Origins Formula with restrictions by national origin, but eliminated explicit racial restrictions. President Harry Truman vetoed it because of its continued use of national quotas, but the Act was passed over his veto. The quotas were in addition to 600,000 refugees admitted from Europe after World War II.

The National Origins Formula was abolished by the Immigration and Nationality Act of 1965. The new act repealed the national origin restrictions, increased the number of available visas, and made family ties to U.S. residents the key factor determining whether an applicant was admitted into the country, ending with more than 40 years of ethnicity considerations driving immigration policies. In his remarks by the symbolic signing of the Immigration Bill at the Liberty Island, President Lyndon B. Johnson's noted that *"the bill says simply that from this day forth those wishing to immigrate to America shall be admitted on the basis of their skills and their close relationship to those already here. This is a simple test, and it is a fair test. Those who can contribute most to this country – to its growth, to its strength, to its spirit – will be the first that are admitted to this land",*[a] emphasizing the potential benefits from heterogeneity of skills which will be introduced in to the model in the next section.
The US is not the only country that has placed ethnicity at the center of immigration policies. For example, Israel still today bases the right to reside in the country on a certain degree of Jewish ancestry as will be explained in detail in Chapter 7. Another interesting case is provided by Japan, the developed country with arguably the most restrictive immigration policies in the world.[b] Japan reviewed its immigration law in 1990 at the height of its economic performance, in order to allow the so-called *"Nikkeijin"* – Latin Americans, mostly Brazilians, of Japanese origin – to enter Japan legally even as unskilled workers, while the Japanese law, in principle, prohibits foreigners from taking unskilled jobs in the country.

[a]For the full text see http://www.lbjlib.utexas.edu/johnson/archives.hom/speeches.hom/651003.asp
[b]1.9% of immigrant stock according to 2013 UN Population Division.

4.2. Benefits from heterogeneity of skills

New members can bring skills which are beneficial for the native population. Advantages may include facilitating a reorganization of the labor force, for example in the case of low skills immigration allowing the native population to move to higher added value jobs, or in the case of high skills immigrants, bringing demanded know-how. From a modeling perspective, in this section benefits will be split between increases in productivity and gains from a larger stock of human capital.

4.2.1. Productivity gains

As described in the introduction, one of the most researched aspects of immigration concerns the potential exogenous productivity gains – beyond allocative efficiency gains. This section will show that incorporating productivity changes into the model helps financing the membership fee in the case of temporary migration, whilst proves to be irrelevant for permanent migration.

Exogenous productivity gains may arise from labor shortages and/or by adding individuals who possess certain demanded skills. In both cases, productivity gains may happen in combination with displacement effects, whereby once the new supply of labor takes care of certain jobs, the incumbent population can attain different jobs (supposedly of higher added-value). The model does not consider substitution effects where immigrants just replace host workers without altering total factor productivity.[5]

When incorporating total factor productivity A in the one-period model, the utility of a representative individual of the host population is:

$$I(K,P,L) = \frac{F(K,P,L)}{L^{\beta}} = AK^{\alpha_K}P^{\alpha_P}L^{1-\alpha_K-\alpha_P-\beta} \tag{4.6}$$

and the corresponding membership fee (assuming again $\frac{\partial K}{\partial L} = \frac{K}{L}$) would be equal to:

$$p^* \geq \left(1 + \frac{\beta - 1}{\alpha_P} - \frac{\frac{\partial A}{A}}{\frac{\partial L}{L}}\right) \cdot p \tag{4.7}$$

The model explains how productivity gains originated by an immigrant inflow help to finance the membership fee in the case of temporary migration. In the case of permanent residence however, the income of the representative individual is independent from total factor productivity A:[6]

$$I(K,P,L) = \frac{P}{\alpha_P L^{\beta}} \tag{4.8}$$

The intuition behind this result is similar to that of the permanent membership, a higher productivity leads to larger production hence augmenting the numerator in (4.1), but also causes the discount rate to increase thus eliminating the benefit. In both cases temporary migration brings short-term benefits that may compensate for dilution in the returns of public capital, whilst in the case permanent residence these benefits disappear due to their impact on the return of public capital.

[5]The model assumes the whole population L is engaged in production.

[6]A similar result is obtained when using labor productivity instead of total factor productivity.

In Chapter 5 however it will be shown how when using a more comprehensive model that accounts for allocative efficiency gains, the permanent membership fee is reduced when a new member generates labor productivity gains, whilst it is invariant to changes in total factor productivity.

Further, in Chapter 9 it will be shown that when the discount rate is determined by global markets, productivity gains for permanent membership are of the same magnitude as those experienced over one period.

4.2.2. Human capital contributions

The benefits of human capital for the incumbent population depend on whether human capital is considered to have positive externalities or if, on the contrary, its benefits accrue only to the new entrant. In this section the club model will be extended assuming that there are positive spillovers and hence a net gain of human capital for the representative individual. If the latter would not be the case, there will be still allocative efficiency gains similar to those analyzed in Berry and Soligo model in Chapter 2 and which will be reviewed in Sec. 4.3.

Assuming a Cobb-Douglas production function $F(H, P, L) = H^{\alpha_H} P^{\alpha_P} L^{1-\alpha_H-\alpha_P}$, where H and P represent the human and public capital stock respectively,[7] α_H and α_P their respective shares of production, and L the population of the country, the entry fee in the case of a one period stay would be:

$$\frac{\partial P}{\partial L} = \frac{\beta + \alpha_H + \alpha_P - 1}{\alpha_P} \cdot \frac{P}{L} - \frac{\alpha_H P}{\alpha_P H} \cdot \frac{\partial H}{\partial L} \tag{4.9}$$

If the new entrant is equally endowed as the native population ($\frac{\partial H}{\partial L} = \frac{H}{L} = h$), the membership fee p^* will be the same as in the one period model derived in Chapter 3:

$$p^* \geq \left(1 + \frac{\beta - 1}{\alpha_P}\right) \cdot p \tag{4.10}$$

However, if the new entrants possess more human capital than the natives and there are knowledge spillovers that accrue to the whole population ($\frac{\partial H}{\partial L} > h$), the entry fee would be reduced. Defining h^* as the excess of human capital per new entrant over the average human capital in the native population h, the entry fee is given by the following formula:

[7] For simplicity of the exhibition private capital is not included.

$$p^* \geq \left(1 + \frac{\beta - 1}{\alpha_P}\right) \cdot p - \frac{\alpha_H P}{\alpha_P H} \cdot h^* \tag{4.11}$$

If a new entrant does not create human capital spill-overs the previous formula has the same limitation as when assuming the private capital endowments from new entrant are different from those of the natives$\left(\frac{\partial K}{\partial L} \neq k\right)$, as the way that income is defined in the optimization problem $\left(I(K,P,L) = \frac{F(K,P,L)}{L^\beta}\right)$ assumes that the economic output is shared equally amongst all members, which would not be the case if some are more capital endowed than the others, unless there is a redistribution of capital.

For the case of permanent residence and similar to what happens with productivity increases, the income of the representative individual is independent from the stock of human capital H and as a consequence new entrants cannot finance its permanent entry by bringing new human capital. The intuition for the result is that the rise in production caused by a larger human capital are neutralized by a higher discounting rate as a consequence of the increase in human capital.

Managing immigration supply: the Points Based Systems and High-Skills visa programs

According to the OECD Migration Report[a] the establishment of *points based systems* (PBS) is one of the most important trends in international migration policies. Following the pioneering experience of Australia (1994), Canada (2001) and the United Kingdom (2003), some OECD countries including New Zealand (2007), Denmark (2008), The Netherlands (2009) and Austria (2011) and the United States (2013), have also adopted PBS for selecting permanent labor migrants. Moreover, the OECD report recognizes that not only are PBS becoming more *widespread*, but also more *selective*, in particular regarding supply-driven migration.

The specific criteria of the points-based programs of the countries surveyed vary but usually include factors such as the applicant's age, educational background, language abilities, experience, employment arrangements, and general adaptability, among others. All of the countries surveyed appear to emphasize labor market needs in their current selection processes.

Often these programs are complemented, or replaced with visa programs for highly skilled professionals like the *H1-B* program in the US and the *Skilled Migrant Programme* in the UK. In the past years a number of countries have followed, and similar programs are now in place in the Czech Republic, Germany, Lithuania, Hong Kong, Singapore, Russia and China.

The pursuit in all cases is to either ensure the skills of the prospective immigrant match with the needs required by the host economy, or to have a net gain of human capital, thus compensating for dilutions in public capital.

The trend towards a proactive management of immigration policies can not only be seen in the accelerating number of countries which are setting up schemes to attract skilled immigrants, but also that those which have had these in place for many years are regularly fine-tuning them to maximize their value for the country. Australia, Canada and the UK are good examples of the latter with revisions in 2012, 2008 and 2011 respectively.[b]

[a]OECD (2011).
[b]For a descriptive summary see:
http://www.loc.gov/law/help/points-based-immigration/index.php

4.3. Equivalence with classical models (II)

Similar as in Chapter 3, this section will extend Usher's model of immigration demand to complement the results of the club model. The latter has the advantage of incorporating heterogeneity of tastes and skills into the equilibrium price, whilst the former incorporates allocative efficiency gains, in this case between labor and human capital. Another difference between the models is the treatment of permanent entry, as the club model incorporates second-order effects on the discounting rate that eliminate gains from productivity or human capital.

4.3.1. Heterogeneity

Heterogeneity can be incorporated into Usher's model in an identical way as was done before with economies of scale in Sec. 3.3.

Defining an heterogeneity parameter $\psi \in [0, \infty]$ as in Sec. 4.1.1, the change in public capital per capita δ_P is given by:

$$\delta_P = p_1 - p_0 = \left(\frac{P_0}{L_0 + (\beta + \psi) \bigtriangleup L} - \frac{P_0}{L_0} \right) \tag{4.12}$$

and the amount of private capital per immigrant to compensate for the loss of income would be:

$$p^* \approx (\beta + \psi)\, p \tag{4.13}$$

Which is equivalent to equation (4.3).

4.3.2. Productivity

The change in income when incorporating total factor productivity is given by (see Appendix sec. A.6):

$$I_1 - I_0 = A_1 f(k_1) - A_0 f(k_0) - A_1 f'(k_1)\,(k_1 - k_0) - A_1 f'(k_1)\delta_p \tag{4.14}$$

Where A_0 and A_1 are the pre and post immigration total productivity. Applying the Taylor approximation the income change can be approximated by:

$$I_1 - I_0 \approx (A_1 - A_0)\, f(k_0) - A_1 f'(k_0)\delta_p - A_1 f''(k_0)\,(k_1 - k_0) \left[\delta_p + \frac{1}{2}\,(k_1 - k_0) \right] \tag{4.15}$$

For values of post-immigration capital per capita in the vicinity of the pre-immigration ones (i.e., whenever redistribution effects predominate), the income change will be approximately equal to:

$$I_1 - I_0 \approx (A_1 - A_0)\, f(k_0) - A_1 f'(k_0)\delta_p \tag{4.16}$$

And the capitalized income change by:

$$\frac{I_1 - I_0}{A_0 f'(k_0)} \approx \frac{A_1 - A_0}{A_0} \cdot \frac{f(k_0)}{f'(k_0)} - \frac{A_1}{A_0}\delta_p \tag{4.17}$$

Hence, if productivity rises as a consequence of the migratory influx ($A_1 > A_0$), the dilution effects can be compensated by an increase in productivity. It is worth noting that contrary to the club model, the discounted income does not include any increase in the interest rates by increases in productivity and public capital brought by the new entrant. However, this crucially depends on the discount rate that is used in the approximation.[8] If the post influx return on capital were used as a discount rate, the membership fee would be invariant to total factor productivity A.

4.3.3. Human capital

Simplifying by using a production function with human capital and public capital only ($f = f(h, p)$), and assuming the post immigration human capital per capita for the representative individual is $\bar{h}$:

$$I_0 = f(h_0, p_0) - h_0 f_h(h_0, p_0) - p_0 f_p(h_0, p_0) + h_0 f_h(h_0, p_0) + p_0 f_p(h_0, p_0) = f(h_0, p_0) \tag{4.18}$$

$$I_1 = f(h_1, p_1) - h_1 f_h(h_1, p_1) - p_1 f_p(h_1, p_1) + \bar{h} f_h(h_1, p_1) + p_1 f_p(h_1, p_1) \tag{4.19}$$

$$I_1 - I_0 \approx f_h\,(h_1 - h_0) + f_p\,(p_1 - p_0) + \frac{1}{2} f_{pp}\,(p_1 - p_0)^2\, 1+ \tag{4.20}$$

$$+ f_{hh}\,(h_1 - h_0)\left[\frac{h_1 - h_0}{2} - h_1 + \bar{h}\right] + f_{hp}\,(p_1 - p_0)\left(\bar{h} - h_0\right) \tag{4.21}$$

[8] Contrary to the club model Usher's derives the change in income by approximation instead of by optimization

If $\bar{h} = h_0$ (i.e., no knowledge spill-overs in the incumbent population), the change in income will be:

$$I_1 - I_0 \approx f_p (p_1 - p_0) + \frac{1}{2} f_{pp} (p_1 - p_0)^2 - \frac{1}{2} f_{hh} (h_1 - h_0)^2 \tag{4.22}$$

which implies that allocative efficiency gains from different levels of human capital between the natives and the newcomers help finance the entry, similar as does private capital in Berry and Soligo's model.

If $\bar{h} = h_1$ (i.e., the representative individual has a knowledge gain), the resulting change in income is:

$$I_1 - I_0 \approx f_h (h_1 - h_0) + f_p (p_1 - p_0) + \tag{4.23}$$
$$+ \frac{1}{2} \left[f_{hh} (h_1 - h_0)^2 + f_{pp} (p_1 - p_0)^2 + 2 f_{hp} (p_1 - p_0)(h_1 - h_0) \right] \tag{4.24}$$

In both cases human capital can help to finance country membership, though in the case when there are spillovers the impact is of a larger order of magnitude.

4.4. Conclusions

This chapter has shown that heterogeneity of preferences, values and culture can cause a reduction in economies of scale and consequently lead to an increase in the membership price requested to new entrants. However, new members can also have skills which are beneficial for the native population, either because they are scarce or complementary, and as a result reduce the value of the membership fee. The model predicts the benefits associated to productivity increases to be restricted only to the short term membership, whilst for permanent membership only human capital gains and heterogeneity costs are relevant.

Further, the role that social heterogeneity and skills diversity play in immigration policies has been illustrated by the case studies offered by the National Origins Act and the Point-Based Systems and High-skills visa programs respectively.

Lastly, the chapter has shown how the classic immigration models can be extended in order to cater for heterogeneity of tastes and skills, and how the implications are comparable in terms of direction of the relationships between variables with those derived from the club model for temporary membership.

This chapter has assumed a homogeneous native population, hence not discussing potential homogeneity costs and heterogeneity gains that may arise when the native population is heterogeneous. These will be discussed in detail in Chapter 7, Sec. 7.2.

5. Allocative efficiency: a comprehensive model of immigration demand

The central argument of this dissertation is the pivotal role that the stock of public capital plays in determining the economic benefits and costs of extending country membership to new members. To keep the model as parsimonious as possible, the definition of the income per capita of a representative individual of the incumbent population in Chapter 3 has not differentiated between different sources of income (i.e. wages and return on capital):

$$I(K,P,L) = \frac{F(K,P,L)}{L^{\beta}} \tag{5.1}$$

This model has proved very useful to analyze the role played by the trade-off between the ownership dilution of public capital and the economies of scale associated to large populations, and how other factors like heterogeneity or human capital add to that basic trade-off.

However, by not differentiating between sources of income the model makes two underlying assumptions. The first is that positive spillovers cannot be circumscribed to public capital exclusively, but they need to be attributed to all production factors instead, which is actually a good feature of the model as it increases its generality. The second assumption is that in order to consider per capita income as a division of overall output, the new entrant needs to bring an amount of private capital equal to the existing per capita one ($\frac{\partial K}{\partial L} = \frac{K}{L} = k$). Otherwise, if the new entrant would bring more capital than the capital per capita of the incumbent population, it would have the effect of transferring the excess capital to the incumbent population and vice-versa. Hence, removing this constraint would render the model useful only for representing an egalitarian society but not an economy with private property rights.

The assumption of equal capital endowments is further limiting, because it prevents us to analyze the potential income gains/ losses the new entrant can bring due to allocative efficiency arising from different factor proportions in the incumbent and immigrant population, which can help to ameliorate dilution effects. As explained in Chapter 2, Usher (1977) proved that in the presence of significant public capital, the dilution effects tend to overshadow allocative efficiency gains. However, when the difference in capital endowments between the incumbent and the immigrant population are large,[1] they can be a factor able to counterbalance the dilution in capital per capita and hence reduce the membership fee.

The fact that only polar cases of wealth endowments can have an influence in the membership fee is not a reason to ignore them. Actually, when looking at countries that have in place investment programs, it is more common to observe requirements on the minimum amount of private capital investments in the country rather than direct contributions to public capital in the form of a fee.

In this chapter the constraints on the private capital of the new member will be relaxed, allowing different factor proportions between native and immigrant populations by considering different sources of income associated to labor and capital. This not only will increase the generality of the model, but also allow to derive an econometric equation that can be used to test its explanatory power in the light of the observable investment programs.

In what follows, four different models will be advanced, depending on the time frame (one period vs. infinite periods) and whether complementarities between public and private capital are assumed. Lastly, a micro-founded model without public capital will be analyzed and proven to be equivalent to the heuristic method of Berry and Soligo.

5.1. Non-complementarity of private and public capital

5.1.1. One period membership

Assuming the economy is in equilibrium prior to the entry of new members, meaning that factors are continuously substitutable and prices are flexible so that factor markets are always cleared, and restricting economies of scale exclusively to public capital,[2] the income of the average individual can be described in the following way:

[1] Typically this is only the case when the newcomers are significantly wealthier, as private capital has a lower boundary at zero.

[2] As explained in Chapter 3, economies of scale are modeled as affecting the utility of the representative individual, which in its reduced scope consists of the different components of income (wages, return on private capital and return on public capital). The model does not make any assumption regarding economies of scale in the production function due to the presence of public capital. In fact, in what follows the analysis is not dependent on whether returns to scale are decreasing, constant or increasing.

$$I = w + r\overline{k} + r\frac{P}{L^{\beta}} \tag{5.2}$$

Where $\overline{k}$ is the average private capital per capita of the native population and P is the total stock of private capital. Assuming that private and public capital are effectively two components of the same factor of production K (i.e., there is non-complementarity between them), $\overline{k}$ can be expressed as follows:

$$\overline{k} = \frac{K - P}{L} = k - p \tag{5.3}$$

The minimum membership fee can be derived as a result of an optimization problem where the income equation needs to result invariant to changes in the number of members,[3] assuming the amount of private capital of the incumbent population $\overline{k}$ remains constant (i.e., the private capital of the incumbent population does not change with the addition of new members):

$$\frac{\partial I}{\partial L} = \frac{\partial w}{\partial L} + \frac{\partial r}{\partial L}\left(\overline{k} + \frac{P}{L^{\beta}}\right) + r\left(\frac{\frac{\partial P}{\partial L}L^{\beta} - \beta P L^{\beta-1}}{L^{2\beta}}\right) = 0$$

As w and r are functions of L and K, the change in wages and return on capital caused by a new entrant can be expressed as:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial w}{\partial L}$$
$$\frac{\partial r}{\partial L} = \frac{\partial r}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial r}{\partial L}$$

As the new entrant can now bring private capital in different proportions, the change in capital K for an increase in L can be expressed as:

$$\frac{\partial K}{\partial L} = p^{*} + k^{*}$$

[3] As explained in Chapter 3, it is worth noting that the optimization problem is not aimed at maximizing income, which would lead us to boundary solutions (e.g., infinite contributions of private capital), but at defining a break-even membership fee.

where p^* and k^* are the public and private capital brought by the new member.

The previous equations can be re-written as follows:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}(p^* + k^*) + \frac{\partial w}{\partial L}$$
$$\frac{\partial r}{\partial L} = \frac{\partial r}{\partial K}(p^* + k^*) + \frac{\partial r}{\partial L}$$

And the change in income for an increase in L turns:

$$\begin{aligned}\frac{\partial I}{\partial L} = p^* &\left[\frac{\partial w}{\partial K} + \frac{\partial r}{\partial K}\left(\overline{k} + \frac{P}{L^\beta}\right) + \frac{r}{L^\beta}\right] + \\ &+ k^* \left[\frac{\partial w}{\partial K} + \frac{\partial r}{\partial K}\left(\overline{k} + \frac{P}{L^\beta}\right)\right] + \\ &+ \frac{\partial w}{\partial L} + \frac{\partial r}{\partial L}\left(\overline{k} + \frac{P}{L^\beta}\right) - \beta\frac{rP}{L^{\beta+1}}\end{aligned}$$

Defining $s = \left(L^{1-\beta} - 1\right)$ as a parameter representing the economies of scale associated to public capital, we can rearrange:

$$\overline{k} + \frac{P}{L^\beta} = \frac{K}{L} - \frac{P}{L} + \frac{P}{L^\beta} = \frac{K}{L} + s\frac{P}{L} = k + sp$$

The membership fee in terms of public capital contribution can be then expressed as:

$$p^* = \frac{\beta\frac{rP}{L^{\beta+1}} - \frac{\partial w}{\partial L} - \frac{\partial r}{\partial L}(k+sp)}{\frac{\partial w}{\partial K} + \frac{\partial r}{\partial K}(k+sp) + \frac{r}{L^\beta}} - k^* \cdot \frac{\frac{\partial w}{\partial K} + \frac{\partial r}{\partial K}(k+sp)}{\frac{\partial w}{\partial K} + \frac{\partial r}{\partial K}(k+sp) + \frac{r}{L^\beta}} \tag{5.4}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.8 for the mathematical proof):

$$\frac{\partial w}{\partial K} = -\frac{\partial r}{\partial K} \cdot \frac{K}{L} = -\frac{\partial r}{\partial K} \cdot k$$
$$\frac{\partial w}{\partial L} = -\frac{\partial r}{\partial L} \cdot \frac{K}{L} = -\frac{\partial r}{\partial L} \cdot k$$

And the membership fee can be simplified as follows

$$p^* = \frac{\beta\frac{rP}{L^{\beta+1}} - s\frac{P}{L}\cdot\frac{\partial r}{\partial L}}{sp\cdot\frac{\partial r}{\partial K} + \frac{r}{L^\beta}} - k^*\cdot\frac{s\frac{P}{L}\cdot\frac{\partial r}{\partial K}}{sp\cdot\frac{\partial r}{\partial K} + \frac{r}{L^\beta}} \tag{5.5}$$

or alternatively:

$$p^* = p\left[\frac{\beta\frac{r}{L^\beta} - s\left(\frac{\partial r}{\partial L} - \frac{k^*}{k}\cdot\frac{\partial w}{\partial K}\right)}{sp\cdot\frac{\partial r}{\partial K} + \frac{r}{L^\beta}}\right] \tag{5.6}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.8):

$$\frac{\partial r}{\partial L} = \frac{\partial w}{\partial K} = -\frac{\partial r}{\partial K}\cdot k$$

And taking into account that $k = \overline{k} + p$, the membership fee would then be:

$$p^* = p\left[\frac{\beta\frac{r}{L^\beta} + s\frac{\partial r}{\partial K}\left(p + \overline{k} - k^*\right)}{sp\frac{\partial r}{\partial K} + \frac{r}{L^\beta}}\right] \tag{5.7}$$

Hence, if the new entrant is less endowed than the incumbent population ($k^* \leq p + \overline{k}$), the second term in the numerator will be negative helping to reduce the membership fee, and vice-versa.

The intuition for the result can be easily found by looking at the income equation (5.2). Assuming decreasing returns to scale, when the new entrant contributes with public capital p^* to offset capital dilution (ameliorated by economies of scale β associated to large populations),[4] it increases the overall amount of capital, and as a consequence reduces the return on capital r creating a further loss to the incumbent population, which ultimately needs to be compensated with a higher membership fee. A larger amount of capital increases the wage rate w, but a larger population increases the amount of labor L which decreases the return on capital r. If the

[4] The first term in the numerator accounts for these effects, as can be easily seen when economies of scale are small $\beta \approx 1$, $s \approx 0$, and the membership fee turns $p^* \approx \beta p$ with allocative efficiency having no influence as in the simplified model as well as Usher's income model.

production function is non-homogeneous, the effects on the membership fee will depend on their relative importance, without changing the generality of the result. Therefore, a Cobb-Douglas production function specification can be used to analyze the implications of the model.

Defining a Cobb-Douglas production function with no differentiation between public and private capital $F = K^{\alpha}L^{1-\alpha} = \left(\bar{K} + P\right)^{\alpha} L^{1-\alpha}$, the membership fee results (see Appendix sec. A.13 for a detailed calculation):

$$p^* = p\left[\frac{\beta L^{1-\beta} + s(1-\alpha)\left(\frac{k^*}{\bar{k}+p} - 1\right)}{L^{1-\beta} - s(1-\alpha)\frac{p}{k}}\right] \tag{5.8}$$

If economies of scale are small $\beta \approx 1$, $s \approx 0$, and the membership fee would be:

$$p^* \approx p \tag{5.9}$$

If economies of scale are large and the population L is large enough, $s \approx L^{1-\beta}$ and the membership fee would be:

$$p^* \approx p\left[\frac{\beta + (1-\alpha)\left(\frac{k^*}{\bar{k}+p} - 1\right)}{1 - (1-\alpha)\frac{P}{K}}\right] \tag{5.10}$$

The country can also decide not to request any membership fee ($p^* = 0$) but allow new entrants to compensate public capital dilution by bringing an amount of private capital that produces allocative efficiency gains. In this case the amount of private capital required would be below the capital per capita of the native population:

$$k^* \approx k\left[1 - \frac{\beta}{(1-\alpha)}\right] \tag{5.11}$$

5.1.2. Infinite periods

Assuming the economy is in equilibrium prior to the entry of new members, and restricting economies of scale exclusively to public capital, the capitalized income per capita of a representative individual can be expressed as follows:

$$I = \frac{w}{r} + \overline{k} + \frac{P}{L^{\beta}} \tag{5.12}$$

As in the previous section, the minimum membership fee can be derived from an optimization problem where the income equation is invariant to changes in the number of members, assuming the amount of private capital of the incumbent population $\overline{k}$ remains constant (i.e., the private capital of the incumbent population does not change with the addition of new members):

$$\frac{\partial I}{\partial L} = \frac{1}{r} \cdot \frac{\partial w}{\partial L} - \frac{w}{r^2} \cdot \frac{\partial r}{\partial L} + \frac{\frac{\partial P}{\partial L} L^{\beta} - \beta P L^{\beta-1}}{L^{2\beta}} = 0$$

As w and r are functions of L and K:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial w}{\partial L}$$
$$\frac{\partial r}{\partial L} = \frac{\partial r}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial r}{\partial L}$$

And as the new entrant can now bring private capital in different proportions, the change in capital K for an increase in L can be expressed as:

$$\frac{\partial K}{\partial L} = p^* + k^*$$

where p^* and k^* are the public and private capital brought by the new member.

The previous equations can be re-written as follows:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}\left(p^* + k^*\right) + \frac{\partial w}{\partial L}$$
$$\frac{\partial r}{\partial L} = \frac{\partial r}{\partial K}\left(p^* + k^*\right) + \frac{\partial r}{\partial L}$$

And the change in income for an increase in L turns:

$$\begin{aligned}\frac{\partial I}{\partial L} = p^* &\left[\frac{1}{r}\cdot\frac{\partial w}{\partial K} - \frac{w}{r^2}\cdot\frac{\partial r}{\partial K} + \frac{1}{L^\beta}\right] + \\ &+ k^*\left[\frac{1}{r}\cdot\frac{\partial w}{\partial K} - \frac{w}{r^2}\cdot\frac{\partial r}{\partial K}\right] + \\ &+ \frac{1}{r}\cdot\frac{\partial w}{\partial L} - \frac{w}{r^2}\cdot\frac{\partial r}{\partial L} - \beta\frac{P}{L^{\beta+1}}\end{aligned}$$

The membership fee in terms of public capital contribution can be expressed as:

$$p^* = \frac{w\cdot\frac{\partial r}{\partial L} + \beta r^2\frac{P}{L^{\beta+1}} - r\cdot\frac{\partial w}{\partial L}}{r\frac{\partial w}{\partial K} - w\frac{\partial r}{\partial K} + \frac{r^2}{L^\beta}} - k^*\cdot\frac{r\cdot\frac{\partial w}{\partial K} - w\frac{\partial r}{\partial K}}{r\frac{\partial w}{\partial K} - w\frac{\partial r}{\partial K} + \frac{r^2}{L^\beta}} \tag{5.13}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.8 for the mathematical proof):

$$\frac{\partial w}{\partial K} = -\frac{\partial r}{\partial K}\cdot\frac{K}{L} = -\frac{\partial r}{\partial K}\cdot k$$
$$\frac{\partial w}{\partial L} = -\frac{\partial r}{\partial L}\cdot\frac{K}{L} = -\frac{\partial r}{\partial L}\cdot k$$

And the membership fee can be simplified as follows

$$p^* = \frac{\frac{\partial r}{\partial L}\left(w + r\cdot\frac{K}{L}\right) + \beta r^2\frac{P}{L^{\beta+1}}}{\frac{r^2}{L^\beta} - \frac{\partial r}{\partial K}\left(r\cdot\frac{K}{L} + w\right)} + k^*\cdot\frac{\frac{\partial r}{\partial K}\left(r\cdot\frac{K}{L} + w\right)}{\frac{r^2}{L^\beta} - \frac{\partial r}{\partial K}\left(r\cdot\frac{K}{L} + w\right)} \tag{5.14}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.8):

$$\frac{\partial r}{\partial L} = \frac{\partial w}{\partial K} = -\frac{\partial r}{\partial K} \cdot k$$

The membership fee can be then expressed as:

$$p^* = \frac{\beta r^2 \frac{P}{L^{\beta+1}} + \frac{\partial r}{\partial K}\left(r \cdot \frac{K}{L} + w\right)(k^* - k)}{\frac{r^2}{L^\beta} - \frac{\partial r}{\partial K}\left(r \cdot \frac{K}{L} + w\right)} \tag{5.15}$$

Assuming decreasing returns to scale, the second term of the numerator will be always negative as $\frac{\partial r}{\partial K} \leq 0$. Therefore, the membership fee will be reduced the larger the amount of private capital k^* brought by the new member. The intuition for this finding can be easily obtained by looking at equation (5.12); a larger contribution of private capital will decrease the return on capital r and as a result increase w/r. In this case we can observe that by capitalizing income, the impact of a larger contribution of private capital is the opposite than in the one-period.

Defining a Cobb-Douglas production function with no differentiation between public and private capital $F = K^\alpha L^{1-\alpha} = \left(\bar{K} + P\right)^\alpha L^{1-\alpha}$, the membership fee results (see Appendix sec. A.18 for a detailed calculation):

$$p^* = \frac{\beta \alpha p L^{1-\beta} + (1-\alpha)(k - k^*)}{\alpha L^{1-\beta} + (1-\alpha)} \tag{5.16}$$

If economies of scale are small $\beta \approx 1$, and the membership fee would be:

$$p^* \approx \alpha p + (1-\alpha)(k - k^*) = p + (1-\alpha)\left(\overline{k} - k^*\right) \tag{5.17}$$

If on the contrary economies of scale are large and the population L is large enough, the membership fee would be:

$$p^* \approx p\left[\beta + \frac{(1-\alpha)}{\alpha L^{1-\beta}}\right] + \frac{(1-\alpha)}{\alpha L^{1-\beta}}\left(\overline{k} - k^*\right) \approx \beta p + \frac{(1-\alpha)}{\alpha L^{1-\beta}}\left(\overline{k} - k^*\right) \tag{5.18}$$

Only when $\overline{k} - k^*$ is of the same order of magnitude as $L^{1-\beta}$ will the contribution of private capital have an impact on the membership fee. This result is similar to Usher's findings concerning the second order importance of allocative efficiency gains, though in this case it is mediated by the factor $L^{1-\beta}$.

If the country does not request a membership fee ($p^* = 0$), the required amount of private capital that the new member should bring would be:

$$k^* \approx \overline{k} + p\left(\frac{\alpha\beta L^{1-\beta}}{(1-\alpha)}\right) \tag{5.19}$$

One implication of this finding is that the larger the population of a country, the larger the amount of private capital in excess of the existing capital per capita that would be required.

Understanding the impact of the degree of economies of scale β in the economy is less straightforward. It can be easily proved that the function $f(\beta) = \beta L^{1-\beta}$ has its maximum at $\beta = \frac{1}{LnL}$. This implies that for large enough populations, the lower the degree of economies of scale in the economy the larger the private capital contributions, as the following chart illustrates for a population of $L = 1,000,000$:

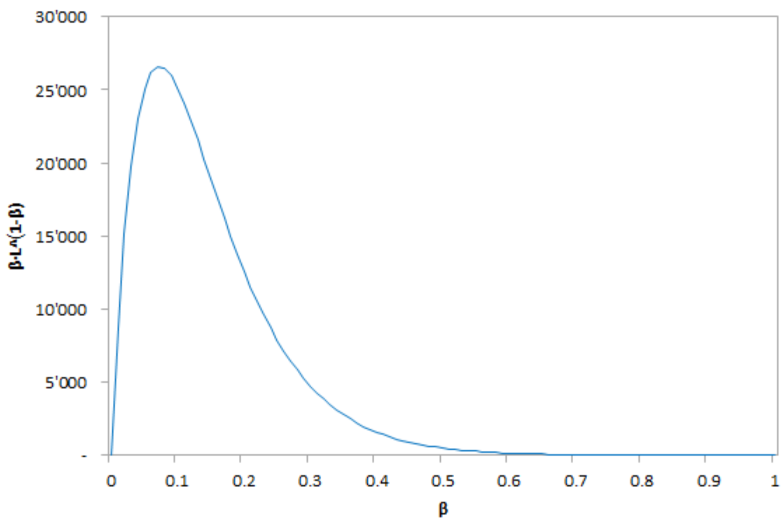

Figure 5.1.: Impact of economies of scale on private capital requirements

Plotting equation (5.18) for different values of β helps to understand the dual role played by economies of scale: large economies of scale would reduce the contribution of public capital required, whilst on the other hand would increase that of private capital, and vice-versa:

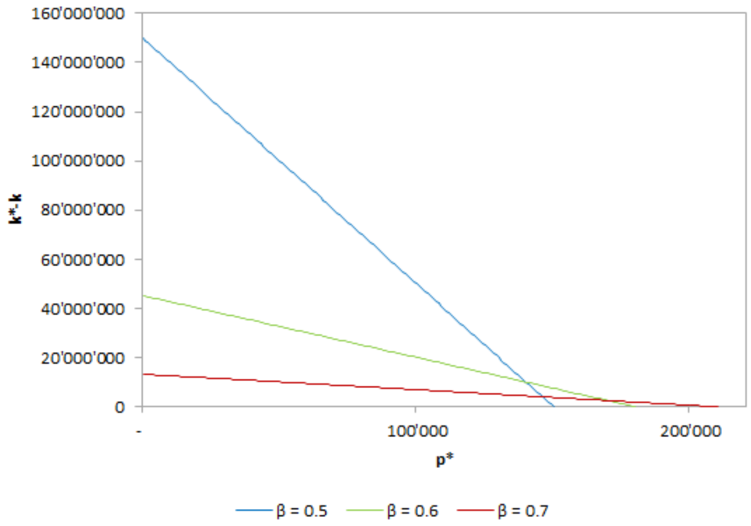

Figure 5.2.: Impact of economies of scale on private/ public capital requirements

5.2. Complementarity of private and public capital

5.2.1. One period membership

Assuming the economy is in equilibrium prior to the entry of new members, different returns on private and public capital and non-complementarity between them, and restricting economies of scale exclusively to public capital, the income of an existing member can be described as:

$$I = w + r_K \overline{k} + r_P \frac{P}{L^\beta} \tag{5.20}$$

Where $\overline{k} = \frac{K}{L}$ is the private capital per capita of the existing population.

As in the previous sections, the minimum membership fee can be derived from an optimization problem where the income equation is invariant to changes in the number of members, assuming the amount of private capital of the incumbent population $\overline{k}$ remains constant (i.e., the private capital of the incumbent population does not change with the addition of new members):

$$\frac{\partial I}{\partial L} = \frac{\partial w}{\partial L} + \frac{\partial r_K}{\partial L}\overline{k} + \frac{\partial r_P}{\partial L}\frac{P}{L^\beta} + r_P\left(\frac{\frac{\partial P}{\partial L}L^\beta - \beta P L^{\beta-1}}{L^{2\beta}}\right) = 0$$

As w, r_K, and r_P are functions of L, K and P:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial w}{\partial P}\frac{\partial P}{\partial L} + \frac{\partial w}{\partial L}$$
$$\frac{\partial r_K}{\partial L} = \frac{\partial r_K}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial r_K}{\partial P}\frac{\partial P}{\partial L} + \frac{\partial r_K}{\partial L}$$
$$\frac{\partial r_P}{\partial L} = \frac{\partial r_P}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial r_P}{\partial P}\frac{\partial P}{\partial L} + \frac{\partial r_P}{\partial L}$$

As private and public capital are assumed to be different complementary factors, the change in capital K and P for an increase in L can be expressed as:

$$\frac{\partial K}{\partial L} = k^*$$
$$\frac{\partial P}{\partial L} = p^*$$

where p^* and k^* are the public and private capital brought by the new member.

The previous equations can be re-written as follows:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}k^* + \frac{\partial w}{\partial P}p^* + \frac{\partial w}{\partial L}$$
$$\frac{\partial r_K}{\partial L} = \frac{\partial r_K}{\partial K}k^* + \frac{\partial r_K}{\partial P}p^* + \frac{\partial r_K}{\partial L}$$
$$\frac{\partial r_P}{\partial L} = \frac{\partial r_P}{\partial K}k^* + \frac{\partial r_P}{\partial P}p^* + \frac{\partial r_P}{\partial L}$$

And the change in income for an increase in L turns:

$$\begin{aligned}
\frac{\partial I}{\partial L} &= \frac{\partial w}{\partial K}k^* + \frac{\partial w}{\partial P}p^* + \frac{\partial w}{\partial L} + \overline{k}\left(\frac{\partial r_K}{\partial K}k^* + \frac{\partial r_K}{\partial P}p^* + \frac{\partial r_K}{\partial L}\right) + \\
&+ \left(\frac{\partial r_P}{\partial K}k^* + \frac{\partial r_P}{\partial P}p^* + \frac{\partial r_P}{\partial L}\right)\frac{P}{L^\beta} + r_P\left(\frac{p^*L - \beta P}{L^{\beta+1}}\right) = \\
&= p^*\left(\frac{\partial w}{\partial P} + \frac{\partial r_K}{\partial P}\overline{k} + \frac{\partial r_P}{\partial P}\cdot\frac{P}{L^\beta} + \frac{r_P}{L^\beta}\right) + \\
&+ k^*\left(\frac{\partial w}{\partial K} + \frac{\partial r_K}{\partial K}\overline{k} + \frac{\partial r_P}{\partial K}\cdot\frac{P}{L^\beta}\right) + \\
&+ \frac{\partial w}{\partial L} + \frac{\partial r_K}{\partial L}\overline{k} + \frac{\partial r_P}{\partial L}\cdot\frac{P}{L^\beta} - \frac{\beta r_P P}{L^{\beta+1}}
\end{aligned}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.9 for the mathematical proof):

$$\frac{\partial w}{\partial K} = -\frac{\partial r_K}{\partial K}\cdot\frac{K}{L} - \frac{\partial r_P}{\partial K}\cdot\frac{P}{L}$$
$$\frac{\partial w}{\partial P} = -\frac{\partial r_K}{\partial P}\cdot\frac{K}{L} - \frac{\partial r_P}{\partial P}\cdot\frac{P}{L}$$
$$\frac{\partial w}{\partial L} = -\frac{\partial r_K}{\partial L}\cdot\frac{K}{L} - \frac{\partial r_P}{\partial L}\cdot\frac{P}{L}$$

Defining the economies of scale associated to public capital as $s = L^{1-\beta} - 1$, we can rearrange:

$$\frac{\partial I}{\partial L} = p^*\left(\frac{\partial r_P}{\partial P}s\cdot\frac{P}{L} + \frac{r_P}{L^\beta}\right) + k^*\left(\frac{\partial r_P}{\partial K}\cdot s\cdot\frac{P}{L}\right) + \frac{\partial r_P}{\partial L}\cdot s\frac{P}{L} - \frac{\beta r_P P}{L^{\beta+1}}$$

And the membership fee results:

$$p^* = p \left[\frac{\frac{\beta r_P}{L^\beta} - s\left(\frac{\partial r_P}{\partial L} + k^* \frac{\partial r_P}{\partial K}\right)}{sp \cdot \frac{\partial r_P}{\partial P} + \frac{r_P}{L^\beta}} \right]$$

When using a Cobb-Douglas production function with complementarity between public and private capital $F = K^{\alpha_K} P^{\alpha_P} L^{\alpha_L}$, the membership fee results (see Appendix sec. A.15 for a detailed calculation):

$$p^* = p \left[\frac{\beta L^{1-\beta} - s\left(\alpha_L + \frac{k^*}{\overline{k}} \alpha_K\right)}{s\left(\alpha_P - 1\right) + L^{1-\beta}} \right]$$

If economies of scale are small $\beta \approx 1$, $s \approx 0$, and the membership fee would be:

$$p^* \approx p \tag{5.21}$$

If economies of scale are large and the population L large enough, $s \approx L^{1-\beta}$ and the membership fee would be:

$$p^* \approx p \left[\frac{\beta - \alpha_L - \frac{k^*}{\overline{k}} \alpha_K}{\alpha_P} \right] \tag{5.22}$$

which as expected is decreasing with the amount of private capital k^* brought by the new member due to the complementarities of public and private capital.

If the country does not request a membership fee ($p^* = 0$), the required amount of private capital that the new member should bring would be:

$$k^* \approx \overline{k} \cdot \frac{\beta - \alpha_L}{\alpha_K} \tag{5.23}$$

5.2.2. Infinite periods

Assuming the economy is in equilibrium prior to the entry of new members, and restricting economies of scale exclusively to public capital, the capitalized income change, assuming that returns on wages and private capital are discounted at the private capital return rate r_K, and that returns on public capital are discounted at the public capital return rate r_P, can accordingly be expressed as follows:

$$I = \frac{w}{r_K} + \overline{k} + \frac{P}{L^{\beta}} \tag{5.24}$$

As in the previous sections, the minimum membership fee can be derived from an optimization problem where the income equation is invariant to changes in the number of members, assuming the amount of private capital of the incumbent population $\overline{k}$ remains constant (i.e., the private capital of the incumbent population does not change with the addition of new members):

$$\frac{\partial I}{\partial L} = \frac{1}{r_K}.\frac{\partial w}{\partial L} - \frac{w}{r_K^2} \cdot \frac{\partial r_K}{\partial L} + \frac{\frac{\partial P}{\partial L} L^{\beta} - \beta P L^{\beta-1}}{L^{2\beta}} = 0$$

As w and r_K are functions of L, K and P:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial w}{\partial P}\frac{\partial P}{\partial L} + \frac{\partial w}{\partial L}$$
$$\frac{\partial r_K}{\partial L} = \frac{\partial r_K}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial r_K}{\partial P}\frac{\partial P}{\partial L} + \frac{\partial r_K}{\partial L}$$

As private and public capital are assumed to be different complementary factors, the change in capital K and P for an increase in L can be expressed as:

$$\frac{\partial K}{\partial L} = k^*$$
$$\frac{\partial P}{\partial L} = p^*$$

where p^* and k^* are the public and private capital brought by the new member.

The previous equations can be re-written as follows:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}k^* + \frac{\partial w}{\partial P}p^* + \frac{\partial w}{\partial L}$$
$$\frac{\partial r_K}{\partial L} = \frac{\partial r_K}{\partial K}k^* + \frac{\partial r_K}{\partial P}p^* + \frac{\partial r_K}{\partial L}$$

And the change in income for an increase in L turns:

$$\frac{\partial I}{\partial L} = \frac{1}{r_K}\cdot\left[\frac{\partial w}{\partial K}k^* + \frac{\partial w}{\partial P}p^* + \frac{\partial w}{\partial L}\right] - \frac{w}{r_K^2}\cdot\left[\frac{\partial r_K}{\partial K}k^* + \frac{\partial r_K}{\partial P}p^* + \frac{\partial r_K}{\partial L}\right] + \left(\frac{p^*L - \beta P}{L^{\beta+1}}\right) =$$
$$= p^*\left[\frac{1}{r_K}.\frac{\partial w}{\partial P} - \frac{w}{r_K^2}\cdot\frac{\partial r_K}{\partial P} + \frac{1}{L^\beta}\right] + k^*\left[\frac{1}{r_K}.\frac{\partial w}{\partial K} - \frac{w}{r_K^2}\cdot\frac{\partial r_K}{\partial K}\right] +$$
$$+ \frac{1}{r_K}.\frac{\partial w}{\partial L} - \frac{w}{r_K^2}\cdot\frac{\partial r_K}{\partial L} - \beta\frac{P}{L^{\beta+1}}$$

The membership fee in terms of public capital contribution can be expressed as:

$$p^* = \frac{w\cdot\frac{\partial r_K}{\partial L} + \beta r_K^2\frac{P}{L^{\beta+1}} - r_K\cdot\frac{\partial w}{\partial L}}{r_K\cdot\frac{\partial w}{\partial P} - w\cdot\frac{\partial r_K}{\partial P} + \frac{r_K^2}{L^\beta}} - k^*\cdot\frac{r_K\cdot\frac{\partial w}{\partial K} - w\cdot\frac{\partial r_K}{\partial K}}{r_K\cdot\frac{\partial w}{\partial P} - w\cdot\frac{\partial r_K}{\partial P} + \frac{r_K^2}{L^\beta}} \tag{5.25}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.8 for the mathematical proof):

$$\frac{\partial w}{\partial K} = -\frac{\partial r_K}{\partial K}\cdot\frac{K}{L} - \frac{\partial r_P}{\partial K}\cdot\frac{P}{L}$$
$$\frac{\partial w}{\partial P} = -\frac{\partial r_K}{\partial P}\cdot\frac{K}{L} - \frac{\partial r_P}{\partial P}\cdot\frac{P}{L}$$
$$\frac{\partial w}{\partial L} = -\frac{\partial r_K}{\partial L}\cdot\frac{K}{L} - \frac{\partial r_P}{\partial L}\cdot\frac{P}{L}$$

And the membership fee can be simplified as follows

$$p^* = \frac{\frac{\partial r_K}{\partial L}\left(w + r_K \cdot \frac{K}{L}\right) + r_K \frac{\partial r_P}{\partial L} \cdot \frac{P}{L} + \beta r_K^2 \frac{P}{L^{\beta+1}}}{\frac{r_K^2}{L^\beta} - \frac{\partial r_K}{\partial P}\left(w + r_K \cdot \frac{K}{L}\right) - r_K \cdot \frac{\partial r_P}{\partial P} \cdot \frac{P}{L}} + \tag{5.26}$$

$$+ k^* \cdot \frac{\frac{\partial r_K}{\partial K}\left(w + r_K \cdot \frac{K}{L}\right) + r_K \cdot \frac{\partial r_P}{\partial K} \cdot \frac{P}{L}}{\frac{r_K^2}{L^\beta} - \frac{\partial r_K}{\partial P}\left(w + r_K \cdot \frac{K}{L}\right) - r_K \cdot \frac{\partial r_P}{\partial P} \cdot \frac{P}{L}} \tag{5.27}$$

When using a Cobb-Douglas production function with complementarity between public and private capital $F = K^{\alpha_K} P^{\alpha_P} L^{\alpha_L}$, the membership fee results (see Appendix sec. A.19 for a detailed calculation):

$$p^* = \beta p + \frac{\alpha_K \alpha_L \overline{k} + \alpha_K k^* \left[\alpha_K + \alpha_P - 1\right]}{\alpha_K^2 L^{1-\beta}} \tag{5.28}$$

If we assume constant return to scale in the production function: $\alpha_K + \alpha_P + \alpha_L = 1$, the membership fee can be expressed as:

$$p^* = \beta p + \frac{\alpha_L}{\alpha_K L^{1-\beta}} \left(\overline{k} - k^*\right) \tag{5.29}$$

The membership fee is thus identical to that of the case of non-complementarity between public and private capital, though the size of the coefficient α_K is expected to be different. In the non-complementarity case, α_K relates to the share of output of total capital, whilst in the complementarity one refers to the share of private capital only.

If economies of scale are small $\beta \approx 1$, and the membership fee would be:

$$p^* \approx p + \frac{\alpha_L}{\alpha_K} \left(\overline{k} - k^*\right) \tag{5.30}$$

The intuition of the result is clear, if the new entrant brings an amount of private capita larger that the existing private capital per capita, it causes a reduction in r_K which increases the income in (5.24), which helps to finance the membership fee.

If the country does not request a membership fee ($p^* = 0$), the required amount of private capital would be:

$$k^* \approx \overline{k} + p\left(\frac{\alpha_K \beta L^{1-\beta}}{\alpha_L}\right) \tag{5.31}$$

This equation is similar to that derived when there are non-complementarities between public and private capital as in both cases the numerator and denominator of the quotient in the second term has the output shares of labor and private capital respectively. The only difference will be the magnitude of the output share of capital. Assuming there are no increasing returns to scale, the value of the output share of private capital will be smaller when there are complementarities of private and public capital, and as a consequence the impact of private capital contributions will be larger than in the case when there are no complementarities. Hence, the same interpretation concerning the role played by the economies of scale and population size can be made.

5.3. Equivalence with classical models (III)

5.3.1. One period membership: Berry and Soligo

The results presented in the previous sections are broadly aligned with those of the previous chapters in what concerns to the importance of the amount of public capital and economies of scale. However, the role played by private capital is different than expected when comparing to Berry and Soligo's findings, as a difference in private capital endowments between the new entrant and the incumbent population does not necessarily translate into a positive income gain, but this depends on whether public and private capital are complementary and whether the optimization problem considers only one period or infinite periods.

This section will analyze why is this the case by demonstrating that Berry and Soligo's approximation is equivalent to an optimization problem similar to a particular case of (5.2), but when there is no stock of public capital.

Assuming the economy is in equilibrium prior to the entry of new members, and assuming there is no public capital, the income of an existing member can be described as follows:

$$I = w + r\overline{k} \tag{5.32}$$

Where $\overline{k}$ is the private capital per capita of the existing population.

The minimum membership fee can be derived from an optimization problem where the income equation is invariant to changes in the number of members, assuming the amount of private capital of the incumbent population $\overline{k}$ remains constant:

$$\frac{\partial I}{\partial L} = \frac{\partial w}{\partial L} + \frac{\partial r}{\partial L}\overline{k} = 0$$

As w and r are functions of L and K, the change in wages and return on capital caused by a new entrant can be expressed as:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial w}{\partial L}$$
$$\frac{\partial r}{\partial L} = \frac{\partial r}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial r}{\partial L}$$

As the new entrant can now bring private capital in different proportions, the change in capital K for an increase in L will be:

$$\frac{\partial K}{\partial L} = k^*$$

The previous equations can be re-written as follows:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K} \cdot k^* + \frac{\partial w}{\partial L}$$
$$\frac{\partial r}{\partial L} = \frac{\partial r}{\partial K} \cdot k^* + \frac{\partial r}{\partial L}$$

And the change in income for an increase in L turns:

$$\frac{\partial I}{\partial L} = k^* \left(\frac{\partial w}{\partial K} + \overline{k} \cdot \frac{\partial r}{\partial K} \right) + \frac{\partial w}{\partial L} + \overline{k} \cdot \frac{\partial r}{\partial L}$$

As for any given production function homogeneous of degree one it always holds that:

$$\frac{\partial w}{\partial K} = -\frac{\partial r}{\partial K} \cdot \frac{K}{L}$$
$$\frac{\partial w}{\partial L} = -\frac{\partial r}{\partial L} \cdot \frac{K}{L}$$

We find that the change in income $\frac{\partial I}{\partial L}$ is equal to 0 and thus invariant to the value of k^*.

At first sight this is surprising, as it seems to contradict Berry and Soligo's result given by equation (2.1), which states that there is a positive change in income when the capital per capita of the new member differs from that of the native population. However, as it will be proved in what follows, this is not the case but just the consequence of the fact that the income effect is of a second order of magnitude when the production function is homogeneous of degree one.

In a first step, it will be proved that Berry and Soligo's income change approximation is equivalent to the derivation of (5.32). This is not obvious as the Taylor approximation in Berry and Soligo's is centered on $k = \frac{K}{L}$ (and takes increments of $\triangle k$), whilst the optimization problem above is based on L (and takes increments of $\triangle L$).

The first order approximation for the change in income is given by:

$$I_1 - I_0 \approx \frac{\partial^2 F}{\partial L^2}(L_1 - L_0) + \frac{\partial^2 F}{\partial L \partial K}(K_1 - K_0) + \tag{5.33}$$
$$+ \frac{K_0}{L_0}\left[\frac{\partial^2 F}{\partial K \partial L}(L_1 - L_0) + \frac{\partial^2 F}{\partial K^2}(K_1 - K_0)\right] \tag{5.34}$$

Defining $\triangle L = L_1 - L_0$, and assuming the private capital per capita of the immigrant population to be a factor a of that of the incumbent population $\overline{k}$ ($k^* = a \cdot \overline{k} = \frac{K_0}{L_0}$), the change in total capital $\triangle K = K_1 - K_0$ can be expressed as:

$$K_1 - K_0 = a \cdot \frac{K_0}{L_0} \cdot \triangle L \tag{5.35}$$

And the change income can be expressed as:

$$I_1 - I_0 \approx \triangle L \left[\frac{\partial^2 F}{\partial L^2} + \frac{\partial^2 F}{\partial L \partial K} \cdot \frac{K_0}{L_0}(a+1) + a\frac{\partial^2 F}{\partial K^2}\left(\frac{K_0}{L_0}\right)^2\right] \tag{5.36}$$

Assuming the production function is homogeneous of degree one: $F(K,L) = L \cdot F(\frac{K}{L},1) = Lf(k)$, the change in income is (see Appendix sec. A.21 for a detailed calculation):

$$I_1 - I_0 \approx \triangle L \left[f''(k) \cdot \frac{k^2}{L} - f''(k) \cdot \frac{k}{L} \cdot k\,(a+1) + af''(k) \cdot \frac{1}{L} \cdot k^2 \right] = 0 \tag{5.37}$$

This result explains why the optimization problem above is invariant to k^*, and confirms the second order magnitude of allocative efficiency gains caused by immigration.

The fact that they are of second order can be proven by expanding the approximation of the income change to derivatives of the production function of third order (see Appendix sec. A.21 for a detailed calculation):

$$I_1 - I_0 \approx \frac{\triangle L^2}{2} \left[\frac{\partial^3 F}{\partial L^3} + a^2 \left(\frac{K_0}{L_0} \right)^3 \frac{\partial^3 F}{\partial K^3} + a\,(a+2) \left(\frac{K_0}{L_0} \right)^2 \frac{\partial^3 F}{\partial K^2 \partial L} + (2a+1) \frac{K_0}{L_0} \cdot \frac{\partial^3 F}{\partial L^2 \partial K} \right] \tag{5.38}$$

If the production function is homogeneous of degree one, the second order approximation of the income change is (see Appendix sec. A.21 for a detailed calculation):

$$I_1 - I_0 \approx -\frac{(\triangle L)^2}{2} \cdot \frac{k^2}{L^2} f''(k)\,(a-1)^2 \geq 0 \tag{5.39}$$

That yields the same result as Berry and Soligo, that is, the incumbent population always benefits from immigration as long as factor proportions are different ($a \neq 1$). In fact the two results are analytically equivalent as is demonstrated in the Appendix sec. A.21.

To further prove that the optimization and income change approximation approaches are equivalent, the second order derivative of income will be calculated:

$$\frac{\partial^2 I}{\partial L^2} = k^{*^2} \left(\frac{\partial^2 w}{\partial K^2} + \overline{k} \cdot \frac{\partial^2 r}{\partial K^2} \right) + 2k^* \left(\frac{\partial^2 w}{\partial K \partial L} + \overline{k} \cdot \frac{\partial^2 r}{\partial K \partial L} \right) + \frac{\partial^2 w}{\partial L^2} + \overline{k} \cdot \frac{\partial^2 r}{\partial L^2}$$

If the production function is homogeneous of degree one, we obtain the following:

$$\frac{\partial^2 I}{\partial L^2} = -\frac{f''}{L^2}(k^* - \overline{k})^2$$

This result confirms that all the derivations of the club model that have been elaborated in the previous chapters ignoring allocative efficiency considerations, are valid as long as the difference in capital per capita between the new member and the existing members is not large. As already explained in Chapter 2, the capital per capita has a lower boundary at 0, in practice allocative efficiency gains can only be significant when the new member is considerably wealthier than the native population.

5.3.2. Infinite periods

Berry and Soligo's model discussed corresponds to the short-run effects of immigration, assuming that the total stock of each factor is fixed and changes which result from migration cannot be offset through the creation of more of a factor when its price rises. They also advance a long-run model for an economy in stationary-equilibrium, where the relative propensities to hold wealth of the immigrants and non-immigrants play the role taken in the short-run case by the relative amounts of capital held, arriving to analogous results as in the short-term case.

In his critique to Berry and Soligo, Rodriguez (1975) shows how their results do not hold in a two-period model in which individuals work for a wage rate in the first period of their lives, consuming part of it and saving the rest for consumption in the second period. His model helps to illustrate that a one period analysis neglects the lifetime changes in income produced by discounting of future consumption (or reinvestment of savings) due to the induced by changes in the interest rates.

In what follows, an extension of the optimization problem equivalent to Berry and Soligo's but for infinite periods will be discussed.[5]

Similar as in the previous sections, assuming the economy is in equilibrium prior to the entry of new members, and assuming there is no public capital, the income of an existing member can be described as follows:

[5] Extending Rodriguez's model to account for public capital has two main shortcomings, first individuals start with no capital thus neglecting income benefits a higher interest rate has in the first period (although it depresses further discounted income) and second, assuming individuals care for the transmission of public capita, it is necessary to discount as a perpetuity, as otherwise dilution of ownership public capital would not be reflected in the model, as already discussed when analyzing Usher's model.

$$I = \frac{w}{r} + \overline{k} \tag{5.40}$$

Where $\overline{k}$ is the private capital per capita of the existing population.

The minimum membership fee can be derived from an optimization problem where the income equation is invariant to changes in the number of members, assuming the amount of private capital of the incumbent population $\overline{k}$ remains constant:

$$\frac{\partial I}{\partial L} = \frac{\frac{\partial w}{\partial L} r - w \frac{\partial r}{\partial L}}{r^2} = 0 \Rightarrow \frac{\partial w}{\partial L} r - w \frac{\partial r}{\partial L} = 0 \tag{5.41}$$

As the new entrant can now bring only private capital (there is no public capital), we have that:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K} \cdot k^* + \frac{\partial w}{\partial L}$$
$$\frac{\partial r}{\partial L} = \frac{\partial r}{\partial K} \cdot k^* + \frac{\partial r}{\partial L}$$

And equation (5.41) can be rewritten:

$$k^* \left(\frac{\partial w}{\partial K} r - w \frac{\partial r}{\partial K} \right) + \frac{\partial w}{\partial L} r - w \frac{\partial r}{\partial L} = 0 \tag{5.42}$$

Assuming the production function is homogeneous of degree one: $F(K, L) = L \cdot F(\frac{K}{L}, 1) = Lf(k)$, the required amount of private capital per capita to the new member to avoid an income loss will be (see Appendix sec. A.22 for a detailed calculation):

$$k^* = \frac{-f(k) \cdot f''(k) \cdot \frac{k}{L}}{-f(k) \cdot f''(k) \cdot \frac{1}{L}} = k \tag{5.43}$$

Assuming diminishing returns to scale, the term in the parenthesis multiplying k^* in equation (5.42) will always be positive, and the second term always negative:

$$\left(\frac{\partial w}{\partial K}r - w\frac{\partial r}{\partial K}\right) = -f(k) \cdot f''(k) \cdot \frac{1}{L} > 0 \tag{5.44}$$

Hence, if $k^* > k$, the native population will have an income gain, and vice-versa if $k^* < k$. It is worth noting that the infinite periods optimization equivalent to Berry and Soligo produces a result that is not aligned with the result for one-period. In this case, the native population has an incentive to accept individuals with larger capital per capita and to reject those with lower endowments. Furthermore, when considering infinite periods, allocative efficiency effects are of first instead of second order.

5.4. Productivity gains in the extended model

In Chapter 4 the simplified model has yielded the somehow counterintuitive result that the membership fee should be invariant to gains in productivity brought by the new member for the case of the infinite periods calculation. This is the case because both numerator and denominator in equation (4.6) are positively affected by the same magnitude, i.e., a change in productivity increases total output but also increases the discount rate.

The critical role played by the discount rate will be analyzed in the discussion section in Chapter 9, where it will be demonstrated that in an open economy when the discount rate is exogenously given productivity gains help to finance the membership fee in the infinite period. This section however, will assess whether productivity gains brought by the new member can have a lasting impact when using the extended model.

For this analysis it will not be relevant whether there are complementarities or not between private and public capital, as what matters is how changes in productivity affect the ratio w/r. However, we will have to differentiate between changes in labor productivity and changes in total factor productivity.

Incorporating total factor productivity into the production function $F = F(K, L, A)$ will extend the partial derivatives used in equations (5.13) and (5.25) as follows:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial w}{\partial A}\frac{\partial A}{\partial L} + \frac{\partial w}{\partial L}$$
$$\frac{\partial r}{\partial L} = \frac{\partial r}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial r}{\partial A}\frac{\partial A}{\partial L} + \frac{\partial r}{\partial L}$$

This extension will create the following additional element in the numerator of the equations defining p^*:

$$w \cdot \frac{\partial r}{\partial A} - r \cdot \frac{\partial w}{\partial A} \tag{5.45}$$

The sign of this element will determine whether changes in productivity brought by the new member have a positive, neutral or negative impact in the membership fee.

5.4.1. Changes in total factor productivity

Assuming a production function homogeneous of degree one with total factor productivity:

$$F(K, L, A) = L \cdot F(\frac{K}{L}, \frac{A}{L}) = L \cdot f(k, a)$$

Equation (5.45) can be expressed as (see Appendix sec. A.10 for the partial derivatives):

$$w \cdot \frac{\partial r}{\partial A} - r \cdot \frac{\partial w}{\partial A} = (f - f_k k - f_a a) \left(f_{ka} \cdot \frac{1}{L} \right) - f_k \left(-f_{aa} \cdot \frac{a}{L} - f_{ak} \cdot \frac{K}{L} \right) \tag{5.46}$$

Taking into consideration that total factor productivity is a factor multiplying the the production function:

$$f(k, a) = a \cdot f(k, 1)$$

the derivatives on a can be expressed as: $f_a = {}^f/_a$ and $f_{aa} = 0$. When substituting in (5.46) the equation turns equal to 0, which implies that changes in total factor productivity brought by the new member have no effect on the membership fee.

5.4.2. Changes in labor productivity

Assuming a production function homogeneous of degree one with labor productivity:

$$F(K,L,A) = AL \cdot F(\frac{K}{AL}) = AL \cdot f(k)$$

Equation (5.45) can be expressed as (see Appendix sec. A.10 for the partial derivatives):

$$w \cdot \frac{\partial r}{\partial A} - r \cdot \frac{\partial w}{\partial A} = -f \cdot f_{kk}k + f_k f_{kk} k^2 - f_k (f - f_k k) - f_k f_{kk} k^2 = \tag{5.47}$$

$$= -f \cdot f_{kk}k - f_k (f - f_k k) \tag{5.48}$$

In order to assess the sign of this equation we will assume the production function has a constant elasticity of substitution:

$$F(K, AL) = [\alpha K^r + (1-\alpha)(AL)^r]^{\frac{1}{r}} \tag{5.49}$$

And the the per capita equivalent will be:

$$f(k) = \frac{F(K,P,L)}{AL} = (\alpha k^r + (1-\alpha))^{\frac{1}{r}} \tag{5.50}$$

In this case equation (5.47) turns (see Appendix sec. A.26 for a detailed calculation):

$$w \cdot \frac{\partial r}{\partial A} - r \cdot \frac{\partial w}{\partial A} = r\alpha k^{r-1} (\alpha k^r + (1-\alpha))^{\frac{2-r}{r}} \left[\alpha k^r (\alpha k^r + (1-\alpha))^{-1} - 1\right] \tag{5.51}$$

The sign of the equation is given by the term in brackets, which can be observed is always ≤ 0, which implies that changes in labor productivity brought by the new member can help to reduce the membership fee.

In the particular case of a Cobb-Douglas specification $r = 0$ and equation (5.47) is equal to zero, implying that when capital and labor are perfect substitutes productivity gains do not have an impact in the membership fee, a similar result as obtained in Chapter 4, Sec. 4.2.1.

5.5. Conclusions

The previous sections have shown how a more comprehensive version of the model that incorporates private capital still holds the main thesis of the previous chapters, which is that in the presence of public capital, immigration creates an ownership dilution of public capital which is attenuated by the degree of economies of scale.

However, when assuming that positive spillovers associated to population size are exclusively circumscribed to public capital, the impact of large differences in private capital endowments between the native and the immigrant population can be significant and critically depends on whether there are complementarities between public and private capital, as well as on whether the optimization problem considers only one period or infinite periods.

Over one period, allocative efficiency effects are of first order – and hence comparable to public capital dilution – when private and public capital are not complementary factors. Over infinite periods, allocative efficiency can only play a role when the differences in capital endowments are very large, which due to the low boundary of capital at zero, can only be the case with the immigration of very wealthy individuals.

Similarly as in Chapter 3, the discount rates have been assumed to remain constant after the influx of new members, and unaffected by the financing needs of the country or the global level of interest rates. Naturally, countries with a high level of private and public debt may need to pay higher interest rates which would reduce the membership fee.

These findings will prove very useful when looking at empirical data. Taking into consideration that investment programs typically require a contribution of either public capital (payment), or private capital (a certain investment into the country), or both, equations (5.18) and (5.29) offer an econometric equation to test the model.

Further, in this chapter it has been mathematically proven that the income optimization problem that is at the foundation of the thesis, is equivalent to the classic income approximation approach mostly seen in the literature; with the particularity that the optimization problem is undetermined for the first order approximation,[6] which makes necessary a second derivative to arrive at the same result. Moreover, the section has demonstrated that the only assumption imposed on the production function is that this is homogeneous of degree one,[7] being all the results valid independently of the value of the elasticity of substitution. Therefore, the model specification with a Cobb-Douglas production function widely used throughout the thesis does not cause a loss of generality of the results.

[6]The optimization problem is undetermined only when no public capital is considered.
[7]This is the same assumption used by Berry and Soligo

Lastly, productivity gains have been incorporated into the extended model showing that increases in total factor productivity brought by the new member does not alter the membership fee, whilst improvements in labor productivity do generally cause a reduction in the membership fee.

The extension of the model did not include heterogeneity considerations but the extension would be straightforward by just replacing β by $(\beta + \psi)$ in all the formulas.

6. Government size and country membership

The previous chapters have described the importance that public capital has in the determination of the membership fee. The stock of public capital depends on the country's endowments, but also on the investment and depreciation rates. By collecting taxes, governments maintain and enlarge the amount of publicly provided goods over time. In principle, more publicly provided goods increase the economies of scale in the economy and with that raise income per capita. However, government size exhibits clear diminishing returns to scale, as every increase in the size of the public sector would include goods of a higher degree of rivalry,[1] that implies there is a tradeoff between government size and economies of scale in the public sector.

This chapter will analyze how government size affects membership fees, first from a static perspective, assuming that the new members cannot alter the size of the government (i.e., have no voting rights) and relaxing this assumption in a second step.

Finally, in the last section, a simple multi-period model will be used to understand how the dynamic nature of the public capital stock can influence membership decisions.

6.1. Membership fee in an economy with private and public sector

One period membership

In order to keep the model as parsimonious as possible, in what follows the simplified model will be used, assuming that the scope of economies of scale associated to population size affect the whole production function. Like in the previous chapters, the model specification will be given by a Cobb-Douglas production function: $F(K, P, L) = K^{\alpha_K} P^{\alpha_P} L^{1-\alpha_K-\alpha_P}$. The utility

[1] Assuming publicly provided goods are chosen from a higher to a lower potential to bring economies of scale.

function will be modified to represent an economy that produces two types of goods, those whose consumption is completely rival and exclusive and those others that present only certain degree of rivalry.[2] The proportion between the two goods is given by the variable g, which can be understood as representing the size of the public sector in the economy, assuming a balanced budget. Under this formulation it is also assumed that the only source of economies of scale associated to population size in the economy are publicly provided goods (i.e., there are no other positive spillovers from population size), as private goods are considered to be perfectly rival:

$$I(K,P,L) = (1-g)K^{\alpha_K}P^{\alpha_P}L^{-\alpha_K-\alpha_P} + gK^{\alpha_K}P^{\alpha_P}L^{1-\alpha_K-\alpha_P-\beta} \tag{6.1}$$

Assuming the new entrant will bring an amount of private capital equal to that of the native population one ($\frac{\partial K}{\partial L} = \frac{K}{L} = k$), the membership fee will be (see sec. A.7 in the Appendix):

$$p^* = p\left[1 - \frac{g(1-\beta)L^{1-\beta}}{\alpha_P g L^{1-\beta} + \alpha_P(1-g)}\right] \tag{6.2}$$

When $g = 1$ all goods in the economy are public and equation (6.2) equals the one-period membership fee derived in Chapter 3. Alternatively, when $g = 0$ all goods are private and $p^* = p$. Therefore, a large public sector leads to a lower membership fee and vice-versa.

For large values of L, and values of β and g which are far from 1 and 0 respectively, the membership fee can be approximated by:

$$p^* \approx p\left[1 - \frac{g(1-\beta)L^{1-\beta}}{\alpha_P g L^{1-\beta}}\right] = k\left[1 - \frac{(1-\beta)}{\alpha_P}\right] \tag{6.3}$$

which is equal to the membership fee when all goods are public ($g = 1$).

[2]The degree of rivalry is not exclusively an intrinsic characteristic of the good that reflects how much of its consumption can be shared, but it is also determined by the legal classification of the good as private or public property. In other words, some goods lend themselves to be shared – for example a car or a flat that is not permanently in use by its owner – but if they are classified as private they will not be shared (unless jointly owned or rented) and therefore will enter the individual utility function on a strictly per capita basis.

Permanent membership In case of permanent membership, the utility function can be described as (See sec. A.7 in the Appendix):

$$I(K,P,L) = \frac{1}{r_P}\left[(1-g)K^{\alpha_K}P^{\alpha_P}L^{-\alpha_K-\alpha_P} + gK^{\alpha_K}P^{\alpha_P}L^{1-\alpha_K-\alpha_P-\beta}\right] = \\ = \frac{P}{\alpha_P}\left[(1-g)L^{-1} + gL^{-\beta}\right] \tag{6.4}$$

And the corresponding membership fee will be given by:

$$p^* = p\left[1 - \frac{g(1-\beta)L^{-\beta}}{gL^{-\beta} + (1-g)L^{-1}}\right] \tag{6.5}$$

Similar as for the one-period membership fee, when $g = 1$ all goods are public and equation (6.5) turns equivalent to the one-period membership fee in the base model. Alternatively, when $g = 0$ all goods are public and $p^* = p$. Similarly, for values of L large enough, the former equation can be approximated by:

$$p^* \approx p\left[1 - \frac{(1-\beta)gL^{-\beta}}{gL^{\beta}}\right] = \beta p \tag{6.6}$$

which is equal to the one period membership fee when $g = 1$.

The size of the government has a higher impact on the membership fee when economies of scale are high (low β), as the income gains are then greater. The marginal reduction in the membership fee by increasing government size however fades out more quickly the higher the degree of economies of scale. The following chart depicts the relationship between the membership fee and the government size for different values of β for both one-period and permanent membership.[3] One curve in the graph can be interpreted in a static manner as if it would reflect the price of the membership fee in countries for with the same economies of scale but different government sizes.

[3]Assuming a population of 10 million and public capital per capital of 100,000.

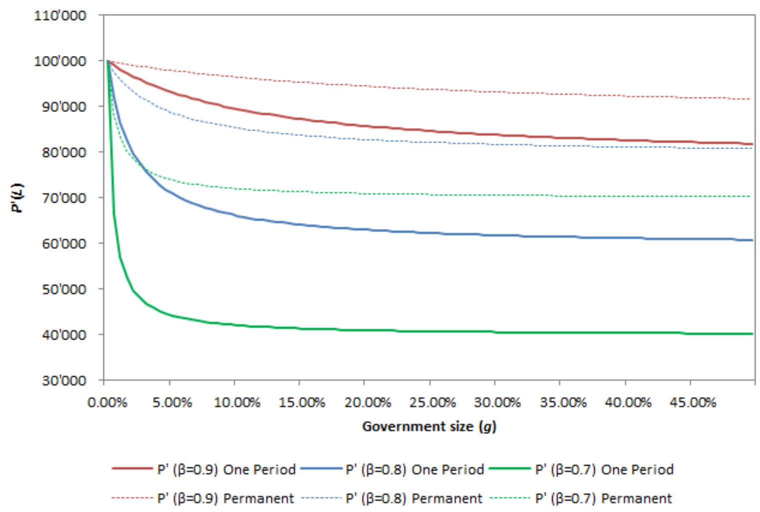

Figure 6.1.: Government size and entry fee

When a country changes the size of its government, most probably the degree of economies of scale will change; it can happen that the associated economies of scale increase – for example at early stages of development – or that on the contrary they decrease if the government provides goods with a high degree of rivalry. This suggests there is a trade-off between the size of the government and the degree of rivalry in the stock of publicly provided goods.

6.2. Optimal government size

A benevolent social planner could try to optimize the percentage of public/ private goods in order to maximize welfare. By looking at equation (6.1), the maximum utility would be achieved for $g = 1$. However, as more private goods are turned public it is expected that β would decrease reflecting a lower level of economies of scale in the economy. Assuming all goods could be sorted by their degree of publicness, the economies of scale β for a country with a constant population would be a strictly monotonically increasing function with the size of the public sector, i.e., $\beta = \beta(g)$.[4] As a result maximizing equation (6.1) is equivalent to maximizing the last term of the equation; and due to the strict monotony of the production function, will also be equivalent to maximizing its logarithm:

[4]For a variable population $\beta = \beta(L, g)$ as the crowding is also dependent on the size of the population.

$$max\, I(K, P, L) = max\, gK^{\alpha_K} P^{\alpha_P} L^{1-\alpha_K-\alpha_P-\beta(g)} \tag{6.7}$$
$$= max\, Ln(gK^{\alpha_K} P^{\alpha_P} L^{1-\alpha_K-\alpha_P-\beta(g)}) \tag{6.8}$$

Taking derivatives with respect to g we obtain the optimal government size to be given by:

$$g^* = \frac{1}{LnL \cdot \frac{\partial\beta(g)}{\partial g}\big|_{g^*}} \tag{6.9}$$

The former equation tells us that the more convex $\beta(g)$ is (i.e., the larger the amount of goods that can be provided by the government without lowering the economies of scale in the economy), the higher the optimal size of the government. The following is an example for three different forms of $\beta(g)$ and their respective optimum levels g^*:

$$\beta(g) = 0.6g \Rightarrow g^* = \frac{1}{0.6 \cdot LnL} = 10.3\% \tag{6.10}$$
$$\beta(g) = 0.6g^2 \Rightarrow g^* = \left(\frac{1}{2 \cdot 0.6 \cdot LnL}\right)^{1/2} = 22.7\% \tag{6.11}$$
$$\beta(g) = 0.6g^3 \Rightarrow g^* = \left(\frac{1}{3 \cdot 0.6 \cdot LnL}\right)^{1/3} = 32.5\% \tag{6.12}$$

The following example shows how the income per capita changes for three different functions $\beta(g)$ that present varying degrees of convexity and a population of 10 million:

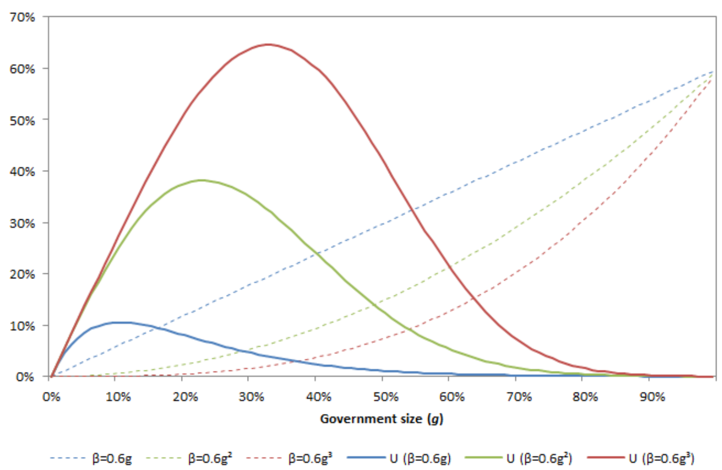

Figure 6.2.: Optimal size of government

6.3. Entry fee with a public sector changing with the size of the population

One period membership

If we assume that government size can change with population size, for example when the new members have other preferences for the size of government, then $g = g(L)$ and $\beta = \beta(L, g(L))$ and the impact that a the new entrant can have in the government size needs to be factored into the membership fee. In this case equation (6.1) can be expressed as:

$$I(K,P,L) = (1-g)K^{\alpha_K}P^{\alpha_P}L^{-\alpha_K-\alpha_P} + gK^{\alpha_K}P^{\alpha_P}L^{1-\alpha_K-\alpha_P-\beta(g(L))} \tag{6.13}$$

and the resulting membership fee:

$$p^* = p\left[1 - \frac{gL^{1-\beta}(1-\beta-LnL\frac{\partial\beta}{\partial L}) - L\frac{\partial g}{\partial L}\left(1 + gL^{1-\beta}LnL\frac{\partial\beta}{\partial g} - L^{1-\beta}\right)}{\alpha g L^{1-\beta} + (1-g)\alpha}\right] \tag{6.14}$$

that for large populations[5] can be simplified as:

$$p^* \approx p\left[1 + \frac{(\beta - 1 + L\cdot LnL\frac{\partial\beta}{\partial L}) + \frac{\partial g/g}{\partial L/L}\left(gLnL\frac{\partial\beta}{\partial g} - 1\right)}{\alpha}\right] \tag{6.15}$$

Assuming $\frac{\partial g}{\partial L} < 0$, as $\beta(g)$ is a monotonic function ($\frac{\partial\beta}{\partial g} > 0$) the membership fee will decrease if: $gL^{1-\beta}LnL\frac{\partial\beta}{\partial g} + 1 > L^{1-\beta}$. For large values of L the inequality can be approximated by $gLnL\frac{\partial\beta}{\partial g} > 1$, or alternative by $g > \frac{1}{\frac{\partial\beta}{\partial g}LnL}$. As the optimal government size is given by $g^* = \frac{1}{\frac{\partial\beta(g)}{\partial g}|_{g^*}LnL}$, if the country has optimized the size of its government, the entry fee will not be dependent on the government size g. However, if the government is bigger than that optimum,

[5]The median population size per country out of 201 countries in the World Bank 2013 database is 7.1 million, being the average value 35.3 million.

a decrease in g caused by an increase in L will bring the size of the government closer to the optimum and thus reduce the entry fee. On the contrary, if the government size is smaller than the optimum, an increase in population will bring the government size further away from the optimum. The opposite analysis can be done if $\frac{\partial g}{\partial L} > 0$. The further away the population is from the optimum the larger the influence of this factor in the entry fee. This result will be further used in to assess political economy considerations in Chapter 7.

Permanent membership

If similar as has been done for the one period calculation above, we assume that after an influx of new members the government size can change, the resulting membership fee will be given by:

$$p^* = p\left[1 + \frac{gL^{-\beta}(\beta - 1 + L \cdot LnL\frac{\partial \beta}{\partial L}) + \frac{\partial g}{\partial L}\left(1 + gL^{1-\beta}LnL\frac{\partial \beta}{\partial g} - L^{1-\beta}\right)}{(1-g)L^{-1} + gL^{-\beta}}\right] \tag{6.16}$$

For large populations, the membership fee can be simplified as:

$$p^* \approx p\left[\beta + L \cdot LnL\frac{\partial \beta}{\partial L} + \frac{\partial g/g}{\partial L/L}\left(gLnL\frac{\partial \beta}{\partial g} - 1\right)\right] \tag{6.17}$$

6.4. Taxation and naturalization requirements

There are several ways of obtaining citizenship for foreign individuals. Excluding marriage or family reunion reasons, the most usual ones are (1) special merits rendered to the country, (2) participating in a investment program and (3) naturalization. Naturalization typically implies a number of conditions including a certain degree of assimilation into the country's culture, a number of years of continued residence and in some cases renouncing to other citizenship.

It can be assumed that the requirements for the up-front obtainment of citizenship should be economically equivalent to those for naturalization. This would be possible if the resident had over a number of periods paid taxes in excess of the consumption of publicly provided goods for an amount equal to the permanent residence entry fee. Notating the per capita taxes as τ, and the number of periods for naturalization as N, the equivalence should be:

$$\beta p = N\left(\tau - \beta r_p p\right) \tag{6.18}$$

Expressing τ as a percentage t of the production function $\tau = t \cdot f$, the equation can be re-written as:

$$\beta p = N\left(t \cdot f - \beta r_p p\right) \tag{6.19}$$

As for a production function with CES it holds that: $r_p p = \alpha_p f$, the number of periods for breaking even would be:

$$N = \frac{1}{\left(\frac{t}{\beta} - \alpha_p\right)} \cdot \frac{p}{f} \tag{6.20}$$

Assuming $t \geq \beta\alpha_p$ (i.e., the number of years needs to be positive), N increases with β, α_p and p, as would be expected. A high tax rate t would on the contrary reduce the number of years for naturalization.

This result helps to understand why countries request different years of permanent residence for obtaining citizenship via naturalization. There is however an important caveat to be made; the excess contributions paid when taxes exceed public capital returns will be accumulated in new public capital, but the membership fee accounts only for the old capital. Only when the depreciation of public assets would be significant, would the contributions of the immigrant over the years pay for the ownership dilution in public capital of the incumbent population (Kamps (2004) estimates a 4% depreciation rate for government assets in OECD countries). Additionally, if the new entrant would pay more taxes than the incumbent population, the number of years for naturalization would obviously increase and vice-versa.

6.5. Conclusions

Economies of scale associated to population size depend exclusively on the size of the public sector, as long as private income is rival and private capital generates no positive externalities. All things being equal, the larger the government the lower the membership fee. There is however a trade-off between economies of scale and government size as the larger the number of goods that are public, the higher their potential degree of rivalry. Therefore, there is an optimum level of government size for a given function $\beta(g)$. If new members have the potential to alter the size of the government deviating/ approximating it to the optimum, the membership fee will increase/ decrease. Lastly, when taxation exceeds the returns on public capital, a new member can pay its membership fee over time, which suggests there may be a positive relationship between the number of years for naturalization and the tax rate.

All the results in this chapter have been derived assuming a balanced budget and a stationary and endogenously determined discount rate, and hence have not taken into consideration possible changes in the return on public capital due to the need to finance a given government size. In Chapter 9 Sec. 9.5 it will be discussed how the membership fee changes when the return on capital is dictated by global market prices in an open economy. If a government were to be over-indebted, this would probably force it to pay risk premium on top of the market interest rate, which would then reduce the membership fee.

7. Political economy considerations

This chapter will build on previous results to analyze a number of political economy implications arising from different capital and skills endowments within the native population, as well as from disparate preferences for government size and population heterogeneity.

7.1. Heterogeneous capital endowments

Review of Benhabib's model Berry and Soligo's (1969) model of immigration demand reviewed in Chapter 2 concludes that – ignoring public capital dilution effects – the pre and post immigration income of a representative agent whose capital endowments equal the average capital per capita in the incumbent population should necessarily increase.[1]

Benhabib (1995) showed that with a native population that is heterogeneous in terms of wealth distribution, free immigration does not benefit every individual. In his model, individuals are indexed by the units of capital that they own, k. The density of individuals is given by the continuous density function $N(k)$. The initial capital stock and population of the native population are respectively given by:

$$K_0 = \int_0^\infty N(k)kdk \tag{7.1}$$

$$L_0 = \int_0^\infty N(k)dk \tag{7.2}$$

The median type of the population k_m, is given by the solution to the following equation:

[1] Except for the singular case when the capital per capita of the immigrants equals that of the native population, in which case there is no gain or loss.

$$\frac{\int_0^{k_m} N(k)dk}{L_0} = \frac{1}{2} \tag{7.3}$$

The total capital stock of the potential immigrants is given $\int_s^q I(k)kdk$, where $I(k)$ is the density function and $s, q \in [0, \infty)$ are the lower and upper boundaries to the capital endowments required to prospective immigrants by the immigration policy $P(s, q)$. The post-immigration capital-labor ratio is given by:

$$R_s^q = \frac{K_0 + \int_s^q I(k)kdk}{L_0 + \int_s^q I(k)dk} \tag{7.4}$$

Denoting the pre-immigration capital-labor ratio by $R_0 \equiv R(s, s)$, and k_i as the type indifferent to immigration policy $P(s, q)$ so that her pre-immigration and post-immigration incomes are identical. Then we have that:

$$f(R_0) - f'(R_0)R_0 + f'(R_0)k_i = f(R_s^q) - f'(R_s^q)R_s^q + f'(R_s^q)k_i \tag{7.5}$$

Benhabib derives then the following Proposition:

(a) *The average person of type $k = R_0$ obtains a higher income than his pre-immigration income under any immigration policy $P(s, q)$ if $R_0 \neq R_s^q$;*

(b) *If $R_s^q < R_0$, then $R_s^q < k_i < R_0$ and all natives of type $k > k_i$ have a higher post-immigration income under policy $P(s, q)$;*

(c) *If $R_0 < R_s^q$, then $R_0 < k_i < R_s^q$ and all natives of type $k < k_i$ have a higher post-immigration income under policy $P(s, q)$;*

(d) *If we assume that natives vote against an immigration policy that reduces their income, then a policy $P(s, q)$ will be defeated in a referendum if:*

1. *$k_m < k_i$ when $R_s^q < R_0$*
2. *$k_m > k_i$ when $R_s^q > R_0$*

(e) *Any immigration policy $P(s, q)$* such that $R_0 \neq R_s^q$ will be approved if the median wealth k_m is sufficiently close to the average wealth R_0

Incorporating public capital In Benhabib's model all capital is private and immigration does not cause any dilution in public capital. In fact, (a) and (e) are a generalization of Berry and Soligo's result. However, as has been shown in Chapter 2, when the stock of public capital is significant, redistribution effects largely prevail over allocative efficiency ones.

Assuming new immigrants dilute the stock of capital in an amount $\delta_p = \frac{P_0}{L_0} - \frac{P_0}{L_1}$, where P_0 is the total amount of public capital,[2] equation (7.5) transforms into:

$$f(R_0) - f'(R_0)R_0 + f'(R_0)k_i = f(R_s^q) - f'(R_s^q)R_s^q + f'(R_s^q)(k_i - \delta_p) \tag{7.6}$$

And the indifferent type will be the solution to:

$$k_i = \frac{f(R_0) - f(R_s^q) - f'(R_s^q)(R_0 - R_s^q) + f'(R_s^q)\delta_p}{f'(R_s^q) - f'(R_0)} \tag{7.7}$$

A Taylor approximation of second order, centered in R_s^q for simplicity of the exhibition,[3] provides the following approximation for the capital endowments of the indifferent type:

$$k_i \approx \frac{1}{2}(R_0 + R_s^q) - \frac{f'(R_s^q)\delta_p}{f''(R_s^q)(R_0 - R_s^q)} \tag{7.8}$$

Denoting for simplicity the second term on the right-hand of the equation by Δ_p, and assuming the production function exhibits decreasing marginal returns, it follows that $\Delta_p > 0$ when $R_s^q < R_0$ and $\Delta_p < 0$ when $R_0 < R_s^q$. Therefore, when there is no dilution in public capital ($\delta_p = \Delta_p = 0$), Benhabib's proposition holds. However, in the presence of redistributive effects (a) and (e) no longer hold, and the rest of the results have to be modified as follows:

(b) *If $R_s^q < R_0$, then $R_s^q < k_i - |\Delta_p| < R_0$ and all natives of type $k > k_i$ have a higher post-immigration income under policy $P(s, q)$;*

(c) *If $R_0 < R_s^q$, then $R_0 < k_i + |\Delta_p| < R_s^q$ and all natives of type $k < k_i$ have a higher post-immigration income under policy $P(s, q)$;*

(d) *If we assume that natives vote against an immigration policy that reduces their income, then a policy $P(s, q)$ will be defeated in a referendum if:*

[2] As the production function does not differentiate between public and private capitalP_0 is supposed to be a fraction of the total capital stock K_0.

[3] $f(R_0) \approx f(R_s^q) + f'(R_s^q)(R_0 - R_s^q) + \frac{1}{2}f''(R_s^q)(R_0 - R_s^q)^2$and $f'(R_0) \approx f'(R_s^q) + f''(R_s^q)(R_0 - R_s^q)$

1. $k_m < k_i|_{\delta_p=0} + \Delta_p$ *when* $R_s^q < R_0$

2. $k_m > k_i|_{\delta_p=0} - \Delta_p$ *when* $R_s^q > R_0$

As a consequence, the existence of public capital has the effect of *shifting* the indifferent type towards higher wealth brackets in the case of a lower post-immigration capital-labor ratio, and towards lower wealth brackets in the opposite case, making any given policy $P(s,q)$ less likely to be accepted. By looking at equation (7.8) it can be observed that the degree of the shift will be closely related to the change in the capital-labor ratio. If the latter is large so is the denominator and allocative efficiency effects ameliorate dilution effects. On the contrary, if the change in capital-labor ratio is small, this will amplify the relative importance of dilution effects on the acceptance of a given immigration policy.

7.2. Heterogenous skills

In Chapter 4 and Chapter 5 it has been analyzed how productivity increases caused by a new entrant can help to reduce the membership fee. The most usual way to think of productivity increases is through "displacement effects", when low skill jobs are taken by immigrants freeing up the native population to move to other jobs of higher added value. However, when at least a part of the population does not have the skills to perform jobs that require higher skills, "replacement effects" take place as immigrants compete directly with natives for the same jobs. Likewise, when immigrants are highly skilled and there is no possibility for the native population to take jobs of higher qualification, competition for jobs takes place at the top. If the supply of jobs is fixed, displacement effects translate into higher unemployment amongst the native population; however, when the supply is elastic, adjustment will come via downward pressure on wages.

This section will analyze the political economy implications when both the native and the immigrant population have heterogeneous skills.[4]

Assuming that the native population is composed of two types of individuals: L_L and L_H with low skills and high skills respectively and, for simplicity in the calculation, taking the case when there are no complementarities between private and public capital, their respective one-period income will be given by:

[4]Heterogeneity of skills can be alternatively modeled as different human capital endowments. When human capital is modeled as a perfect substitute of private capital, the model will reproduce the results in Sec. 7.1

$$I_L = \frac{w_L}{r} + \overline{k} + \frac{P}{L^\beta} \tag{7.9}$$
$$I_H = \frac{w_H}{r} + \overline{k} + \frac{P}{L^\beta} \tag{7.10}$$

The membership fee required by a native with low/ high skills in order to accept a new individual with low skills will be given by the adaptation of equation (5.4):

$$p_L^* = \frac{\beta \frac{rP}{L^{\beta+1}} - \frac{\partial w_L}{\partial L_L} - \frac{\partial r}{\partial L_L}(k+sp)}{\frac{\partial w_L}{\partial K} + \frac{\partial r}{\partial K}(k+sp) + \frac{r}{L^\beta}} - k^* \cdot \frac{\frac{\partial w_L}{\partial K} + \frac{\partial r}{\partial K}(k+sp)}{\frac{\partial w_L}{\partial K} + \frac{\partial r}{\partial K}(k+sp) + \frac{r}{L^\beta}} \tag{7.11}$$
$$p_H^* = \frac{\beta \frac{rP}{L^{\beta+1}} - \frac{\partial w_H}{\partial L_L} - \frac{\partial r}{\partial L_L}(k+sp)}{\frac{\partial w_H}{\partial K} + \frac{\partial r}{\partial K}(k+sp) + \frac{r}{L^\beta}} - k^* \cdot \frac{\frac{\partial w_H}{\partial K} + \frac{\partial r}{\partial K}(k+sp)}{\frac{\partial w_H}{\partial K} + \frac{\partial r}{\partial K}(k+sp) + \frac{r}{L^\beta}} \tag{7.12}$$

Assuming diminishing marginal returns and complementarily between both types of labor an capital, it is clear that $\frac{\partial w_L}{\partial L_L} < 0$ in the first equation, whilst $\frac{\partial w_H}{\partial L_L} > 0$ implying a higher fee for a same individual due to the downward pressure on wages generated. The sign of the other partial derivatives on wages, $\frac{\partial w_L}{\partial K}$ and$\frac{\partial w_H}{\partial K}$ is the same, but its magnitude will depend on the elasticity of substitution between both types of labor as well as their relative quantities. In order to ascertain the relative importance of all factors it will help to have a specified production function form.[5] Assuming that the final output good is produced by using capital and a composite input good that is produced using two intermediate inputs which are a linear function of employment of low skilled and high skilled workers, that for simplicity in this case correspond to the quantity of workers,[6] the production function can be described as:

$$F(K, L_L, L_H) = K^\alpha \left[x L_L^r + (1-x) L_H^r\right]^{\frac{1-\alpha}{r}} \tag{7.13}$$

Where x is a productivity parameter that accounts for the relative importance in production of both types of individuals, and $1/(1-r)$for their elasticity of substitution. The two partial derivatives whose relative magnitude we want to study are:

[5] Assuming that the production function is homogeneous of degree one is in this case not sufficient to produce easily interpretable results (see sec. A.12 in the Appendix for an analytical derivation)

[6] In Battisti et. al (2014) the intermediate inputs are also a function of productivity and the unemployment rate for each worker type

$$\frac{\partial w_L}{\partial K} = \alpha\left(1-\alpha\right)xL_L^{r-1}K^{\alpha-1}\left[xL_L^r + \left(1-x\right)L_H^r\right]^{\frac{1-\alpha-r}{r}}$$
$$\frac{\partial w_H}{\partial K} = \alpha\left(1-\alpha\right)\left(1-x\right)L_H^{r-1}K^{\alpha-1}\left[xL_L^r + \left(1-x\right)L_H^r\right]^{\frac{1-\alpha-r}{r}}$$

The difference between the two will be given by:

$$\frac{\partial w_L}{\partial K} - \frac{\partial w_H}{\partial K} = \left[xL_L^{r-1} - \left(1-x\right)L_H^{r-1}\right]\alpha\left(1-\alpha\right)K^{\alpha-1}\left[xL_L^r + \left(1-x\right)L_H^r\right]^{\frac{1-\alpha-r}{r}}$$

If the quotient between both labor types is given by: $\rho = \frac{L_L}{L_H}$, the former expression can be re-written as:

$$\frac{\partial w_L}{\partial K} - \frac{\partial w_H}{\partial K} = \left[x\left(\rho^{r-1}+1\right)-1\right]\alpha\left(1-\alpha\right)K^{\alpha-1}L_H^{r-1}\left[xL_L^r + \left(1-x\right)L_H^{1-r}\right]^{\frac{1-\alpha-r}{r}} \tag{7.14}$$

If L_L and L_H are perfect substitutes ($r = 1$) the sign of equation (7.14) will be determined by:

$$Sign\left[\frac{\partial w_L}{\partial K} - \frac{\partial w_H}{\partial K}\right] = Sign\left[2x-1\right] \tag{7.15}$$

If L_L and L_H have an elasticity of substitution of 1 ($r = 0$) the sign of equation (7.14) will be determined by:

$$Sign\left[\frac{\partial w_L}{\partial K} - \frac{\partial w_H}{\partial K}\right] = Sign\left[x\left(\frac{L_H}{L_L}+1\right)-1\right] \tag{7.16}$$

If L_L and L_H are perfect complements ($r \to -\infty$)

$$Sign\left[\frac{\partial w_L}{\partial K} - \frac{\partial w_H}{\partial K}\right] < 0\;\forall\,x,\rho \tag{7.17}$$

If we assume both types of labor are same productive ($x = \frac{1}{2}$), then equation (7.15) turns equal to 0 in the case the two types of labor are perfect substitutes, implying that a new addition of a worker of low skills will always be penalized by workers of low skills and favored by workers of high skills.

When the two types of workers have an elasticity of substitution of one, the sign of the equation (7.16) will be determined by their relative abundance in the population. If $L_H > L_L$ the sign is positive implying that the addition of a new worker of low skills will have a mixed effect whereby the difference in membership fees asked by the two types of workers will narrow. If on the contrary there are more low-skill workers than high-skills ones ($L_H < L_L$) the sign will be negative, implying that the low-skill workers will penalize heavily the membership of a new low-skill member, whilst high skills workers will discount it aggressively, as it will affect both numerator and denominator in the same direction. In most countries, it can be safely assumed both that the productivity of high-skills workers is higher than that of low-skill workers ($x < \frac{1}{2}$) and that their relative number is larger ($L_L > L_H$). Therefore, the sign of the equation (7.16) will generally be negative implying resistance to admit new low-skill members. The relative size of both worker types can also explain the immigration policies, as being low-skill workers the majority type, it is expected that policies will be restricted towards low-skill workers and open for high-skill ones.

Conversely, the symmetric results can be easily obtained, whereby the addition of a high-skill worker will be penalized by high-skill members and incentivized by low-skill members. However, as the relative number of high-skill workers is usually smaller, on average the addition of high-skill members will be more favored.

Finally, when the two types of labor are perfect complements the sign of (7.15) will be negative for any value of x and ρ, and the negative effects of adding a new worker with low skills will be maximum for the native low-skill workers.

These results by itself are not new to the literature on immigration. The novelty however comes from the fact that when adding public capital to the overall picture, replacement and displacement effects do no longer determine by themselves whether immigration should be favored or resisted, but rather turn to be one more factor that can either ameliorate or exacerbate the dilution in public capital per capita.

7.3. Preferences for government size

Preferences for government size can be considered as one of the most salient ideological elements in political life. Broadly speaking, right-wing parties typically advocate for a lean government that provides public goods of high degree of publicness, like defense, law and order, infrastructure, etc. Left-wing parties on the contrary favor large governments that provide a wider range of public goods, some of them of a higher degree of rivalry, like healthcare or education, financed by a redistributive system of taxation.

Assuming new members can vote, they can contribute to a change in the size of the government and as a consequence be favored by those incumbent members closer to their ideological affiliation. This section will analyze how the membership fee is modified as a consequence of the ideological split of the native population, and the ideology of the new member.

In what follows in this section, the calculations are done for a one period membership, though they are easily extended for the case of permanent membership.

7.3.1. Fixed government size with no crowding effects

The model will be extended by assuming that there are two types of individuals, right-wing and left-wing, who make different use of publicly provided goods. Both right-wing and left-wing members support the provision of pure public goods. However, left-wing members show a stronger preference for the state providing a wider range of impure goods. Therefore, depending on the government size, both types of individuals would present different levels of β. For example, if the government is larger than the optimum for the right-wing individuals but smaller than the optimum for the left-wing, the former will have a larger β (i.e., extract less income from publicly provided goods) than the latter. Their respective income functions can be represented as:

$$I_R(K,P,L) = (1-g)K^{\alpha_K}P^{\alpha_P}L^{-\alpha_K-\alpha_P} + gK^{\alpha_K}P^{\alpha_P}L^{1-\alpha_K-\alpha_P-\beta_R} = \tag{7.18}$$

$$= K^{\alpha_K}P^{\alpha_P}\left[(1-g)L^{-\alpha_K-\alpha_P} + gL^{1-\alpha_K-\alpha_P-\beta_R}\right] \tag{7.19}$$

$$I_L(K,P,L) = (1-g)K^{\alpha_K}P^{\alpha_P}L^{-\alpha_K-\alpha_P} + gK^{\alpha_K}P^{\alpha_P}L^{1-\alpha_K-\alpha_P-\beta_L} = \tag{7.20}$$

$$= K^{\alpha_K}P^{\alpha_P}\left[(1-g)L^{-\alpha_K-\alpha_P} + gL^{1-\alpha_K-\alpha_P-\beta_L}\right] \tag{7.21}$$

$$\frac{\partial P}{\partial L}|_R = p\left[1 - \frac{g(1-\beta_R)L^{1-\beta_R}}{\alpha_P g L^{1-\beta_R} + (1-g)\alpha_P}\right] \tag{7.22}$$

$$\frac{\partial P}{\partial L}|_L = p\left[1 - \frac{g(1-\beta_L)L^{1-\beta_L}}{\alpha_P g L^{1-\beta_L} + (1-g)\alpha_P}\right] \tag{7.23}$$

For a large population, the entry fee does not depend significantly on g and we can approximate by:

$$\frac{\partial P}{\partial L}|_R \approx p\left[1 - \frac{1-\beta_R}{\alpha_P}\right] \tag{7.24}$$

$$\frac{\partial P}{\partial L}|_L \approx p\left[1 - \frac{1-\beta_L}{\alpha_P}\right] \tag{7.25}$$

If the relative size of right-wing and left-wing is given by w_R and w_L, with $w_R + w_L = 1$ the entry price for a newcomer will be:

$$\frac{\partial P}{\partial L} \approx w_R p\left[1 - \frac{(1-\beta_R)}{\alpha_P}\right] + w_L p\left[1 - \frac{(1-\beta_L)}{\alpha_P}\right] \tag{7.26}$$

$$\frac{\partial P}{\partial L} \approx p\left[1 - \frac{1 - w_R\beta_R + w_L\beta_L}{\alpha_P}\right] \tag{7.27}$$

The membership fee therefore will be determined by the blended β, which will depend on whether the government size is smaller or larger than the optimum for the two groups, as well as their relative weights.

7.3.2. Fixed government size with crowding effects

If new entrants generate crowding ($\frac{\partial \beta}{\partial L} \neq 0$) the entry fee demanded by right-wing and left-wing individuals is given by:

$$\frac{\partial P}{\partial L}|_R \approx p\left[1 + \frac{(\beta_R - 1 + L \cdot LnL\frac{\partial \beta_R}{\partial L})}{\alpha_P}\right] \tag{7.28}$$

$$\frac{\partial P}{\partial L}|_L \approx p\left[1 + \frac{(\beta_L - 1 + L \cdot LnL\frac{\partial \beta_L}{\partial L})}{\alpha_P}\right] \tag{7.29}$$

In the case of right-wing incumbents who favor pure public goods, crowding will not be as relevant as in the case of left-wing incumbents independently of whether the new joiner is left-wing or right-wing.[7] Left-wing incumbents will probably suffer a higher deterioration in β when a new left-wing individual joins than when a right-wing one does as the latter will eventually cause a larger income dilution. As a result, $(\frac{\partial \beta_R}{\partial L_R} < \frac{\partial \beta_R}{\partial L_L} < \frac{\partial \beta_L}{\partial L_R} < \frac{\partial \beta_L}{\partial L_L})$ there would be a bias towards accepting right-wing individuals independently of the split between right-wing and left-wing in the existing population. This factor will determine the political economy in case new entrants are excluded from voting.

7.3.3. Variable government size

If individuals could vote for their desired size of the government, right-wing individuals would prefer a lower government size, as they would have a higher preference for pure public goods versus impure ones (the convexity of $\beta(g)$ is higher for left-wing than for right-wing), whilst left-wing individuals would prefer a larger government.

If we assume that all individuals can vote, and that the resulting government size is a weighted average of the optimum levels for right-wing and left-wing individuals g^*_R and g^*_L:

$$g = g^*_R w_R + g^*_L w_P \tag{7.30}$$

$$L = L_R + L_L \tag{7.31}$$

$$w_R = \frac{L_R}{L_R + L_L} \tag{7.32}$$

$$w_L = \frac{L_P}{L_R + L_L} \tag{7.33}$$

$$\frac{\partial g}{\partial L_R} = \frac{(g^*_R - g^*_L)\, L_L}{(L_R + L_L)^2} = \frac{(g^*_R - g^*_L)\, L_L}{L^2} \tag{7.34}$$

$$\frac{\partial g}{\partial L_L} = \frac{(g^*_L - g^*_R)\, L_R}{(L_R + L_L)^2} = \frac{(g^*_L - g^*_R)\, L_R}{L^2} \tag{7.35}$$

As $g^*_R < g^*_L$, a new right-wing individual will decrease government size $(\frac{\partial g}{\partial L_R} < 0)$ whilst a new left-wing individual would increase it $(\frac{\partial g}{\partial L_L} > 0)$

For large populations, the membership fee for a government size that changes with L is given by:

[7] Under the implicit assumption that right-wing members use less impure public goods than left-wing. This is the case when right-wing individuals are richer and prefer to pay for their education or healthcare instead of consuming the one providing by the state.

$$\frac{\partial P}{\partial L}\mid_R \approx p\left[1+\frac{(\beta_R-1+L\cdot LnL\frac{\partial \beta_R}{\partial L})+\frac{\partial g/g}{\partial L/L}\left(gLnL\frac{\partial \beta_R}{\partial g}-1\right)}{\alpha_P}\right] \tag{7.36}$$

$$\frac{\partial P}{\partial L}\mid_L \approx p\left[1+\frac{(\beta_L-1+L\cdot LnL\frac{\partial \beta_L}{\partial L})+\frac{\partial g/g}{\partial L/L}\left(gLnL\frac{\partial \beta_L}{\partial g}-1\right)}{\alpha_P}\right] \tag{7.37}$$

For incumbent right-wing individuals, allowing entry to new right-wing individual will be beneficial as $\frac{\partial g}{\partial L_R} < 0$ and $g_R^* < g^*$(which implies $gLnL\frac{\partial \beta_L}{\partial g} > 1$) whilst admitting a left-wing will result detrimental as $\frac{\partial g}{\partial L_L} > 0$. The opposite will hold from the point of view of the incumbent left-wing individuals.

Looking at (7.34) and (7.35), it also holds that the larger the difference in optimum levels $g_R^* - g_L^*$, and the number of members of the opposite group, the larger the incentive to accept members of the same group, and vice-versa:

$$\frac{\partial P}{\partial L}\mid_R^R \approx p\left[1+\frac{(\beta_R-1+L\cdot LnL\frac{\partial \beta_R}{\partial L})+\frac{(g_R^*-g_L^*)}{g}\cdot\frac{L_L}{L}\left(gLnL\frac{\partial \beta_R}{\partial g}-1\right)}{\alpha_P}\right] \tag{7.38}$$

$$\frac{\partial P}{\partial L}\mid_R^L \approx p\left[1+\frac{(\beta_R-1+L\cdot LnL\frac{\partial \beta_R}{\partial L})+\frac{(g_L^*-g_R^*)}{g}\cdot\frac{L_R}{L}\left(gLnL\frac{\partial \beta_R}{\partial g}-1\right)}{\alpha_P}\right] \tag{7.39}$$

$$\frac{\partial P}{\partial L}\mid_L^R \approx p\left[1+\frac{(\beta_L-1+L\cdot LnL\frac{\partial \beta_L}{\partial L})+\frac{(g_R^*-g_L^*)}{g}\cdot\frac{L_L}{L}\left(gLnL\frac{\partial \beta_L}{\partial g}-1\right)}{\alpha_P}\right] \tag{7.40}$$

$$\frac{\partial P}{\partial L}\mid_L^L \approx p\left[1+\frac{(\beta_L-1+L\cdot LnL\frac{\partial \beta_L}{\partial L})+\frac{(g_L^*-g_R^*)}{g}\cdot\frac{L_R}{L}\left(gLnL\frac{\partial \beta_L}{\partial g}-1\right)}{\alpha_P}\right] \tag{7.41}$$

7.3.4. Citizenship premium

If incumbents were much less prone to a large government than new joiners, giving vote to the latter would be detrimental to the incumbents, as the new entrants may vote for a more redistributive form of society. As a consequence, incumbents would price in the potential change in g in the entry fee. The price or better said premium of citizenship would then be the difference between the membership fee for the permanent residence with and without voting rights, which is given by:

$$\frac{\partial P}{\partial L} \approx p\left[\frac{\partial g/g}{\partial L/L}\left(gLnL\frac{\partial \beta}{\partial g} - 1\right)\right] \tag{7.42}$$

The model helps to explain why besides capital dilution considerations, poor immigration may be perceived as undesirable as it can potentially lead to an enlargement of government size, and thus extract a rent from richer incumbents. Similarly, even in the case when new members cannot vote, as is the case with non naturalized immigrants, if the latter make a much larger use of public services, like healthcare or education, that cause an increase in its provision in order to neutralize crowding effects, immigration can cause an expansion in the size of the government which may come at a cost of the native population.

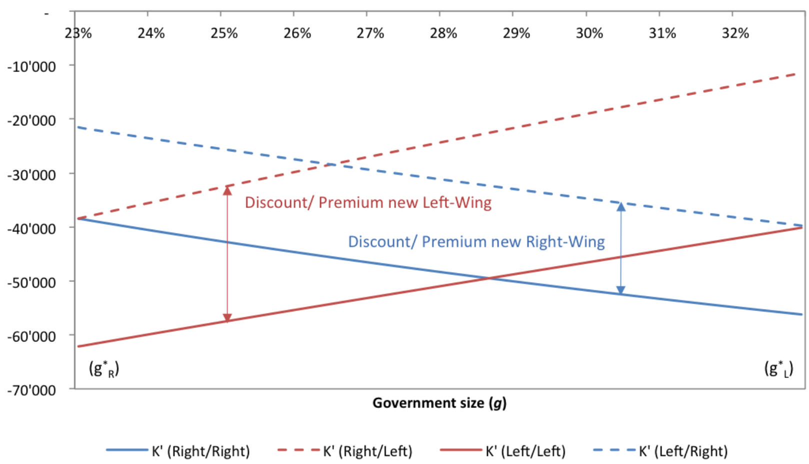

Figure 7.1.: Entry fee for different types of incumbents/ new joiners

7.3.5. Case study: Immigrant regularization programs in the EU

Since the 70s the large majority of governments in Europe have put in place at some point in time regularization programs aimed at addressing the increasing number of unauthorized immigrants within their borders. In simplest terms, regularizations have consisted in granting legal status to unauthorized immigrants who fulfilled a number of requisites (humanitarian grounds, family reunification, years of residence, etc.). Regularizations have been used as a pragmatic though contentious corrective tool to deal with the fact that countries had large pools of immigrants in an irregular situation.

According to Brick (2011) regularization programs have broadly pursued two main aims, to regulate labor markets and grant unauthorized workers legal status, and to facilitate residence for humanitarian reasons. Northern European countries were the first to introduce labor market-driven regularization programs in de 70s, once immigration started to be managed in a more restrictive basis following the halt on labor demand brought by the oil crisis. Nowadays however these countries exclusively regularize immigrants for humanitarian purposes, whilst southern European countries have launched in the last decade large-scale regularization programs focusing on migrant workers.

Generally speaking, illegal workers typically belong to the lowest income quartile of the labor force. Accordingly and in line with the economic literature dedicated to the study of the fiscal and transfer effects of migration, regularized immigrants can be assumed to cause an expansion in government size, independently of whether they can vote or not. Moreover, regularizations open the door for immigrants to achieve citizenship via naturalization. Despite the opportunities for social mobility, it can be assumed that, in aggregate, they will remain in the lower income brackets of society,[8] and hence be inclined to vote for parties supporting a larger government. If the latter would be the case, one would expect regularizations to be supported by left-wing parties and opposed by right-wing parties. On the other hand, low-income workers would be negatively affected by facing competition in the labor market. Which of the two effects dominates cannot be easily ascertained and as it will be latter discussed, a quantitative analysis will produce inconclusive results.

When looking at the rich data collection of immigrant regularization programs in the EU provided by Kraler (2009), we can observe however that regularizations have been undertaken by governments of all political signs, as tables 7.2 and 7.3 clearly illustrate. To assess whether a certain relationship can be observed between the political sign of the government and the propensity to regularize illegal immigrants, this study has complemented Kraler's (2009) data by looking at the composition of government at the time the regularization program took place, as well as the amount, in percentage of the total population, that the regularized immigrants represented. It can be observed how since 1973 a total of 4.93 million irregular immigrants have been regularized in the EU through 62 different programs. Out of the total, 2.88 million were regularized by governments that can be labeled as left-wing, whilst 2.06 million were regularized by right-wing parties.

Table 7.1 shows the results of conducting a simple regression analysis taking as dependent variable the percentage of total population represented by the immigrants regularized in the

[8] Borjas (1994) confirms this for the US markets which is one of the countries where social mobility is highest.

program,[9] and as independent variable the ideology of the ruling party (coded as a dummy variable: 1 = "Left-wing", = 0 "Right-wing"). It can be observed that as predicted by the model there is a positive yet not statistically significant relation between left-wing governments and the size of immigrants regularized. When adding a new variable to inform whether the government was a coalition of parties, we can observe both the coefficient for government ideology and its significance decrease. The sign of the coefficient for a coalition government is negative indicating that the need to find consensus reduces the amount of immigrants regularized. The interaction variable shows that this effect is more significant in left-wing coalitions as the coefficient is negative. Lastly, it can be observed that when accounting for the year of introduction of the program, regularization programs seem to gain in size over time. Additionally, the coefficient associated to the sign of the government increases.

The results can have several interpretations. First when associating preference for government size with political sign we are obviously ignoring other elements associated to each political option that can have a counteracting effect on their stance towards immigration. For example, left-wing parties typically represent the interests of the working class which is the most affected by replacement effects in the labor market as has been illustrated in Sec. 7.2. Conversely, right-wing parties in Europe typically endorse liberal values, which speak for the free movement of people and equal opportunities for all individuals. Hollifield (2004) argues that migration policies of liberal states can be interpreted as steering a path between the realization of economic gains (which requires careful, if not always restrictive, management) and respect for liberal values (which tends to erode such policies). Kriesi et al. (2006, 2008) find that as a result of globalization, party behavior is structured along two cleavages, a socio-economic and a socio-cultural one. The well-educated individuals reap the rewards of globalization, while the less qualified are confronted with the off shoring of jobs and increasing domestic labor competition from immigrants. As a result, the *losers* of globalization are more likely to support restrictive immigration policies

A second reason that can explain why left-wing parties do not pursue much more actively to enlarge their electoral base by promoting immigration may lie in the fact that immigrants are to a certain degree *self-selected*,[10] and hence may have more entrepreneurial traits than the average native population.[11] If this would be true, a significant number of immigrants could be actually positioned closer to a right-wing ideology. Evidence in the US however seems to point in the other direction. The Pew Research Center's National Survey of Latinos in 2012[12]

[9]Measuring population at the year when the regularization took place.
[10]Instead of just an average sample from their respective countries of origin.
[11]See Borjas (1994) for a discussion on different theories of immigrant self-selection.
[12]"Are unauthorized immigrants overwhelmingly Democrats?". Pew Research Center, July 23, 2013.

found that among Latino immigrants who are not U.S. citizens or legal permanent residents (and therefore likely unauthorized immigrants), some 31% identify themselves as Democrats and just 4% as Republicans.[13] When looking at political party affiliation amongst Hispanics, 70% of registered votes either support or lean towards the Democratic Party, whilst only 20% do so with the Republican Party.[14] Not surprisingly Obama's immigration reform proposal has triggered speculation that Democrats will extract a political gain if the nation's estimated 11.1 million unauthorized immigrants – three quarters of whom are Hispanics – eventually are granted the right to vote.

A third plausible explanation is that as proposed by Freeman (1995), the concentrated benefits and diffuse costs associated to immigration produce client politics dominated by interest groups (employer groups, trade unions, human rights activists, etc.); diffuse costs and benefits yield majoritarian politics with no clear winners or losers; concentrated costs and diffuse benefits produce entrepreneurial politics as adversely affected groups seek to escape bearing the burden of policies. In fact, the political debate around immigration has been largely absent in Europe until very recently.[15] Mainstream political parties seemed to have an implicit pact to exclude the topic from the political agenda, with most measures, like the regularization programs, introduced by administrative decree instead of by debate in open parliamentary forum. Only when extreme right-wing parties started capturing votes from public discontent around immigration, have mainstream political parties brought immigration prominently into the political agenda, up to the point that in the recent elections in the UK, immigration featured as one of the top issues deciding the election.[16] The increasing saliency of immigration as a political topic would explain why when accounting for the year of introduction in the regression the coefficient associated to the political sign increases. This confirms the results obtained from Alonso and da Fonseca (2009) by comparing the policy positions of left and right party families towards immigration across 18 West European countries since 1945 using data from the Comparative Manifestos Project.

In summary, even though there seems to be a certain empirical evidence pointing towards left-wing parties being more accommodating of immigration than right-wing ones, the relationship is not statistically significant; probably affected by other variables rather than preference for government size affecting political choices, as well as by the changing visibility of immigration

[13] An additional 33% say they are political independents, 16% mention some other political party and 15% say they "don't know" or refuse to answer the question.

[14] Even though the Democratic Party could not be considered as a left-wing part by European standards, it supports a larger government than the Republican party.

[15] With the exception of Switzerland as explained in Chapter 3, Sec. 3.4

[16] International internet-based market research firm YouGov showed immigration was the most important issue for the electorate between May to December 2014, save for on three occasions when tied with the economy.

as a political issue.

Beyond mainstream parties, there is clear evidence that immigration has been one of the main sources of support for extreme right populist parties in Western Europe.[17] Interestingly, the main support for these parties has come from the working class.[18] The far left on the contrary tend to focus on mitigating the humanitarian and social issues arising from immigration, but do not pursue actively to increase the immigration intake.

[17] See Betz (1994), Betz and Immerfall (1998) and Schain et al. (2002)

[18] Oesch (2008) explains workers support for extreme right parties is remarkable, as it runs counter to common wisdom about class voting, whereby individuals strongly exposed to labor market risks and possessing few socioeconomic resources are expected to opt for more state intervention and hence to favor parties on the left

	(1)	(2)	(3)	(4)
Political sign of Govt.	0.002	0.001	0.002	0.002
	[0.94]	[0.58]	[0.76]	[1.02]
Coalition		-0.003	-0.002	-0.001
		[-1.55]	[-0.72]	[-0.45]
Political sign * Coalition			-0.002	-0.002
			[-0.51]	[-0.62]
Year				0.000
				[1.62]
Intercept	0.003***	0.005***	0.004**	-0.271
	[2.72]	[3.10]	[2.28]	[-1.60]
Observations	62	62	62	62
R-squared	0.014	0.053	0.057	0.099
Adjusted R-squared	-0.002	0.021	0.008	0.035

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Dependent variable: Regularized immigrants in % of total population at year of start of the program

t statistics in brackets

Data source: tables 7.2 and 7.3

Table 7.1.: Regression table for immigrant regularization programs in the EU 1972 - 2008

Country	Program Year(s)	Government Party	Ideology	Coalition	Regularized	% Population
France	1973	Union of Democrats for the Republic	Right-wing	No	40’000	0.08%
Belgium	1973-75	Socialist Party	Left-wing	Yes	7’448	0.08%
United Kingdom	1974-1978	Labour Party	Left-wing	No	1’809	0.00%
Netherlands	1975	Labour Party	Left-wing	Yes	15’000	0.11%
United Kingdom	1977	Labour Party	Left-wing	No	462	0.00%
Netherlands	1978	Christian Democratic Appeal	Right-wing	Yes	180	0.00%
Netherlands	1979	Christian Democratic Appeal	Right-wing	Yes	1’800	0.01%
France	1981-82	Socialist Party	Left-wing	No	130’000	0.23%
Italy	1982	Christian Democracy	Right-wing	Yes	12’000	0.02%
Spain	1985	Socialist Party	Left-wing	No	23’000	0.06%
Italy	1986	Socialist Party	Left-wing	Yes	118’700	0.21%
Luxembourg	1986	Popular Party	Right-wing	Yes	1’100	0.30%
Austria	1990	Social Democrat	Left-wing	Yes	30’000	0.39%
Italy	1990	Christian Democrat	Right-wing	Yes	234’841	0.41%
France	1991	Socialist Party	Left-wing	No	15’000	0.03%
Spain	1991	Socialist Party	Left-wing	No	109’135	0.28%
Denmark	1992-2002	Social Democrat	Left-wing	Yes	4’989	0.10%
Portugal	1992-93	Social Democratic	Right-wing	No	38’364	0.39%
Luxembourg	1994	Popular Party	Right-wing	Yes	470	0.12%
Belgium	1995-99	Christian People’s Party	Right-wing	Yes	37’900	0.37%
Italy	1995	Forza Italia	Right-wing	Yes	238’000	0.42%
Luxembourg	1995	Popular Party	Right-wing	Yes	996	0.24%
Germany	1996	Christian Democratic Union	Right-wing	Yes	7’856	0.01%
Luxembourg	1996	Popular Party	Right-wing	Yes	1’500	0.36%
Portugal	1996	Popular Party	Left-wing	No	31’000	0.31%
Spain	1996	Socialist Party	Left-wing	No	21’300	0.05%
France	1997-98	Socialist Party	Left-wing	Yes	87’000	0.15%
Austria	1998	Social Democrat	Left-wing	Yes	85’000	1.07%
Greece	1998	Socialist Party	Left-wing	No	370’000	3.41%
Greece	1998	Socialist Party	Left-wing	No	220’000	2.03%
Italy	1998	The Olive Tree	Left-wing	Yes	193’200	0.34%

Table 7.2.: EU regularization programs (I)

Country	Program Year(s)	Government Party	Ideology	Coalition	Regularized	% Population
Germany	1999	Social Democratic Party of Germany	Left-wing	No	18’258	0.02%
Netherlands	1999	Labour Party	Left-wing	Yes	1’877	0.01%
Slovenia	1999	Liberal Democracy of Slovenia	Right-wing	No	12’000	0.61%
United Kingdom	1999	Labour Party	Left-wing	No	11’140	0.02%
Belgium	2000	Flemish Liberal & Democrats	Right-wing	Yes	37’900	0.37%
Denmark	2000	Social Democrat	Left-wing	No	3’000	0.06%
Spain	2000	Popular Party	Right-wing	No	153’463	0.38%
United Kingdom	2000	Labour Party	Left-wing	No	10’235	0.02%
Greece	2001	Socialist Party	Left-wing	No	228’000	2.08%
Luxembourg	2001	Popular Party	Right-wing	Yes	1’839	0.42%
Portugal	2001	Socialist Party	Left-wing	No	185’000	1.79%
Spain	2001	Popular Party	Right-wing	No	221’083	0.54%
Italy	2002	Forza Italia	Right-wing	Yes	634’728	1.11%
Slovenia	2002	Liberal Democracy of Slovenia	Right-wing	No	2’200	0.11%
Poland	2003	Democratic Left Alliance (SLD)	Left-wing	Yes	2’747	0.01%
Portugal	2003	Social Democratic	Right-wing	No	19’408	0.19%
Hungary	2004	MSZP	Left-wing	Yes	1’194	0.01%
Netherlands	2004	Christian Democratic Appeal	Right-wing	Yes	2’300	0.01%
Portugal	2004	Social Democratic	Right-wing	No	19’261	0.18%
United Kingdom	2004	Labour Party	Left-wing	No	9’235	0.02%
Greece	2005	New Democracy	Right-wing	No	186’400	1.68%
Ireland	2005	Fianna Fáil	Right-wing	No	16’693	0.40%
Serbia	2005-2006	Democratic Party of Serbia	Right-wing	No	17’000	0.23%
Spain	2005	Socialist Party	Left-wing	No	578’375	1.32%
United Kingdom	2005	Labour Party	Left-wing	No	11’245	0.02%
Germany	2006	Christian Democratic Union	Right-wing	Yes	71’857	0.09%
Italy	2006	The Olive Tree	Left-wing	Yes	350’000	0.60%
United Kingdom	2006	Labour Party	Left-wing	No	5’000	0.01%
Greece	2007	New Democracy	Right-wing	No	20’000	0.18%
Netherlands	2007	Christian Democratic Appeal	Right-wing	Yes	25’000	0.15%
Poland	2007-2008	Civic Platform (PO)	Right-wing	Yes	459	0.00%

Table 7.3.: EU regularization programs (II)

7.4. Preferences for social homogeneity

7.4.1. Political economy implications of social homogeneity

Assuming there are two types of individuals A and B who in principle agree on the optimal size of the government, and assuming also that each of them would *perceive heterogeneity from their own point of view* (i.e., individuals of type A see beneficial a high proportion of type A relative to type B and vice-versa), the respective heterogeneity parameters can be written as:

$$\psi_A = \phi\left(1 - \frac{L_A}{L_A + L_B}\right) = \phi\frac{L_B}{L_A + L_B} \tag{7.43}$$

$$\psi_B = \phi\left(1 - \frac{L_B}{L_A + L_B}\right) = \phi\frac{L_A}{L_A + L_B} \tag{7.44}$$

where ϕ is a parameter that scales the influence heterogeneity has on the utility of the individuals, or alternatively, scales how different A and B are.

The changes in heterogeneity for individuals of type A when a different type of individuals joins can be expressed as:

$$\frac{\partial\psi_A}{\partial L_A} = -\phi\frac{L_B}{(L_A + L_B)^2} = -\frac{\psi_A}{L_A + L_B} \tag{7.45}$$

$$\frac{\partial\psi_A}{\partial L_B} = \phi\frac{L_A}{(L_A + L_B)^2} = \frac{\psi_B}{L_A + L_B} \tag{7.46}$$

$$\frac{\partial\psi_B}{\partial L_A} = \phi\frac{L_B}{(L_A + L_B)^2} = \frac{\psi_A}{L_A + L_B} \tag{7.47}$$

$$\frac{\partial\psi_B}{\partial L_B} = -\phi\frac{L_A}{(L_A + L_B)^2} = -\frac{\psi_B}{L_A + L_B} \tag{7.48}$$

When the proportion in individuals of one type is much larger than the other, the discount in the entry fee for individuals of the predominant type is much smaller than the premium requested to individuals of the other type.

Assuming that both types of individuals A and B can vote and that the membership fee would be the weighted average of the fee requested by the two types, the entry fee for individuals of type A for permanent residence will be given by:

$$p_A^* = p\left[\left(\frac{L_A}{L_A + L_B}\right)\left(\beta + \psi_A + LnL \cdot \frac{\partial \psi_A}{\frac{\partial L_A}{L}}\right) + \left(\frac{L_B}{L_A + L_B}\right)\left(\beta + \psi_B + LnL \cdot \frac{\partial \psi_B}{\frac{\partial L_A}{L}}\right)\right] = \tag{7.49}$$

$$= p\left[\beta + \phi \frac{L_B}{(L_A + L_B)^2}\left(2L_A - LnL\left(L_A - L_B\right)\right)\right] \tag{7.50}$$

As expected by construction, the last term in the parenthesis takes a negative value (i.e., decreases the membership fee) when the new entrant (A) belongs to the majority type ($L_A > L_B$) and vice-versa. To assess the values that the second term in the equation takes in relation to the proportion of individuals of type A and B, we define $\rho = \frac{L_A}{L_A + L_B} = \frac{L_A}{L}$, therefore $L_A = \rho L$ and $L_B = L(1-\rho)$. Equation (7.50) can be then expressed as:

$$p_A^* = p\left[\beta + 2\phi(1-\rho)(\rho - LnL(\rho - \frac{1}{2}))\right] \tag{7.51}$$

The minimum of this function is at:

$$\frac{\partial p_A^*}{\partial \rho} = 2LnL\rho - \frac{3LnL}{2} + 1 = 0 \Rightarrow \rho \approx \frac{3}{4} \tag{7.52}$$

The second term of (7.51) will be equal to zero when $\rho = 1$ or when $(\rho - LnL(\rho - \frac{1}{2})) = 0$, which occurs when $\rho \approx \frac{1}{2}$. The following graph shows p_A^* and p_B^* in multiples of p (assuming $\beta = 0$ for simplicity) and in relation to their relative proportion in the society.

The chart helps to illustrate how when a certain type dominates, the membership fee for individuals of the same type has a discount. This is maximum when the share of the type in total population is 75%, and zero when is 50% or 100%.

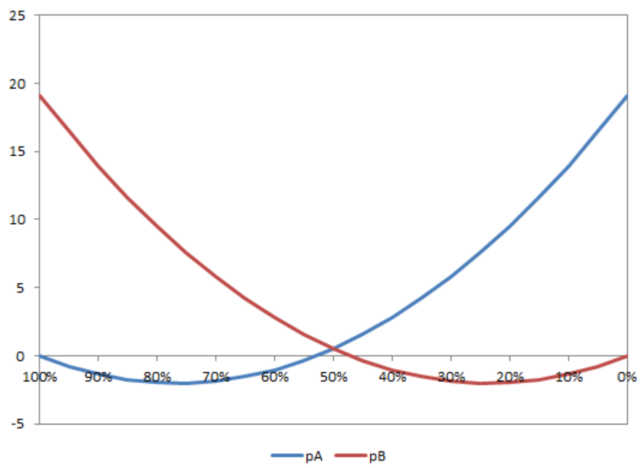

Figure 7.2.: Heterogeneity premium/discount in relation to share of individuals of type A in the total population

7.4.2. Case study: Israel's Law of Return

The Parliament of Israel enacted the "Law of Return", on July 5, 1950. The Law declares the right of Jews to come to Israel. The Law of Return was modified in 1970 to extend the right of return to non-Jews with a Jewish grandparent, and their spouses. Several reasons for the late amendment have been advanced, the first and most obvious is the perceived demographic threat that an Arab population with higher fertility rates posed to the subservience of the state of Israel. This decision has to be analyzed in the context of the regional conflict, where Israel had fought several wars with its neighboring countries, and in particular after the Six day War in 1967, which exacerbated the perception within the country of being at threat.

In 1968, the Government of Israel established the Ministry of Immigrant Absorption for the specific purpose of facilitating immigrant integration. The government did not merely assist passively but offered a series of incentives for newcomers to settle in the country in the form of travel assistance, housing, facilities for establishing business, custom and tax reliefs for importing or acquiring new goods after settlement, as well as free education for a certain period of time.[19] Official support for immigration was very open, as proves the following statement in the Israel Government Yearbook (1968-69): *"Today, more than ever before, the State is geared to absorb newcomers. Our citizens and our institutions are alive to the essentiality of that objective, and are prepared to invest all the good-will, the finances and endeavor that they can*

[19]Toren (1978).

muster to ease and hasten its attainment. The gates of Israel stand wide open. Israel is ready and welcomes its new citizens." which represents an unprecedented case of a state promoting mass immigration in modern times (though ethnically selective).

When comparing with the theoretical model above, it is apparent that the influence of heterogeneity in the utility function (the parameter ϕ) had to be large enough so that an increase in homogeneity more than compensated the crowding and dilution effects associated to such an increase in population. This welcoming attitude towards immigration did not materially change even after Michael Gorbachev lifted in 1989 the restrictions on emigration for Jews in the USSR and a large number of them fled to Israel.

Jews in the USSR had been first allowed to migrate to Israel for family reunion reasons in 1970. From 1970 to 1988, a total of about 291,000 Soviet Jews and their relatives emigrated from the country, of which 165,000 settled in Israel [20], and the rest further emigrated to other countries mostly to the US. In a clear sign of the importance that Jewish immigration had to the country, the government made great efforts to retain as many of these immigrants in the country.[21] However, the opening that started with the Perestroika facilitated the arrival between 1989 and 1993 of almost half a million Jews from the USSR (a 10% increase when compared with an existing population of about 5 million in 1989) and that reached almost a million by 2006.[22] The abruptness and extensiveness of this immigration wave created some concerns about crowding in public services for the incumbent population but the increase in heterogeneity seems to have overcompensated them. To the extent that the government proactively tried to accommodate the newcomers by s initiating several programs to encourage the construction of residential buildings. Lustick (1999) reflects the social debates at the time around the degree of *"Jewishness"* of the newcomers (as in many cases there was only one family member with a distant Jewish ancestor), but how overwhelmingly the Jewish population perceived this wave of immigrants as a positive outcome for the demographics of the country. Speaking to Likud Party veterans in January 1990 Prime Minister Yitzhak Shamir referred to the *miraculous* appearance of the mass immigration *"Just when many among us were saying that time is working against us, time has brought us this aliya and has solved everything. In five years, we won't even be able to recognize the country... .The Arabs around us are in a state of disarray and panic... .They are shrouded by a feeling of defeat, because they see the intifada doesn't help... . They cannot stop the natural streaming of the Jewish people to their homeland"*.

When looking at the model, it becomes apparent that at the moment when mass migration

[20] Lazin (2005).

[21] For a detailed description of these efforts and the lobby exerted by American Jews to provide them with freedom of choice see Lazin (2005).

[22] Tolts (2009).

started to be proactively pursued, the percentage of Jewish population was about 85% (80% when Russian Jews started to arrive en mass), exactly in the region where the model predicts the incentives for admitting like individuals are the highest. As a thought experiment, it is not difficult to imagine that the resistance to such a sudden flow of immigrants would have been much larger had the population been totally homogeneous, or had the share of the Arab population been large enough to oppose the movement.

Despite the temporary halt brought by the immigration of Russian Jews, the non-Jewish share of the Israeli population has kept on growing, as illustrated in Figure 7.3. As a consequence, the incumbent Jewish majority has not only maintained the policy of open doors for Jewish immigrants but also proactively increased the hurdles for immigrants of Arab origin to become citizens of the state. The most prominent example is given by the enactment of the *"Citizenship and Entry into Israel Law"* in 2003. This law makes inhabitants of Iran, Afghanistan, Lebanon, Libya, Sudan, Syria, Iraq, Pakistan, Yemen, the West Bank and Gaza Strip ineligible for the automatic granting of Israeli citizenship and residency permits that is usually available through marriage to an Israeli citizen (i.e., family reunification).

This phenomenon is also predicted by the model as, contrary to what happens with immigrants from the majority type, when there is a region where the benefits can overturn the costs, in the case of immigrants from the minority there is always a large incentive to reject them.

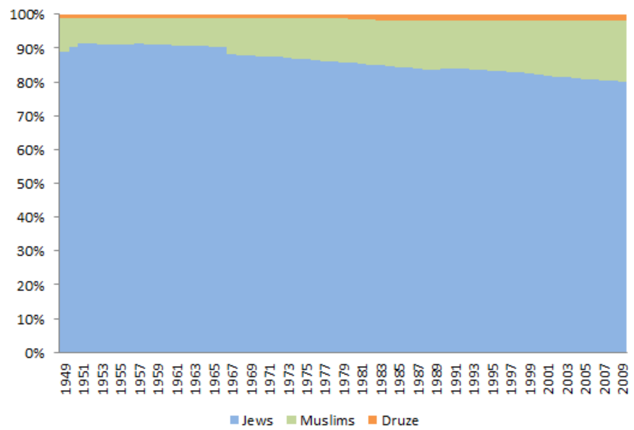

Figure 7.3.: Population of Israel. Source: The Central Bureau of Statistics

7.4.3. Case study: Native American's *"blood quantum"* tribe membership requirements

Historic evolution of blood quantum requirements Native American tribes enjoy a unique legal status in the United States. They have the right to form their own governments, to enforce laws within their lands, to tax, to license and regulate activities and to zone and to exclude persons from tribal territories. Tribes have also the right to determine membership requirements and to determine who is entitled to receive benefits from either the tribe or the federal government. A majority of tribes have their own written constitutions.[23]

The notion of tribe membership has historical roots that extend back to the early nineteenth century, when in the process of dispossessing Native Americans of their lands, the US Government negotiated treaties that entitled both the tribes as entities and individual tribal members for a compensation. As a consequence, the Federal Government started to register who was recognized as an *"Indian"* and thus eligible for benefits. Although requisites differed between States and treaties, they typically required the possession of a threshold amount of Indian or tribal ancestry that is know *as "blood quantum"*.[24]

The definition of *"Indian"* was formalized with the Indian Reorganization Act (IRA) of 1934, and included: *"[A]ll persons of Indian descent who are members of any recognized Indian tribe now under Federal jurisdiction, and all persons who are descendants of such members who were, on June 1, 1934, residing within the present boundaries of any Indian reservation, and . . . persons of one-half or more Indian blood"*.[25]

After the enactment of the IRA, The Bureau of Indian Affairs (BIA) encouraged tribes to enact constitutions embedding a certain blood quantum membership requirement[26] and still today the BIA still uses a blood quantum definition – generally one-fourth Native American blood – and/or tribal membership to recognize an individual as Native American.[27] However, with the IRA, tribes also gained the right to organize constitutional governments and form corporate entities, and over time began to regulate their membership more carefully, especially with regard to land allotments, royalties from the sale of resources, distributions of tribal funds, and voting.[28]

Some tribes have changed enrollment criteria over time. These changes have often entailed the introduction of blood quantum requirements for those born after a certain date. For instance,

[23] Cohen (1942).
[24] See Spruhan (2006) for a recount of the legal history of blood quantum in Federal Indian law.
[25] Spruhan (2006).
[26] See Spruhan (2007).
[27] Thornton (1997).
[28] See Thornton (1997).

in 1962, the Blackfeet tribal council amended the constitution to include a 1/4 blood quantum requirement.[29] Sometimes the change has been to establish more stringent requirements: the Confederated Salish and Kootenai Tribes have tightened their initial membership requirements and established that only those born with a 1/4 or more blood quantum could be tribal members.[30] Conversely, some tribes have opted for reducing their blood quantum requirements, sometimes even completely eliminating them: the White Earth Band of Ojibwe decided in referendum in 2013.[31]

Economic incentives of tribe membership Tribe membership has many elements in common with club membership. Tribe members can enjoy several benefits; some are subsidized by the federal Government, like healthcare and education, whilst others are derived from the tribe's common assets. The later includes amongst others access to communal resources (land, fisheries, hunting reserves, etc.), distributions from natural resources held in trust (timber, mineral resources) as well as distribution of profits from the casinos which, since the introduction in Native American reservations following the approval of the Indian Gaming Regulatory Act in 1988, have become widespread.

Conversely, the tribe benefits from a new member in first instance by receiving more federal funds, which are typically calculated on a per capita basis. There are more than 50 Federal programs administered by the BIA and the Bureau of Indian Education (BIE), which administer an annual budget of roughly $2.9 billion for about 1 million Native American Indians who live in reservations. These programs encompass: education, economic development, road maintenance, tribal courts, agriculture and social services. Besides the BIA and the BIE, other Federal agencies have subsidy programs. The Indian Health Service has a budget of about $4 billion and the Native American Housing block Grant Program has a budget of about $1 billion.[32] This results in a per capita transfer of roughly $8,000, which is a significant amount even for those tribes that have other relevant sources of income.

Moreover, a larger population decreases the risk that the tribe is declared "terminated" as a political entity by the government[33] and thus loses the main platform to preserve its heritage as well as all the economic benefits associated to its special political status, which include not

[29] See http://www.nativenews.jour.umt.edu/2013/?page_id=30.
[30] Trosper (1976).
[31] See http://www.mprnews.org/story/2013/11/20/politics/white-earth-band-votes-to-end-blood-quantum-for-tribal-membership.
[32] Edwards (2012).
[33] The US congress proactively terminated 109 tribes between 1953 and 1964 when the Indian Termination Policy was in place. Moreover, some scholars argue the BIA have actively pursued blood quantum policies as an *"autogenocidal"* measure, as with intermarriage and urbanization the number of members fulfilling the requirements will necessarily decrease. See Schmift (2011) for a review.

only direct Federal transfers but also the tax-free status for tribal assets held in trust. The threat of extinction is particularly relevant taking into consideration that the median size for Native American Tribes is only about one thousand individuals.[34]

When a tribe is rich in assets, the incentives to increase the number of members are naturally smaller. However, reducing membership by increasing blood quantum requirements requires a majority of incumbents possessing a higher blood quantum to support it. This has happened when there was a dominant faction within the tribe and strong economic interests involved. For example the Northern Ute tribe has been accused of disenfranchising other Ute groups since they received compensation for lost lands, transfer of water reserves and the discovery of oil and gas in the reservations. The Utes increased their blood quantum requirements twice, in 1950 to 1/2 and in 1958 to 5/8 – currently the highest requirement of any tribe. Other rich tribes have tried to alter their numerical composition by inspecting in detail the ancestry of its members. The Pechanga tribe in California operates a very profitable casino and has performed investigations over the course of several years to determine whether some of its members were legitimate Pechanga descendants, leading to the disenrollment of a considerable number of its members.[35] Some authors claim that tribes adopting gaming under IGRA have altered membership criteria.[36]

Other tribes on the contrary may have an incentive to reduce the blood quantum in order to secure Federal Funds that allows the tribe to survive and preserve their heritage. The Otoe Missouria for example decided in 2010 to lower the blood quantum requirements from 1/4 to 1/8. As the chairman of the tribe stated after the vote *"Our Tribe has gotten younger. A majority of our new members are younger people. This ensures a strong future for the Otoe-Missouria Tribe. With a larger membership, we should be able to obtain additional funds from government agencies"*.[37]

A club model explanation of blood quantum requirements Tribe and country membership are very similar and can be both explained by the same club model described in Sec. 4.1.1. The main assumption of the model is that membership requirements in Native American tribes are not only influenced by the economic costs and benefits of a larger population on incumbent members, but also steered towards facilitating the preservation of the values, cultural distinctiveness and autonomy of the tribe. Consequently, in principle a high degree of homogeneity or

[34] See Thornton (1997).
[35] Pechanga council release Feb 20, 2007.
[36] See Henderson (1998) for a recount of legal cases.
[37] See http://www.nativetimes.com/index.php/news/tribal/4551-tribe-reflects-on-blood-quantum-enrollment-change

blood quantum would be preferred by its members, who may choose to lower the blood quantum requirement if the economic benefits brought by a larger population – economies of scale and federal funds – compensate for the dilution of tribal assets and the decrease in homogeneity.

Assuming public assets per capita p are the sum of the existing tribal assets per capita p_t and the Federal transfers per capita p_{fed}, and defining the heterogeneity parameter as the complement of the blood quantum in the population q ($\psi = 1 - q$, $q \in [0, 1]$), equation (3.11) can be rewritten as follows to derive the entry fee into the tribe:

$$p^* \geq (1 + \beta - q) \cdot (p_t + p_{fed}) \tag{7.53}$$

In practice, individuals cannot enroll into a tribe by making a personal financial contribution. However, their enrollment is accompanied by an increase in Federal funds. Therefore, equation (7.53) turns into:

$$p_{fed} \geq (1 + \beta - q) \cdot (p_t + p_{fed}) \tag{7.54}$$

As tribes cannot request a financial payment to new members, nor can they deny access to a candidate who satisfies the blood quantum requirements, the only way tribe members have to regulate enrollment in a way that results advantageous for them is by requesting a blood quantum that satisfies the following inequality:

$$q \geq 1 + \beta - \frac{1}{1 + \frac{p_t}{p_{fed}}} \tag{7.55}$$

The empirical implications of the model are straightforward: the minimum blood quantum requirement should increase with the amount of crowding β in the tribe (or alternatively decrease with the degree of economies of scale) and the ratio of tribal assets over Federal transfers (p_t/p_{fed}).

Economies of scale will depend on the size and degree of economic development of the tribe, as well as on the nature of tribal assets. For example, tribes that are rich in depletable natural resources will have a higher β than those others that have renewable resources like forest land or fisheries. High per capita distributions to tribe members per se in relation to revenues invested in communal assets are also an indication of a high β as money is a rival good and communal assets are partially non-rival.

Assuming the amount of federal transfers per capita p_{fed} is the same for all tribes, rich tribes will tend to have higher blood quantum requirements than poor ones. As a result, tribes operating profitable casinos, receiving significant compensation from expropriated lands or receiving revenues from leases on mineral resources concessions on their reservations, should tend to have higher blood quantum requirements.

However, the assets of a tribe per se are not a good indicator of the blood quantum requirement, as these need to be weighted against the total number of individuals in the tribe as well as with the percentage of revenues that are passed to tribe members as opposed to invested in communal assets, which further affects the economies of scale of tribal assets.

Moreover, some of the assets the tribe wants to preserve are of an intangible nature, like language, folklore, values. These assets are non-rival and therefore the larger their importance in relation to tangible ones, the lower the crowding parameter β.

Empirical considerations: initial blood quantum and succeeding *"drift"* Original blood quantum requirements were necessarily influenced by the existing blood quantum degree in the tribe at the time they were defined. As constitutions had to be accepted by a majority, it is unlikely that some members would vote for a blood quantum requirement that would throw them out of the tribe. Conversely a $1/4$ requirement in a population with an average of $1/2$ is as exclusive as a $1/8$ requirement in a population with an average of $1/4$, as new high blood quantum cannot be created from outside the tribe (assuming all individuals with high blood quantum are enrolled in the tribe). Therefore, when making cross-tribal empirical tests it is important to cater for these differences or to test for changes in blood quantum requirements instead. For a particular tribe the heterogeneity parameter could be normalized in relation to the median blood quantum of the existing tribe members $\psi = \tilde{q} - q$. Equation (7.55) transforms then into:

$$q \geq \tilde{q} + \beta - \frac{1}{1 + \frac{p_t}{p_{fed}}} \tag{7.56}$$

Furthermore, intermarriage and urbanization have made the average blood quantum decrease over time. Therefore original requirements have turned more stringent, making it more difficult to be enrolled for the progeny of existing members. As current members will not only care for themselves but also for their descendants, there has to be a necessary *"drift"* of blood quantum requirements over time. On the other hand, there is at least anecdotal evidence that tribe members enjoying large benefits may have made mating choices allowing them to secure the entitlements for their descendants. These two aspects need to be taken into consideration when making inter-temporal empirical tests.

7.4.4. Case study: secessions and unifications

The club model has provided a framework to derive the equilibrium membership conditions required to a new member, assuming the number of new entrants is relatively small, as is usually the case with immigration.[38] Furthermore, a reverse use of the model can also help us explain the conditions for *"country exit"*, i.e. the amount of public capital a leaving member should receive. If economies of scale allow the membership fee to be below the existing public capital per capita, the loss of these economies would also cause the *exit fee* to be below that level. Even if the model assumes the number of new entrants is infinitesimally small, the intuition it provides is helpful for understanding instances when a country decides on letting a large number of individuals to join or to leave, as is the case in unifications and secessions.

Conditions for a Pareto-efficient split When observing these phenomena, homogeneity plays a crucial role. The German reunification for example would be difficult to imagine if not because of the cultural proximity of both countries. An opposite case is that of the enlargement of the European Union, and where to set its limits, with the proposed accession of Turkey been contested on claims for cultural homogeneity.[39] Conversely, the majority of the separatist movements can be explained by the opposite reason: a desire to gain cultural or ethnic homogeneity (e.g., the Basque and Catalan movements in Spain, Corsican in France, or Quebec in Canada). On the other hand, there are several advantages from a large population size that speak for keeping a country together and to join unions.

Alesina and Spolaore (1997) propose a model where the optimal size of nations results from the interplay between economies of scale and costs of heterogeneity. The club model however differs in two important ways. First, it provides a within-country perspective instead of a total economy view.[40] Second and most importantly, it incorporates public capital into the calculation, as the split of public capital per capita between the two new countries would matter.

[38] Annual net new immigration rates are rarely beyond the single digit percentage numbers.
[39] Triggering a debate about the need to mention Christian values in the European constitution.
[40] i.e., social planner optimization of the number of countries.

Assuming a country is composed of two homogeneous populations A and B with equal private capital endowments, a secession would be accepted by both parties when the following conditions are met:

$$I_A = \frac{F(K, P_A, L_A)}{L^{\beta_A+\psi_A}} \geqq I_{A\cup B} = \frac{F(K, P, L)}{L^{\beta+\psi}} \tag{7.57}$$

$$I_B = \frac{F(K, P_B, L_B)}{L^{\beta_B+\psi_B}} \geqq I_{A\cup B} = \frac{F(K, P, L)}{L^{\beta+\psi}} \tag{7.58}$$

After the split, both populations should necessarily decrease their degree of economies of scale associated to population size ($\beta_A > \beta$ and $\beta_B > \beta$). However, they will increase their degree of social homogeneity ($\psi_A < \psi$ and $\psi_B < \psi$). The change in homogeneity will be asymmetric when the two populations are very different in size, being the impact much larger in the minority than in the dominant population. On the other hand, the decrease in economies of scale should be larger for the smaller population as normally there are decreasing returns to scale. Hence, the incentives for a split depend on the relative importance of the two factors and are more salient for the minority population.

The way public capital is split can also have a great importance. If the post-split public capital per capita of the two populations differ ($\frac{P_A}{L_A} \neq \frac{P_B}{L_B}$), the one with the lower ratio will have a disincentive to split. In fact, very often it can be observed that secessionist regions are more public capital rich than the average of the rest of country (e.g., Basque and Catalan movements in Spain, or Lombardy in Italy).

The conditions for a unification will be the opposite as the ones given by equations (7.57) and (7.58). Interestingly, in the case of a unification the pre and post public capital per capita are more visible than in the case of a split, where it is difficult to calculate ex-ante the resulting split of public capital.[41] As a result, minimum convergence requirements are common to prevent a capital dilution of existing members. In the case of the EU the so-called Copenhagen criteria require *"the existence of a functioning market economy as well as the capacity to cope with competitive pressure and market forces within the Union. Membership presupposes the candidate's ability to take on the obligations of membership including adherence to the aims of political, economic and monetary union"*. Adherence to the monetary union however comes with more precise macroeconomic requirements including a limit for public debt to GDP. Conversely, this transparency has led to some European countries richer than the average, like is the case with Switzerland or Norway, to remain apart.

[41] Even in the highly transparent process around the referendum for Scottish independence, it was not clear to which extend both countries would split armies, national banks and some key infrastructure.

The dissolution of the Soviet bloc The disintegration of the former USSR led by Russia is a telling example of the importance that different capital endowments have in fostering secessions. In 1991, the GDP per capita in PPP of the different republics was significantly different: Lithuania \$9,079, Russia \$7,850, Latvia \$7,079, Estonia \$6,972, Ukraine \$5,503, Belarus \$4,745, Kazakhstan \$4,682, Georgia \$3,591, Azerbaijan \$3,471, Moldova \$2,867, Turkmenistan \$2,594, Tajikistan \$2,010, Armenia \$1,955, Kyrgyzstan \$1,696, Uzbekistan \$1,456 (Source: World Bank). Not surprisingly, it was the richer republic, Lithuania, the first to claim independence in March 1990, to which Russian elites opposed by ordering an economic blockade. It was followed by Latvia in March 1991. Estonia, which had issued the Estonian Sovereign Declaration in 1988, declared independence on August 20 1991, immediately after the failed coup d'état in August 1991. Russia, being the dominant republic (about 50% of the population at the time) had a more complex set of incentives as there was an inherent trade-off between enjoying a dominant role or departing alone as the other rich republics. Moreover, the USSR was not democratic but ruled by a privileged elite. It seems the Russian elite initially resisted the dissolution of the USSR as for them it meant losing their privileges, but the majority of Russian citizens were in favor of the independence. After the effective secession of the three Baltic republics, the other twelve republics continued discussing the continuation of a looser union, but in December 8, 1991 the presidents of Russia, Ukraine and Belarus (the next three richer republics) signed the *Belavezha Acccords* that dissolved the Soviet Union, and replaced it by the Commonwealth of Independent States. If capital per capita and homogeneity are the driving forces behind secessions, it can be questioned why there are cases where a richer majority does not allow the independence of a poorer minority (e.g., Corsica, Quebec, Palestine) which, according to the model, should be beneficiary for the richer group. The answer here might be that the majority might try to use its dominant position to *homogenize* the minority by means of cultural persuasion/ oppression and/or population settlements. Hence, even if at a given point in time a negotiated secession could be Pareto-efficient, majority groups might have an incentive to postpone any negotiation and use power tactics instead. The latter incentive is obviously larger when the majority is poorer. As a conclusion, we should expect peaceful secessions in geographically and ethnically separable groups when (i) One of the two is very dominant in number and has an economic benefit in dissolving the union or (ii) the size of the groups are comparable, and the capital per capita is not too different. In these cases, the resulting gains in homogeneity could provide clear incentives to both groups to split assuming the two resulting countries have still enough scale. This would explain why some countries from the former Soviet Bloc peacefully dissolved, even though there was certain disparity in capital per capita. The best example is the dissolution of Czechoslovakia.

When the split happened, the Czech GDP per capita (a proxy of capital per capita) was somewhat 20% higher that that of and Slovakia, but the very clear geographic and ethnic separation provided homogeneity gains for the Slovaks (particularly as before the split the capital was in Prague) and to a lesser extent to the Czechs (as fiscal transfers were stopped). Interestingly, at the time of the split most federal assets were divided in a ratio of 2 to 1, which was the approximate ratio between the Czech and the Slovak population. This is exactly what the model would predict.

The case of the former Yugoslavia provides also dramatic insights on the determinants for secessions turning out not peaceful. Yugoslavia was composed of Serbia (7.6 million inhabitants, $5,729 GDP/Capita in PPP 1997), Croatia (4.7 million inhabitants, $9,595 GDP/Capita in PPP 1997), Bosnia and Herzegovina (4.3 million inhabitants, $3,475 GDP/Capita in PPP 1997), and Macedonia (1.9 million inhabitants, $5,064 GDP/Capita in PPP 1997). Serbs, despite being the biggest majority, were about 40% of the population. All the countries with the exception of Bosnia and Herzegovina where ethnically relatively homogeneous and significant groups of Serbs were present in Bosnia and Herzegovina and in Croatia, but not in Macedonia. As the model would predict, Serbia allowed for the peaceful independence of Macedonia, as they had similar capital and perfect ethnic and geographic separability. Moreover, they fought Croatians when they declared their independence, which is what the model would imply once the capital per capita in Croatia was higher than in Serbia, and the geographical and ethnic split was contested on the borders. In the case of Bosnia the split of the population amongst Bosnian, Serbian, and Croatians offered no easy ethnic and geographical split, offering the Serbs the incentive to use their majority power.

Paradoxically, whilst we can observe abundant cases of separatist movements, we rarely see integration of nations. In the economic literature about secessions there are two main theories.[42] Bolton and Roland[43] argue that, unions should always be more efficient than splits, as the same redistributive results can be achieved with fiscal transfers. However, they reach that conclusion by considering only income differences between the subgroups, but not different endowments in capital per capita – or alternatively, the future income this capital will provide. Alesina and Spolaore (2003) argue on the contrary that the underlying driver is geography and the spread of democracy, as location is generally positively correlated with cultural homogeneity, first due to the increasing costs of administering distant locations, and second, by a lengthy process of sorting, identity formation and active policies aimed at increasing the degree of homogeneity. Thus, it is in those countries where marked and divisible differences are present - probably due

[42]See Bolton, Roland and Spolaore (1996) for a survey.
[43]Bolton and Roland (1997).

to a forced process of country formation in the past - that incentives for a split arise with the advent of democracy. However, the explanation for the asymmetry between splits and unions of nations might be in the answer to a different question: why it is so difficult to achieve capital and cultural homogeneity? History is one obvious reason, as the formation of nations is a path dependent and often violent process, from which countries arise with a certain amount of cultural and capital homogeneity. The other one is geography, as natural boundaries have been the biggest catalyst of culturally homogeneous societies. One might think that in non-democratic times, wars and geography molded the nation's borders, and that since the advent of democracy, economic forces are driving the process.

7.5. Conclusions

This chapter has analyzed a number of political economy implications arising from the country membership model. In a first step Benhabib's political economy model of immigration has been revisited to include dilution in public capital, which translates in larger changes in the labor-income ratio for an immigration policy to be accepted. Second, the model in Chapter 5 has been extended to cope with heterogeneous skills in the native population, analyzing then how the relative size of how skills and low skills workers as well as their elasticity of substitution affects the membership fee. Third, the chapter has analyzed the impact that diverging preferences for government size has on membership policies, and looked at the immigrant regularization programs in the EU for empirical evidence. Lastly, the chapter has reviewed how preferences for social homogeneity can play an important role in defining country membership policies, as illustrated by the case studies of Israel's Law of Return, the blood quantum requirements in Native American tribes, and a number of secessionist movements.

8. Empirical implications of the model

8.1. Introduction

The different case studies presented throughout the previous charters have illustrated, in a qualitative manner, the versatility of the model in providing an economic explanation for a wide range of country membership policies. However, so far it has not been quantitatively assessed whether the stock of public capital – the cornerstone of the model – as well as other important variables influencing the economic benefits and costs for the native population, like economies of scale, heterogeneity costs and allocative efficiency gains, have a direct influence on the membership policies that we can observe.

This chapter will set out to explore whether these variables have the expected influence by looking at two novel datasets which offer instances of non-selective country membership policies – meaning not depending on the individual characteristics of the applicant in terms of age, race, skills, etc. – and that as a consequence are ideally suited for making quantitative cross-country comparisons.

The first dataset consists of a collection of the immigrant investor programs currently available. These programs offer legal residence into the country in exchange of a combination of a non-refundable fee and private (refundable) investments. As investor programs are in fact a sort of membership fee, finding whether the model can explain their requirements constitutes a *direct test* of the model. If the latter would be a good representation of reality, we should expect to see a positive correlation between the stock of public and private capital in the country and those the newcomer is asked to contribute with.

The second dataset compiles country requirements for the acquisition of citizenship by naturalization. In most instances, before applying for naturalization a number of years of legal residence in the country are required. Therefore, before being naturalized the applicant is already a "member", though with less rights than a citizen. Citizenship is more capital dilutive than permanent residence for a number of reasons: it "locks-in" residence,[1] it can be passed to

[1] Contrary to permanent residence, the citizen can be absent from the country without losing citizenship rights.

further generations and it gives the right to vote and hence decide on the use of public capital. Further, as sketched in Chapter 6, Sec. 6.4, in the presence of depreciation and taxes, immigrants can pay over time their share of capital. If the model predictions are correct, we should expect to observe that countries rich in public capital enact higher barriers for naturalization. This will be a consequence of the model and hence could be seen as an *indirect test* of the theory.

The empirical analysis needs to be framed within the challenges associated to testing a theory that has a certain normative content due to the assumption that countries should pursue economic gain. As a consequence, it may work best when analyzing those countries that are at the forefront of a proactive economic management of immigration. This should be the case for those countries offering investment programs, however this is a “thin market” and the prices observed may command varying premiums far from the “break-even” prices implied by the model.

The quantitative analysis is further complicated by the fact that there are no comprehensive datasets of internationally comparable private an public capital stocks available, the two most important independent variables in the model. This research contributes to the literature by providing estimates of the two types of capital for all the countries in the different samples.[2]

The remainder of the chapter is organized as follows. Section 8.2 dwells on the main challenges and data limitations for quantitative testing the model, providing a frame for later analyzing the results. Section 8.3 describes the empirical strategy, including method and data sources. Section 8.4 presents the results for the two datasets. Section 8.5 concludes.

8.2. Challenges in quantitatively testing the model

Even though the aim of this chapter is to assess to which degree empirical data confirms the predictions of the theoretical model advanced by this research, empirically testing it is not exempt of significant challenges. The following is a recount of the main issues that need to be taken into consideration when conducting such an analysis:

Normative vs. descriptive nature of the model The club membership model advanced by this thesis derives a theoretical break-even membership fee that the native population should request to new entrants in order to avoid an economic loss. The membership fee is determined by two main economic drivers, which are: (1) the trade-off between economies of scale and public

[2] 180 countries in the case of the naturalization requirements.

capital dilution and (2) the trade-off between heterogeneity of skills and societal homogeneity. In fact, there is a small number of countries (ten in total[3]) where legal residence is granted upon the payment of a preset amount, either to the government or to a designated development fund or local charitable organization. There is also a larger number of countries (thirty-eight in total[4]) that request a refundable investment into the country to gain legal permanent residence.[5]

Despite the number of countries offering investment programs is rapidly increasing, the fact is that still the majority of countries in the world do not offer such programs. This could be interpreted as a rebuttal of the model and a reflection of its underlying normative content. However, investment programs do only filter out individuals based on wealth, leaving aside other important characteristics of an individual that can have a large influence, like social homogeneity, human capital and productivity considerations. What we observe in fact is that virtually all countries – including those which offer investment programs – have very restrictive and selective criteria for admitting new prospective members,[6] with the only exception of the refugee programs for humanitarian reasons. In other words, the default immigration policy across the world consists in heavily restricting immigration instead of allowing a free flow of people across borders, and the model is actually able to explain why immigration should be restricted in the absence of qualifying requirements at individual level or a contribution in the form of public and/or private capital to the country.

Range of applicability of the model An alternative explanation for the reduced number of countries offering investment programs can be found in the way immigration has been historically managed. Countries that have traditionally been large receptors and/ or seekers of immigrants, like the US, Canada, UK and Australia, have tended to manage immigration in a much more proactive manner than those others that have been experiencing low levels of immigration. As a consequence, they have developed more sophisticated policies to optimize the immigration intake, like the points-based systems and the investor programs. As immigration has become more widespread and prominent in the political debate, the trend towards a more proactive management of immigration policies has increased particularly along developed countries. Additionally, looking at the increasing number of countries which offer investment

[3]Antigua and Barbuda, Austria, Bulgaria, Cyprus, Dominica, Grenada, Hungary, Ireland, Malta and Saint Kitts and Nevis.

[4]Andorra, Antigua and Barbuda, Australia, Austria, Bahamas, Bulgaria, Canada, Cayman Islands, Costa Rica, Cyprus, Dominica, Germany, Hong Kong, Hungary, Ireland, Latvia, Malaysia, Malta, Monaco, Montenegro, New Zealand, Panama, Portugal, Saint Kitts and Nevis, Singapore, Slovakia, Spain, United Kingdom and United States.

[5]The case of Switzerland is an exception.

[6]Most countries that offer investment programs have also very selective requirements.

programs since the start of the financial crisis (eight new countries since 2012[7]), it seems that there may also be an increased awareness of the potential that immigration policies have as a tool for to *monetizing* some of the assets of a country, particularly in times of economic distress. All this evidence would suggest that the model is rather of an *anticipatory* or forward looking nature (i.e., describes how membership policies may increasingly look like in the future) and has most of its explanatory power when looking at membership policies of those countries that are at the forefront of a proactive management of immigration.

Non-comprehensive policies As explained above, membership policies are usually partial and fail to capture all the economic factors at play in a comprehensive manner. Broadly speaking, two main types of membership policies can be observed: *selective* policies aimed at conferring membership only to those individuals who possess a particular skill-set or background (e.g., points-based systems or ethnicity requirements) and *undifferentiated* policies which are invariant to the intrinsic individual characteristics (e.g., membership conferred by investment or naturalization requirements by years of residence). Undifferentiated policies are very useful for testing the model in a quantitative manner.[8] The fact that countries do not mix selective and undifferentiated requirements[9] allows for comparing undifferentiated policies across countries, and hence to assess whether the implications of the model are confirmed by empirical evidence.

Membership premium One important limitation when testing the model by analyzing observed membership requirements comes from the fact the model accounts for *membership supply* (i.e., immigration demand) but does not incorporate *membership demand* (i.e., immigration supply). Or alternatively, the membership fee calculated by the model is not more than a break-even value or *cost price*, whilst the observed value is a *market price*. Countries will most likely try to command a *premium* above the cost price. This will depend on the potential supply, which conversely will be determined by their absolute and relative attractiveness as a location, the latter being influenced by international competition for attracting individuals who possess certain skills or capital endowments. This explains the otherwise surprising fact that some countries with very strict immigration requirements like Switzerland or Singapore, have large stocks of immigrant population (an indicator of large membership demand), as if knowing

[7] Australia, Bulgaria, Cyprus, Hungary, Ireland, Malta, Portugal and Spain.

[8] Selective policies are much more difficult to compare due to the diversity of scope and requirements observed across countries.

[9] Many countries that offer investment programs have also selective immigration policies in place to attract individual who possess particular characteristics (like the H1b program in the US), but they do not combine them in a complementary manner.

of their attractiveness as a destination they might be seeking to command a large premium.[10] Nonetheless, assuming that there is enough competition between countries to attract the most sought-after individuals, the premium could be considered proportional to the attractiveness of the country that, ceteris paribus, should be a result of the stock and quality of its public capital as well as the private capital endowments of the population. A hint of the former can be seen in those countries that offer full membership (i.e., citizenship) for a payment, like is the case of Antigua and Barbuda, Cyprus, Dominica, Grenada, Malta or St. Kitts and Nevis, where the amount required is larger (in some cases several times) than the estimated public capital. This may imply there is a premium, as obviously a certain degree of economies of scale need to exist (the parameter β is expected to be smaller than one), though it could also be explained by anticipated changes in crowding and heterogeneity being priced into the membership fee.

Diversity of membership levels and requirements As explained in the introduction, country membership can take many forms, from temporary residence to full citizenship, varying also widely across the countries that offer them. In some cases permanent residence is offered outright, whilst in other instances residence is granted for a certain period, with periodic renewals subject to fulfilling certain investment requirements (usually holding a total or a part of the initial investment required). Citizenship via naturalization, which confers ownership rights over the public capital of the country, can usually be obtained after a number of years of permanent residence. As a consequence, countries have a choice between asking for high investment requirements to achieve legal residence but a small number of years of residence to achieve citizenship via naturalization, and asking for lower investment requirements and a larger number of years of residence for naturalization.

Further, there are some countries that impose demands that go beyond capital contributions. For example, not entertaining any gainful occupation, having a certain amount of personal wealth (besides that invested in the country), receiving income above a certain threshold, or the obligation to physically living in the country a certain number of days per year.

Likewise, when looking at naturalization requirements across countries, they also vary in terms of degree of assimilation demanded (knowledge of the language and culture of the country), the obligation to renounce to any other nationality, the absence of a criminal record, the intention to be resident in the country and a number of others.

All these constellations of requirements make it challenging to quantitatively compare membership policies across countries. However, whilst in the case of naturalization requirements

[10] An alternative explanation would be that countries with a large stock of immigrant population would cause immigration policies to become more strict due to the heterogeneity cost.

there is a large number of observations that allow for incorporating many independent variables, in the case of immigrant investment programs the data points are much more limited, which constrains the amount of variables that can be used in the quantitative analysis without substantially decreasing the degrees of freedom.

The MIPEX Index is one attempt at quantifying immigration policies in a way that facilitates comparison across countries, though the index has only a limited history,[11] its subject to qualitative assessments and weighting of individual factors and the number of countries covered is relatively small (36).

Limited variability of immigration policies across time Immigration policies tend to evolve slowly across time. This not only reduces the data points and deprives us of a way of conducting panel data analysis, but also poses the bigger challenge of distorting cross-country comparability. For example, Canada was one of the first countries to introduce an immigrant investment program in 1986, but the investment requirements stayed constant over decades. In the light of the great number of applications received during the last decade, in 2012 a consultation was opened by the federal government, which was followed by a twofold increase in the requirements.[12] This means that when comparing the investment program of Canada in 2011 with that of a country that set up its own recently, like New Zealand in 2012, we may have a big margin of error due to obsolescence. In the UK, where rates have not changed since 1994, some policy advocates, who are proposing to replace the current system of fix prices by a new one where visas are auctioned instead, have reckoned this problem.[13]

With regards to naturalization policies, changes are even slower as in many countries the requirements are often embedded in their respective constitutions. Hence, they are only modified when the social or economic circumstances change significantly. A good example of the former can be seen in Kuwait. The first oil discovery in the country dates from 1938. At that time there was no law regulating the Kuwaiti nationality. In 1946 Kuwait exported its first oil cargo and in 1948 enacted its first decree regulating who was entitled to nationality. This turned into a Nationality Law in 1959 and was subsequently modified several times in a way that conditions were ever more stringent. Naturalization requirements, which were initially granting nationality to those born in the country from non Kuwaitis, were subsequently amended and currently 25 years of residence in the country are required to be naturalized.

[11] There is only data since 2004 published on a triannual basis.

[12] The program was further terminated at federal in the light of the very large backlog of orders to process, although is still offered in the province of Quebec.

[13] "No country for poor men". The Economist, February 27, 2014.

Lack of data for some key variables Finding quantitative data for two of the most relevant independent variables in the model, the stock of private/ public capital and the economies of scale associated to large populations is not an easy task. Starting with capital stocks, there is no well-accepted source that provides a broad measure of cross-country private/ public capital estimates. This makes necessary to look into the literature for methods and partial data sources. Bova et. al. (2013) illustrate how even for OECD countries, reported data on non-financial public assets is uneven in scope, difficult to compare and tends to reflect the cost price instead of the market value of the assets. Kamps (2004) estimates of cross-country total capital – including both public and private – following the *perpetual inventory method* estimation approach, which factors in changes in the stock of produced capital, but does not account for non-produced capital like land or natural resources, as well as intangible capital. The World Bank (2006) on the contrary, provides a comprehensive estimate of total capital (including non-produced capital and intangible capital) for a large number of countries by following a combination of the perpetual inventory method and the net present value of the income that capital is able to produce over time, however, it makes no distinction between the private and public nature of the capital.

In what concerns to the economies of scale associated to population size, or alternatively, the degree of purity of publicly provided goods, no estimate can be found in the literature. Further, as explained in Chapter 3, from an utilitarian perspective, economies of scale are a subjective factor, as they depend on the individual preferences and perception of crowding of publicly provided goods. This fact, compounded with the non-linear influence this variable has in the model, is critically important to bear in mind when assessing the statistical significance of the results.

Lastly, the membership fee for permanent residence is in its most general expression influenced by the output shares of capital and labor. Similarly as happens with capital stocks, data on labor shares can be found for OECD economies but not for many of the countries in the datasets.

8.3. Empirical strategy

8.3.1. Method

8.3.1.1. Direct approach: immigrant investor programs

When analyzing undifferentiated membership policies allowing for permanent residence, equations (5.18) and (5.29) provide the most comprehensive econometric equations to use. As explained in Chapter 5, the two are equivalent and only differ in the magnitude of the output share of private capital. If we incorporate the heterogeneity parameter ψ, and assume that the output shares of labor and capital are equal,[14] the most general static[15] membership equation will be:

$$p^* + L^{(\beta+\psi)-1}k^* = (\beta+\psi)\,p + L^{(\beta+\psi)-1}k + \varepsilon \tag{8.1}$$

In this equation, the private capital k^* requested to the new member is a dependent variable that is codetermined together with the amount of public capital p^* required. The rational behind is that when determining the characteristics of a given immigrant investment program, a country choses a certain combination of p^* and k^*, for a given set of existing public and private capital per capita p and k , under certain degree of economies of scale associated to publicly provided goods β, the heterogeneity of its population ψ, and its population size L.

This equation presents some obvious challenges for conducting a regression analysis. In the first place because of its strong non-linearity on the structural parameters β, ψ,[16] which cannot be easily overcome by taking logs. Moreover, as it will be explained in the data section, it is virtually impossible to find high-accuracy estimates for β and ψ. Furthermore, most of the investment programs tend to be biased towards requesting private capital investments, instead of opting for public capital contributions, which makes the fit to the equation even more dependent on the structural parameters, once the term on L cannot be disregarded.

To complicate things further, there is a very high correlation between the estimates of private and public capital stocks (0.98 for the countries in the sample). This is partly a result of the way the capital series are constructed, as will be explained later on in the data section, partly

[14] This is a necessary assumption due to lack of data as will be discussed in Sec. 8.3.2.2.

[15] In the sense that it does no include changes in the heterogeneity and economies of scale parameters caused by the addition of a new member.

[16] As graphically depicted in Chapter 5, relatively small variations in β can have a very large impact on the membership fee.

an unavoidable reflection of the fact the two variables are intimately related. The reason being that public capital is built from contributions of private capital trough taxes, whilst at the same time public capital is one main contributor to output and hence to private capital accumulation via savings. As a consequence, when testing an equation in the form of (8.2) below – where the expression in brackets means that the content will be treated as a single composite variable – we obtain a high R^2 (0.47) but with coefficients that are not statistically significant ($t_1 = 1.33$ and $t_2 = 0.17$); a clear sign of the presence of multicollinearity.

$$\left[p^* + L^{(\beta+\psi)-1}k^*\right] = a_1 p + a_2 k + \varepsilon \tag{8.2}$$

To deal with this problem, composite variables will also be used for the right hand side of the equation, despite their dependence on the structural parameters. The analysis will start assessing whether an overall positive relationship can be observed between both sides of the equation by regressing the following econometric equation:

$$\left[p^* + L^{(\beta+\psi)-1}k^*\right] = a_1 \left[(\beta+\psi)\, p + L^{(\beta+\psi)-1}k\right] + \varepsilon \tag{8.3}$$

To mitigate the dependence on the structural parameters, several estimates will be used at country level. Additionally, a non-linear least-squares estimate will be derived and plugged back into the variables as a constant for all countries.

In a second step, it will be assumed that public capital requirements p^* act as the only dependent variable, treating the stock of public capital p and the delta in private capital $(k - k^*)$ as independent variables. This obviously poses some problems of endogeneity as p^* and k^* are jointly determined, but presents the advantage of circumventing the problem of multicollinearity, as correlation between p and $(k - k^*)$ is much smaller (0.46). As a consequence, it is possible to rescind of the structural parameters, and estimate coefficients instead. The term on $L\,(k - k^*)$ can be decomposed into two variables and the interaction variable, resulting in the following disaggregated econometric equation:

$$p^* = a_1 p + a_2 \left[k - k^*\right] + a_3 L + a_4 \left[L\,(k - k^*)\right] + \varepsilon \tag{8.4}$$

8.3.1.2. Indirect approach: naturalization requirements

Conferring citizenship by naturalization is always public capital dilutive and, contrary to what happens in the investment programs, there is no mechanism that allows ameliorating it by private or public capital contributions.[17] As a consequence, we should expect the stock of public capital to act as an independent variable influencing naturalization requirements, whilst the private capital stock should not play any role in this case. Further, the theory would predict that economies of scale and the heterogeneity of the population should influence naturalization requirements, as they serve to amplify or dampen the capital dilution. Thus, an indirect test of the theory would consist in assessing whether the *strictness* of country naturalization requirements can be explained by the former variables. In this case the econometric equation will turn into:

$$n^* = a + b_1 p + b_2 \beta + b_3 \psi + \varepsilon \tag{8.5}$$

Where n^* is a variable representing the *strictness* of the membership requirements, that will be measured by both the number of years for naturalization and the MIPEX Access to Nationality index.

8.3.2. Data sources

8.3.2.1. Dependent variables

As explained above, two different types of dependent variables will be used. In the first place private and public capital requirements obtained from immigrant investor programs will be used to directly test the model. This will be complemented in a second stage with data from naturalization requirements and the MIPEX Access to Nationality indexes to test the model in an indirectly manner.

Immigrant investor programs investment requirements Immigrant investor programs are characterized by offering long-term residence or direct access to citizenship by means of investing a certain (refundable) amount of capital in a certain type of eligible investments in the

[17] Normally naturalization entails the payment of a number of fees, but these are usually not significant when comparing to the investment programs. Setting up higher fees would be in principle possible and some countries like Antigua and Barbuda, Cyprus, Grenada, Malta or St. Kitts and Nevis do it, but most countries typically set requirements mainly in terms of years of legal residence.

country, or by making a (non-refundable) payment to the government, or an endowment to a designated development fund, charity organization or to a project of public benefit in the arts, sports, health, cultural or educational field. The type of refundable investments that qualify for the program varies widely across countries, although they typically account for one or a combination of the following:[18] bank deposits in a local bank, investments into designated development projects, direct investments in real state (designated or unconstraint), indirect real estate investments via REITS or investment funds, purchase of sovereign or regional bonds (or concession of free loans), investments in financial assets (direct or commingled) or investments into venture capital funds. Besides the former investment requirements, most programs demand the payment of processing and due-diligence fees, which in some cases can be very significant and of a comparable order of magnitude as the non-refundable investment requirements. Therefore, the dependent variable p^* will be proxied by sum of all non-refundable payments, including all fees, whilst the variable k^* will be proxied by the sum of all refundable investments.

The diversity of the programs however requires to make a number of controls as there may be several observations of the independent variables for a same values of the dependent ones. First, some programs offer direct access to citizenship, which consistently with our theory, typically comes at the expense of a higher investment/ payment.[19] Further, the investment amount required typically varies depending on either the riskiness of the investment (bank deposits or bonds require a larger investment amount than venture capital) or its desirability for the economic development country (development funds or the creation of jobs). This can be seen in countries which offer different investment alternatives, for example, Spain requires an investment of more than either €2 million investment in government bonds, €1 million if the investment is in stocks or shares of Spanish companies, or bank deposits in Spanish financial entities, €500,000 if it entails the acquisition of a real estate property and no minimum if the investment is in a business project that will be carried out in Spain, considered and accredited as of general interest, and meets one of the following conditions: (1) creation of employment (2) investment with economic impact on the geographical area in which the activity will be carried out (3) contribution to scientific and/or technological innovation. Further controls will have to be introduced to cater for the fact that some of the programs require not only a investment but also a minimum amount of proved wealth (which does not need to be brought to the country) and/ or a minimum annual rent.

In total there are 68 individual programs corresponding to 30 different countries. As many countries offer several investment program types, these have been blended into one single ag-

[18] See tables A.2, A.3 and A.4 in the Appendix for the details of every country program and data sources.

[19] This can be observed because several countries offer both the possibility to acquire long-term residence or citizenship.

gregated program per country in order to ensure that the observations are independent from each other. The aggregation has been conducted by averaging the values of every individual variable, including the control variables, for each of the different programs per country.

Minimum number of years of residence for acquiring citizenship by naturalization Most countries allow for non-citizens to become nationals by means of naturalization. This typically entails proving a certain number of years of legal residence (in total and uninterrupted) in the country. This number varies significantly across countries and offers a quantitative measure of how protective they are of the institution of citizenship. Accordingly, the number of years of residence will be used as a proxy of the strictness of the naturalization requirements n^*. These requirements can be easily found in official immigration websites for most developed countries, but in other cases it requires looking for them into their citizenship laws. As a data source, the compendium of Citizenship Laws of the World (2001) made by the United States Office of Personnel Management has been taken. This provides comparable information for all countries based on information from US embassies, the Library of Congress, and the Department of State. In those countries where information is insufficient or outdated,[20] data has been complemented by looking at the different country nationality laws compiled by the United Nations Refugee Agency (UNHCR)[21]. For those countries where citizenship by naturalization is not available or where it can only be obtained by presidential decree, the average life expectancy at birth (71.0 years according to United Nations World Population Prospects 2012) has been used.[22]

Besides the number of years of residence, rules may include the renunciation of other citizenship,[23] familiarity with the language, law and customs of the country, absence of a criminal record, proof of good character and/or mental and physical health, not being a threat to the security of the country, proof of occupation and/ or own means of subsistence, commitment to maintain residence in the country and, in some rare cases, ownership of a state in the country. This will require of introducing controlling variables for all these elements.

MIPEX Access to Nationality index The MIPEX index is computed by the Barcelona Centre for International Affairs (CIDOB), and the Migration Policy Group (MPG) and measures policies that promote integration in 36 countries. The methodology consists of 148 policy indi-

[20]e.g. countries which have undergone significant changes as a result of wars or regime changes.
[21]www.refworld.org
[22]As life expectancy differs by countries, the long-term resident's life expectancy has to be different between countries. However, an immigrant may come from any country at any given point in time in life and a simplifying assumption has been made by choosing the world's average.
[23]In some cases dual citizenship is only accepted if there is a bilateral treaty. These instances have been classified as not accepting dual nationality as a default case.

cators designed to benchmark current laws and policies against the highest standards through consultations with top scholars and institutions using and conducting comparative research in their area of expertise. A policy indicator is a question relating to a specific policy component of one of the seven policy areas: (1) Labor market mobility, (2) Family reunion for third-country nationals, (3) Education, (4) Political participation, (5) Long-term residence (6) Access to nationality and (7) Anti-discrimination. For each answer, there are 3 options. The maximum of 3 points is awarded when policies meet the highest standards for equal treatment. Within each of the 7 policy areas, the indicator scores are averaged together to give one of 4 dimension scores that examine the same aspect of policy. The 4 dimension scores are then averaged together to give the policy area score for each of the seven policy areas per country that, averaged together one more time, lead to the overall scores for each country. In order to make rankings and comparisons, the initial 1-3 scale is converted into a 0-100% scale for dimensions and policy areas, where 100% is the top score.

Overall, immigrant integration can be a poor indicator of the strictness of the membership requirements s^*, as some countries may be very selective on their immigration intake, but once entry is granted they may facilitate a full integration into the country. However, one of the sub-indices of the MIPEX index, the Access to Nationality index, will be of particular interest as it offers a broader measure of the strictness of the requirements for achieving citizenship than just the mere number of years of residence. The index includes four broad measures, eligibility conditions, acquisition requirements, security of status, and acceptance of dual nationality. The detailed composition of the index is shown in tables A.5. in the Appendix. These two sub-indexes provide a much richer indication of the strictness of membership requirements than the mere number of years for naturalization. However, there number of countries represented is limited to 34 countries, which considerably restricts the validity of the quantitative analysis.

8.3.2.2. Independent variables

Private and public capital stock As explained in the previous section, there is currently no comprehensive dataset available of internationally comparable private an public capital stocks that covers most countries in the world, and particularly those that offer immigrant investor programs, as some of them are small states. Kamps (2004) estimates capital stock data for OECD countries for three categories of investment: (1) private non-residential gross fixed capital formation, (2) private residential gross fixed capital formation, and (3) government gross fixed capital formation, using data from the OECD Analytical Database. Kamps' methodology for the estimation of capital stock data out of investment flows draws in large part on OECD (2001) and on the U.S. Bureau of Economic Analysis (1999), by employing the perpetual inventory method. In order to enlarge the number of countries covered, the approach followed in this study has consisted in building on the World Development Indicators dataset provided by the World Bank (2014), and in particular in the *Gross Capital Formation (% of GDP)*[24] and the *Government Final Consumption Expenditure (% of GDP).*[25] The latter will be used in order to split the investments series amongst private and public capital formation, assuming that total capital formation is allocated according to the respective weights of the public and private sectors in the economy. This is a reasonable assumption if one thinks that the percentage of the public and government sectors in the economy has remained relatively stable in an environment of constant economic growth, which suggests stocks of public and private capital have increased over time in proportion to their respective shares.

According to the perpetual inventory method, the net capital stock at the beginning of the following period, K_{t+1}, can be expressed as a function of the net capital stock at the beginning of the current period, K_t, the gross investment in the current period, I_t less the depreciation in the current period, D_t:

$$K_{t+1} = K_t + I_t - D_t \tag{8.6}$$

If one further assumes that the capital stock depreciates at a constant rate δ, then the previous equation can be rewritten as:

$$K_{t+1} = (1 - \delta)K_t + I_t \tag{8.7}$$

In order to calculate the capital stock, it is necessary to define an initial capital stock K_1 to be used as a starting point.[26] As the investment flows provided by the World Bank date back to 1961, the capital stock at that year will be chosen as a starting point for the calculation. However, as there is no official information on the magnitude of the initial capital stock for any

[24] The World Bank definition of gross capital formation consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress". According to the 1993 SNA, net acquisitions of valuables are also considered capital formation.

[25] The World Bank definition of government expense is cash payments for operating activities of the government in providing goods and services. It includes compensation of employees (such as wages and salaries), interest and subsidies, grants, social benefits, and other expenses such as rent and dividends.

[26] In theory, one should start with zero capital and account for an infinite number of past investment flows.

country except the United States, this study will follow a similar approach as Kamps (2004)[27] in order to estimate the initial capital stock. For that purpose, an artificial investment series for the period 1860–1959 will be constructed for each country, assuming that fixed capital investments increased by 4 percent a year during this period, finally reaching its observed level in 1961. The rationale for this assumption is that total gross investment in the 22 OECD countries under consideration in Kamps study grew by a factor g equal to 4 percent a year on average during the period 1960–2001. In his paper Kamps acknowledges this is a necessary simplification but also conducts a sensitivity analysis where it becomes apparent that, in the presence of depreciation, the initial capital stock is of minor importance for the final capital stock reached at the end of the period. The initial capital stock at in 1961 will be then given by the following formula:

$$K_1 = K_{1961} = \sum_{i=1860}^{1961} I_{1961} \cdot \frac{(1-\delta)^{i-1860}}{(1+g)^{i-1860}} = I_{1961} \cdot \frac{\left[1 - \left(\frac{1-d}{1+g}\right)^{101}\right]}{1 - \left(\frac{1-d}{1+g}\right)} \tag{8.8}$$

And the capital stock at period $t+1$ would be then given by:

$$K_{t+1} = (1-\delta)^t K_1 + \sum_{i=0}^{t-1} (1-\delta)^i I_{t-i} \tag{8.9}$$

As we want to differentiate between public and private capital K^k and K^p, we will have that:

$$K_t = K_t^k + K_t^p \tag{8.10}$$

$$I_t = I_t^k + I_t^p \tag{8.11}$$

The gross capital investment for any given period will be assumed to be divided between private and public capital according to the share of the public sector G in the economy F (represented by government consumption expenditure as a percentage of GDP), and the investment flows for private and public capital I_t^k and I_t^p:

[27] Kamps follows Jacob, Sharma, and Grabowski (1997, p. 567).

$$I_t^k = (1 - \frac{G_t}{F_t}) \cdot I_t \tag{8.12}$$

$$I_t^p = (\frac{G_t}{F_t}) \cdot I_t \tag{8.13}$$

Following Kamps (2004), the depreciation rate applied for the period 1860 - 1961 is 2.5% constant. For the period 1961- 2013 depreciation is time varying for both the public and the private capital stock. This assumption allows taking into account the empirically observed different depreciation rates. Depreciation will be assumed to increase over the period from 2.5% to 4.5% for both public and private capital.[28] Hence, the public and private capital stock series will be given by:

$$K_{t+1}^k = (1-\delta)^t K_1^k + \sum_{i=0}^{t-1} (1-\delta_i^k)^i (1 - \frac{G_{t-1}}{F_{t-1}}) \cdot I_{t-i} \tag{8.14}$$

$$K_{t+1}^p = (1-\delta)^t K_1^p + \sum_{i=0}^{t-1} (1-\delta_i^p)^i (\frac{G_{t-1}}{F_{t-1}}) \cdot I_{t-i} \tag{8.15}$$

When comparing the resulting capital stocks with those of Kamps (2004) for OECD countries in Table A.1., it can be observed that the amounts are in the same order of magnitude though there are significant deviations in size and rank for several countries. There are several explanations for these variations. First, as Kamps acknowledges, there can be very large differences between the national reported figures (which are the source behind the World Bank series) and OECD figures. Second, Kamps uses values in \$PPP, whilst this study uses current dollars, taking into consideration that the dependent variable (investment requirements) will be expressed in current dollars. Despite the possible errors in absolute terms, the methodology followed has a very big advantage for this study, as it provides comparable estimates of private and public capital stocks (they come from the same data source) and for a very large number of countries. As the split between private and public investment is done according to the annual estimated size of the government, which varies significantly over the time series, collinearity between the variables is avoided, as would otherwise be the case if the split is applied over the resulting total capital stock.

[28] Kamps differentiates between different depreciation rates for public capital, private residential and private non-residential, being depreciation 1.5% constant for the private residential capital stock and increasing from 4.5% to 8.5% for private non-residential. However, as we do not have the split between private residential and non-residential in the World Bank data, a blended depreciation rate similar to that of public capital has been used (2.5%-4.5%).

The table A.2. also shows that out of two possible proxies of government size that can be extracted from the World Bank database, government consumption and government total expense (containing transfers, social security payments and gross capital formation), the differences versus Kamps estimates are smaller and less volatile for the former. Using government consumption has one further advantage, as there are records for most countries starting in 1960, whilst for government expense they start in 1990 at best and need to be extrapolated.

As this study is looking at capital from an ownership perspective, the stocks of produced capital need to be adjusted by the corresponding amounts of private and public net financial assets (i.e, including private and public debt) F^k and F^p to derive the net capital stocks.[29] The net stock of private and public capital has to be further adjusted to account for non-produced assets. Following the methodology of World Bank (2006) for estimating the total wealth of nations, there are two broad categories of non-produced assets: (1) Natural assets and (2) Intangible assets. Hence, the broadest measure of private and capital stock Π^k and Π^p will be:

$$\Pi^k = K^k + F^k + N^k + I^k \tag{8.16}$$

$$\Pi^p = K^p + F^p + N^p + I^p \tag{8.17}$$

For deriving the public net financial assets defined as government debt less the government financial assets, *Government Net Debt* estimates from the IMF will be used. The private net financial assets estimate will be derived as the difference between the *Net Foreign Assets*[30] statistics from the World Bank World Development Indicators (F^e) and the government net debt. The underlying assumption is that there is no lending/ investment from the public into the private sector and as a consequence the net financial assets equal the net foreign assets, bearing in mind that, in aggregate, domestic lending/ investments have a net zero effect on domestic net financial assets. This is a realistic assumption in most developed countries where the financial sector has been almost entirely privatized. It is important to bear in mind that in order to avoid double counting, only external financial assets are relevant, as debts and equity within the country have necessarily to be matched to an equivalent amount of other tangible assets:

[29] In countries with large amounts of public debt like Japan and the United States the net public capital stock is negative, whilst others like Norway or the United Arab Emirates having a large sovereign fund have a very large net financial position.

[30] Net foreign assets are the sum of foreign assets held by monetary authorities and deposit money banks, less their foreign liabilities.

$$F^p = A^p - D^p \tag{8.18}$$

$$F^e = F^k + F^p \tag{8.19}$$

$$F^k = F^e - (A^p - D^p) \tag{8.20}$$

For natural resources and intangible capital, data from World Bank (2006) wealth estimates will be used. These estimates however relate to total capital and a split between private and public capital will have to be made. Natural resources encompass (1) Subsoil assets, (2) Timber resources, (3) Non-timber forest resources, (4) Protected areas, (5) Cropland and (6) Pastureland. A simplifying assumption will be to presume all natural resources to be private except for protected areas and subsoil assets. The logic for that split comes from the fact most protected areas are natural parks of public nature, and that in the majority of resource-rich countries, the Napoleonic Code has been historically followed, whereby property rights of surface owners and owners of subsoil resources are separated, being the latter typically retained by the state, which would grant a concession to exploration companies for a fee or a percentage of the revenues.

In what regards to intangible capital, the split between private and public capital will be made following the World Bank (2006, p. 96) aggregated decomposition of the intangible capital residual amongst (1) Rule of law (57%), (2) Schooling (36%) and (3) Foreign remittances (7%), assuming rule of law belongs to the public capital category and the other two to the private one.

The World bank data despite covering 152 countries is not available for some small states that offer investor programs, like is the case of Antigua & Barbuda, Bahamas, Cayman Islands, Cyprus, Monaco and Montenegro. As this reduces further the number of observations in the investment programs, only produced capital estimates derived from the investment series will be used for the direct approach.

Scale economies As explained in the introduction to this chapter, scale economies are difficult to measure in a direct manner. Furthermore, to the best of my knowledge, there is no estimate for the degree of *publicness* of publicly provided goods per country available in the literature. In order to overcome this problem, two different strategies have been followed.

The first has been to find a proxy of the *quality* of public goods that is not dependent on the *quantity* of public goods, and that is also unrelated with the other main variables, particularly private capital. There are many development or quality of life indicators that at first sight can be deemed to be good candidates. However, by the way they are constructed, the wealth of the country plays always a big role in its total score.[31] The indicator that has been deemed most suitable is an index of quality public governance derived from the Worldwide Governance Indicators (WGI). This project reports aggregate and individual governance indicators for 215 economies over the period 1996–2013, for six dimensions of governance: (1) Voice and accountability, (2) Political stability and absence of violence, (3) Government effectiveness, (4) Regulatory quality, (5) Rule of law and (6) Control of corruption. The index used has been constructed as the geometric mean of these six indicators. The rational for using this index is that the better the governance[32] of a country is the higher the quality of publicly provided goods, as these will be chosen to maximize public benefit and hence should exhibit high economies of scale. This indicator is in fact reflecting the degree of scale economies $\hat{s}$, meaning that the higher the value of s the lower should be the parameter β. Hence, it will be proxied by the complementary value, i.e. $\hat{\beta} = 1 - \hat{s}$.

The second strategy for finding an indicator for β builds on the concept of optimal government size developed in Chapter 6, Sec. 6.2. Supposing that the sizes of governments we currently observe[33] g_i are optimal for every country, and assuming a isoelastic functional form $\beta_i(g) = g^{n_i}$, with $n_i > 1$ in order to ensure convexity, we have that:

$$g_i = \frac{1}{LnL \cdot \frac{\partial \beta_i(g_i)}{\partial g} |_{g_i}} = \frac{1}{n_i g_i^{n_i - 1} LnL} \tag{8.21}$$

By numerically solving n_i from this equation, we can derive an estimate for β_i as $\hat{\beta}_i = g_i^{n_i}$ for every country in the sample.

Heterogeneity As measure for the heterogeneity parameter ψ this study has built on Alesina et al. (2003), where indices of ethnic, linguistic and religious fractionalization are provided for about 190 countries. In order to derive a single indicator a blended index has been derived by computing the geometric mean of the three indices. In those cases where one or more of the indices were not provided, the composite has been created with those that were available.

Measuring heterogeneity is easier than measuring economies of scale as there are some observ-

[31] In Chapter 9, Sec. 9.6.1 some directions for future research are advanced.

[32] Governance is defined as the traditions and institutions by which authority in a country is exercised. This includes the process by which governments are selected, monitored and replaced; the capacity of the government to effectively formulate and implement sound policies; and the respect of citizens and the state for the institutions that govern economic and social interactions among them.

[33] Defining government size as Government Expense (% of GDP) from the World Bank Development Indicators.

able characteristics of the population. However, the problem of calibrating the impact of the heterogeneity proxy on the utility function is similar, as both affect a non-linear term of the equation.

Output shares of capital and labor Estimates of output shares of labor and capital are only available for OECD countries. A proxy for the labor share can be derived from the UN System of National Accounts (SNA93) by dividing the compensation of employees item of the total economy statistics (*SNA93 table code: 4.1, sub-group: II.1.1 Generation of income account - Uses*) by the GDP of the respective country. When comparing with OECD statistics this estimate seems to be downward biased as for most of the countries it results in a lower labor share.

Further, most small states that are offer immigrant investor programs (Andorra, Antigua and Barbuda, Bahamas, Dominica, Grenada, Mauritius, Monaco, Montenegro, Saint Kitts and Nevis and Singapore) do not report national accounts with enough granularity for deriving a proxy for the labor share of output. As a consequence, the number of observations for investor programs would be very limited when including this variable, and in order to increase the number of observations it will be assumed that the shares of capital and labor α_K and α_L are equal to 0.5 for all countries in the sample, hence, not having any impact on the econometric equation ($\gamma = L^{(\beta+\psi)-1}$).

Population Population data will be taken from the World Bank World Development Indicators.

8.4. Results

8.4.1. Immigrant investor programs

Basic correlations The econometric equations described at the beginning of the section pose some serious challenges due to endogeneity and collinearity. Table 8.1 illustrates the correlation between the independent variables and the different components of both private and public capital.[34] It can be observed that there is a very high correlation between the private and public capital stocks, which, as explained in Sec. 8.3.1 complicates the choice of econometric equation. We can also see how, as implied by the theory, the public and private capital requirements p^* and k^* are positively correlated with the capital stocks in the native population p and k. They are also weakly correlated amongst themselves, which is a consequence of the fact that investor programs typically opt for requesting one or the other type of capital, but not a combination of both.[35] Further, the inverse of the size of the population L is negatively related to the contributions of private capital k^*, as the model predicts. When looking at the two estimates of economies of scale, the one extracted from the assumption of an optimal government size β_{Govt} is negatively correlated with the capital requirements p^* and k^*, whilst that derived from the World Government Indicators β_{WGI} is practically uncorrelated. Finally, the degree of heterogeneity in the population ψ is negatively related with p^* and k^*. Here the prediction from the model is less clear, as on the one hand low heterogeneity increases the utility of the native population and hence lowers the membership fee, whilst on the other hand an increase in heterogeneity caused by a new member has a negative impact. As it has been illustrated in Chapter 7, Sec. 7.4, this impact is larger the less heterogeneous the population is. If the model were correct, the data would imply that the second effect predominates over the former.

	$Log\,(p^*)$	$Log\,(k^*)$	$Log\,(p)$	$Log\,(k)$	$Log\,(L^{-1})$	$Log(\beta_{Govt})$	$z\beta$	ψ
$Log\,(p^*)$	1.0000							
$Log\,(k^*)$	0.0915	1.0000						
$Log\,(p)$	0.2709	0.0458	1.0000					
$Log\,(k)$	0.2623	0.0142	0.9896	1.0000				
$Log\,(L^{-1})$	0.3113	-0.2574	-0.4586	-0.4361	1.0000			
$Log(\beta_{Govt})$	-0.1568	-0.3511	-0.3539	-0.2758	0.5645	1.0000		
β_{WGI}	0.0530	-0.0133	-0.2078	-0.1602	-0.2515	0.1075	1.0000	
ψ	-0.5883	-0.1368	-0.1684	-0.1421	-0.1128	0.4181	0.1217	1.0000

Table 8.1.: Correlation amongst different components of capital and capital requirements

[34]Logs have been taken for all variables with the exception of index variables β_{WGI} and ψ that have been standardized.

[35]With the exception of fees, that in a few cases can be very significant.

Aggregated econometric equation As explained in Sec. 8.3.1, the first test of the model consists of regressing the aggregated econometric equation (8.3) and observing whether there is a positive relationship between both sides of the equation. The aggregates on both sides include the factor $L^{(\beta+\psi)-1}$, which depends non-linearly on the two structural parameters β and ψ.

Four different specifications will be used depending on the different estimates for $(\beta + \psi)$ used. The first two specifications will correspond to the two estimates for β discussed in Sec. 8.3.2.2, and the estimate for ψ provided by the fractionalization index. The third specification will assume that $(\beta + \psi) = 1$ and hence that private capital and public capital are interchangeable. The fourth specification corresponds to the estimate of $(\beta + \psi)$ derived from a non-linear least-squares estimation.[36]

Additionally, the same regression will be run including a number of controls that account for a number of qualifying requirements usually found in investment programs, and that are not included in p^* and k^*, such as the requisite that the investment creates jobs, or the obligation to proof a certain wealth or annual income; as well as whether the program grants citizenship status.

Table 8.2 shows the results of the regression for the eight specifications. When looking at the sign of the first coefficient, this is positive and statistically significant for the specifications (1) and (3), negative and not significant for (2) and marginally positive and not statistically significant for (4). Specification (3) shows also a relatively large value R^2 and a value for the coefficient that is very close to one. When adding the control variables, the significance of the coefficients increases in general, but does not alter the overall picture.

The controls work as expected, with the exception of the requirement to bring a certain amount of net assets that increases the membership fee instead of reducing it. The coefficients however are not statistically significant, except for specification using β_{Govt}. The concession of citizenship causes a marked increase in the capital requirements, which is statistically significant for all the specifications except that where $\beta + \psi = 1$. The reason for this is that most of the investment programs that confer citizenship are fee-based instead of investment-based. However, when making $\beta + \psi = 1$, we are assuming contributions in private capital and public capital to be equivalent, and hence ameliorating the explanatory power of the control variable. Both the requirement to create jobs and to have an annual income, reduce the capital requirements, though the coefficients are not statistically significant.

[36] The value of the least-squares estimate of $(\beta + \psi)$ for the countries in the sample is 0.507

In order to interpret the results, it is useful to look at how the different estimates of the structural parameters affect the values of the aggregated variables. Table A.6 in the Appendix shows the values for the different estimates of β, ψ and the corresponding values of $L^{\beta+\psi-1}$. It can be observed how the estimate that has been reverse engineered assuming an optimal government size β_{Govt} has a much lower value than the one derived from the WGI index β_{WGI}. This translates into lower values for $L^{\beta+\psi-1}$ and hence a much more reduced influence of the variables k^* and k in (8.1). Thus when using β_{Govt} , we are de facto regressing p^* over p:

$$p^* \approx a_1 \left[(\beta + \psi) \, p \right] + \varepsilon \tag{8.22}$$

As most immigrant investor programs are skewed towards private capital investments, the results need to be necessary weak, as in many cases the only public capital contribution are small processing fees. On the contrary, when assuming that $\beta + \psi = 1$, we are giving equal weight to both types of capital and we are actually regressing:

$$[p^* + k^*] = a_1 \, [p + k] + \varepsilon \tag{8.23}$$

The tilt towards private capital investments causes the fit of this equation to be much better, producing not only the expected sign for the coefficient, but being also its magnitude remarkably close to one.

Using the β_{WGI} as an estimate seems to be a middle case, in which the estimated value for $\beta + \psi$ gets closer to one (65.2% in average). This produces a less significant coefficient than when assuming $\beta + \psi = 1$, but a higher overall R^2 when introducing the controls, as citizenship gains in significance.

In the case of the least-squares estimate $\widehat{\beta + \psi}$, the impact is different. In this case as all countries are assigned the same value for the estimate (50.6%). The effect on $L^{\beta+\psi-1}$is twofold, first, population size turns the only differentiating factor, with large countries giving less importance to private capital contributions and, second, making the differences in heterogeneity redundant.

	(1) β_{WGI}	(2) β_{Govt}	(3) $\beta+\psi=1$	(4) $\widehat{\beta+\psi}$	(5) β_{WGI}	(6) β_{Govt}	(7) $\beta+\psi=1$	(8) $\widehat{\beta+\psi}$
Log $\left[(\beta+\psi)\,p+L^{(\beta+\psi)-1}k\right]$	1.358**	-0.407	0.923***	0.063	1.627***	-0.465	1.007***	0.307
	[2.54]	[-0.70]	[4.34]	[0.09]	[3.54]	[-0.98]	[3.84]	[0.47]
Log Citizenship					4.218***	5.576***	0.073	5.504***
					[3.21]	[3.92]	[0.11]	[3.43]
Log Job creation					-1.027	-0.315	-1.347	-1.498
					[-0.44]	[0.12]	[-1.13]	[-0.50]
Log Annual income					-0.095	-0.163	-0.046	-0.066
					[-0.86]	[-1.39]	[-0.86]	[-0.48]
Log Net assets					0.027	0.203**	0.006	0.095
					[0.38]	[2.46]	[0.18]	[0.99]
Observations	26	26	26	26	26	26	26	26
R-squared	0.212	0.020	0.440	0.000	0.585	0.5663	0.505	0.484
Adjusted R-squared	0.179	-0.021	0.417	-0.041	0.482	0.4578	0.381	0.356

*** p<0.01, ** p<0.05, * p<0.1

Dependent variable: Log$\left[p^*+L^{(\beta+\psi)-1}k^*\right]$

t statistics in brackets

Data source: Tables A.2, A.4, A.6 and A.13 - A.19

Table 8.2.: Regression results for aggregated econometric equation (8.3)

Figure 8.1 shows how the data points for regressions (1) to (4) change for the different estimates and it helps to get an idea of how dependent the results are on the structural parameters. It can be observed how the smaller the value of the parameters the larger the dispersion in the data is.

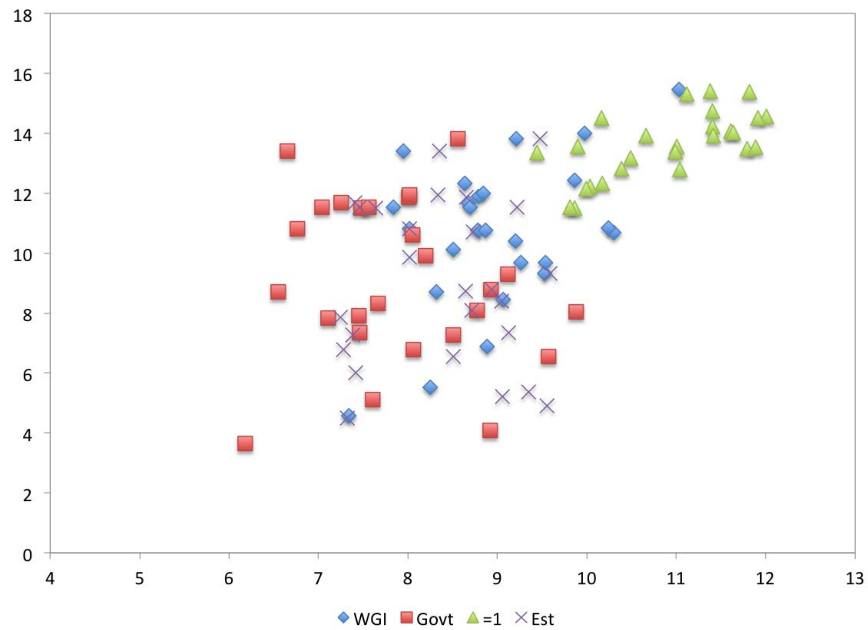

Figure 8.1.: Data points for regression (8.3) for different estimates of $\beta + \psi$

Disaggregated econometric equation on p^* As explained in Sec. 8.3.1, due to the high sensitivity to the structural parameters, it helps to have an econometric equation in which public capital requirements act as the only dependent variable. In this way it can be avoided the estimation of the structural parameters by estimating coefficients to the main variables instead. Table 8.3 shows the results of the regression corresponding to equation (8.4) with two different specifications, the first without control variables and the second including them.

By looking at the coefficients, it can be observed that, as predicted by the model, the membership fee is positively related to the stock of public capital p and negatively related to the difference in private capital endowments $(k^* - k)$,[37] though the results are not statistically significant. The size of the coefficient for public capital is greater than one suggesting that there may be a "market premium".[38]

The coefficient for the difference in private capital endowments $(k^* - k)$ is negative and of a smaller magnitude than that of p, indicating that as the model predicts, financing membership in the form of private capital contributions requires of investments which are several times larger than the capital stock of the native population.

When introducing the controls, the sign of the coefficients are maintained, but the significance decreases slightly. The control variables themselves work in the opposite direction than expected, with the exception of the concession of citizenship. Nonetheless, the coefficients for the control are not statistically significant either.

The weakness of the results can be attributed in part to the endogeneity at play between the variables p^* and k^*, as well as to the exclusion of the parameters β and ψ, that in this econometric equation are captured by the coefficients on the other variables.

[37] As the private capital requirements from the investment programs are larger than the estimated stocks in all observations but one, the logs have been taken on $(k^* - k)$instead of on $(k - k^*)$, thus a negative sign on the former implies a positive one on the latter. For the negative observation the value has been replaced by 0.

[38] Otherwise it would imply that there are diseconomies of scale associated to population size.

	(1)	(2)
Log p	1.721	1.338
	[1.34]	[0.82]
Log $(k^* - k)$	-0.401	-0.294
	[-0.17]	[-0.10]
Log L	-1.517	-1.217
	[-0.54]	[-0.34]
Log $[L\,(k^* - k)]$	0.028	0.022
	[0.13]	[0.09]
Log Citizenship		3.205
		[0.77]
Log Job creation		2.473
		[0.39]
Log Annual income		0.750
		[0.28]
Log Net assets		0.742
		[0.40]
Observations	26	26
R-squared	0.312	0.343
Adjusted R-squared	0.181	-0.034

*** p<0.01, ** p<0.05, * p<0.1

Dependent variable: Log p^*

t statistics in brackets

Data source: Tables A.2, A.4, A.6 and A.13 - A.19

Table 8.3.: Regression results for disaggregated econometric equation (8.4)

8.4.2. Naturalization requirements

Number of years for naturalization In this section the number of years of residence for the acquisition of citizenship by naturalization will be regressed against the main variables of the model, as well as a set of control variables that correspond to some further requisites, like are the obligation to renounce any other nationality, to speak one or several of the national languages, to prove a certain degree of cultural assimilation, to have an absence of criminal records, to be a person of good character and health, to have own means of support, to intend to be a resident in the country and not to be a threat to the national security.

The data for the independent variables is the same as that used in the immigrant investor programs. However, in this case the number of records is much larger (180 countries), and the different components of capital (produced, natural, financial and intangible) can be included, as the size of the sample remains large enough after removing those countries for which there are no capital estimates. For simplicity, the control variables are regarded to be an independent variable, so that that the number of years requested by a naturalization policy is assumed to be derived once a set of restrictions have been established.

If the theory is correct in regarding citizenship as capital dilutive for the existing citizens, the larger the stock of public capital the more stringent the requisites for naturalization should be. As citizenship via naturalization is in general granted to individuals independently of the amount of private capital they possess,[39] the latter is not expected to play a role in the determination of the number of years requested.

Table 8.4, illustrates the regression results for equation (8.5) under six different specifications, corresponding to the four individual types of public capital, the aggregated total, and an aggregated value excluding intangible capital. For public financial capital most countries present a negative balance and the inverse value have been used instead. This leaves outside the sample some resource rich countries like Norway or Saudi Arabia which request higher than average years of residence. However, as this variable has been constructed from IMF data, the sample remains large enough (108 observations).

For simplicity, in this regression it will only be used one estimate of β corresponding to the one derived from the WGI index. Both variables β_{WGI} and ψ are index variables and thus have been standardized.

When looking at the results in Table 8.4, it can be observed that from all the specifications, those using produced capital, natural capital, the total aggregate and the aggregate excluding

[39] With the exception made for those countries which offer investment citizenship, and a handful of others which leave the discretion to naturalize depending on an unspecified significant contribution to the country.

intangible capital, are all positively related to the number of years for obtaining citizenship via naturalization, whilst financial and intangible capital are negatively related. The coefficients are only statistically significant for both, public produced capital and the aggregate excluding intangible capital, and marginally significant for public natural capital.

The fact that the coefficient for intangible capital is negatively related does not necessarily contradict the theory, as intangible capital is not expected to be diluted with the addition of a new citizen.[40] The negative impact of public financial capital cannot be interpreted in isolation. This capital is negative for most countries, and thus it can be assumed to have "lent" its value the other capital series, as the proceeds from borrowing money should have been used to finance government expenditures.

At this point it is important to bear in mind the different sources and methods for constructing the capital estimates. Whilst produced capital has been estimated from capital investments series, the other capital estimates have been derived from the World Bank report estimate of the wealth of nations. In the latter not only the public capital part has been more roughly approximated, but also the intangible capital, which is estimated as a residual, is by far the largest capital component.[41] The estimates of public produced capital can be considered to provide a better proxy of the differences in public capital between countries, however it presents the problem of neither accounting for public debt[42] nor for natural assets. Therefore, probably the best possible estimate of the public capital stock that can be used is the sum of produced, natural and financial capital. This corresponds to specification (6). With this capital aggregate, the results imply that there is a positive relationship between public capital and the number of years requested for acquiring citizenship by naturalization that is significant with a 95% probability. As in some cases this capital aggregate yields a negative value,[43] a regression with the native values has been also run to assess whether the negative observations are negatively correlated to the number of years for naturalization. The coefficient in this case is positive but not significant ($t = 0.55$).

Concerning the other variables. As implied by the theory, the coefficient associated to β is negative for the specification with produced capital, being its value statistically significant; however, it yields non-significant results in the other specifications. As equally expected, the heterogeneity coefficient ψ has a positive value and is statistically significant for the first specification, and positive and marginally significant for the rest.

[40] This would be the case only when considering cultural dilution that affects the institutions and values of the country, however, this is covered by the heterogeneity variable.

[41] On average 84% of the capital of the countries in the sample.

[42] In fact many developed countries have in the last decades consistently increased the amount of debt over GDP and hence financed investments in public capital.

[43] There are a total of 32 countries which have a negative sum of produced, natural and financial capital.

The coefficients for the control variables are in general negative, implying a reduction in the years for naturalization, as one would expect. However, none of the coefficients is statistically significant.

MIPEX Access to Nationality index This section will conduct a regression analysis selecting the MIPEX index as the dependent variable.[44] The same specifications for the independent variables as in the previous regression analysis for the number of years for naturalization will be used. For the aggregate excluding intangible capital, two series are constructed – with positive and negative logs – to deal with the fact that a large number of countries in the sample (13) have a negative value.

In this instance there are no control variables as all the conditions for naturalization are included in the calculation of the index, as shown in Table A.5 in the Appendix. In this respect, it is important to remind the MIPEX index constitute a blend where the different elements are equally weighted, and hence the number of years of nationalization has a similar weight as the security of the status, or the possibility to have dual nationality.

Table 8.5 shows the results of the regression. As the higher the index value is for a country, the more accommodative its policies around access to nationality are, a positive coefficient implies that the public capital stock is positively correlated[45] with the disposition to grant citizenship status. This is opposed to the predictions of the model, and it is what we can observe for all specifications, with the exception of financial capital as well as the aggregate excluding intangible capital with negative values.

Contrary to the case for the years for naturalization, the number of observations that have negative and positive values splits the sample in a way that the two resulting datasets are too small.[46] As a consequence the results are not significant and it is not possible to discriminate which of the two predominates.

Concerning β and ψ, the sign of the coefficients are mixed and not statistically significant, implying that they do not play a role in determining the value of the index.

[44] Similar as with β_{Govt} and ψ the values are standardized.

[45] Negatively correlated for the specifications with negative logs.

[46] The reason behind is that the MIPEX composition is skewed towards rich economies with high levels of debt per capita. Therefore, when comparing with the sample for the years for naturalization, it presents a much larger relative number of negative values for the aggregate variable.

	(1) Produced	(2) Natural	(3) Financial (-)	(4) Intangible	(5) Total	(6) Ex-Intangible
Log p	0.168***	0.054*	0.085	$-1.06\cdot10^{-6}$	0.085	0.083**
	[2.79]	[1.97]	[1.42]	[-0.97]	[1.42]	[2.15]
β_{WGI}	-0.225**	0.004	-0.135	0.110	-0.135	0.085
	[-2.31]	[0.05]	[-1.35]	[0.98]	[-1.35]	[0.91]
ψ	0.131**	0.114*	0.118*	0.119*	0.118*	0.102
	[2.04]	[1.82]	[1.65]	[1.78]	[1.65]	[1.38]
Dual Citizenship	-0.006	-0.078	-0.041	-0.028	-0.041	-0.076
	[-0.05]	[-0.61]	[-0.31]	[-0.20]	[-0.31]	[-0.46]
Language	0.238	-0.160	0.046	-0.032	0.046	0.022
	[0.16]	[-0.10]	[0.27]	[-0.18]	[0.27]	[0.12]
Assimilation	-0.141	-0.085	-0.120	-0.051	-0.120	-0.134
	[-0.92]	[-0.52]	[-0.68]	[-0.29]	[-0.68]	[-0.68]
Criminal	-0.125	-0.132	-0.205	-0.148	-0.205	-0.197
	[-0.89]	[-0.88]	[-1.24]	[-0.93]	[-1.24]	[-1.06]
Character	0.228	0.220	0.219	0.339*	0.219	0.272
	[1.57]	[1.29]	[1.37]	[1.93]	[1.37]	[1.24]
Means	0.006	-0.005	-0.041	-0.04	-0.041	-0.046
	[0.04]	[-0.03]	[-0.25]	[-0.02]	[-0.25]	[-0.23]
Security	-0.240	-0.067	0.101	-0.091	0.101	0.008
	[-0.12]	[-0.32]	[0.45]	[-0.41]	[0.45]	[0.03]
Residence	-0.167	-0.219	-0.167	-0.337	-0.167	-0.327
	[-0.95]	[-1.11]	[-0.84]	[-1.64]	[-0.84]	[-1.28]
Observations	167	142	144	144	144	108
R-squared	0.082	0.083	0.058	0.072	0.058	0.113
Adjusted R-squared	0.017	0.005	-0.020	-0.005	-0.020	0.0113

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Dependent variable: number of years for acquiring citizenship via naturalization

t statistics in brackets

Data source: Tables A.7 - A.19

Table 8.4.: Regression results for naturalization econometric equation (8.5) using years for naturalization as the dependent variable

	(1) Produced	(2) Natural	(3) Financial (-)	(4) Intangible	(5) Total	(6) Ex-Intangible (+)	(6) Ex-Intangible (-)
Log p	0.862**	0.053	0.434**	$6.35 \cdot 10^{-6}$**	0.801**	0.188	0.312
	[2.40]	[0.42]	[2.59]	[2.65]	[2.52]	[0.87]	[1.02]
β_{WGI}	-0.338	0.403**	0.731	-0.129	-0.125	0.263	0.163
	[-1.01]	[2.16]	[0.37]	[-0.49]	[-0.46]	[0.77]	[0.04]
ψ	-0.207	-0.087	0.733	-0.0322	-0.053	-0.003	0.198
	[-0.14]	[-0.48]	[0.44]	[-0.21]	[-0.03]	[-0.01]	[0.68]
Observations	37	33	32	33	32	19	13
R-squared	0.276	0.89	0.272	0.343	0.35	0.355	0.126
Adjusted R-squared	0.210	0.106	0.195	0.275	0.26	0.227	-0.165

*** p<0.01, ** p<0.05, * p<0.1
Dependent variable: MIPEX Access to Nationality index (standardized)
t statistics in brackets
Data source: Table A.13 - A.19

Table 8.5.: Regression results for naturalization econometric equation (8.5) using the MIPEX Access to Nationality index as the dependent variable

8.5. Conclusions

This section has set out to explore quantitatively some of the main implications of the model, and particularly whether the public and private capital stocks in the host country determine the way membership policies are set up.

The first analysis has looked at the different immigrant investor programs available. In a first step it has assessed whether the investment requirements are related to the main variables of the model by running a cross-country regression on two broad aggregated variables. The results point towards public and private capital stocks per capita of the native population being positively related to the public and private capital requirements asked to those who seek to gain legal residence. This relationship however is critically influenced by the choice of estimates for the structural parameters β and ψ due to the strong non-linearity of the equation. When disaggregating the econometric equation to avoid the estimation of the parameters, the sign of the coefficients in the regression are in line with the model predictions, but the results are not statistically significant.

The second analysis has focused on naturalization requirements as determined by both the number of years for the acquisition of citizenship by naturalization, and the MIPEX Access to Nationality index. The theory would imply that the larger the public capital stock in a country, the more restrictive its naturalization policy should be. The regression on the number of years for citizenship provides some confirmatory evidence of this relationship being at work, however its statistical significance depends on the specification for public capital chosen. The MIPEX on the contrary produces mixed results with overall lower significance. The reason for the discrepancy is twofold; first the MIPEX index has much less observations and is skewed towards rich highly-indebted countries. Second, the index value is a broader measure that blends of 21 different indicators from which the number of years for naturalization is only one. If one would consider the number of years of legal residence to be the most salient and discriminating element, the two results should not be necessarily contradictory.

In summary, it can be concluded that empirical data point towards public capital playing a role in determining country membership policies, particularly investment programs, but the relationship is weak and hampered by data availability and estimating assumptions. Furthermore, in the absence of a broad international market for such programs, countries may set up requirements far away from the break-even price derived by the model, and thus it may be too early to say whether the theory can be rejected based on current evidence.

9. Discussion

This chapter sets out to provide a critical review of the country membership model advanced by this dissertation, covering its normative content as well as the main modeling assumptions, and analyzing possible alternative formulations. In this chapter we will also look forward towards avenues for future research stemming from the model.

9.1. Normative content of the model

As explained in Chapter 1, there may be many different ways in which an increase in the size of the population can affect the utility of an existing member. The utility of a representative member of the native population can be described as the sum of the income generated from the production function of the economy $I(K, P, L, \beta, \psi)$ – noting that scale effects and heterogeneity are considered to have an effect on income – plus any other non income-related factors dependent on the size of the population that have the potential to affect the individual's utility, like solidarity, compassion, (dis)like for diversity, etc.:

$$U(K, P, L, \beta, \psi) = I(K, P, L, \beta, \psi) + \Omega(L) \tag{9.1}$$

Throughout the dissertation, only the effects on income were taken into consideration for deriving the membership fee. However, this does not imply that the magnitude of the impact of the non-income factors $\Omega(L)$ has to be necessary smaller than the income ones. The model can be perceived as normative in as much as it states that there is a change in utility of the native population when accepting new members that a membership policy should try to optimize. Should non-income effects predominate over income related ones, as would be the case for those who advocate that the free movement of people has to be considered a human right, the utility value derived from preserving this altruistic value would be greater than any dilutive effects in public capital, and hence immigration should always be unconstrained. The fact that non-income factors are left aside for the formulation and testing of the model has to do with the difficulty of operationalizing and measuring them.

Furthermore, what we seem to observe in the real world is that income effects tend to predominate over non-income ones. One good example is the treatment of asylum seekers. Every country signatory to the Refugee Convention (146 in total) is obliged to provide protection for those people to whom it has obligations under the Convention, regardless of whether they entered the country in a lawful or unlawful manner.[1] However, in practice, countries set tight annual quotas on the number of asylum seekers who are granted visas and have a thorough review processes so that there is a disincentive to abuse the system by those applicants whose main reason to leave their countries is of an economic nature. Moreover, in cases of a clear humanitarian crisis like that following the civil war in Syria, we have seen how states have been very reluctant to openly welcome those seeking scape from the tragedy. Cultural dissimilarities may be often argued to be an explanation for rejecting refugees, however, the existence of more than 5 million Palestinian refugees almost 80 years after the Palestine war, [2] a majority of them living in in culturally close countries like Jordan, Syria and Lebanon, is a good reflection of how powerful economic and political considerations can be.

As explained in Chapter 8, the model can also be considered to be of a *forward-looking* nature, as the debate on the social benefits and costs of immigration is increasingly prominent in public policy but not yet mature and transparent enough. A prominent example of a country that is at the forefront of the management of immigration is offered by Switzerland, where the main party behind the initiative to regulate immigration is supporting the idea advanced by Eichenberger (2014) of imposing an *immigrant tax* of between CHF 4,000 - 6,000 per annum to be paid by the firms employing the immigrants.[3]

[1] Every country that has adopted the 1951 UN Refugee Convention makes a commitment to protect the rights of refugees. The most essential part of this commitment is never to return a refugee to a country where he or she has reason to fear persecution. Article 33 of the Refugee Convention is titled 'Prohibition of expulsion or return ('refoulement')' and says: (1) *No Contracting State shall expel or return ("refouler") a refugee in any manner whatsoever to the frontiers of territories where his life or freedom would be threatened on account of his race, religion, nationality, membership of a particular social group or political opinion* (2) *The benefit of the present provision may not, however, be claimed by a refugee whom there are reasonable grounds for regarding as a danger to the security of the country in which he is, or who, having been convicted by a final judgement of a particularly serious crime, constitutes a danger to the community of that country.*

[2] Source UN Relief and Works Agency, http://www.unrwa.org/palestine-refugees

[3] The idea of imposing an annual tax to corporations per foreign employer is on itself not new and has been in place in the Cayman Islands for a long time.

9.2. Modeling assumptions and alternative formulations

All the different model formulations have assumed a neoclassical production function homogeneous of degree one, with inputs given by labor as well as private and public capital. This section will review to which degree the different modeling assumptions and specifications impact the generality of the results.

9.2.1. Production function specification

In order to arrive at easy to manipulate and understand formulas, a Cobb-Douglas specification has been usually chosen. However, the non-specified model introduced in Chapter 5 has shown that the only necessary assumption for the production function is that this is homogeneous of degree one: $F(K, P, L) = L \cdot f(k, p)$. Hence, it is not even necessary for the results to hold to assume a production function with CES, and a Cobb-Douglas can be used without losing any generality.

Using a Cobb-Douglas specification does only make a difference when using a discount rate for deriving the membership fee for infinite periods, as will be shown later in this section.

9.2.2. Complementarity between private and public capital

Throughout the thesis two main formulations have been used, one in which private and public capital are complementary ($F = K^{\alpha_K} P^{\alpha_P} L^{1-\alpha_K-\alpha_P}$) and a second one in which they are treated as different components of the same variable ($F = (K+P)^{\alpha} L^{1-\alpha}$). If complementarities between public and private capital are assumed, the marginal return of one type of capital when adding an infinitesimal amount of the other type will be positive ($\frac{\partial r_K}{\partial P} = \frac{\partial r_P}{\partial K} = \frac{\partial F}{\partial K \partial K} > 0$), whilst if both sorts of capital are parts of the same factor of production, marginal returns will be negative.

The implications of assuming one or the other form do not fundamentally alter the model, as the main trade-offs between scale economies, dilution of public capital and heterogeneity are not affected. However, it changes the magnitude and direction of allocative efficiency effects as shown in Chapter 5. In the one-period case, contributions of private capital have an opposite effect depending on whether there are complementaries or not, whilst for the infinite period the results are equivalent.

Furthermore, depending on whether public and private capital are considered to be same or complementary, the discount rates used for the infinite period calculation differ. If both sorts of capital are different components of the same total aggregated capital (i.e., non complementary) there is one single discount rate r. However, if they are complementary, there are two different discount rates, one for private capital r_K and a different one for public capital r_P.

There is a whole strand of the economic literature that sets out to explain the characteristics of public capital. When proposing his well known model, Barro (1990, pp. 107-108) provides a concise explanation of why to use a production function with both private and public capital as separate inputs: *"The general idea of including g as a separate argument of the production function is that private inputs, represented by k, are not a close substitute for public inputs. Private activity would not readily replace public activity if user charges were difficult to implement, as in the case of such nonexcludable services as national defense and the maintenance of law and order. In other cases, user charges would be undesirable, either because the service is nonrival or because external effects cause private production to be too low (as is sometimes argued for basic education)"*.

Further, one of the main questions addressed by the research in this area is whether the returns to scale for the production function are decreasing, constant or increasing. Throughout the thesis, when assuming public and private capital are complementary, no assumption has been made in this respect as the model does not require it.

9.2.3. Discount rate (r_P vs. r_K)

Discounting obviously plays a key role in deriving the membership fee for infinite periods, and so does the chosen specification with complementarities between labor, private capital and public capital. A derivation of the membership fee with a non-specified production function is provided in Appendix sec. A.23. When private and and public capital are complementary, the non-specified model discounting income by the returns of public capital will be:

$$I(K,P,L) = \frac{F(K,P,L)}{L^{\beta} \cdot \frac{\partial F}{\partial P}} \tag{9.2}$$

That gives us the following membership fee in a non-specified form:

$$p^{*} = p + \frac{f \cdot f_p}{f_p^2 - f \cdot f_{pp}} \cdot (\beta - 1) + \frac{f_p \cdot f_k - f \cdot f_{kp}}{f_p^2 - f \cdot f_{pp}} \cdot (k - k^{*}) \tag{9.3}$$

Whilst if we discount by private capital returns:

$$I(K,P,L) = \frac{F(K,P,L)}{L^{\beta} \cdot \frac{\partial F}{\partial K}} \tag{9.4}$$

We obtain the following membership fee:

$$p^{*} = p + \frac{f\left(\beta f_p - f_k\right)}{f_p \cdot f_k - f \cdot f_{kp}} + \frac{f_k^2 - f \cdot f_{kk}}{f_p \cdot f_k - f \cdot f_{kp}} \cdot (k - k^{*}) \tag{9.5}$$

As the definition of income of the representative individual does not differentiate between private and public income, the assumption of equal capital endowments between the new member and the native population is necessary ($k = k^{*}$),[4] which thus turns irrelevant the third member of the equation.

Even if the two equations look similar at first sight, the differences can be acute depending on the production function specification. If a Cobb-Douglas production function is chosen, the second term in (9.3) turns zero, as $f_p \cdot f_k - f \cdot f_{kp} = 0$ independently of the amount of capital k^{*} brought by the new member. This explains why the assumption of equal capital endowments was necessary for the calculation of the membership fee in the one-period model in Chapter 3 but was not required for the infinite period one. This however would not be the case when private and public capital are not complementary. Moreover, the denominator of (9.5) will equal zero and the membership fee will tend to $\pm\infty$ depending of the sign of $\beta\alpha_K p - \alpha_P k$ (see Appendix sec. A.23), whilst the membership would equal to βp when discounting by the public capital returns. This is the case because the income equation will be $I = \frac{F(K,P,L)}{r_K L^{\beta}} = \frac{K}{\alpha_K L^{\beta}}$, which does not depend on P and hence cannot be optimized. This was the reason not to choose to discount by private capital returns in Chapter 3.

When private and public capital are assumed to be alternative non-complementary sources of total aggregated capital, the discount rate is unambiguously given by the returns of total capital. When this is the case the non-specified membership fee will be equal to (see Appendix sec. A.23):

[4]The necessity of the assumption of equal capital endowments has been explained in detail in Chapter 3 and Chapter 5.

$$p^* = p + \frac{f \cdot f_p}{f_p^2 - f \cdot f_{pp}} \cdot (\beta - 1) + (k - k^*) \tag{9.6}$$

Imposing again equal capital endowments ($k = k^*$) and a Cobb-Douglas production function, the membership fee turns:

$$p^* = \beta p - k(1 - \beta) \tag{9.7}$$

Pointing towards private capital stock having a large impact in reducing the membership fee. This is the case because the economies of scale associated to population size have been assumed to play a role over the whole production, and the non complementarity of public an private capital means contributions of public capital will decrease the discount rate and hence increase the infinite-period income.

When using the income specifications of Chapter 5 in which economies of scale affect only public capital ($I = w + r\overline{k} + r\frac{P}{L^\beta}$), the membership fee turns:

$$p^* \approx \beta p + \frac{(1 - \alpha)}{\alpha L^{1-\beta}} \left(\overline{k} - k^*\right) \tag{9.8}$$

Which is not impacted by the absolute level of existing capital per capita k, but by the delta between the capital endowments of the native population and those of the new member. As seen in Chapter 5, we obtain a similar equation when complementarities between different forms of capital are assumed, but requires to discount private income (from wages and private capital) using private capital returns, and public income using public capital returns.

9.2.4. Non-Linearity and scope of the parameter β

One of the analytical and empirical complications of the model is created by the non-linearity of the parameter β that reflects the economies of scale associated to a larger population size, or alternatively the crowding effects produced. All the models used throughout this research have exhibited non-linearity but it has not been assessed so far whether simple linear model would be more appropriate. Such a model would express income as:

$$I(K,P,L) = \frac{F(K,P,L)}{\beta L} \tag{9.9}$$

When optimizing income for a change in population we have:

$$\frac{\partial I}{\partial L} = \frac{1}{\beta} \cdot \frac{\partial}{\partial L}\left(\frac{F(K,P,L)}{L}\right) \tag{9.10}$$

$$\frac{\partial I}{\partial L} = 0 \Rightarrow \frac{\partial}{\partial L}\left(\frac{F(K,P,L)}{L}\right) = 0 \tag{9.11}$$

This implies that the membership fee for the linear model would be equal to that of the non-linear model but with the requirement that $\beta = 1$. When this is the case, the membership fee p^* is in all cases is equal to p, and it is independent of whether or not one considers one period or multiple periods, or complementarities between public and private capital. This happens because by defining income as in equation (9.9) the economies of scale affect all variables equally and hence play no role in the optimization problem.

As explained in Chapter 3 the nature of scale economies associated to population size are not exclusively associated to public capital, as there are other positive spillovers such as larger internal markets or exposure to uninsurable shocks. The model in its most simple form assumes scale economies impact all sources of income (i.e., total output) in the same way. However, in the model formulations proposed in Chapter 5 for incorporating allocative efficiency, economies of scale are exclusively circumscribed to public capital. This creates the possibility of defining a linear formulation for the model such as the following for the one-period with non-complementarities between private and public capital:

$$I = w + r\overline{k} + r\frac{P}{\beta L} \tag{9.12}$$

In this formulation economies of scale affect the ratio of public capital per capita $p = P/L$, instead of only population as in the non-linear specification (L^β). The membership fee in a non-specified model would be:

$$p^* = p\left[\frac{\frac{r}{L} + \frac{\partial r}{\partial K}(1-\beta)\left(\overline{k} - k^*\right)}{\frac{\partial r}{\partial K}\cdot p\,(1-\beta) + \frac{r}{L}}\right] \tag{9.13}$$

which for a Cobb-Douglas specification results in:

$$p^* = p\left[\frac{1 + (1-\alpha)(1-\beta)\left(\frac{k^*}{\overline{k}+p} - 1\right)}{1 - (1-\alpha)(1-\beta)\frac{p}{k}}\right] \tag{9.14}$$

It can be observed that the membership fee is in this case very similar to equation (5.10) obtained in Chapter 5 when economies of scale are small large. In fact, economies of scale play no role in the term of the equation associated to dilution effects, whilst they impact the allocative efficiency term in a linear way.[5]

In the case of infinite periods, the linear version of the model would be:

$$I = \frac{w}{r} + \overline{k} + \frac{P}{\beta L} \tag{9.15}$$

which for a Cobb-Douglas specification gives the following membership fee:

$$p^* = \frac{\alpha p + \beta(1-\alpha)(k - k^*)}{\alpha + \beta(1-\alpha)} \tag{9.16}$$

The dilution term of membership fee is again invariant to β, whilst the latter scales linearly the allocative efficiency term.

Appendix sec. A.27 illustrates the different membership fees obtained for the four alternative model specifications to those of Chapter 5.[6] In all cases the linear model yields a membership fee where the parameter β influences the relative importance of the different sources of income – wages, private capital returns and public capital returns – but does not serve to model the economies of scale arising from the partial non-rivalry associated to publicly provided goods. In conclusion, the non-linear specification seems to be a more appropriate modeling option despite the analytical and empirical complications that it introduces.

[5]The non linear form scales by $s = L^{1-\beta} - 1$, whilst the linear form scales by $(1-\beta)$

[6]One period and infinite periods, with and without complementarities between private and public capital

9.2.5. Summary of modeling assumptions

In the previous sub-sections it has been analyzed how the different modeling options may influence the results obtained throughout the dissertation. These include whether economies of scale associated to population size affect the whole production function or only public capital, the intensity of scale economies (linear vs. non-linear), the potential complementarities between private and public capital, and discount rate used in the case of infinite periods. The membership fee is in all cases dependent on the existing stock of public capital per capita p, with the interplay of the different modeling factors determining the extent to which scale economies attenuate dilution effects, as well as the relative importance of allocative efficiency effects due to unequal capital endowments.

The following table shows the corresponding membership fee for the different modeling options:

Periods	Scope β	Linearity	Complementarity	Income	Membership Fee
Single	$F(K,P,L)$	Non-linear	Yes	$I = \frac{K^{\alpha_K} P^{\alpha_P} L^{1-\alpha_K-\alpha_P}}{L^{\beta}}$	$p^* = p \cdot \left(1 + \frac{\beta-1}{\alpha_P}\right)$
			No	$I = \frac{(K+P)^{\alpha} L^{1-\alpha}}{L^{\beta}}$	$p^* = (k+p) \cdot \left(1 + \frac{\beta-1}{\alpha}\right)$
		Linear	Yes	$I = \frac{K^{\alpha_K} P^{\alpha_P} L^{1-\alpha_K-\alpha_P}}{\beta L}$	$p^* = p$
			No	$I = \frac{(K+P)^{\alpha} L^{1-\alpha}}{\beta L}$	$p^* = k + p$
	P	Non-linear	Yes	$I = w + r_K \overline{k} + r_P \frac{P}{L^{\beta}}$	$p^* \approx p \left[\frac{\beta - \alpha_L - \frac{k^*}{\overline{k}} \alpha_K}{\alpha_P}\right]$
			No	$I = w + r\overline{k} + r\frac{P}{L^{\beta}}$	$p^* \approx p \left[\frac{\beta + (1-\alpha)\left(\frac{k^*}{\overline{k}+p} - 1\right)}{1-(1-\alpha)\frac{p}{\overline{k}}}\right]$
		Linear	Yes	$I = w + r_K \overline{k} + r_P \frac{P}{\beta L}$	$p^* = p \left[\frac{1-\alpha_L(1-\beta) - \frac{k^*}{\overline{k}}(\alpha_K(1-\beta))}{1+(\alpha_P - 1)(1-\beta)}\right]$
			No	$I = w + r\overline{k} + r\frac{P}{\beta L}$	$p^* = p \left[\frac{1+(1-\alpha)(1-\beta)\left(\frac{k^*}{\overline{k}+p} - 1\right)}{1-(1-\alpha)(1-\beta)\frac{p}{\overline{k}}}\right]$
Infinite	$F(K,P,L)$	Non-linear	Yes	$I = \frac{K^{\alpha_K} P^{\alpha_P} L^{1-\alpha_K-\alpha_P}}{r_P L^{\beta}}$	$p^* = \beta p$
				$I = \frac{K^{\alpha_K} P^{\alpha_P} L^{1-\alpha_K-\alpha_P}}{r_K L^{\beta}}$	$p^* = \pm\infty$
			No	$I = \frac{(K+P)^{\alpha} L^{1-\alpha}}{r L^{\beta}}$	$p^* = \beta p - k(1-\beta)$
		Linear	Yes	$I = \frac{K^{\alpha_K} P^{\alpha_P} L^{1-\alpha_K-\alpha_P}}{r_P \beta L}$	$p^* = p$
			No	$I = \frac{(K+P)^{\alpha} L^{1-\alpha}}{r_P \beta L}$	$p^* = p$
	P	Non-linear	Yes	$I = \frac{w}{r_K} + \overline{k} + \frac{P}{L^{\beta}}$	$p^* = \beta p + \frac{\alpha_L}{\alpha_K L^{1-\beta}} \left(\overline{k} - k^*\right)$
			No	$I = \frac{w}{r} + \overline{k} + \frac{P}{L^{\beta}}$	$p^* \approx \beta p + \frac{(1-\alpha)}{\alpha L^{1-\beta}} \left(\overline{k} - k^*\right)$
		Linear	Yes	$I = \frac{w}{r_K} + \overline{k} + \frac{P}{\beta L}$	$p^* = p + \beta \frac{\alpha_L\left(\overline{k} - k^*\right)}{\alpha_K}$
			No	$I = \frac{w}{r} + \overline{k} + \frac{P}{\beta L}$	$p^* = p + \frac{\beta(1-\alpha)\left(\overline{k} - k^*\right)}{\alpha + \beta(1-\alpha)}$

Table 9.1.: Membership fee under different modeling assumptions for a Cobb-Douglas specification

9.3. Endogenously determined scale economies β

In the empirical section the parameter β has been considered as given when determining the membership fee and hence treated as an independent variable, and Chapter 7 has addressed how different preferences for government size can affect the economies of scale associated to publicly provided goods and hence change impact the membership fee. There is however a way for β to become a policy variable, as one could think country membership could be discouraged by reducing the scale and scope of those goods that are publicly provided. If this were the case, β would turn to be a dependent variable codetermined together with the membership fee p^*, which would have implications for empirically testing the model. Explicitly managing government size to attract or repel foreigners is something that is typically observed at local intra-country level (e.g., fiscal competition between Swiss cantons), however if the freedom of movement of people would increase, it could be envisaged to take place also at country level.

9.4. Open economy

Throughout this research it has always been considered that both wages and return on capital are endogenously determined. This would be descriptive of a closed economy, or alternatively, appropriate for the analysis of the short-run effects of immigration.

The first assumption is not essential, but coherent with the thesis that countries restrict heavily the inward flow of people and as a result wage differentials between countries can be persistent. Moreover, this is what can be empirically observed.

The assumption of an endogenously determined return on capital however has to be relaxed for an open economy when analyzing the long-run effects of immigration, as contrary to labor, countries are much more flexible in allowing capital to circulate freely.

In this section, the model will be adapted in steps to reflect an exogenously given return on capital and wage rate, and the results will be compared to those of the previous chapters.

9.4.1. Exogenous r with economies of scale on F

The income of the representative individual over a perpetuity when the return on capital is constant will be defined as:

$$I(K,P,L) = \frac{F(K,P,L)}{rL^{\beta}} \tag{9.17}$$

The change in income for an increase of population will be given in this case by:

$$\frac{\partial I}{\partial L} = \frac{1}{r} \cdot \frac{\partial}{\partial L}\left(\frac{F(K, P, L)}{L^{\beta}}\right) \tag{9.18}$$

Therefore, the membership fee will be similar to that of the one period case. This is the case independently of whether there are complementarities between private and public capital.

The most obvious consequence of assuming an exogenously determined return on capital is that the dilution in public capital is much smaller than when the latter is endogenously determined. Another implication is that, contrary to the case when the discount rate is endogenously determined, productivity increases brought by the new member would have a lasting effect on the membership fee even when infinite periods are considered.

9.4.2. Exogenous r with non-complementarity of capital and economies of scale on P

Taking first the case where there are no complementarities between private and public capital and assuming an exogenously given return on capital $\hat{r}$, the infinite-period income of an representative native member can be expressed as:

$$I = \frac{w}{\hat{r}} + \overline{k} + \frac{P}{L^{\beta}} \tag{9.19}$$

The optimization problem is equivalent to that of the one period:

$$\frac{\partial I}{\partial L} = \frac{1}{\hat{r}} \frac{\partial}{\partial L}\left(w + \hat{r}\overline{k} + \hat{r}\frac{P}{L^{\beta}}\right) = 0$$

This implies that the membership fee is independent of the number of periods of residence in the country. As Appendix sec. A.23 shows, the membership fee for a Cobb-Douglas specification can be approximated as:

$$p^{*} \approx \beta p + \frac{r}{\hat{r}} \cdot \frac{(1-\alpha)}{L^{1-\beta}} \cdot (k - k^{*}) \tag{9.20}$$

This is similar to that of the infinite-period case when the return on capital is endogenously determined, but with the second term multiplied by $r/\hat{r}$, where r is the endogenously given return on capital. In the long run, the return on capital differential will disappear assuming private capital can flow freely and thus $r = \hat{r}$. Hence, if private and public capital are not complementary, the long-run results derived for a closed economy hold for an open economy,[7] whilst the short-term results diverge.[8]

9.4.3. Exogenous r with complementarity of capital and economies of scale on P

In the case when private and public capital are complementary and the return on private capital is exogenously given but not the return on public capital, the one-period income of the representative incumbent member would be described by:

$$I = w + \hat{r}\bar{k} + r_P \frac{P}{L^\beta} \tag{9.21}$$

And membership fee in the short run can be approximated by:

$$p^* \approx p \left[\frac{\beta - \alpha_L - \frac{k^*}{\bar{k}}\alpha_K}{\alpha_P} \right] \tag{9.22}$$

This is exactly the same membership fee we obtained for the one-period case with the endogenously given return on capital. Hence, when assuming an open economy, the results are not altered.

In the case of infinite periods, the income of the representative individual will be given by:

$$I = \frac{w}{\hat{r}} + \bar{k} + \frac{P}{L^\beta} \tag{9.23}$$

This equation looks similar to (9.19). The detailed calculation in Appendix sec. A.23 shows, that the membership fee for a Cobb-Douglas specification can be approximated as:

[7] Only the output share of capital disappears from the denominator of the second term.

[8] Both the direction and the magnitude of the differential in capital endowments between the incumbent and the incoming population are different.

$$p^* \approx \beta p + \frac{r_K}{\hat{r}} \cdot \frac{\alpha_L (k - k^*)}{L^{1-\beta}} \tag{9.24}$$

This is the same result as in the case of non-complementarities between private and public capital, and more importantly, similar in direction and magnitude to that of the case when the return on capital is endogenously given, with the difference that the output share of private capital does not play any role. Hence, when complementarities between private and public capital are assumed, the membership fee is marginally changed when the return on capital is endogenous or exogenously given both in the short and long run.

9.4.4. Exogenous wage rate

If the assumption of wages being determined endogenously would also be relaxed, and wages as well as the return on capital were assumed to be given by global markets, $\widehat{w}$ and $\hat{r}$, independently of whether there are complementarities or not between private and public capital, the infinite period income per capita of the representative individual would be given by:

$$I = \frac{\widehat{w}}{\hat{r}} + \overline{k} + \frac{P}{L^{\beta}} \tag{9.25}$$

As the first two terms are constant in this case, the optimization problem would be then equivalent to the simplified model when economies of scale affect the whole production function:

$$\frac{\partial I}{\partial L} = \frac{\partial}{\partial L}\left(\frac{P}{L^{\beta}}\right) = 0$$

And the membership fee would be:

$$p^* = \beta p \tag{9.26}$$

Intuitively, this result was to be expected, as when wages and rates are exogenously given, there are no possible allocative efficiency gains, and dilution effects dictate the value of the membership fee. This is consistent with the conventional view of immigration provided by the

HOV, where immigration is is expected to exercise little long-run impact on national labor markets. In contrast, the closed-economy version of the model, as well as the version that assumes global interest rates but endogenously determined wages derive predictions that are in line with specific-factors models of international trade. The purpose of this dissertation is not to address the competing insights into the economic impact of immigration that these two widely employed models of international trade provide,[9] but to show that, when incorporating public capital dilution into the equation, the cost and benefits of immigration need to be readdressed. In fact, if one considers fiscal expenses/ income associated to immigration to be a equivalent to a change in public capital, the model presented in this dissertation builds a bridge between the three major strands of the literature on immigration provided by international trade, labor economics and public finance.

9.4.5. Summary

Throughout this dissertation wages and return on capital rates have been assumed to be endogenously determined. This is consistent with the classic analysis of the short-run cost/ benefits of immigration advanced by Berry and Soligo (1969) and the long-run effects in the presence of public capital derived by Usher (1977). Allocative efficiency gains/ losses arise from different private capital endowments between the incumbent and the immigrant population, as well as by the potential contributions of public capital by the new entrants. These effects certainly have an impact in the short run, though in the long run they may disappear if factors of production are allowed to flow freely and the wage and return on capital levels are dictated by global markets. As the infinite period membership fee is a long-run calculation, it is important to analyze how the membership fee would vary if the prices for the factors of production were exogenously given.

In the particular case when there is a free flow of private capital and market prices dictate the rate of return on private capital, but wages and the return on public capital are endogenously determined due to restrictions to movements of labor and the immovable nature of public capital, the long-run results obtained are largely equivalent to those derived assuming an endogenously determined return on capital, which speaks for the robustness of the model under different discounting assumptions.

When the prices for both labor and return on private capital are exogenously given, but return on private capital remains endogenously determined, allocative efficiency effects would not play any role in the determination of the membership fee, which will be influenced by dilution and

[9] See Grether et al. (2001) and Venables (1999).

heterogeneity effects.

9.5. Unbalanced budget

Throughout this dissertation it has always been assumed a balanced budget and a stationary and endogenously determined discount rate. Thus, possible changes in the discount rate due to the need to finance government expenditures have not been taken into consideration.

The previous section has shown how the results would vary when the return on capital is dictated by global market prices in an open economy. A natural extension of the former would be to consider that if a government were to be over-indebted, this would probably force it to pay risk premium π on top of the market interest rate $\hat{r}$, which would then cause the membership fee to decrease:

$$p^* \approx \beta p + \frac{r_K}{\hat{r} + \pi} \cdot \frac{\alpha_L \left(k - k^*\right)}{L^{1-\beta}} \tag{9.27}$$

Besides the impact on the interest rate paid, the amount of debt in principle does not necessarily need to affect the membership fee. If a government were to take on a certain amount of debt d to finance new public assets $\triangle p$ that would produce a return equal to the interest rate paid $\hat{r} + \pi$, the net public assets over one period would remain unchanged: $p_1 = p_0 + (\triangle p - d) \cdot (\hat{r} + \pi) = p_0$

Naturally, in the case the debt were to be used to finance public current expenditure instead of new investments, or if the return of the new assets were below the required interest rate, this would cause a decline in the public capital per capita p and hence a reduction in the membership fee.

9.6. Directions for further research

9.6.1. Economies of scale in publicly provided goods and optimal government size

The pivotal role played by economies of scale associated to publicly provided goods in the determination of a membership fee contrasts with the absence of empirical work assessing its value. Economies of scale arise from both the amount and purity of the goods publicly provided.

As discussed in Chapter 6, there is an interplay between the range of publicly provided goods, its degree of purity and the optimal government size.

As Kahn (2011) points out, the question of optimal government size has been typically addressed in the literature on economic growth, although a probably more relevant question is how government size influences the total level of output, rather than its growth rate. Khan argues that available data sports the thesis of smaller governments being better, and suggests that the optimal size of government is probably smaller than what we observe today. Kahn also advocates that conventional measures of size, such as the share of government spending in GDP fail to capture the full impact of government, and proposes to use broader measures like *Economic Freedom Index* or Hall and Jones (1999) *Social Infrastructure Index*.

Interestingly, Hall and Jones look at how a broad measure of government affects output via productivity increases, but a complementary question would be how government size affects citizens' *wellbeing*, as due to economies of scale in publicly provided goods, a certain government size may be optimal for maximizing utility but sub-optimal for maximizing total output. The OECD *Better Life Initiative*, The Economist *Where-to-be-born Index* (formerly known as *Quality of Life Index*), the *Genuine Progress Index* or the *Word Happiness Report* are all prominent examples of aiming to quantify other measures affecting an individual utility besides solely output or income. All these indices follow a certain rational for selecting a number of factors affecting happiness (e.g., health, quality of government, equality, freedom to make choices, social support, generosity, climate, job security, crime rate), but their purpose is more to serve as an alternative to GDP as a measure to guide public policy, rather than to provide a theoretical micro-founded framework, what could be offered by the model presented in this dissertation. Conversely, some of the research in the area of wellbeing might be a good starting point for quantifying the quality of publicly provided goods, and their corresponding economies of scale, as they provide a broad measure of the individual's utility. Concretely, defining λ as the proportion of total utility divided by utility derived exclusively from production, we can estimate the implicit economies of scale β as follows:

$$\lambda = \frac{\frac{F(K,P,L)}{L^{\beta}}}{\frac{F(K,P,L)}{L}} = L^{1-\beta} \Rightarrow \beta = 1 - \frac{Ln\lambda}{LnL} \tag{9.28}$$

In the World Happiness Report, Helliwell, Layard and Sachs (2013) use as a dependent variable the results of a ranking (Cantril ladder)[10] from a Gallup World Poll based on answers to the

[10]The poll asks respondents to think of a ladder, with the best possible life for them being a 10, and the worst possible life being a 0. They are then asked to rate their own current lives on that 0 to 10 scale.

main life evaluation question asked in the poll. They then regress the estimated extent to which six factors – levels of GDP, life expectancy, generosity, social support, freedom, and corruption – contribute to making life evaluations higher in each country than they are in an imaginary country with the lowest scores for each factor. Assuming the coefficient in the regression for the GDP contribution[11] is a good estimate of the contribution of production to total utility, the parameter λ could be estimated for every country i as follows:

$$\lambda_i = \frac{Cantril_i}{0.283 \cdot (LnGDP_i - LnGDP_{Worse})} \tag{9.29}$$

The problem with this estimation is that it tends to overstate/ understate the amount of economies of scale in those countries with a very low/ high economic output due to the large value of the residual that, amongst other things, reflects country-specific factors including the different base for comparison (a member of the top scoring country will probably weigh the factors differently than a member of the lowest scoring country if relocating to the latter). Further, the measure of happiness is arguably broader than just economic utility (even when accounting for social output) and despite the statistical significance of the factors, happiness may be influenced by other variables. In fact, comparing with the Economist Where-to-be-born Index (2013),[12] which is also derived from a Gallup life-satisfaction survey, out of 10 factors[13] they find that GDP per head alone explains some two thirds of the inter-country variation in life satisfaction,[14] compared to just 0.28 in the World Happiness Report.

Moreover, some of the factors that have a large influence, like life expectancy and the rule of law, can be heavily influenced by the stock of public capital and not just by its degree of publicness. The approach followed in this research has been to consider exclusively the quality of public governance as the best indicator of the quality of public goods. However, survey-based contingent valuation methods similar to those used in environmental economics

[11] The coefficient they find for Log GDP is 0.283 (pp. 19 in the report)

[12] The index aims to measure which country will provide the best opportunities for a healthy, safe and prosperous life in the years ahead by linking the results of Gallup life-satisfaction surveys to the objective determinants of quality of life across countries along with a forward-looking element.

[13] Material wellbeing as measured by GDP per head (in \$, at 2006 constant PPPS); life expectancy at birth; the quality of family life, based primarily on divorce rates; the state of political freedoms; job security (measured by the unemployment rate); climate (measured by two variables: the average deviation of minimum and maximum monthly temperatures from 14 degrees Celsius; and the number of months in the year with less than 30mm rainfall); personal physical security ratings (based primarily on recorded homicide rates and ratings for risk from crime and terrorism); quality of community life (based on membership in social organizations); governance (measured by ratings for corruption); gender equality (measured by the share of seats in parliament held by women).

[14] "The lottery of life methodology". The Economist, November 21, 2012.

for valuing passive use of public goods, could be a good starting point for deriving more precise estimates of economies of scale derived from public goods.

9.6.2. Endogenous population growth

Throughout the dissertation it has only been considered the case when population growth is exogenous via immigration. However, in most countries endogenous population growth is in the long run a much more powerful engine of overall population growth. If adding a new citizen is by default dilutive, fertility rates larger than those consistent with a constant population would be public capital dilutive. However, younger generations usually start at a more advanced point in the technological frontier than their predecessors, and have the potential to bring new advances in human capital. If the membership fee p^* in Chapter 4 would be assumed to be zero for newborns, the advance in human capital that would allow for a higher fertility rate will be given by:

$$h^* \geq \frac{\alpha_H p}{\alpha_P h} \cdot \left(1 + \frac{\beta - 1}{\alpha_P}\right) \cdot p \tag{9.30}$$

An alternative formulation can be done considering that productivity increases brought by the new generation need to compensate for public capital dilution. In this case we would obtain the rate of change in population as a function of the rate of change in productivity growth:

$$\frac{\partial L}{L} \leq \frac{\frac{\partial A}{A}}{1 + \frac{\beta - 1}{\alpha_P}} \tag{9.31}$$

Interesting avenues for research would be to investigate whether fertility rates or population growth are influenced by expected productivity or human capital increases, or alternatively, if increasing childbearing costs are a way of internalizing and/or discouraging excess fertility and hence avoiding public capital dilution.

9.6.3. Taxation

This dissertation has focused on the requirements that the incumbent population should impose on a new member at the time of entry. Despite the fact it has allowed for different private capital endowments, it has not consider how post-entry redistribution policies could affect the determination of the membership fee. If the newcomer would pay more/ less taxes than the incumbent population, the membership fee should be downward/ upward adjusted to account for larger/ smaller contributions. In fact redistribution may be argued to be a factor behind the skewness of immigration policies towards admitting wealthy new members. Accordingly, countries would not only seek to have allocative efficiency gains but larger tax contributions.

The question of whether it is possible to find an optimal size of government is also intimately linked to that of optimal taxation. As Samuelson (1954) pointed out, attempts to define a benefit theory of taxation are hampered by the impossibility of finding a decentralized spontaneous solution in the presence of public goods. The reason is that a market solution would require that every individual would reveal her true preferences for public goods, which is in practice difficult as there is an incentive to *"piggy back"* and signal less interest on a public good than the actual one. The model presented in this dissertation does not solve the problem of finding a decentralized solution, but would provide a way to define the optimal amount of public goods provided in a centralized manner. Accordingly, one could think of publicly provided goods being arranged according to their degree of publicness, with only those that can be afforded by a given budget constrain being provided, the latter resulting from optimizing the representative individual income or from political economy considerations.

9.6.4. International trade

Some well-known theories of international trade like the HOV model are based on the existence of differing factor endowments between countries. Whilst the movement of labor across countries is severely restricted, the liberalization of capital flows is nowadays quite extended, and if capital can move freely, differences in labor abundance would not produce a difference in relative factor abundance (in relation to mobile capital) because the labor/capital ratio would be identical everywhere. By differentiating between public and private capital, a model could be advanced that justifies persistent differences in the labor/capital ratio, as public capital is in general of an immovable nature.

Additionally, a model could be derived as a thought experiment where both labor and private capital would be mobile. Countries would then have to agree to exchange the public capital share of the migrant individual from the country of origin to the country of destination, or alternatively, the individual who is migrating would receive an exit fee from the departing country and pay a membership fee to the country of destination, which could be both derived from the membership model provided by this dissertation.

10. Conclusions

This dissertation sets out to address a gap in the literature by providing a comprehensive micro-founded economic model of country membership, which accounts for the different costs and benefits that admitting a new member may have for the incumbent population, the different levels of membership offered, as well as the different ways in which membership can be financed.

In Chapter 2 the most relevant models of immigration demand have been reviewed, concluding that due to the strict divisibility of capital they imposed, they fail to capture the (partially) non-rival indivisible nature of most publicly provided goods. To address this problem, Chapter 3 has introduced an stylized micro-founded club model of country membership that derives the equilibrium membership conditions as a trade off between the benefits of economies of scale and the redistribution costs associated to a larger population. As an increase in new members can also generate crowding effects when economies of scale have been exhausted, the latter have been included in the model. Lastly, the chapter has shown how the classic immigration models can be extended in order to cater for economies of scale, and how the results are comparable in terms of direction of the relationships between variables with those derived from the club model.

Chapter 4 has discussed how heterogeneity of preferences, values and culture can cause a reduction in economies of scale, and consequently lead to an increase in the membership price requested to new entrants. Alternatively, when new members posses skills that are beneficial for the native population the membership fee is reduced. Further, the role played by social heterogeneity and skills diversity in immigration policies has been illustrated by the case studies offered by the National Origins Act and the Point-Based Systems and High-skills visa programs respectively. Same as in Chapter 3, it has been shown how the classic immigration models can be extended in order to cater for heterogeneity of tastes and skills.

Chapter 5 is a key element of this dissertation, as here the model is extended to cater for allocative efficiency gains caused by different private capital endowments between the native and the immigrant population, which had been assumed to be equal in the stylized model. Importantly, in the chapter is also mathematically proven that the income optimization problem that is at the foundation of the thesis is equivalent to the classic income approximation approach mostly seen in the literature. Moreover, the chapter demonstrates that the only assumption imposed on the production function is that this is homogeneous of degree one, being all the results valid independently of the value of the elasticity of substitution. Lastly, productivity gains have been incorporated into the extended model showing that increases in total factor productivity brought by the new member does not alter the membership fee, whilst improvements in labor productivity do generally cause a reduction in the membership fee.

Being public capital central for the theory, Chapter 6 has focused on the role of the government. When economies of scale associated to population size depend exclusively on the size of the public sector, the larger the government the lower the membership fee should be. However, there is a trade-off between economies of scale and government size – the larger the number of goods that are public, the higher their potential degree of rivalry. This implies that there is an optimum level of government size, for which an implicit formulation has been provided. If new members have the potential to alter the size of the government deviating/ approximating it to the optimum, the membership fee will increase/ decrease. Lastly, when taxation exceeds the returns on public capital, a new member can pay its membership fee over time, which suggests there may be a positive relationship between the number of years for naturalization and the tax rate.

Chapter 7 has built on previous results to analyze a number of political economy implications arising from different capital and skills endowments within the native population, as well as from disparate preferences for government size and population heterogeneity. The country membership model has been then used to analyze a number of cases studies, including the regularization programs in Europe, changes to Israel's "Law of Return", the "blood quantum" tribe membership requirements by Native American tribes, and the dissolution of the USSR.

Chapter 8 has quantitatively assessed whether the stock of public capital as well as other important variables influencing the economic benefits and costs for the native population, like economies of scale, heterogeneity costs and allocative efficiency gains, have a direct influence on the membership policies that we can observe. Empirical data from immigrant investor programs points towards public and private capital stocks in the host country being positively related to the public and private capital requirements asked to those who seek to gain legal residence, but the relationship is weak and hampered by data availability and estimating assumptions. Evidence from the acquisition of citizenship by naturalization also indicates a positive relationship between public capital and the number of years of legal residence requested, whilst results are mixed when using a broader measure like the MIPEX Access to Residence index.

Finally, Chapter 9 has provided a critical review of the country membership model advanced by this dissertation, covering its normative content as well as the main modeling assumptions, and analyzing possible alternative formulations. The chapter has also shown how when making different assumptions about the degrees of openness in the economy, the model bridges three major strands of the literature on immigration, that originate from the areas of international trade, labor economics and public finance. The chapter has also discussed several avenues for future research stemming from the model.

In summary, at theoretical level this dissertation has provided a novel way to bridge the literature of immigration and local public goods, two areas whose overlap has been mostly circumscribed to the fiscal effects of immigration. Moreover, it has advanced a micro-founded model that is able to incorporate in a comprehensive manner all relevant elements usually identified in the literature. In fact, the model could be perceived as superseding other classic immigration models that are based on income approximations instead of an income optimization problem. Lastly, this research has created two novel datasets – for private capital and naturalization requirements – and set out to explore quantitatively some of the main implications of the model. The evidence found is weak and hampered by data availability and estimating assumptions, but the effort can be seen as a first step in this new avenue of research.

A. Appendix

A.1. Glossary

$K \equiv$ Private capital stock

$H \equiv$ Human capital stock

$k \equiv$ Private capital per capita

$\overline{k} \equiv$ Pre-immigration private capital per capita

$P \equiv$ Public capital stock

$p \equiv$ Public capital per capita

$p^* \equiv$ Public capital contribution per new member

$k^* \equiv$ Private capital contribution per new member

$F \equiv$ Total output

$A \equiv$ Total factor productivity

$f \equiv$ Total output per capita

$L \equiv$ Population size

$\Delta L \equiv$ Change in population

$\alpha_K \equiv$ Private capital share of output

$\alpha_P \equiv$ Public capital share of output

$\alpha_H \equiv$ Human capital share of output

$\alpha_L \equiv$ Labor share of output

$I \equiv$ Income per capita

$w \equiv$ Wage level

$r_P \equiv$ Return on public capital

$r_K \equiv$ Return on private capital

$\beta \equiv$ Degree of economies of scale in the consumption of public goods

$\delta_P \equiv$ Post immigration dilution in public capital per capita

$\psi \equiv$ Social heterogeneity

$\phi \equiv$ Scale factor in heterogeneity parameter for a given population composition

$\Omega \equiv$ Non income-related factors associated to population size affecting representative individual utility

$g \equiv$ Size of the public sector in the economy

$\tau \equiv$ Per capita tax

$t \equiv$ Tax rate

A.2. Berry and Soligo (1969) derivation of change in income for a small influx of immigrants

The result will be proved mathematically assuming a homogeneous production function with constant returns to scale: $F(K,L) = L \cdot f\left(\frac{K}{L}\right) = L \cdot f(k)$, a competitive wage rate $w = f(k) - f'(k) \cdot k$ and the return on capital $r = f'(k)$, the change in income for the average individual will be given by:

$$I_0 = f(k_0) - f'(k_0) \cdot k_0 + f'(k_0) \cdot k_0 = f(k_0) \tag{A.1}$$

$$I_1 = f(k_1) - f'(k_1) \cdot k_1 + f'(k_1) \cdot k_0 = f(k_1) - f'(k_1)(k_1 - k_0) \tag{A.2}$$

$$I_1 - I_0 = f(k_1) - f(k_0) - f'(k_1)(k_1 - k_0) \tag{A.3}$$

By using Taylor approximation of second order: $f(k_1) = f(k_0) + f'(k_0)(k_1 - k_0) + \frac{1}{2} f''(k_0)(k_1 - k_0)^2$ and $f'(k_1) = f'(k_0) + f''(k_0)(k_1 - k_0)$, the change in income can be approximated to:

$$I_1 - I_0 \approx f(k_0) + f'(k_0)(k_1 - k_0) + \frac{1}{2} f''(k_0)(k_1 - k_0)^2 - \tag{A.4}$$

$$- f(k_0) - [f'(k_0) + f''(k_0)(k_1 - k_0)](k_1 - k_0) \tag{A.5}$$

Assuming diminishing marginal returns, the change in income post immigration results positive :

$$I_1 - I_0 \approx -\frac{1}{2} f''(k_0)(k_1 - k_0)^2 \gtrapprox 0 \tag{A.6}$$

A.3. Usher (1977) derivation of change in income for a small influx of immigrants

In what follows a slightly different analytical proof than that of Usher will be provided. In order to account for the dilution in public capital per capita we need to replace k_0 in equation (A.2) by $k_0 - \left(\frac{P_0}{L_0} - \frac{P_0}{L_1}\right)$, where P_0 is the total amount of public capital stock, which results invariant to changes in immigration as it will be assumed immigrants bring private capital but cannot carry any public capital from their countries. The logic behind is clear, before immigration the individual owns a total (private and public) amount of capital k_0 which includes a part of public capital $\frac{P_0}{L_0}$ that after immigration results diluted to $\frac{P_0}{L_1}$. Defining δ_p as the post immigration net dilution in public capital per capita: $\delta_p = \frac{P_0}{L_0} - \frac{P_0}{L_1}$, equation (A.3) results then:

$$I_1 - I_0 = f(k_1) - f(k_0) - f'(k_1)(k_1 - k_0) - f'(k_1)\delta_p \tag{A.7}$$

Applying again the Taylor approximation we obtain:

$$I_1 - I_0 \approx -\frac{1}{2}f''(k_0)(k_1 - k_0)^2 - [f'(k_0) + f''(k_0)(k_1 - k_0)]\,\delta_p = \tag{A.8}$$

$$= -\frac{1}{2}f''(k_0)(k_1 - k_0)^2 - f''(k_0)\delta_p(k_1 - k_0) - f'(k_0)\delta_p \tag{A.9}$$

A.4. Increasing returns to scale the production function

The non-rival nature of public capital implies the role of public capital in the production should be different than that of the private one. Following the tradition of Barro (1990), in this section it will be assumed public capital enters the production capital separately: $f = f(k, p)$

Denoting $f_k = \frac{\partial f}{\partial k}$, $f_p = \frac{\partial f}{\partial p}$, $f_{kk} = \frac{\partial^2 f}{\partial k^2}$ and $f_{pp} = \frac{\partial^2 f}{\partial p^2}$, the pre and post immigration income for the average individual will be given by:

$$I_0 = f(k_0, p_0) - k_0 f_k(k_0, p_0) - p_0 f_p(k_0, p_0) + k_0 f_k(k_0, p_0) + p_0 f_p(k_0, p_0) = f(k_0, p_0) \tag{A.10}$$

$$I_1 = f(k_1, p_1) - k_1 f_k(k_1, p_1) - p_1 f_p(k_1, p_1) + k_0 f_k(k_1, p_1) + p_1 f_p(k_1, p_1) \tag{A.11}$$

And the Taylor approximation of second order provides us the following change in income per capita:

$$I_1 - I_0 \approx f_k(k_0, p_0)(k_1 - k_0) + f_p(k_0, p_0)(p_1 - p_0) + \tag{A.12}$$

$$+ \frac{1}{2}\Big(f_{kk}(k_0, p_0)(k_1 - k_0)^2 + f_{pp}(k_0, p_0)(p_1 - p_0)^2 + 2 f_{kp}(k_0, p_0)(k_1 - k_0)(p_1 - p_0)\Big) - \tag{A.13}$$

$$- (k_1 - k_0)\left(f_k(k_0, p_0) + f_{kk}(k_0, p_0)(k_1 - k_0) + f_{kp}(k_0, p_0)(p_1 - p_0)\right) \tag{A.14}$$

$$I_1 - I_0 \approx f_p (p_1 - p_0) + \frac{1}{2} f_{pp} (p_1 - p_0)^2 - \frac{1}{2} f_{kk} (k_1 - k_0)^2 \tag{A.15}$$

Assuming decreasing marginal returns on capital, the formula above shows the change in income is positive related to changes in private capital per capital as in the model of Berry and Soligo. The effect of the change in public capital needs of further analysis. If immigrants do not contribute with any public capital, $p_1 < p_0$ and the first term in the equation will be negative. The sign of the second term depends on whether there are increasing or decreasing marginal returns. Thus, if economies of scale in public capital bring increasing marginal returns ($f_{pp} > 0$), they will partially compensate for public capital dilution. In order to assess the relative importance of both factors, the capitalized income loss per capita will be calculated discounting by the marginal rate of public capital (assuming the entrants are equally endowed in private capital as the host population) and a Cobb-Douglas production function similar to Barro's will be used $f = k^\alpha p^\beta$:

$$\frac{I_1 - I_0}{f_p} \approx (p_1 - p_0) + \frac{1}{2}\frac{\beta - 1}{p_0}(p_1 - p_0)^2 = \tag{A.16}$$

As $p_1 - p_0 = \left(\frac{P_0}{L_1} - \frac{P_0}{L_0}\right) = -P_0\frac{\triangle L}{L_1 L_0}$ the former equation can be expressed:

$$\frac{I_1 - I_0}{f_p} \approx -p_0\frac{\triangle L}{L_1}\left(1 + (1-\beta)\frac{\triangle L}{L_1}\right) \tag{A.17}$$

It can be observed that for small population changes, the second part of the parenthesis is much smaller that one. Therefore, increasing returns to scale in public capital ($\beta > 0$) only mitigate marginally the loss of income by the host population.

Similarly as in equation (2.6), the amount of capital per immigrant to compensate for the loss of income can be calculated. However, now immigrants can contribute to the public capital stock P_0 or to the private one of the incumbent population K_0. In the first case the amount of public capital per immigrant needs to be necessary equal to the existing public capital per capita p_0. In case there is a transfer of private capital, this should be equal to:

$$\triangle L \cdot p^* = -\frac{I_1 - I_0}{f_p}L_1 \tag{A.18}$$

$$p^* = \frac{P_0}{L_1}\left(1 + (1-\beta)\frac{\triangle L}{L_1}\right) \approx p_0 \tag{A.19}$$

In both cases, the presence of increasing returns to scale does not alter the results from the previous section, and immigration should still generally be considered negative for the incumbent population unless immigrants contribute with their equivalent share of public capital.

A.5. Club model optimization using a Lagrange operator

A club's optimization problem[1] applied to a country whose economy is given by a production function $F(Y, X, K, P, L) = 0$ would take the form:

$$Max\, U(Y, X, K, P, L) \quad s.t. \quad \frac{F(Y, X, K, P, L)}{L} = 0$$

where X represents the public (club) good and Y a nummeraire good, or total production in our case. The Lagrange operator and the respective marginal substitution rates will be:

$$\mathcal{L} = U(Y, X, K, P, L) + \lambda F(Y, X, K, P, L)$$

$$MRS_{XY} = \tfrac{\partial U}{\partial X} / \tfrac{\partial U}{\partial Y}$$

$$MRT_{XY} = \tfrac{\partial F}{\partial X} / \tfrac{\partial F}{\partial Y}$$

$$MRS_{KY} = \tfrac{\partial U}{\partial K} / \tfrac{\partial U}{\partial Y}$$

$$MRT_{KY} = \tfrac{\partial \left(\frac{F}{L}\right)}{\partial K} / \tfrac{\partial \left(\frac{F}{L}\right)}{\partial Y} = \frac{\frac{1}{L} \cdot \frac{\partial F}{\partial K}}{\frac{1}{L} \cdot \frac{\partial F}{\partial Y}} = \frac{\frac{\partial F}{\partial K}}{\frac{\partial F}{\partial Y}}$$

$$MRS_{PY} = \tfrac{\partial U}{\partial P} / \tfrac{\partial U}{\partial Y}$$

$$MRT_{PY} = \tfrac{\partial \left(\frac{F}{L}\right)}{\partial P} / \tfrac{\partial \left(\frac{F}{L}\right)}{\partial Y} = \frac{\frac{1}{L} \cdot \frac{\partial F}{\partial P}}{\frac{1}{L} \cdot \frac{\partial F}{\partial Y}} = \frac{\frac{\partial F}{\partial P}}{\frac{\partial F}{\partial Y}}$$

$$MRS_{LY} = \tfrac{\partial U}{\partial L} / \tfrac{\partial U}{\partial Y}$$

$$MRT_{LY} = \tfrac{\partial \left(\frac{F}{L}\right)}{\partial K} / \tfrac{\partial \left(\frac{F}{L}\right)}{\partial Y} = \frac{\frac{\frac{\partial F}{\partial L} \cdot L - F}{L^2}}{\frac{1}{L} \cdot \frac{\partial F}{\partial Y}} = \frac{\frac{\frac{\partial F}{\partial L} \cdot L - 0}{L^2}}{\frac{1}{L} \cdot \frac{\partial F}{\partial Y}} = \frac{\frac{\partial F}{\partial L}}{\frac{\partial F}{\partial Y}}$$

If the amount of existing private and public capital K, P is fixed, new members will be admitted as long as, the following F.O.C. are simultaneously met:

$$\frac{\partial \mathcal{L}}{\partial Y} = \frac{\partial U(Y, X, K, P, L)}{\partial Y} + \lambda \frac{\partial F(Y, X, K, P, L)}{\partial Y} = 0$$

$$\frac{\partial \mathcal{L}}{\partial X} = \frac{\partial U(Y, X, K, P, L)}{\partial X} + \lambda \frac{\partial F(Y, X, K, P, L)}{\partial X} = 0$$

$$\frac{\partial \mathcal{L}}{\partial L} = \frac{\partial U(Y, X, K, P, L)}{\partial L} + \lambda \frac{\partial F(Y, X, K, P, L)}{\partial L} = 0$$

and the optimality conditions for a *representative individual* are those of the Buchanan club

[1] For a representative individual

representation:

$$MRS_{XY} = MRT_{XY} \tag{A.20}$$
$$MRS_{LY} = MRT_{LY} \tag{A.21}$$

In the case of the specification of Sec. 3.2.1, we consider the public good X to be the total economy Y, so the first equation is always met. In order to see the conditions to meet the second one, it is convenient to slightly reformulate the notation using a closed form production function $F(K,P,L,Y) = K^{\alpha_K} P^{\alpha_P} L^{1-\alpha_K-\alpha_P} - Y = 0$ and rewriting the utility function as: $U(K,P,L) = \frac{Y}{L^\beta}$. The respective substitution and transformation rates will therefore be:

$$\begin{aligned}
MRS_{LY} &= \tfrac{\partial U}{\partial L} / \tfrac{\partial U}{\partial Y} = \frac{-\frac{Y\beta}{L^{\beta+1}}}{\frac{1}{L^\beta}} = -\frac{\beta Y}{L} = -\beta K^{\alpha_K} P^{\alpha_P} L^{-\alpha_K-\alpha_P} \\
MRT_{LY} &= \tfrac{\partial\left(\frac{F}{L}\right)}{\partial K} / \tfrac{\partial\left(\frac{F}{L}\right)}{\partial Y} = \frac{\frac{\partial F}{\partial L}}{\frac{\partial F}{\partial Y}} = \frac{(1-\alpha_K-\alpha_P)\, K^{\alpha_K} P^{\alpha_P} L^{-\alpha_K-\alpha_P}}{-1} = \\
&= -\left(1-\alpha_K-\alpha_P\right) K^{\alpha_K} P^{\alpha_P} L^{-\alpha_K-\alpha_P}
\end{aligned}$$

It can be observed that for both equations being equal it has to happen that: $\beta + \alpha_K + \alpha_P = 1$, which equivalent to obtaining a membership fee ($\frac{\partial P}{\partial L} = 0$) in (4.7) when no private capital contribution are allowed ($\frac{\partial K}{\partial L} = 0$). This result is logical as if new members cannot finance their entry, existing club members will only admit them if the required price would be zero.

If we let now K, P vary with a change in L – hence allowing the new entrant to the club to make capital contributions – the F.O.C. will be:

$$\begin{aligned}
\frac{\partial \mathcal{L}}{\partial Y} &= \frac{\partial U(Y,X,K(L),P(L),L)}{\partial Y} + \lambda \frac{\partial F(Y,X,K(L),P(L),L)}{\partial Y} = 0 \\
\frac{\partial \mathcal{L}}{\partial L} &= \frac{\partial U(Y,X,K(L),P(L),L)}{\partial L} + \lambda \frac{\partial F(Y,X,K(L),P(L),L)}{\partial L} = \\
&= \left(\frac{\partial U}{\partial L} + \frac{\partial U}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial U}{\partial P}\frac{\partial P}{\partial L}\right) + \lambda \left(\frac{\partial F}{\partial L} + \frac{\partial F}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial F}{\partial P}\frac{\partial P}{\partial L}\right) = 0
\end{aligned}$$

and the optimality condition for a *representative individual* are given then by:

$$MRS_{LY} - MRT_{LY} = \frac{\partial K}{\partial L}(MRT_{KY} - MRS_{KY}) + \frac{\partial P}{\partial L}(MRT_{PY} - MRS_{PY}) \tag{A.22}$$

which results in the following membership fee in the form of public capital contribution:

$$\frac{\partial P}{\partial L} = \frac{MRS_{LY} - MRT_{LY}}{MRT_{PY} - MRS_{PY}} + K'(L)(MRS_{KY} - MRT_{KY}) \tag{A.23}$$

The calculation of the marginal rates of substitution and transformation in private and public capital for the specified model are as follows:

$$\begin{aligned}
MRS_{KY} &= \tfrac{\partial U}{\partial K} / \tfrac{\partial U}{\partial Y} = 0 \\
MRT_{KY} &= \tfrac{\partial\left(\frac{F}{L}\right)}{\partial K} / \tfrac{\partial\left(\frac{F}{L}\right)}{\partial Y} = \frac{\frac{1}{L}\cdot\frac{\partial F}{\partial K}}{\frac{1}{L}\cdot\frac{\partial F}{\partial Y}} = \frac{\frac{\partial F}{\partial K}}{\frac{\partial F}{\partial Y}} = \frac{\alpha_1 K^{\alpha_K - 1} P^{\alpha_P} L^{1-\alpha_K-\alpha_P}}{-1} = \\
&= -\alpha_1 K^{\alpha_K - 1} P^{\alpha_P} L^{1-\alpha_K-\alpha_P} \\
MRS_{PY} &= \tfrac{\partial U}{\partial P} / \tfrac{\partial U}{\partial Y} = 0 \\
MRT_{PY} &= \tfrac{\partial\left(\frac{F}{L}\right)}{\partial P} / \tfrac{\partial\left(\frac{F}{L}\right)}{\partial Y} = \frac{\frac{1}{L}\cdot\frac{\partial F}{\partial P}}{\frac{1}{L}\cdot\frac{\partial F}{\partial Y}} = \frac{\frac{\partial F}{\partial P}}{\frac{\partial F}{\partial Y}} = \frac{\alpha_2 K^{\alpha_K} P^{\alpha_P - 1} L^{1-\alpha_K-\alpha_P}}{-1} = \\
&= -\alpha_2 K^{\alpha_K} P^{\alpha_P - 1} L^{1-\alpha_K-\alpha_P}
\end{aligned}$$

If same as in Sec. 3.2.1 we impose $\frac{\partial K}{\partial L} = K$, equation (A.23) will then read:

$$\frac{\partial P}{\partial L} = \frac{-\beta K^{\alpha_K} P^{\alpha_P} L^{-\alpha_K-\alpha_P} + (1-\alpha_K-\alpha_2)\, K^{\alpha_K} P^{\alpha_P} L^{-\alpha_K-\alpha_P}}{-\alpha_P K^{\alpha_K} P^{\alpha_P - 1} L^{1-\alpha_K-\alpha_P}} + \tag{A.24}$$

$$+ \alpha_1 K^{\alpha_K} P^{\alpha_P} L^{1-\alpha_K-\alpha_P} \tag{A.25}$$

$$= \left(1 + \frac{\beta - 1}{\alpha_P}\right) \cdot \frac{P}{L} \tag{A.26}$$

which is equal to equation (4.2)

A.6. Incorporating productivity into classic models of immigration demand

A.6.1. Extension of Berry and Soligo model

Assuming a neoclassical production function with constant-returns to scale and total factor productivity A: $F(A, K, L) = AL \cdot f\left(\frac{K}{L}\right) = AL \cdot f(k)$, a competitive wage rate $w = A\left[f(k) - f'(k) \cdot k\right]$ and the interest rate $r = Af'(k)$, the change in income for the average individual will be given by:

$$I_0 = A_0\left[f(k_0) - f'(k_0) \cdot k_0 + f'(k_0) \cdot k_0\right] = A_0 f(k_0) \tag{A.27}$$

$$I_1 = A_1\left[f(k_1) - f'(k_1) \cdot k_1 + f'(k_1) \cdot k_0\right] = A_1\left[f(k_1) - f'(k_1)(k_1 - k_0)\right] \tag{A.28}$$

$$I_1 - I_0 = A_1 f(k_1) - A_0 f(k_0) - A_1 f'(k_1)(k_1 - k_0) \tag{A.29}$$

By using Taylor approximation of second order the change in income can be approximated to:

$$I_1 - I_0 \approx (A_1 - A_0) f(k_0) - \frac{A_1}{2} f''(k_0)(k_1 - k_0)^2 \tag{A.30}$$

If productivity rises as a consequence of the migratory influx ($A_1 > A_0$), the change in income increases beyond that caused from allocative efficiency gains.

A.6.2. Extension of Usher model

Defining δ_p as the post immigration dilution in public capital per capita: $\delta_p = \frac{P_0}{L_0} - \frac{P_0}{L_1}$, the change in income can be expressed as:

$$I_1 - I_0 = A_1 f(k_1) - A_0 f(k_0) - A_1 f'(k_1)(k_1 - k_0) - A_1 f'(k_1)\delta_p \tag{A.31}$$

Applying again the Taylor approximation we obtain:

$$I_1 - I_0 \approx (A_1 - A_0) f(k_0) - A_1 f'(k_0)\delta_p - A_1 f''(k_0)(k_1 - k_0)\left[\delta_p + \frac{1}{2}(k_1 - k_0)\right] = \tag{A.32}$$

The maximum income loss occurs for values of post-immigration capital per capita in the vicinity of the pre-immigration ones (i.e., whenever redistribution effects predominate) and will be equal to:

$$I_1 - I_0 \approx (A_1 - A_0)\, f(k_0) - A_1 f'(k_0)\delta_p \tag{A.33}$$

The former is just a one-period calculation of the income change. Assuming an infinite lifetime of individuals, the total impact will be given by the *capitalized* income loss:

$$\frac{I_1 - I_0}{A_0 f'(k_0)} \approx \frac{A_1 - A_0}{A_0} \cdot \frac{f(k_0)}{f'(k_0)} - \frac{A_1}{A_0}\delta_p \tag{A.34}$$

Using a Cobb-Douglas production function $f(k) = k^{\alpha}$, the former equation can be rewritten:

$$\frac{I_1 - I_0}{A_0 f'(k_0)} \approx \frac{A_1 - A_0}{A_0}\alpha k - \frac{A_1}{A_0}\delta_p \tag{A.35}$$

And the resulting entry fee will be:

$$p^* = \frac{A_1}{A_0}p_0 - \frac{A_1 - A_0}{A_0}\alpha k \frac{L_1}{\triangle L} \tag{A.36}$$

A.7. Membership fee in an economy with private and public sector

A.7.1. One period membership

The optimization problem in an economy with a private and public sector can be written as:

$$I(K,P,L) = (1-g)K^{\alpha_K}P^{\alpha_P}L^{-\alpha_K-\alpha_P} + gK^{\alpha_K}P^{\alpha_P}L^{1-\alpha_K-\alpha_P-\beta} = \tag{A.37}$$

$$= K^{\alpha_K}P^{\alpha_P}\left[(1-g)L^{-\alpha_K-\alpha_P} + gL^{1-\alpha_K-\alpha_P-\beta}\right] \tag{A.38}$$

$$\frac{\partial I}{\partial L} = \left(P^{\alpha_P}\frac{\partial K}{\partial L}\alpha_K K^{\alpha_K-1} + K^{\alpha_K}\frac{\partial P}{\partial L}\alpha_P P^{\alpha_P-1}\right)\left[gL^{1-\alpha_K-\alpha_P-\beta} + (1-g)L^{-\alpha_K-\alpha_P}\right] + \tag{A.39}$$

$$+ K^{\alpha_K}P^{\alpha_P}\left[g\left(1-\alpha_K-\alpha_P-\beta\right)L^{-\alpha_K-\alpha_P-\beta} - \left(\alpha_K+\alpha_P\right)(1-g)L^{-\alpha_K-\alpha_P-1}\right] \tag{A.40}$$

Assuming the new entrant will bring an amount of private capital equal to that of the native population one ($\frac{\partial K}{\partial L} = \frac{K}{L} = k$):

$$\frac{\partial I}{\partial L} = 0 \Rightarrow \frac{\partial P}{\partial L} = -\frac{P}{\alpha_P}\left[\frac{g\left(1-\alpha_K-\alpha_P-\beta\right)L^{-\beta} - \left(\alpha_K+\alpha_P\right)(1-g)L^{-1}}{gL^{1-\beta}+(1-g)} + \alpha_K L^{-1}\right] = \tag{A.41}$$

$$= -\frac{P}{\alpha_P}\left[\frac{g\left(1-\alpha_K-\alpha_P-\beta\right)L^{-\beta} - \left(\alpha_K+\alpha_P\right)(1-g)L^{-1} + g\alpha_K L^{-\beta} + \alpha_K(1-g)L^{-1}}{gL^{1-\beta}+(1-g)}\right] = \tag{A.42}$$

$$= -\frac{P}{\alpha_P}\left[\frac{g\left(1-\beta\right)L^{-\beta} - \alpha_P gL^{-\beta} - \alpha_P(1-g)L^{-1}}{gL^{1-\beta}+(1-g)}\right] = \tag{A.43}$$

$$= -p\left[\frac{g\left(1-\beta\right)L^{-\beta} - \alpha_P gL^{-\beta} - \alpha_P(1-g)L^{-1}}{\alpha_P gL^{-\beta}+\alpha_P(1-g)L^{-1}}\right] = \tag{A.44}$$

$$= p\left[1 + \frac{g(\beta-1)L^{1-\beta}}{\alpha_P gL^{1-\beta}+\alpha_P(1-g)}\right] \tag{A.45}$$

A.7.2. Permanent membership

In case of permanent residence, the utility function can be described as:

$$
\begin{aligned}
I(K,P,L) = & \frac{1}{r_P}\left[(1-g)K^{\alpha_K}P^{\alpha_P}L^{-\alpha_K-\alpha_P} + gK^{\alpha_K}P^{\alpha_P}L^{1-\alpha_K-\alpha_P-\beta}\right] = && \text{(A.46)}\\
= & \frac{(1-g)K^{\alpha_K}P^{\alpha_P}L^{-\alpha_K-\alpha_P} + gK^{\alpha_K}P^{\alpha_P}L^{1-\alpha_K-\alpha_P-\beta}}{\alpha_P K^{\alpha_K}P^{\alpha_{P-1}}L^{1-\alpha_K-\alpha_P}} = && \text{(A.47)}\\
= & \frac{(1-g)P^{\alpha_P}L^{-1} + gP^{\alpha_P}L^{-\beta}}{\alpha_P P^{\alpha_{P-1}}} = && \text{(A.48)}\\
= & \frac{P}{\alpha_P}\left[(1-g)L^{-1} + gL^{-\beta}\right] && \text{(A.49)}
\end{aligned}
$$

And the membership fee will be derived from the usual optimization problem:

$$
\begin{aligned}
&\frac{\partial I}{\partial L} = \frac{\partial P}{\partial L}\cdot\frac{1}{\alpha_P}\left[(1-g)L^{-1} + gL^{-\beta}\right] + \frac{P}{\alpha_P}\left[-(1-g)L^{-2} - gL^{-\beta-1}\right] && \text{(A.50)}\\
&\frac{\partial I}{\partial L} = 0 \Rightarrow \frac{\partial P}{\partial L} = p\left[1 - \frac{(1-\beta)gL^{-\beta}}{gL^{-\beta} + (1-g)L^{-1}}\right] && \text{(A.51)}
\end{aligned}
$$

A.8. Partial derivatives for a production function homogeneous of degree one in K

If the production function is homogeneous of degree one it holds that:

$$F(K, L) = L \cdot F(\frac{K}{L}, 1) = Lf(k)$$

The partial derivatives are as follows:

$$\begin{aligned}
\frac{\partial F}{\partial K} &= \frac{\partial f}{\partial k} \cdot \frac{\partial k}{\partial K} \cdot L = f'(k) \cdot \frac{1}{L} \cdot L = f'(k) \\
\frac{\partial F}{\partial L} &= \frac{\partial f}{\partial k} \cdot \frac{\partial k}{\partial L} \cdot L + f(k) = \frac{\partial f}{\partial k} \cdot \frac{-K}{L^2} \cdot L + f(k) = f(k) - f'(k)k \\
\frac{\partial^2 F}{\partial K^2} &= \frac{\partial}{\partial K}\left(\frac{\partial F}{\partial K}\right) = \frac{\partial^2 f}{\partial k^2} \cdot \frac{\partial k}{\partial K} = f''(k) \cdot \frac{1}{L} \\
\frac{\partial^2 F}{\partial L^2} &= \frac{\partial}{\partial L}\left(\frac{\partial F}{\partial L}\right) = \left(\frac{\partial f}{\partial k} - \frac{\partial^2 f}{\partial k^2} \cdot k - \frac{\partial f}{\partial k}\right) \cdot \frac{-K}{L^2} = f''(k) \cdot \frac{k^2}{L} = -k \cdot \frac{\partial r}{\partial L} \\
\frac{\partial^2 F}{\partial K \partial L} &= \frac{\partial}{\partial L}\left(\frac{\partial F}{\partial K}\right) = \frac{\partial^2 f}{\partial k^2} \cdot \frac{-K}{L^2} = -f''(k) \cdot \frac{k}{L} \\
\frac{\partial^2 F}{\partial L \partial K} &= \frac{\partial}{\partial K}\left(\frac{\partial F}{\partial L}\right) = \left(\frac{\partial f}{\partial k} - \frac{\partial^2 f}{\partial k^2} \cdot k - \frac{\partial f}{\partial k}\right) \cdot \frac{1}{L} = -f''(k) \cdot \frac{k}{L} = -k\frac{\partial r}{\partial K} \\
\frac{\partial^3 F}{\partial K^3} &= \frac{\partial}{\partial K}\left(\frac{\partial^2 F}{\partial K^2}\right) = f'''(k) \cdot \frac{1}{L^2} \\
\frac{\partial^3 F}{\partial L^3} &= \frac{\partial}{\partial L}\left(\frac{\partial^2 F}{\partial L^2}\right) = \left(f'''(k) \cdot \frac{k^2}{L} + 2f''(k) \cdot \frac{k}{L}\right) \cdot \frac{-K}{L^2} - f''(k) \cdot \frac{k^2}{L^2} = \\
&= -f'''(k) \cdot \frac{k^3}{L^2} - 3f''(k) \cdot \frac{k^2}{L^2} \\
\frac{\partial^3 F}{\partial L \partial K^2} &= \frac{\partial}{\partial K}\left(\frac{\partial^2 F}{\partial L \partial K}\right) = -\left(f'''(k) \cdot \frac{k}{L} + f''(k) \cdot \frac{1}{L}\right) \cdot \frac{1}{L} = -f'''(k) \cdot \frac{k}{L^2} - f''(k) \cdot \frac{1}{L^2} \\
\frac{\partial^3 F}{\partial K \partial L^2} &= \frac{\partial}{\partial K}\left(\frac{\partial^2 F}{\partial L^2}\right) = \left(f'''(k) \cdot \frac{k^2}{L} + 2f''(k) \cdot \frac{K}{L}\right) \cdot \frac{1}{L} = f'''(k) \cdot \frac{k^2}{L^2} + 2f''(k) \cdot \frac{k}{L^2}
\end{aligned}$$

And it always holds that:

$$\begin{aligned}
\frac{\partial w}{\partial K} &= \frac{\partial^2 F}{\partial L \partial K} = -\frac{\partial r}{\partial K} \cdot \frac{K}{L} \\
\frac{\partial w}{\partial L} &= \frac{\partial^2 F}{\partial L^2} = -\frac{\partial r}{\partial L} \cdot \frac{K}{L}
\end{aligned}$$

A.9. Partial derivatives for a production function homogeneous of degree one in P and K

Assuming a production function homogeneous of degree one $F(K,P,L) = L \cdot F(\frac{K}{L}, \frac{P}{L}, 1) = L \cdot f(k,p)$, the partial derivatives of first and second order will be:

$$
\begin{aligned}
\frac{\partial F}{\partial K} &= \frac{\partial f}{\partial k} \cdot \frac{\partial k}{\partial K} \cdot L = f_k \cdot \frac{1}{L} \cdot L = f_k \\
\frac{\partial F}{\partial P} &= \frac{\partial f}{\partial p} \cdot \frac{\partial p}{\partial P} \cdot L = f_p \cdot \frac{1}{L} \cdot L = f_p \\
\frac{\partial F}{\partial L} &= \frac{\partial f}{\partial k} \cdot \frac{\partial k}{\partial L} \cdot L + \frac{\partial f}{\partial p} \cdot \frac{\partial p}{\partial L} \cdot L + f = \\
&= \frac{\partial f}{\partial k} \cdot \frac{-K}{L^2} \cdot L + \frac{\partial f}{\partial p} \cdot \frac{-P}{L^2} \cdot L + f = f - f_k k - f_p p \\
\frac{\partial^2 F}{\partial K^2} &= \frac{\partial}{\partial K}\left(\frac{\partial F}{\partial K}\right) = \frac{\partial^2 f}{\partial k^2} \cdot \frac{\partial k}{\partial K} = f_{kk} \cdot \frac{1}{L} \\
\frac{\partial^2 F}{\partial P^2} &= \frac{\partial}{\partial P}\left(\frac{\partial F}{\partial P}\right) = \frac{\partial^2 f}{\partial p^2} \cdot \frac{\partial p}{\partial P} = f_{pp} \cdot \frac{1}{L} \\
\frac{\partial^2 F}{\partial L^2} &= \frac{\partial}{\partial L}\left(\frac{\partial F}{\partial L}\right) = \left(\frac{\partial f}{\partial k} - \frac{\partial^2 f}{\partial k^2} \cdot k - \frac{\partial f}{\partial k}\right) \cdot \frac{-K}{L^2} + \left(\frac{\partial f}{\partial p} - \frac{\partial^2 f}{\partial p^2} \cdot p - \frac{\partial f}{\partial p}\right) \cdot \frac{-P}{L^2} = \\
&= f_{kk} \cdot \frac{k^2}{L} + f_{pp} \cdot \frac{p^2}{L} \\
\frac{\partial^2 F}{\partial K \partial L} &= \frac{\partial}{\partial L}\left(\frac{\partial F}{\partial K}\right) = \frac{\partial^2 f}{\partial k^2} \cdot \frac{-K}{L^2} + \frac{\partial^2 f}{\partial p \partial k} \cdot \frac{-P}{L^2} = -f_{kk} \cdot \frac{k}{L} - f_{kp} \cdot \frac{p}{L} \\
\frac{\partial^2 F}{\partial L \partial K} &= \frac{\partial}{\partial K}\left(\frac{\partial F}{\partial L}\right) = \left(\frac{\partial f}{\partial k} - \frac{\partial^2 f}{\partial k^2} \cdot k - \frac{\partial f}{\partial k} - \frac{\partial^2 f}{\partial k \partial p} \cdot p\right) \cdot \frac{1}{L} = -f_{kk} \cdot \frac{k}{L} - f_{kp} \cdot \frac{p}{L} \\
\frac{\partial^2 F}{\partial P \partial L} &= \frac{\partial}{\partial L}\left(\frac{\partial F}{\partial P}\right) = \frac{\partial^2 f}{\partial p^2} \cdot \frac{-P}{L^2} + \frac{\partial^2 f}{\partial k \partial p} \cdot \frac{-K}{L^2} = -f_{pp} \cdot \frac{p}{L} - f_{pk} \cdot \frac{k}{L} \\
\frac{\partial^2 F}{\partial L \partial P} &= \frac{\partial}{\partial P}\left(\frac{\partial F}{\partial L}\right) = \left(\frac{\partial f}{\partial p} - \frac{\partial^2 f}{\partial p^2} \cdot p - \frac{\partial f}{\partial p} - \frac{\partial^2 f}{\partial p \partial k} \cdot k\right) \cdot \frac{1}{L} = -f_{pp} \cdot \frac{p}{L} - f_{pk} \cdot \frac{k}{L} \\
\frac{\partial^2 F}{\partial K \partial P} &= \frac{\partial}{\partial P}\left(\frac{\partial F}{\partial K}\right) = f_{kp} \cdot \frac{1}{L}
\end{aligned}
$$

And it always holds that:

$$\frac{\partial w}{\partial K} = \frac{\partial^2 F}{\partial K \partial L} = -f_{kk} \cdot \frac{k}{L} - f_{kp} \cdot \frac{p}{L} = -\frac{\partial^2 F}{\partial K^2} \cdot k - \frac{\partial^2 F}{\partial K \partial P} \cdot p = -\frac{\partial r_K}{\partial K} \cdot k - \frac{\partial r_P}{\partial K} \cdot p$$
$$\frac{\partial w}{\partial P} = \frac{\partial^2 F}{\partial P \partial L} = -f_{pp} \cdot \frac{p}{L} - f_{pk} \cdot \frac{k}{L} = -\frac{\partial^2 F}{\partial P^2} \cdot p - \frac{\partial^2 F}{\partial K \partial P} \cdot k = -\frac{\partial r_K}{\partial P} \cdot k - \frac{\partial r_P}{\partial P} \cdot p$$
$$\frac{\partial w}{\partial L} = \frac{\partial^2 F}{\partial L^2} = f_{kk} \cdot \frac{k^2}{L} + f_{pp} \cdot \frac{p^2}{L} = \frac{\partial^2 F}{\partial K^2} \cdot k + \frac{\partial^2 F}{\partial P^2} \cdot p = -\frac{\partial r_K}{\partial L} \cdot k - \frac{\partial r_P}{\partial L} \cdot p$$

A.10. Partial derivatives for a production function homogeneous of degree one in A and K

Assuming a production function homogeneous of degree one $F(K, A, L) = L \cdot F(\frac{K}{L}, \frac{A}{L}, 1) = L \cdot f(k, a)$, the partial derivatives of first and second order will be:

$$
\begin{aligned}
\frac{\partial F}{\partial K} &= \frac{\partial f}{\partial k} \cdot \frac{\partial k}{\partial K} \cdot L = f_k \cdot \frac{1}{L} \cdot L = f_k \\
\frac{\partial F}{\partial A} &= \frac{\partial f}{\partial a} \cdot \frac{\partial a}{\partial A} \cdot L = f_a \cdot \frac{1}{L} \cdot L = f_a \\
\frac{\partial F}{\partial L} &= \frac{\partial f}{\partial k} \cdot \frac{\partial k}{\partial L} \cdot L + \frac{\partial f}{\partial a} \cdot \frac{\partial a}{\partial L} \cdot L + f = \\
&= \frac{\partial f}{\partial k} \cdot \frac{-K}{L^2} \cdot L + \frac{\partial f}{\partial a} \cdot \frac{-A}{L^2} \cdot L + f = f - f_k k - f_a a \\
\frac{\partial^2 F}{\partial K^2} &= \frac{\partial}{\partial K} \left(\frac{\partial F}{\partial K} \right) = \frac{\partial^2 f}{\partial k^2} \cdot \frac{\partial k}{\partial K} = f_{kk} \cdot \frac{1}{L} \\
\frac{\partial^2 F}{\partial A^2} &= \frac{\partial}{\partial A} \left(\frac{\partial F}{\partial A} \right) = \frac{\partial^2 f}{\partial a^2} \cdot \frac{\partial a}{\partial A} = f_{aa} \cdot \frac{1}{L} \\
\frac{\partial^2 F}{\partial L^2} &= \frac{\partial}{\partial L} \left(\frac{\partial F}{\partial L} \right) = \left(\frac{\partial f}{\partial k} - \frac{\partial^2 f}{\partial k^2} \cdot k - \frac{\partial f}{\partial k} \right) \cdot \frac{-K}{L^2} + \left(\frac{\partial f}{\partial a} - \frac{\partial^2 f}{\partial a^2} \cdot a - \frac{\partial f}{\partial a} \right) \cdot \frac{-A}{L^2} = \\
&= f_{kk} \cdot \frac{k^2}{L} + f_{aa} \cdot \frac{a^2}{L} \\
\frac{\partial^2 F}{\partial K \partial L} &= \frac{\partial}{\partial L} \left(\frac{\partial F}{\partial K} \right) = \frac{\partial^2 f}{\partial k^2} \cdot \frac{-K}{L^2} + \frac{\partial^2 f}{\partial a \partial k} \cdot \frac{-A}{L^2} = -f_{kk} \cdot \frac{k}{L} - f_{ka} \cdot \frac{a}{L} \\
\frac{\partial^2 F}{\partial L \partial K} &= \frac{\partial}{\partial K} \left(\frac{\partial F}{\partial L} \right) = \left(\frac{\partial f}{\partial k} - \frac{\partial^2 f}{\partial k^2} \cdot k - \frac{\partial f}{\partial k} - \frac{\partial^2 f}{\partial k \partial a} \cdot a \right) \cdot \frac{1}{L} = -f_{kk} \cdot \frac{k}{L} - f_{ka} \cdot \frac{a}{L} \\
\frac{\partial^2 F}{\partial A \partial L} &= \frac{\partial}{\partial L} \left(\frac{\partial F}{\partial A} \right) = \frac{\partial^2 f}{\partial a^2} \cdot \frac{-A}{L^2} + \frac{\partial^2 f}{\partial k \partial a} \cdot \frac{-K}{L^2} = -f_{aa} \cdot \frac{a}{L} - f_{ak} \cdot \frac{k}{L} \\
\frac{\partial^2 F}{\partial L \partial A} &= \frac{\partial}{\partial A} \left(\frac{\partial F}{\partial L} \right) = \left(\frac{\partial f}{\partial a} - \frac{\partial^2 f}{\partial a^2} \cdot a - \frac{\partial f}{\partial a} - \frac{\partial^2 f}{\partial a \partial k} \cdot k \right) \cdot \frac{1}{L} = -f_{aa} \cdot \frac{a}{L} - f_{ak} \cdot \frac{k}{L} \\
\frac{\partial^2 F}{\partial K \partial A} &= \frac{\partial}{\partial A} \left(\frac{\partial F}{\partial K} \right) = f_{ka} \cdot \frac{1}{L}
\end{aligned}
$$

A.11. Partial derivatives for a production function homogeneous of degree one in $^{K}/_{AL}$

Assuming a production function homogeneous of degree one $F(K, A, L) = AL \cdot F(\frac{K}{AL}, 1) = AL \cdot f(k)$, the partial derivatives of first and second order will be:

$$
\begin{aligned}
\frac{\partial F}{\partial K} &= \frac{\partial f}{\partial k} \cdot \frac{\partial k}{\partial K} \cdot AL = f_k \cdot \frac{1}{AL} \cdot AL = f_k \\
\frac{\partial F}{\partial A} &= Lf + ALf_k \frac{\partial k}{\partial A} = Lf + ALf_k \left(\frac{-K}{A^2 L}\right) = L\left(f - f_k k\right) \\
\frac{\partial F}{\partial L} &= Af + ALf_k \frac{\partial k}{\partial L} = Af + ALf_k \left(\frac{-K}{AL^2}\right) = A\left(f - f_k k\right) \\
\frac{\partial^2 F}{\partial A \partial L} &= \frac{\partial}{\partial A}\left(\frac{\partial F}{\partial L}\right) = f - f_k k + \left(f_k - f_{kk} k - f_k\right) \cdot \frac{-K}{A^2 L} \cdot A = f - f_k k + f_{kk} k^2 \\
\frac{\partial^2 F}{\partial K \partial A} &= \frac{\partial}{\partial A}\left(\frac{\partial F}{\partial K}\right) = f_{kk} \cdot \frac{-K}{A^2 L} = -f_{kk} \cdot \frac{k}{A}
\end{aligned}
$$

A.12. Partial derivatives for a production function homogeneous of degree one in K, L_H, and L_L

Assuming a production function homogeneous of degree one $F(K, L_L, L_H) = L_H \cdot F(\frac{K}{L_H}, \frac{L_L}{L_H}, 1) = L_H \cdot f(k_H, l)$, the partial derivatives of first and second order will be (for simplicity the partial derivatives on $k_H$will be denoted f_k and f_{kk}):

$$\frac{\partial F}{\partial K} = \frac{\partial f}{\partial k} \cdot \frac{\partial k_H}{\partial K} \cdot L_H = f_k \cdot \frac{1}{L_H} \cdot L_H = f_k$$

$$\frac{\partial F}{\partial L_L} = \frac{\partial f}{\partial l} \cdot \frac{\partial l}{\partial L_L} \cdot L_H = f_l \cdot \frac{1}{L_H} \cdot L_H = f_l$$

$$\frac{\partial F}{\partial L_H} = \frac{\partial f}{\partial k_H} \cdot \frac{\partial k_H}{\partial L_H} \cdot L_H + \frac{\partial f}{\partial l} \cdot \frac{\partial l}{\partial L_H} \cdot L_H + f =$$

$$= \frac{\partial f}{\partial k_H} \cdot \frac{-K}{L_H^2} \cdot L_H + \frac{\partial f}{\partial l} \cdot \frac{-L_L}{L_H^2} \cdot L_H + f = f - f_k k_H - f_l l$$

$$\frac{\partial^2 F}{\partial K^2} = \frac{\partial^2 f}{\partial k_H^2} \cdot \frac{\partial k}{\partial K} = f_{kk} \cdot \frac{1}{L_H}$$

$$\frac{\partial^2 F}{\partial L_L^2} = \frac{\partial^2 f}{\partial l^2} \cdot \frac{\partial l}{\partial L_L} = f_{ll} \cdot \frac{1}{L_H}$$

$$\frac{\partial^2 F}{\partial L_H^2} = \left(\frac{\partial f}{\partial k_H} - \frac{\partial^2 f}{\partial k_H^2} \cdot k_H - \frac{\partial f}{\partial k}\right) \cdot \frac{-K}{L_H^2} + \left(\frac{\partial f}{\partial l} - \frac{\partial^2 f}{\partial l^2} \cdot l - \frac{\partial f}{\partial l}\right) \cdot \frac{-L_L}{L_H^2} =$$

$$= f_{kk} \cdot \frac{k_H^2}{L_H} + f_{ll} \cdot \frac{l^2}{L_H}$$

$$\frac{\partial^2 F}{\partial K \partial L_H} = \frac{\partial^2 f}{\partial k_H^2} \cdot \frac{-K}{L_H^2} + \frac{\partial^2 f}{\partial l \partial k_H} \cdot \frac{-L_L}{L_H^2} = -f_{kk} \cdot \frac{k_H}{L_H} - f_{kl} \cdot \frac{l}{L_H}$$

$$\frac{\partial^2 F}{\partial L_H \partial K} = \left(\frac{\partial f}{\partial k_H} - \frac{\partial^2 f}{\partial k_H^2} \cdot k_H - \frac{\partial f}{\partial k_H} - \frac{\partial^2 f}{\partial k_H \partial l} \cdot l\right) \cdot \frac{1}{L_H} = -f_{kk} \cdot \frac{k_H}{L_H} - f_{kl} \cdot \frac{l}{L_H}$$

$$\frac{\partial^2 F}{\partial L_L \partial L_H} = \frac{\partial^2 f}{\partial l^2} \cdot \frac{-L_L}{L_H^2} + \frac{\partial^2 f}{\partial k_H \partial l} \cdot \frac{-K}{L_H^2} = -f_{ll} \cdot \frac{l}{L_H} - f_{lk} \cdot \frac{k_H}{L_H}$$

$$\frac{\partial^2 F}{\partial L_H \partial L_L} = \left(\frac{\partial f}{\partial l} - \frac{\partial^2 f}{\partial l^2} \cdot l - \frac{\partial f}{\partial l} - \frac{\partial^2 f}{\partial l \partial k_H} \cdot k_H\right) \cdot \frac{1}{L_H} = -f_{ll} \cdot \frac{l}{L_H} - f_{lk} \cdot \frac{k_H}{L_H}$$

$$\frac{\partial^2 F}{\partial K \partial L_L} = f_{kl} \cdot \frac{1}{L_H}$$

$$\frac{\partial^2 F}{\partial L_L \partial K} = f_{lk} \cdot \frac{1}{L_H}$$

And it always holds that:

$$\frac{\partial w_H}{\partial K} = \frac{\partial^2 F}{\partial K \partial L_H} = -f_{kk} \cdot \frac{k_H}{L_H} - f_{kl} \cdot \frac{l}{L_H} = -\frac{\partial^2 F}{\partial K^2} \cdot k_H - \frac{\partial^2 F}{\partial K \partial L_L} \cdot l = -\frac{\partial r_K}{\partial K} \cdot k_H - \frac{\partial w_L}{\partial K} \cdot l$$
$$\frac{\partial w_H}{\partial L_L} = \frac{\partial^2 F}{\partial L_L \partial L_H} = -f_{ll} \cdot \frac{l}{L_H} - f_{lk} \cdot \frac{k_H}{L_H} = -\frac{\partial^2 F}{\partial L_L^2} \cdot l - \frac{\partial^2 F}{\partial K \partial L_L} \cdot k_H = -\frac{\partial r_K}{\partial L_L} \cdot k_H - \frac{\partial w_L}{\partial L_L} \cdot l$$

As $k_H = \frac{K}{L_H} = \frac{K}{L}\left(\frac{L_L+L_H}{L_H}\right) = k\,(1+l)$, we can re-write equations (7.11) and (7.12) as follows:

$$p_L^* = \frac{\beta \frac{rP}{L^{\beta+1}} - \frac{\partial w_L}{\partial L_L} - \frac{\partial r}{\partial L_L}(k+sp)}{\frac{\partial w_L}{\partial K} + \frac{\partial r}{\partial K}(k+sp) + \frac{r}{L^\beta}} - k^* \cdot \frac{\frac{\partial w_L}{\partial K} + \frac{\partial r}{\partial K}(k+sp)}{\frac{\partial w_L}{\partial K} + \frac{\partial r}{\partial K}(k+sp) + \frac{r}{L^\beta}} \tag{A.52}$$
$$p_H^* = \frac{\beta \frac{rP}{L^{\beta+1}} + \frac{\partial w_L}{\partial L_L} \cdot l - \frac{\partial r}{\partial L_L}(sp-kl)}{-\frac{\partial w_L}{\partial K} \cdot l + \frac{\partial r}{\partial K}(sp-kl) + \frac{r}{L^\beta}} - k^* \cdot \frac{-\frac{\partial w_L}{\partial K} \cdot l + \frac{\partial r}{\partial K}(sp-kl)}{-\frac{\partial w_L}{\partial K} \cdot l + \frac{\partial r}{\partial K}(sp-kl) + \frac{r}{L^\beta}} \tag{A.53}$$

Both equations can be further rearranged as:

$$p_L^* = \frac{\beta \frac{rP}{L^{\beta+1}} - \left(\frac{\partial w_L}{\partial L_L} + k\frac{\partial r}{\partial L_L}\right) - \frac{\partial r}{\partial L_L}(sp)}{\left(\frac{\partial w_L}{\partial K} + k\frac{\partial r}{\partial K}\right) + \frac{\partial r}{\partial K}(sp) + \frac{r}{L^\beta}} - k^* \cdot \frac{\frac{\partial w_L}{\partial K} + \frac{\partial r}{\partial K}(k+sp)}{\left(\frac{\partial w_L}{\partial K} + k\frac{\partial r}{\partial K}\right) + \frac{\partial r}{\partial K}(sp) + \frac{r}{L^\beta}} \tag{A.54}$$
$$p_H^* = \frac{\beta \frac{rP}{L^{\beta+1}} + l\left(\frac{\partial w_L}{\partial L_L} + k\frac{\partial r}{\partial L_L}\right) - \frac{\partial r}{\partial L_L}(sp)}{-l\left(\frac{\partial w_L}{\partial K} + k\frac{\partial r}{\partial K}\right) + \frac{\partial r}{\partial K}(sp) + \frac{r}{L^\beta}} - k^* \cdot \frac{-l\left(\frac{\partial w_L}{\partial K} + k\frac{\partial r}{\partial K}\right) + \frac{\partial r}{\partial K}(sp)}{-l\left(\frac{\partial w_L}{\partial K} + k\frac{\partial r}{\partial K}\right) + \frac{\partial r}{\partial K}(sp) + \frac{r}{L^\beta}} \tag{A.55}$$

In this case elements do not cancel out and there is no easy way to assess the relative importance of the distinctive members in bot numerator and denominator of both equations. As a consequence, a specified functional form has to be used.

A.13. Non-complementarity of private and public capital - one period (non-linear form)

Using a Cobb-Douglas production function $F = K^{\alpha} L^{1-\alpha} = \left(\bar{K} + P\right)^{\alpha} L^{1-\alpha}$:

$$
\begin{aligned}
r &= \frac{\partial F}{\partial K} = \alpha \frac{F}{K} \\
\frac{\partial r}{\partial L} &= \alpha(1-\alpha)\frac{F}{KL} \\
\frac{\partial r}{\partial K} &= \alpha(\alpha-1)\frac{F}{K^2} \\
\frac{\partial w}{\partial K} &= \alpha(1-\alpha)\frac{F}{KL}
\end{aligned}
$$

$$
p^* = p\left[\frac{\beta \frac{r}{L^{\beta}} + s\frac{\partial r}{\partial K}\left(p + \overline{k} - k^*\right)}{sp\frac{\partial r}{\partial K} + \frac{r}{L^{\beta}}}\right] = \tag{A.56}
$$

$$
= p\left[\frac{\beta\alpha\frac{F}{KL^{\beta}} + s\alpha(\alpha-1)\frac{F}{K^2}\left(p + \overline{k} - k^*\right)}{s\alpha(\alpha-1)\frac{F}{K^2}\cdot\frac{P}{L} + \alpha\frac{F}{KL^{\beta}}}\right] = \tag{A.57}
$$

$$
= p\left[\frac{\beta L^{1-\beta} + s(1-\alpha)\frac{\left(k^* - p - \overline{k}\right)}{k}}{L^{1-\beta} - s(1-\alpha)\frac{p}{k}}\right] = \tag{A.58}
$$

$$
= p\left[\frac{\beta L^{1-\beta} + s(1-\alpha)\left(\frac{k^*}{k} - 1\right)}{L^{1-\beta} - s(1-\alpha)\frac{p}{k}}\right] \tag{A.59}
$$

A.14. Non-complementarity of private and public capital - one period (linear form)

Using a Cobb-Douglas production function $F = K^{\alpha} L^{1-\alpha} = \left(\bar{K} + P\right)^{\alpha} L^{1-\alpha}$:

$$\begin{aligned} r &= \frac{\partial F}{\partial K} = \alpha \frac{F}{K} \\ \frac{\partial r}{\partial L} &= \alpha(1-\alpha)\frac{F}{KL} \\ \frac{\partial r}{\partial K} &= \alpha(\alpha-1)\frac{F}{K^2} \\ \frac{\partial w}{\partial K} &= \alpha(1-\alpha)\frac{F}{KL} \end{aligned}$$

$$p^* = p\left[\frac{\frac{r}{L} + \frac{\partial r}{\partial K}\left(1-\beta\right)\left(k-k^*\right)}{\frac{\partial r}{\partial K} \cdot p\left(1-\beta\right) + \frac{r}{L}}\right] = \tag{A.60}$$

$$= p\left[\frac{\alpha\frac{F}{KL} + \alpha(\alpha-1)\frac{F}{K^2}\left(1-\beta\right)\left(k-k^*\right)}{\alpha(\alpha-1)\frac{F}{K^2} \cdot \frac{P}{L}\left(1-\beta\right) + \alpha\frac{F}{KL}}\right] = \tag{A.61}$$

$$= p\left[\frac{1 + \left(\alpha-1\right)\left(1-\beta\right)\frac{(k-k^*)}{k}}{1 + \left(\alpha-1\right)\left(1-\beta\right)\frac{p}{k}}\right] = \tag{A.62}$$

$$= p\left[\frac{1 + \left(1-\alpha\right)\left(1-\beta\right)\left(\frac{k^*}{k} - 1\right)}{1 - \left(1-\alpha\right)\left(1-\beta\right)\frac{p}{k}}\right] = \tag{A.63}$$

$$= p\left[\frac{1 + \left(1-\alpha\right)\left(1-\beta\right)\left(\frac{k^*}{\bar{k}+p} - 1\right)}{1 - \left(1-\alpha\right)\left(1-\beta\right)\frac{p}{k}}\right] \tag{A.64}$$

A.15. Complementarity of private and public capital - one period (non-linear form)

Using a Cobb-Douglas production function $F = K^{\alpha_K} P^{\alpha_P} L^{\alpha_L}$:

$$\begin{aligned} r_P &= \frac{\partial F}{\partial P} = \alpha_P \frac{F}{P} \\ \frac{\partial r_P}{\partial L} &= \alpha_P \alpha_L \frac{F}{PL} \\ \frac{\partial r_P}{\partial K} &= \alpha_P \alpha_K \frac{F}{PK} \\ \frac{\partial r_P}{\partial P} &= \alpha_P \left(\alpha_P - 1\right) \frac{F}{P^2} \end{aligned}$$

$$\begin{aligned} p^* &= p \left[\frac{\frac{\beta r_P}{L^\beta} - s\left(\frac{\partial r_P}{\partial L} + k^* \frac{\partial r_P}{\partial K}\right)}{\frac{\partial r_P}{\partial P} \cdot s \cdot \frac{P}{L} + \frac{r_P}{L^\beta}} \right] = \\ &= p \left[\frac{\frac{\beta \alpha_P}{L^\beta} \frac{F}{P} - s\left(\alpha_P \alpha_L \frac{F}{PL} + k^* \alpha_P \alpha_K \frac{F}{PK}\right)}{s \alpha_P \left(\alpha_P - 1\right) \frac{F}{P^2} \cdot \frac{P}{L} + \frac{\alpha_P}{L^\beta} \frac{F}{P}} \right] = \\ &= p \left[\frac{\beta L^{1-\beta} - s\left(\alpha_L + \frac{k^*}{k} \alpha_K\right)}{s\left(\alpha_P - 1\right) + L^{1-\beta}} \right] \end{aligned}$$

If economies of scale are small $\beta \approx 1$, $s \approx 0$, and the membership fee would be:

$$p^* \approx p \tag{A.65}$$

If economies of scale are large and the population L large enough, $s \approx L^{1-\beta}$ and the membership fee would be:

$$p^* \approx p \left[\frac{\beta - \left(\alpha_L + \frac{k^*}{k} \alpha_K\right)}{\alpha_P} \right] \tag{A.66}$$

A.16. Complementarity of private and public capital - one period (linear form)

Using a Cobb-Douglas production function $F = K^{\alpha_K} P^{\alpha_P} L^{\alpha_L}$:

$$\begin{aligned}
r_P &= \frac{\partial F}{\partial P} = \alpha_P \frac{F}{P} \\
\frac{\partial r_P}{\partial L} &= \alpha_P \alpha_L \frac{F}{PL} \\
\frac{\partial r_P}{\partial K} &= \alpha_P \alpha_K \frac{F}{PK} \\
\frac{\partial r_P}{\partial P} &= \alpha_P \left(\alpha_P - 1\right) \frac{F}{P^2}
\end{aligned}$$

$$\begin{aligned}
p^* &= p\left[\frac{\frac{r_P}{L} - \frac{\partial r_P}{\partial L}\left(1-\beta\right) - k^*\left(\frac{\partial r_P}{\partial K}\left(1-\beta\right)\right)}{p\frac{\partial r_P}{\partial P}\left(1-\beta\right) + \frac{r_P}{L}}\right] = \\
&= p\left[\frac{\frac{\alpha_P F}{LP} - \alpha_P \alpha_L \frac{F}{PL}\left(1-\beta\right) - k^*\left(\alpha_P \alpha_K \frac{F}{PK}\left(1-\beta\right)\right)}{p\alpha_P\left(\alpha_P - 1\right)\frac{F}{P^2}\left(1-\beta\right) + \frac{\alpha_P F}{LP}}\right] = \\
&= p\left[\frac{\alpha_P - \alpha_P \alpha_L \left(1-\beta\right) - \frac{k^*}{k}\left(\alpha_P \alpha_K \left(1-\beta\right)\right)}{\alpha_P\left(\alpha_P - 1\right)\left(1-\beta\right) + \alpha_P}\right] = \\
&= p\left[\frac{1 - \alpha_L\left(1-\beta\right) - \frac{k^*}{k}\left(\alpha_K\left(1-\beta\right)\right)}{1 + \left(\alpha_P - 1\right)\left(1-\beta\right)}\right]
\end{aligned}$$

If economies of scale are small $\beta \approx 1$, and the membership fee would be:

$$p^* \approx p \tag{A.67}$$

If economies of scale are large $\beta \approx 0$ and the membership fee would be:

$$p^* \approx p\left[\frac{1 - \alpha_L - \frac{k^*}{k}\alpha_K}{\alpha_P}\right] \tag{A.68}$$

In the particular case when $k = k^*$, we obtain $p^* = p$, which shows that even in cases when the parameter β is low enough, the membership fee would be basically defined by the difference in factor endowments.

A.17. Non-complementarity of private and public capital - infinite periods (non-linear form)

Using a Cobb-Douglas production function $F = K^\alpha L^{1-\alpha} = \left(\bar{K} + P\right)^\alpha L^{1-\alpha}$:

$$
\begin{aligned}
r &= \frac{\partial F}{\partial K} = \alpha \frac{F}{K} \\
w &= \frac{\partial F}{\partial L} = (1-\alpha)\frac{F}{L} \\
\frac{\partial r}{\partial L} &= \alpha(1-\alpha)\frac{F}{KL} \\
\frac{\partial r}{\partial K} &= \alpha(\alpha-1)\frac{F}{K^2} \\
\frac{\partial w}{\partial K} &= \alpha(1-\alpha)\frac{F}{KL}
\end{aligned}
$$

$$p^* = \frac{\beta r^2 \frac{P}{L^{\beta+1}} + \frac{\partial r}{\partial K}\left(r \cdot \frac{K}{L} + w\right)(k^* - k)}{\frac{r^2}{L^\beta} - \frac{\partial r}{\partial K}\left(r \cdot \frac{K}{L} + w\right)} = \tag{A.69}$$

$$= \frac{\beta \frac{\alpha^2 F^2}{K^2} \cdot \frac{P}{L^{\beta+1}} + \alpha(\alpha-1)\frac{F}{K^2}\left(\frac{F}{L}\right)(k^* - k)}{\frac{\alpha^2 F^2}{L^\beta K^2} - \alpha(\alpha-1)\frac{F}{K^2}\left(\frac{F}{L}\right)} = \tag{A.70}$$

$$= \frac{\beta\alpha^2 \cdot \frac{P}{L^\beta} + \alpha(\alpha-1)(k^* - k)}{\alpha^2 L^{1-\beta} - \alpha(\alpha-1)} = \tag{A.71}$$

$$= \frac{\beta\alpha \cdot \frac{P}{L^\beta} + (\alpha-1)(k^* - k)}{\alpha L^{1-\beta} - (\alpha-1)} = \tag{A.72}$$

$$= \frac{\beta\alpha p L^{1-\beta} + (1-\alpha)(k - k^*)}{\alpha L^{1-\beta} + (1-\alpha)} \tag{A.73}$$

A.18. Non-complementarity of private and public capital - infinite periods (linear form)

Using a Cobb-Douglas production function $F = K^{\alpha}L^{1-\alpha} = \left(\bar{K} + P\right)^{\alpha} L^{1-\alpha}$:

$$\begin{aligned} r &= \frac{\partial F}{\partial K} = \alpha \frac{F}{K} \\ w &= \frac{\partial F}{\partial L} = (1-\alpha)\frac{F}{L} \\ \frac{\partial r}{\partial L} &= \alpha(1-\alpha)\frac{F}{KL} \\ \frac{\partial r}{\partial K} &= \alpha(\alpha-1)\frac{F}{K^2} \\ \frac{\partial w}{\partial K} &= \alpha(1-\alpha)\frac{F}{KL} \end{aligned}$$

$$p^* = \frac{r^2 \frac{P}{\beta L^2} + \frac{\partial r}{\partial K}\left(r \cdot \frac{K}{L} + w\right)(k^* - k)}{\frac{r^2}{\beta L} - \frac{\partial r}{\partial K}\left(r \cdot \frac{K}{L} + w\right)} = \tag{A.74}$$

$$= \frac{\alpha^2 \frac{F^2}{K^2} \cdot \frac{P}{\beta L^2} + \alpha(\alpha-1)\frac{F}{K^2} \cdot \frac{F}{L}(k^* - k)}{\alpha^2 \frac{F^2}{K^2} \cdot \frac{1}{\beta L} - \alpha(\alpha-1)\frac{F}{K^2} \cdot \frac{F}{L}} = \tag{A.75}$$

$$= \frac{\alpha^2 \frac{P}{\beta L} + \alpha(\alpha-1)(k^* - k)}{\alpha^2 \frac{1}{\beta} - \alpha(\alpha-1)} = \tag{A.76}$$

$$= \frac{\frac{\alpha^2}{\beta} p + \alpha(1-\alpha)(k - k^*)}{\frac{\alpha^2}{\beta} + \alpha(1-\alpha)} = \tag{A.77}$$

$$= \frac{\alpha p + \beta(1-\alpha)(k - k^*)}{\alpha + \beta(1-\alpha)} = \tag{A.78}$$

$$= \frac{\alpha p + \beta(1-\alpha)\left(\overline{k} + p - k^*\right)}{\alpha + \beta(1-\alpha)} = \tag{A.79}$$

$$= p + \frac{\beta(1-\alpha)\left(\overline{k} - k^*\right)}{\alpha + \beta(1-\alpha)} \tag{A.80}$$

A.19. Complementarity of private and public capital - infinite periods (non-linear form)

Using a Cobb-Douglas production function $F = K^{\alpha_K} P^{\alpha_P} L^{\alpha_L}$:

$$
\begin{aligned}
r_P &= \frac{\partial F}{\partial P} = \alpha_P \frac{F}{P} \\
r_K &= \frac{\partial F}{\partial K} = \alpha_K \frac{F}{K} \\
\frac{\partial r_P}{\partial L} &= \alpha_P \alpha_L \frac{F}{PL} \\
\frac{\partial r_P}{\partial K} &= \alpha_P \alpha_K \frac{F}{PK} \\
\frac{\partial r_P}{\partial P} &= \alpha_P \left(\alpha_P - 1\right) \frac{F}{P^2} \\
\frac{\partial r_K}{\partial L} &= \alpha_K \alpha_L \frac{F}{KL} \\
\frac{\partial r_K}{\partial K} &= \alpha_K \left(\alpha_K - 1\right) \frac{F}{K^2} \\
\frac{\partial r_K}{\partial P} &= \alpha_K \alpha_P \frac{F}{KP}
\end{aligned}
$$

$$
p^* = \frac{\frac{\partial r_K}{\partial L}\left(w + r_K \cdot \frac{K}{L}\right) + r_K \frac{\partial r_P}{\partial L} \cdot \frac{P}{L} + \beta r_K^2 \frac{P}{L^{\beta+1}}}{\frac{r_K^2}{L^\beta} - \frac{\partial r_K}{\partial P}\left(w + r_K \cdot \frac{K}{L}\right) - r_K \cdot \frac{\partial r_P}{\partial P} \cdot \frac{P}{L}} + \tag{A.81}
$$

$$
+ k^* \cdot \frac{\frac{\partial r_K}{\partial K}\left(w + r_K \cdot \frac{K}{L}\right) + r_K \cdot \frac{\partial r_P}{\partial K} \cdot \frac{P}{L}}{\frac{r_K^2}{L^\beta} - \frac{\partial r_K}{\partial P}\left(w + r_K \cdot \frac{K}{L}\right) - r_K \cdot \frac{\partial r_P}{\partial P} \cdot \frac{P}{L}} = \tag{A.82}
$$

$$
= \frac{\alpha_K \alpha_L \frac{F}{KL}\left(\frac{F}{L} - r_P \cdot \frac{P}{L}\right) + \alpha_K \frac{F}{K} \alpha_P \alpha_L \frac{F}{PL} \cdot \frac{P}{L} + \beta \alpha_K^2 \frac{F^2}{K^2} \frac{P}{L^{\beta+1}}}{\alpha_K^2 \frac{F^2}{K^2} \frac{1}{L^\beta} - \alpha_K \alpha_P \frac{F}{KP}\left(\frac{F}{L} - r_P \cdot \frac{P}{L}\right) - \alpha_K \frac{F}{K} . \alpha_P \left(\alpha_P - 1\right) \frac{F}{P^2} \cdot \frac{P}{L}} + \tag{A.83}
$$

$$
+ k^* \cdot \frac{\alpha_K \left(\alpha_K - 1\right) \frac{F}{K^2}\left(\frac{F}{L} - r_P \cdot \frac{P}{L}\right) + \alpha_K \frac{F}{K} . \alpha_P \alpha_K \frac{F}{PK} \cdot \frac{P}{L}}{\alpha_K^2 \frac{F^2}{K^2} \frac{1}{L^\beta} - \alpha_K \alpha_P \frac{F}{KP}\left(\frac{F}{L} - r_P \cdot \frac{P}{L}\right) - \alpha_K \frac{F}{K} . \alpha_P \left(\alpha_P - 1\right) \frac{F}{P^2} \cdot \frac{P}{L}} = \tag{A.84}
$$

$$
= \frac{\alpha_K \alpha_L \frac{K}{L} + \beta \alpha_K^2 \frac{P}{L^\beta}}{\alpha_K^2 L^{1-\beta}} + k^* \cdot \frac{\alpha_K \left(\alpha_K - 1\right)\left(1 - \alpha_P\right) + \alpha_K \alpha_P \alpha_K}{\alpha_K^2 L^{1-\beta}} = \tag{A.85}
$$

$$
= \beta p + \frac{\alpha_K \alpha_L \overline{k} + \alpha_K k^* \left[\alpha_K + \alpha_P - 1\right]}{\alpha_K^2 L^{1-\beta}} \tag{A.86}
$$

If we assume constant return to scale in the production function: $\alpha_K + \alpha_P + \alpha_L = 1$ and the membership fee results:

$$p^* = \beta p + \frac{\alpha_L}{\alpha_K L^{1-\beta}} \left(\overline{k} - k^*\right) \tag{A.87}$$

Same as happens in the case of non-complementarity between public and private capital, the private capital brought by the new member only reduces the amount of the membership fee for positive values of $\overline{k} - k^*$that are of the same order of magnitude than $L^{1-\beta}$

If economies of scale are small $\beta \approx 1$, and the membership fee would be:

$$p^* \approx p + \frac{\alpha_L}{\alpha_K} \left(\overline{k} - k^*\right) \tag{A.88}$$

The intuition of the result is clear, if the new entrant brings an amount of private capita larger that the existing private capital per capita, it causes a reduction in r_K which increases the income in (5.24), which helps to finance the membership fee.

If the country does not request a membership fee ($p^* = 0$), the required amount of private capital would be:

$$k^* \approx \overline{k} + \frac{\alpha_K \beta L^{1-\beta}}{\alpha_L} \cdot p \tag{A.89}$$

A.20. Complementarity of private and public capital - infinite periods (linear form)

Using a Cobb-Douglas production function $F = K^{\alpha_K} P^{\alpha_P} L^{\alpha_L}$:

$$
\begin{aligned}
r_P &= \frac{\partial F}{\partial P} = \alpha_P \frac{F}{P} \\
r_K &= \frac{\partial F}{\partial K} = \alpha_K \frac{F}{K} \\
\frac{\partial r_P}{\partial L} &= \alpha_P \alpha_L \frac{F}{PL} \\
\frac{\partial r_P}{\partial K} &= \alpha_P \alpha_K \frac{F}{PK} \\
\frac{\partial r_P}{\partial P} &= \alpha_P \left(\alpha_P - 1\right) \frac{F}{P^2} \\
\frac{\partial r_K}{\partial L} &= \alpha_K \alpha_L \frac{F}{KL} \\
\frac{\partial r_K}{\partial K} &= \alpha_K \left(\alpha_K - 1\right) \frac{F}{K^2} \\
\frac{\partial r_K}{\partial P} &= \alpha_K \alpha_P \frac{F}{KP}
\end{aligned}
$$

$$
p^* = \frac{\frac{\partial r_K}{\partial L}\left(w + r_K \cdot \frac{K}{L}\right) + r_K \frac{\partial r_P}{\partial L} \cdot \frac{P}{L} + r_K^2 \frac{P}{\beta L^2}}{\frac{r_K^2}{\beta L} - \frac{\partial r_K}{\partial P}\left(w + r_K \cdot \frac{K}{L}\right) - r_K \cdot \frac{\partial r_P}{\partial P} \cdot \frac{P}{L}} + \tag{A.90}
$$

$$
+ k^* \cdot \frac{\frac{\partial r_K}{\partial K}\left(w + r_K \cdot \frac{K}{L}\right) + r_K \cdot \frac{\partial r_P}{\partial K} \cdot \frac{P}{L}}{\frac{r_K^2}{\beta L} - \frac{\partial r_K}{\partial P}\left(w + r_K \cdot \frac{K}{L}\right) - r_K \cdot \frac{\partial r_P}{\partial P} \cdot \frac{P}{L}} = \tag{A.91}
$$

$$
= \frac{\alpha_K \alpha_L \frac{F}{KL}\left(\frac{F}{L} - r_P \cdot \frac{P}{L}\right) + \alpha_K \frac{F}{K} \alpha_P \alpha_L \frac{F}{PL} \cdot \frac{P}{L} + \alpha_K^2 \frac{F^2}{K^2} \frac{P}{\beta L^2}}{\alpha_K^2 \frac{F^2}{K^2} \frac{1}{\beta L} - \alpha_K \alpha_P \frac{F}{KP}\left(\frac{F}{L} - r_P \cdot \frac{P}{L}\right) - \alpha_K \frac{F}{K} . \alpha_P \left(\alpha_P - 1\right) \frac{F}{P^2} \cdot \frac{P}{L}} + \tag{A.92}
$$

$$
+ k^* \cdot \frac{\alpha_K \left(\alpha_K - 1\right) \frac{F}{K^2}\left(\frac{F}{L} - r_P \cdot \frac{P}{L}\right) + \alpha_K \frac{F}{K} . \alpha_P \alpha_K \frac{F}{PK} \cdot \frac{P}{L}}{\alpha_K^2 \frac{F^2}{K^2} \frac{1}{\beta L} - \alpha_K \alpha_P \frac{F}{KP}\left(\frac{F}{L} - r_P \cdot \frac{P}{L}\right) - \alpha_K \frac{F}{K} . \alpha_P \left(\alpha_P - 1\right) \frac{F}{P^2} \cdot \frac{P}{L}} = \tag{A.93}
$$

$$
= \frac{\alpha_K \alpha_L \frac{K}{L} + \alpha_K^2 \frac{P}{\beta L}}{\frac{\alpha_K^2}{\beta}} + k^* \cdot \frac{\alpha_K \left(\alpha_K - 1\right)\left(1 - \alpha_P\right) + \alpha_K \alpha_P \alpha_K}{\frac{\alpha_K^2}{\beta}} = \tag{A.94}
$$

$$
= \beta \left[\frac{\alpha_L \overline{k} + \alpha_K \frac{p}{\beta} + k^* \left[\alpha_K + \alpha_P - 1\right]}{\alpha_K}\right] = \tag{A.95}
$$

$$
= p + \beta \left[\frac{\alpha_L \overline{k} + k^* \left[\alpha_K + \alpha_P - 1\right]}{\alpha_K}\right] \tag{A.96}
$$

A.21. Equivalence of optimization problem and Berry and Soligo's Taylor approximation

Assuming the economy is in equilibrium both before and after the influx of immigrants, and defining the pre and post immigration income can be described as follows:

$$I_0 = w_0 + r_0\overline{k} = \frac{\partial F}{\partial L}\Big|_{(K_0,L_0)} + \frac{\partial F}{\partial K}\Big|_{(K_0,L_0)}\overline{k}$$
$$I_1 = w_1 + r_1\overline{k} = \frac{\partial F}{\partial L}\Big|_{(K_1,L_1)} + \frac{\partial F}{\partial K}\Big|_{(K_1,L_1)}\overline{k}$$

Where w_0, $w_1$and r_0, $r_1$are the pre and post immigration wages and return on capital respectively, and $\overline{k} = \frac{K_0}{L_0}$ is the private capital per capita of the incumbent population.

The first order Taylor approximation centered in (K_0, L_0) will be given by:

$$\frac{\partial F}{\partial L}\Big|_{(K_1,L_1)} = \frac{\partial F}{\partial L}\Big|_{(K_0,L_0)} + \frac{\partial^2 F}{\partial L^2}\Big|_{(K_0,L_0)}(L_1 - L_0) + \frac{\partial^2 F}{\partial L \partial K}\Big|_{(K_0,L_0)}(K_1 - K_0)$$
$$\frac{\partial F}{\partial K}\Big|_{(K_1,L_1)} = \frac{\partial F}{\partial L}\Big|_{(K_0,L_0)} + \frac{\partial^2 F}{\partial K \partial L}\Big|_{(K_0,L_0)}(L_1 - L_0) + \frac{\partial^2 F}{\partial K^2}\Big|_{(K_0,L_0)}(K_1 - K_0)$$

Accordingly, the first order Taylor approximation for the change in income in the incumbent population will be given by (using a simplified notation with all derivatives evaluated in (K_0, L_0)):

$$I_1 - I_0 = \frac{\partial^2 F}{\partial L^2}(L_1 - L_0) + \frac{\partial^2 F}{\partial L \partial K}(K_1 - K_0) + \tag{A.97}$$
$$+\frac{K_0}{L_0}\left[\frac{\partial^2 F}{\partial K \partial L}(L_1 - L_0) + \frac{\partial^2 F}{\partial K^2}(K_1 - K_0)\right] \tag{A.98}$$

Defining $\triangle L = L_1 - L_0$, and assuming the private capital per capita of the immigrant population to be a factor a of that of the incumbent population $\overline{k}$ is $(k* = a \cdot \overline{k} = \frac{K_0}{L_0})$, the change in total capital $\triangle K = K_1 - K_0$ can be expressed as:

$$K_1 - K_0 = a \cdot \frac{K_0}{L_0} \cdot \triangle L \tag{A.99}$$

And the change income can be expressed as:

$$I_1 - I_0 = \triangle L \left[\frac{\partial^2 F}{\partial L^2} + \frac{\partial^2 F}{\partial L \partial K} \cdot \frac{K_0}{L_0} (a+1) + a \frac{\partial^2 F}{\partial K^2} \left(\frac{K_0}{L_0} \right)^2 \right] \tag{A.100}$$

Assuming a production function homogeneous of degree one $F(K, L) = L \cdot F(\frac{K}{L}, 1) = Lf(k)$, the partial derivatives of first and second order will be (see Appendix sec. A.8):

$$\begin{aligned}
\frac{\partial F}{\partial K} &= f'(k) \\
\frac{\partial F}{\partial L} &= f(k) - f'(k)k \\
\frac{\partial^2 F}{\partial K^2} &= f''(k) \cdot \frac{1}{L} \\
\frac{\partial^2 F}{\partial L^2} &= f''(k) \cdot \frac{k^2}{L} \\
\frac{\partial^2 F}{\partial K \partial L} &= -f''(k) \cdot \frac{k}{L} \\
\frac{\partial^2 F}{\partial L \partial K} &= -f''(k) \cdot \frac{k}{L}
\end{aligned}$$

And the first order approximation for the change in income will be:

$$I_1 - I_0 = \triangle L \left[f''(k) \cdot \frac{k^2}{L} + -f''(k) \cdot \frac{k}{L} \cdot k\,(a+1) + af''(k) \cdot \frac{1}{L} \cdot k^2 \right] = 0 \tag{A.101}$$

The second order terms for the approximation of the post immigration wages and income will be:

$$\begin{aligned}
\frac{\partial F}{\partial L} \Big|_{(K_1,L_1)} &= \frac{\partial^3 F}{\partial L^3} \Big|_{(K_0,L_0)} (L_1 - L_0)^2 + \frac{\partial^3 F}{\partial L \partial K^2} \Big|_{(K_0,L_0)} (K_1 - K_0)^2 + \\
&+2 \frac{\partial^3 F}{\partial L^2 \partial K} \Big|_{(K_0,L_0)} (L_1 - L_0)(K_1 - K_0) \\
\frac{\partial F}{\partial K} \Big|_{(K_1,L_1)} &= \frac{\partial^3 F}{\partial K^3} \Big|_{(K_0,L_0)} (K_1 - K_0)^2 + \frac{\partial^2 F}{\partial K \partial L^2} \Big|_{(K_0,L_0)} (L_1 - L_0)^2 + \\
&+2 \frac{\partial^3 F}{\partial K^2 \partial L} \Big|_{(K_0,L_0)} (L_1 - L_0)(K_1 - K_0)
\end{aligned}$$

And the second order approximation for the change income will be (using a simplified notation with all derivatives evaluated in (K_0, L_0)):

$$I_1 - I_0 = \frac{(\triangle L)^2}{2}\left[\frac{\partial^3 F}{\partial L^3} + a^2\left(\frac{K_0}{L_0}\right)^3\frac{\partial^3 F}{\partial K^3} + a\,(a+2)\left(\frac{K_0}{L_0}\right)^2\frac{\partial^3 F}{\partial K^2 \partial L} + (2a+1)\frac{K_0}{L_0}\cdot\frac{\partial^3 F}{\partial L^2 \partial K}\right] \tag{A.102}$$

If the production function homogeneous of degree one, its partial derivatives of third order will be (see Appendix sec. A.8):

$$\frac{\partial^3 F}{\partial K^3} = \frac{\partial}{\partial K}\left(\frac{\partial^2 F}{\partial K^2}\right) = f'''(k)\cdot\frac{1}{L^2}$$

$$\frac{\partial^3 F}{\partial L^3} = \frac{\partial}{\partial L}\left(\frac{\partial^2 F}{\partial L^2}\right) = -f'''(k)\cdot\frac{k^3}{L^2} - 3f''(k)\cdot\frac{k^2}{L^2}$$

$$\frac{\partial^3 F}{\partial L \partial K^2} = \frac{\partial}{\partial K}\left(\frac{\partial^2 F}{\partial L \partial K}\right) = -f'''(k)\cdot\frac{k}{L^2} - f''(k)\cdot\frac{1}{L^2}$$

$$\frac{\partial^3 F}{\partial K \partial L^2} = \frac{\partial}{\partial K}\left(\frac{\partial^2 F}{\partial L^2}\right) = f'''(k)\cdot\frac{k^2}{L^2} + 2f''(k)\cdot\frac{k}{L^2}$$

And the second order approximation for the change in income:

$$2\frac{I_1 - I_0}{(\triangle L)^2} = -f'''(k)\cdot\frac{k^3}{L^2} - 3f''(k)\cdot\frac{k^2}{L^2} + a^2 f'''(k)\cdot\frac{k^3}{L^2} + \tag{A.103}$$

$$+ a\,(a+2)\,k^2\left(-f'''(k)\cdot\frac{k}{L^2} - f''(k)\cdot\frac{1}{L^2}\right) + \tag{A.104}$$

$$+ (2a+1)k\cdot\left(f'''(k)\cdot\frac{k^2}{L^2} + 2f''(k)\cdot\frac{k}{L^2}\right) = \tag{A.105}$$

$$= -\frac{k^2}{L^2}f''(k)\,(a-1)^2 \tag{A.106}$$

Berry and Soligo's approximation in k is:

$$I_1 - I_0 \approx -\frac{1}{2}f''(k_0)\,(k_1 - k_0)^2 \gtrapprox 0 \tag{A.107}$$

To prove that the approximation in L is equivalent, we need to substitute $k_1$by:

$$k_1 = \frac{K + \triangle K}{L + \triangle L} = \frac{K + \triangle L \cdot a \cdot \frac{K}{L}}{L + \triangle L} \tag{A.108}$$

And the income change will be:

$$I_1 - I_0 \approx -\frac{1}{2} f''(k_0) \left(\frac{K + \triangle L \cdot a \cdot \frac{K}{L}}{L + \triangle L} - \frac{K}{L} \right)^2 = \tag{A.109}$$

$$= -\frac{1}{2} f''(k_0) \left(\frac{KL + \triangle L \cdot a \cdot K - KL - K \triangle L}{L(L + \triangle L)} \right)^2 = \tag{A.110}$$

$$= -\frac{1}{2} f''(k_0) \left(\frac{\triangle L \cdot K(a-1)}{L(L + \triangle L)} \right)^2 \approx \tag{A.111}$$

$$\approx -\frac{1}{2} f''(k_0) \left(\frac{\triangle L \cdot K(a-1)}{L^2} \right)^2 = \tag{A.112}$$

$$= -\frac{1}{2} \frac{k^2}{L^2} (\triangle L)^2 f''(k) (a-1)^2 \tag{A.113}$$

Why the two approximation are not exactly equal needs of a subtle analysis. The approximation in L remains valid only when the number of new members is infinitesimal in comparison to the existing population, independently of whether they bring a very large amount of capital. In Berry and Soligo however, a given change in capital per capita can be the result of both a large number of individuals who bring slightly more capital than the incumbent population, or a small number of individuals who bring a large amount of capital. However, when approximating in L it is clear that the approximation for the first case should include elements of higher order, as the change in L is not infinitesimal. Looking into the equation this is explained by the fact the two approximations are equal only when $\triangle L$ is very small.

To further prove that the optimization and income change approximation approaches are equivalent, the second order derivative of income will be calculated:

$$
\begin{aligned}
\frac{\partial^2 I}{\partial L^2} &= k^* \left[\frac{\partial^2 w}{\partial K^2} \cdot k^* + \frac{\partial^2 w}{\partial K \partial L} + \overline{k} \cdot \left(\frac{\partial^2 r}{\partial K^2} \cdot k^* + \frac{\partial^2 r}{\partial K \partial L}\right)\right] + \\
&= + \frac{\partial^2 w}{\partial L \partial K} \cdot k^* + \frac{\partial^2 w}{\partial L^2} + \overline{k} \cdot \left(\frac{\partial^2 r}{\partial L \partial K} \cdot k^* + \frac{\partial^2 r}{\partial L^2}\right) + \\
&+ k^* \left[k^* \left(\frac{\partial^2 w}{\partial K^2} + \overline{k} \cdot \frac{\partial^2 r}{\partial K^2}\right) + \frac{\partial^2 w}{\partial K \partial L} + \overline{k} \cdot \frac{\partial^2 r}{\partial K \partial L}\right] + \\
&+ k^* \left(\frac{\partial^2 w}{\partial L \partial K} + \overline{k} \cdot \frac{\partial^2 r}{\partial L \partial K}\right) + \frac{\partial^2 w}{\partial L^2} + \overline{k} \cdot \frac{\partial^2 r}{\partial L^2} = \\
&= k^{*^2} \left(\frac{\partial^2 w}{\partial K^2} + \overline{k} \cdot \frac{\partial^2 r}{\partial K^2}\right) + 2k^* \left(\frac{\partial^2 w}{\partial K \partial L} + \overline{k} \cdot \frac{\partial^2 r}{\partial K \partial L}\right) + \frac{\partial^2 w}{\partial L^2} + \overline{k} \cdot \frac{\partial^2 r}{\partial L^2}
\end{aligned}
$$

If the production function is homogeneous of degree one (see Appendix sec. A.8 for a calculation of the derivatives):

$$
\begin{aligned}
\frac{\partial^2 I}{\partial L^2} &= k^{*^2} \left(-f''' \frac{\overline{k}}{L^2} - \frac{f''}{L^2} + \overline{k} \cdot \frac{f'''}{L^2}\right) + \\
&+ 2k^* \left[f''' \frac{\overline{k}^2}{L^2} + 2f'' \frac{\overline{k}}{L^2} + \overline{k} \cdot \left(-f''' \frac{\overline{k}}{L^2} - \frac{f''}{L^2}\right)\right] - \\
&= -f''' \frac{\overline{k}^3}{L^2} - 3f'' \frac{\overline{k}^2}{L^2} + \overline{k} \cdot \left(f''' \frac{\overline{k}^2}{L^2} + 2f'' \frac{\overline{k}}{L^2}\right) = \\
&= -\frac{f''}{L^2} k^{*^2} + 2k^* f'' \frac{\overline{k}}{L^2} - f'' \frac{\overline{k}^2}{L^2} = -\frac{f''}{L^2}(k^{*^2} + -2k^* \overline{k} + \overline{k}^2) = \\
&= -\frac{f''}{L^2}(k^* - \overline{k})^2
\end{aligned}
$$

A.22. Berry and Soligo equivalent optimization for infinite periods

$$k^* \left(\frac{\partial w}{\partial K} r - w \frac{\partial r}{\partial K} \right) + \frac{\partial w}{\partial L} r - w \frac{\partial r}{\partial L} = 0 \tag{A.114}$$

Assuming a production function homogeneous of degree one $F(K, L) = L \cdot F(\frac{K}{L}, 1) = Lf(k)$, the partial derivatives of first and second order will be (see Appendix sec. A.8):

$$\begin{aligned}
\frac{\partial F}{\partial K} &= f'(k) \\
\frac{\partial F}{\partial L} &= f(k) - f'(k)k \\
\frac{\partial^2 F}{\partial K^2} &= f''(k) \cdot \frac{1}{L} \\
\frac{\partial^2 F}{\partial L^2} &= f''(k) \cdot \frac{k^2}{L} \\
\frac{\partial^2 F}{\partial K \partial L} &= -f''(k) \cdot \frac{k}{L} \\
\frac{\partial^2 F}{\partial L \partial K} &= -f''(k) \cdot \frac{k}{L}
\end{aligned}$$

And the required amount of private capital per capita required to the new member in order to avoid an income loss will be:

$$k^* = \frac{\frac{-\partial w}{\partial L} r + w \frac{\partial r}{\partial L}}{\frac{\partial w}{\partial K} r - w \frac{\partial r}{\partial K}} = \tag{A.115}$$

$$k^* = \frac{-f''(k) \cdot \frac{k^2}{L} \cdot f'(k) - [f(k) - f'(k)k] \, f''(k) \cdot \frac{k}{L}}{-f''(k) \cdot \frac{k}{L} \cdot f'(k) - (f(k) - f'(k)k) \, f''(k) \cdot \frac{1}{L}} = \tag{A.116}$$

$$= \frac{-f''(k) \cdot f'(k) \cdot \frac{k^2}{L} - f(k) \cdot f''(k) \cdot \frac{k}{L} + f''(k) \cdot f'(k) \cdot \frac{k^2}{L}}{-f''(k) \cdot f'(k) \cdot \frac{k}{L} - f(k) \cdot f''(k) \cdot \frac{1}{L} + f''(k) \cdot f'(k) \cdot \frac{k}{L}} = \tag{A.117}$$

$$= \frac{-f(k) \cdot f''(k) \cdot \frac{k}{L}}{-f(k) \cdot f''(k) \cdot \frac{1}{L}} = k \tag{A.118}$$

A.23. Alternative discount rates

A.23.1. Discounting by the return of public capital

The income of the representative individual over a perpetuity will be defined as:

$$I(K,P,L) = \frac{F(K,P,L)}{L^{\beta} \cdot \frac{\partial F}{\partial P}} \tag{A.119}$$

The change in income for an increase of population will be given in this case by:

$$\frac{\partial I}{\partial L} = \left(\frac{\partial F}{\partial K} \cdot \frac{\partial K}{\partial L} + \frac{\partial F}{\partial P} \cdot \frac{\partial P}{\partial L} + \frac{\partial F}{\partial L} \right) L^{\beta} \frac{\partial F}{\partial P} - \tag{A.120}$$

$$- F \left[\beta L^{\beta-1} \frac{\partial F}{\partial P} + L^{\beta} \left(\frac{\partial^2 F}{\partial P \partial L} + \frac{\partial^2 F}{\partial P^2} \cdot \frac{\partial P}{\partial L} + \frac{\partial^2 F}{\partial P \partial K} \cdot \frac{\partial K}{\partial L} \right) \right] \tag{A.121}$$

And the contribution of public capital that will optimize the host population income will be given by:

$$p^* = \frac{\partial P}{\partial L} = \frac{\beta F L^{-1} \frac{\partial F}{\partial P} + F \left(\frac{\partial^2 F}{\partial P \partial L} + \frac{\partial^2 F}{\partial P \partial K} \cdot \frac{\partial K}{\partial L} \right) - \frac{\partial F}{\partial P} \left(\frac{\partial F}{\partial L} + \frac{\partial F}{\partial K} \cdot \frac{\partial K}{\partial L} \right)}{\left(\frac{\partial F}{\partial P} \right)^2 - F \cdot \frac{\partial^2 F}{\partial P^2}} = \tag{A.122}$$

$$= \frac{\beta F L^{-1} \frac{\partial F}{\partial P} + F \left(\frac{\partial^2 F}{\partial P \partial L} \right) - \frac{\partial F}{\partial P} \cdot \frac{\partial F}{\partial L} + k^* \left(F \cdot \frac{\partial^2 F}{\partial P \partial K} - \frac{\partial F}{\partial P} \cdot \frac{\partial F}{\partial K} \right)}{\left(\frac{\partial F}{\partial P} \right)^2 - F \cdot \frac{\partial^2 F}{\partial P^2}} \tag{A.123}$$

Assuming a production function homogeneous of degree one $F(K,P,L) = L \cdot F(\frac{K}{L}, \frac{P}{L}, 1) = L \cdot f(k,p)$, the membership fee can be re-written (see sec. A.9):

$$p^* = \frac{\beta f \cdot f_p + f\left(-f_{pp} \cdot p - f_{pk} \cdot k\right) - f_p \cdot \left(f - f_k k - f_p p\right) + k^* \left(f \cdot f_{kp} - f_p \cdot f_k\right)}{f_p^2 - f \cdot f_{pp}} = \tag{A.124}$$

$$= \frac{f \cdot f_p(\beta - 1) + p\left(f_p^2 - f \cdot f_{pp}\right) + (k - k^*)\left(f_p \cdot f_k - f \cdot f_{kp}\right)}{f_p^2 - f \cdot f_{pp}} = \tag{A.125}$$

$$= p + \frac{f \cdot f_p}{f_p^2 - f \cdot f_{pp}} \cdot (\beta - 1) + \frac{f_p \cdot f_k - f \cdot f_{kp}}{f_p^2 - f \cdot f_{pp}} \cdot (k - k^*) \tag{A.126}$$

Assuming that the new member's private capital is equal to the capital per capita of the native population ($k = k^*$), the membership fee would be equal to:

$$p^* = p + \frac{f \cdot f_p}{f_p^2 - f \cdot f_{pp}} \cdot (\beta - 1) \tag{A.127}$$

A.23.1.1. Complementarity between private and public capital

As explained in Chapter 5, the assumption of equal capital endowments is necessary when defining income as a per capita division of total output, as otherwise there would be direct transfers of private capital which could only represent an egalitarian society. However, it is worth noting that if $k \neq k^*$, and assuming the function has CES with complementarity between private and public capital, it holds that $f_p \cdot f_k - f \cdot f_{kp} > 0$ (see sec. A.24). Thus, obtaining again that when private and public capital are complementary, contributions of private capital help to finance the membership fee.

In the particular case of a Cobb-Douglas specification, CES =1, $r = 0$, and $f_p \cdot f_k - f \cdot f_{kp} = 0$, thus eliminating the effect of contributions of private capital. The membership fee in this particular case will be given by:

$$p^* = p + \frac{p}{(1 - r)}(\beta - 1) = \beta p \tag{A.128}$$

This explains why in the case of permanent residence, the assumption of equal capital endowments is not necessary when formulating the optimization problem.

A.23.1.2. Non complementarity between private and public capital

If private and public capital are nor complementary in the sense that they constitute the same form of capital, it will imply that the partial derivatives will be the same for both types of capital, and $f_p \cdot f_k - f \cdot f_{kp} = f_p^2 - f \cdot f_{pp}$. Hence, the membership fee will be equal to:

$$p^* = p + \frac{f \cdot f_p}{f_p^2 - f \cdot f_{pp}} \cdot (\beta - 1) + (k - k^*) \tag{A.129}$$

In this case the term on private capital does not disappear, independently of the form of the production function. If the production function is has CES on the total capital and $r = 0$, the membership fee would be re-written (see sec. A.25):

$$p^* = p + (k+p)\cdot(\beta-1) + (k-k^*) = \beta(k+p) - k^* \tag{A.130}$$

If we make the assumption that $k = k^*$ in order to avoid direct redistributions of private capital imposed on a new member (as the model divides all output per capita), the membership fee will be:

$$p^* = \beta p - k(1-\beta) \tag{A.131}$$

Hence, the entry fee would be reduced by auditions of private capital.

A.23.2. Discounting by the return of private capital

When discounting for perpetuity with the return of private capital, the income of the representative individual over a perpetuity will be defined as:

$$I(K,P,L) = \frac{F(K,P,L)}{L^\beta \cdot \frac{\partial F}{\partial K}} \tag{A.132}$$

The change in income for an increase of population will be given in this case by:

$$\frac{\partial I}{\partial L} = \left(\frac{\partial F}{\partial K}\cdot\frac{\partial K}{\partial L} + \frac{\partial F}{\partial P}\cdot\frac{\partial P}{\partial L} + \frac{\partial F}{\partial L}\right) L^\beta \frac{\partial F}{\partial K} - \tag{A.133}$$

$$- F\left[\beta L^{\beta-1}\frac{\partial F}{\partial K} + L^\beta\left(\frac{\partial^2 F}{\partial K \partial L} + \frac{\partial^2 F}{\partial K^2}\cdot\frac{\partial K}{\partial L} + \frac{\partial^2 F}{\partial P \partial K}\cdot\frac{\partial P}{\partial L}\right)\right] \tag{A.134}$$

And the contribution of public capital that will optimize the host population income will be given by:

$$p^* = \frac{\partial P}{\partial L} = \frac{\beta F L^{-1} \frac{\partial F}{\partial K} + F\left(\frac{\partial^2 F}{\partial K \partial L} + \frac{\partial^2 F}{\partial K^2} \cdot \frac{\partial K}{\partial L}\right) - \frac{\partial F}{\partial K}\left(\frac{\partial F}{\partial L} + \frac{\partial F}{\partial K} \cdot \frac{\partial K}{\partial L}\right)}{\frac{\partial F}{\partial P} \cdot \frac{\partial F}{\partial K} - F \cdot \frac{\partial^2 F}{\partial P \partial K}} = \tag{A.135}$$

$$= \frac{\beta F L^{-1} \frac{\partial F}{\partial K} + F\left(\frac{\partial^2 F}{\partial K \partial L}\right) - \frac{\partial F}{\partial K} \cdot \frac{\partial F}{\partial L} + k^*\left(F \cdot \frac{\partial^2 F}{\partial K^2} - \left(\frac{\partial F}{\partial K}\right)^2\right)}{\frac{\partial F}{\partial P} \cdot \frac{\partial F}{\partial K} - F \cdot \frac{\partial^2 F}{\partial P \partial K}} \tag{A.136}$$

Assuming a production function homogeneous of degree one $F(K, P, L) = L \cdot F(\frac{K}{L}, \frac{P}{L}, 1) = L \cdot f(k, p)$, the membership fee can be re-written (see sec. A.9):

$$p^* = \frac{\beta f \cdot f_p + f\left(-f_{kk} \cdot k - f_{kp} \cdot p\right) - f_k \cdot (f - f_k k - f_p p) + k^*\left(f \cdot f_{kk} - f_k^2\right)}{f_p \cdot f_k - f \cdot f_{kp}} = \tag{A.137}$$

$$= \frac{\beta f \cdot f_p + p\left(f_p \cdot f_k - f \cdot f_{kp}\right) - f_k \cdot f + (k^* - k)\left(f \cdot f_{kk} - f_k^2\right)}{f_p \cdot f_k - f \cdot f_{kp}} = \tag{A.138}$$

$$= p + \frac{f\left(\beta f_p - f_k\right)}{f_p \cdot f_k - f \cdot f_{kp}} + \frac{f_k^2 - f \cdot f_{kk}}{f_p \cdot f_k - f \cdot f_{kp}} \cdot (k - k^*) \tag{A.139}$$

Assuming that the new member's private capital is equal to the capital per capita of the native population ($k = k^*$), the membership fee would be equal to:

$$p^* = p + \frac{f\left(\beta f_p - f_k\right)}{f_p \cdot f_k - f \cdot f_{kp}} \tag{A.140}$$

A.23.2.1. Complementarity between private and public capital

If $k \neq k^*$and the production function has CES with complementarity between public and private capital, contributions of private capital in excess of existing capital per capita finance the entry fee as $f_p \cdot f_k - f \cdot f_{kp} > 0$ (see sec. A.24) and $f_k^2 - f \cdot f_{kk} > 0$.

It can also be observed that when economies of scale are large ($\beta \ll 1$) the membership fee can be approximated by:

$$p^* = p + \frac{-f \cdot f_k}{f_p \cdot f_k - f \cdot f_{kp}} \tag{A.141}$$

And as $f_p \cdot f_k - f \cdot f_{kp} > 0$ and $-f \cdot f_k < 0$ it can be seen how economies of scale reduce the membership fee.

In the particular case of a Cobb-Douglas specification, CES =1, $r = 0$, and $f_p \cdot f_k - f \cdot f_{kp} = 0$, and the membership fee will tend to $\pm\infty$ depending of the sign of $\beta \alpha_K p - \alpha_P k$

A.23.2.2. Non complementarity between private and public capital

If private and public capital are nor complementary in the sense that they constitute the same form of capital, it will imply that the partial derivatives will be the same for both types of capital, and the membership fee will be equal to:

$$p^* = p + \frac{f\left(\beta f_p - f_k\right)}{f_p \cdot f_k - f \cdot f_{kp}} + (k - k^*) = \tag{A.142}$$

$$= p + \frac{f \cdot f_p}{f_p^2 - f \cdot f_{pp}} \cdot (\beta - 1) + (k - k^*) \tag{A.143}$$

Which as expected is the same result obtained in the case when we discount by the return of public capital, as in this case there is no differentiation between both forms of capital.

A.23.3. Discounting by a constant return on capital (Open economy)

A.23.3.1. No allocative efficiency effects

The income of the representative individual over a perpetuity when the return on capital is constant will be defined as:

$$I(K, P, L) = \frac{F(K, P, L)}{rL^\beta} \tag{A.144}$$

The change in income for an increase of population will be given in this case by:

$$\frac{\partial I}{\partial L} = \frac{1}{r}\frac{\partial}{\partial L}\left(\frac{F(K, P, L)}{L^\beta}\right) \tag{A.145}$$

Therefore, the membership fee will be similar to that of the one period case. This is the case independently of whether there are complementarities between private and public capital.

A.23.3.2. Allocative efficiency effects: one period, no complementarity, exogenous discount rate

Denoting $\hat{r}$ as the exogenously given return on capital, equation (5.2) turns:

$$I = w + \hat{r}\overline{k} + \hat{r}\frac{P}{L^{\beta}} \tag{A.146}$$

Assuming $\overline{k}$ and $\hat{r}$ remain constant:

$$\frac{\partial I}{\partial L} = \frac{\partial w}{\partial L} + \hat{r}\left(\frac{\frac{\partial P}{\partial L}L^{\beta} - \beta P L^{\beta-1}}{L^{2\beta}}\right) = 0$$

As w is a function of L and K, the change in wages and return on capital caused by a new entrant can be expressed as:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial w}{\partial L}$$

As the new entrant can now bring private capital in different proportions, the change in capital K for an increase in L can be expressed as:

$$\frac{\partial K}{\partial L} = p^{*} + k^{*}$$

where p^{*} and k^{*} are the public and private capital brought by the new member.

The previous equations can be re-written as follows:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}\left(p^{*} + k^{*}\right) + \frac{\partial w}{\partial L}$$

And the change in income for an increase in L turns:

$$\frac{\partial I}{\partial L} = p^{*}\left[\frac{\partial w}{\partial K} + \frac{\hat{r}}{L^{\beta}}\right] + k^{*}\left[\frac{\partial w}{\partial K}\right] + \frac{\partial w}{\partial L} - \beta\frac{\hat{r}P}{L^{\beta+1}}$$

The membership fee in terms of public capital contribution can be then expressed as:

$$p^* = \frac{\beta \frac{\hat{r}P}{L^{\beta+1}} - \frac{\partial w}{\partial L}}{\frac{\partial w}{\partial K} + \frac{\hat{r}}{L^\beta}} - k^* \cdot \frac{\frac{\partial w}{\partial K}}{\frac{\partial w}{\partial K} + \frac{\hat{r}}{L^\beta}} \tag{A.147}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.8 for the mathematical proof):

$$\frac{\partial w}{\partial K} = -\frac{\partial r}{\partial K} \cdot \frac{K}{L} = -\frac{\partial r}{\partial K} \cdot k$$
$$\frac{\partial w}{\partial L} = -\frac{\partial r}{\partial L} \cdot \frac{K}{L} = -\frac{\partial r}{\partial L} \cdot k$$
$$\frac{\partial r}{\partial L} = \frac{\partial w}{\partial K} = -\frac{\partial r}{\partial K} \cdot k$$

Which gives us:

$$p^* = \frac{\beta \frac{\hat{r}P}{L^{\beta+1}} + \frac{\partial r}{\partial L} \cdot k}{\frac{\hat{r}}{L^\beta} - \frac{\partial r}{\partial K} \cdot k} + k^* \cdot \frac{\frac{\partial r}{\partial K} \cdot k}{\frac{\hat{r}}{L^\beta} - \frac{\partial r}{\partial K} \cdot k} = \tag{A.148}$$

$$= p \frac{\beta \frac{\hat{r}}{L^\beta}}{\frac{\hat{r}}{L^\beta} - \frac{\partial r}{\partial K} \cdot k} + \frac{\frac{\partial r}{\partial K} \cdot k}{\frac{\hat{r}}{L^\beta} - \frac{\partial r}{\partial K} \cdot k} \cdot (k^* - k) \tag{A.149}$$

When economies of scale are small $\beta \approx 1$, and taking into consideration that $k = \overline{k} + p$, the membership fee would be: $p^* = p + (\overline{k} - k^*)$

$$p^* = p + (\overline{k} - k^*) \tag{A.150}$$

When economies of scale are large $\beta \approx 0$, and the membership fee turns:

$$p^* = (k^* - k) \cdot \frac{\frac{\partial r}{\partial K} \cdot k}{\hat{r} - \frac{\partial r}{\partial K} \cdot k} \tag{A.151}$$

Using a Cobb-Douglas production function with no differentiation between public and private capital $F = K^\alpha L^{1-\alpha} = \left(\bar{K} + P\right)^\alpha L^{1-\alpha}$, and defining the endogenous equilibrium interest rate as r the membership fee results:

$$p^* = p\frac{\beta\hat{r}L^{1-\beta}}{\hat{r}L^{1-\beta} + (1-\alpha)r} + \frac{(1-\alpha)r}{\hat{r}L^{1-\beta} + (1-\alpha)r} \cdot (k - k^*) \tag{A.152}$$

If economies of scale are large and the population L large enough, $L^{1-\beta} \gg (1-\alpha)r$ and the membership fee would be:

$$p^* \approx \beta p + \frac{r}{\hat{r}} \cdot \frac{(1-\alpha)}{L^{1-\beta}} \cdot (k - k^*) \approx \beta p + \frac{r}{\hat{r}} \cdot \frac{(1-\alpha)}{L^{1-\beta}} \cdot \left(\overline{k} - k^*\right) \tag{A.153}$$

A.23.3.3. Allocative efficiency effects: infinite periods, no complementarity, exogenous discount rate

Denoting $\hat{r}$ as the exogenously given return on capital, equation (5.12) turns:

$$I = \frac{w}{\hat{r}} + \overline{k} + \frac{P}{L^\beta} \tag{A.154}$$

The optimization problem is equivalent to that of the one period:

$$\frac{\partial I}{\partial L} = \frac{1}{\hat{r}}\frac{\partial}{\partial L}\left(w + \hat{r}\overline{k} + \hat{r}\frac{P}{L^\beta}\right) = 0$$

And hence so is the membership fee:

$$p^* \approx \beta p + \frac{(1-\alpha)r}{\hat{r}L^{1-\beta}} \cdot \left(\overline{k} - k^*\right) \tag{A.155}$$

A.23.3.4. Allocative efficiency effects: one period, complementarity, exogenous discount rate

Assuming the return on private capital to be exogenously given and denote by $\hat{r}$, whilst the return on public capital r_P remains endogenously determined, equation (5.20) turns:

$$I = w + \hat{r}\overline{k} + r_P\frac{P}{L^\beta} \tag{A.156}$$

Assuming $\overline{k}$ and $\hat{r}$ remain constant:

$$\frac{\partial I}{\partial L} = \frac{\partial w}{\partial L} + \frac{\partial r_P}{\partial L}\frac{P}{L^\beta} + r_P\left(\frac{\frac{\partial P}{\partial L}L^\beta - \beta P L^{\beta-1}}{L^{2\beta}}\right) = 0$$

As w and r are functions of L, K and P:

$$\begin{aligned}\frac{\partial w}{\partial L} &= \frac{\partial w}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial w}{\partial P}\frac{\partial P}{\partial L} + \frac{\partial w}{\partial L}\\ \frac{\partial r_P}{\partial L} &= \frac{\partial r_P}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial r_P}{\partial P}\frac{\partial P}{\partial L} + \frac{\partial r_P}{\partial L}\end{aligned}$$

And as private and public capital are assumed to be different complementary factors: the change in capital K and P for an increase in L can be expressed as:

$$\begin{aligned}\frac{\partial K}{\partial L} &= k^*\\ \frac{\partial P}{\partial L} &= p^*\end{aligned}$$

where p^* and k^* are the public and private capital brought by the new member.

The previous equations can be re-written as follows:

$$\begin{aligned}\frac{\partial w}{\partial L} &= \frac{\partial w}{\partial K}k^* + \frac{\partial w}{\partial P}p^* + \frac{\partial w}{\partial L}\\ \frac{\partial r_P}{\partial L} &= \frac{\partial r_P}{\partial K}k^* + \frac{\partial r_P}{\partial P}p^* + \frac{\partial r_P}{\partial L}\end{aligned}$$

And the change in income for an increase in L turns:

$$\begin{aligned}
\frac{\partial I}{\partial L} &= \frac{\partial w}{\partial K}k^* + \frac{\partial w}{\partial P}p^* + \frac{\partial w}{\partial L} + \left(\frac{\partial r_P}{\partial K}k^* + \frac{\partial r_P}{\partial P}p^* + \frac{\partial r_P}{\partial L}\right)\frac{P}{L^\beta} + r_P\left(\frac{p^* L - \beta P}{L^{\beta+1}}\right) = \\
&= p^*\left(\frac{\partial w}{\partial P} + \frac{\partial r_P}{\partial P}\cdot\frac{P}{L^\beta} + \frac{r_P}{L^\beta}\right) + \\
&+ k^*\left(\frac{\partial w}{\partial K} + \frac{\partial r_P}{\partial K}\cdot\frac{P}{L^\beta}\right) + \\
&+ \frac{\partial w}{\partial L} + \frac{\partial r_P}{\partial L}\cdot\frac{P}{L^\beta} - \frac{\beta r_P P}{L^{\beta+1}}
\end{aligned}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.9 for the mathematical proof):

$$\begin{aligned}
\frac{\partial w}{\partial K} &= -\frac{\partial r_K}{\partial K}\cdot\frac{K}{L} - \frac{\partial r_P}{\partial K}\cdot\frac{P}{L} \\
\frac{\partial w}{\partial P} &= -\frac{\partial r_K}{\partial P}\cdot\frac{K}{L} - \frac{\partial r_P}{\partial P}\cdot\frac{P}{L} \\
\frac{\partial w}{\partial L} &= -\frac{\partial r_K}{\partial L}\cdot\frac{K}{L} - \frac{\partial r_P}{\partial L}\cdot\frac{P}{L}
\end{aligned}$$

Defining the economies of scale associated to public goods as $s = L^{1-\beta} - 1$, we can rearrange:

$$\begin{aligned}
\frac{\partial I}{\partial L} &= p^*\left(-\frac{\partial r_K}{\partial P}\cdot\frac{K}{L} + \frac{\partial r_P}{\partial P}s\cdot\frac{P}{L} + \frac{r_P}{L^\beta}\right) + \\
&+ k^*\left(-\frac{\partial r_K}{\partial K}\cdot\frac{K}{L} + \frac{\partial r_P}{\partial K}\cdot s\cdot\frac{P}{L}\right) - \frac{\partial r_K}{\partial L}\cdot\frac{K}{L} + \frac{\partial r_P}{\partial L}\cdot s\frac{P}{L} - \frac{\beta r_P P}{L^{\beta+1}}
\end{aligned}$$

And the membership fee results:

$$p^* = p\left[\frac{\frac{\beta r_P}{L^\beta} - s\frac{\partial r_P}{\partial L} - \frac{\partial r_K}{\partial L}\cdot\frac{K}{P}}{\frac{\partial r_P}{\partial P}\cdot s\cdot p + \frac{r_P}{L^\beta} - \frac{\partial r_K}{\partial P}\cdot k} - \frac{sk^*\frac{\partial r_P}{\partial K} - \frac{\partial r_K}{\partial K}\cdot\frac{K}{P}}{\frac{\partial r_P}{\partial P}\cdot s\cdot\frac{P}{L} + \frac{r_P}{L^\beta} - \frac{\partial r_K}{\partial P}\cdot\frac{K}{L}}\right]$$

Using a Cobb-Douglas production function with differentiation between public and private capital $F = K^{\alpha_K}P^{\alpha_P}L^{\alpha_L}$, the membership fee is:

$$p^* = p\left[\frac{\beta\alpha_P\frac{F}{P}L^{-\beta} - s\alpha_P\alpha_L\frac{F}{PL} - \alpha_K\alpha_L\frac{F}{KL}\cdot\frac{K}{P}}{sp\alpha_P\left(\alpha_P-1\right)\frac{F}{P^2} + \alpha_P\frac{F}{P}L^{-\beta} - \alpha_K\alpha_P\frac{F}{KP}k} - \frac{sk^*\alpha_P\alpha_K\frac{F}{PK} - \alpha_K\left(\alpha_K-1\right)\frac{F}{K^2}\cdot\frac{K}{P}}{sp\alpha_P\left(\alpha_P-1\right)\frac{F}{P^2} + \alpha_P\frac{F}{P}L^{-\beta} - \alpha_K\alpha_P\frac{F}{KP}k}\right] =$$
$$= p\left[\frac{\beta\alpha_P KL^{1-\beta} - s\alpha_P\alpha_L K - \alpha_K\alpha_L K}{s\alpha_P\left(\alpha_P-1\right)K + \alpha_P KL^{1-\beta} - \alpha_K\alpha_P K} - \frac{sk^*\alpha_P\alpha_K L - \alpha_K\left(\alpha_K-1\right)L}{s\alpha_P\left(\alpha_P-1\right)K + \alpha_P KL^{1-\beta} - \alpha_K\alpha_P K}\right] =$$
$$= p\left[\frac{\beta\alpha_P L^{1-\beta} - s\alpha_P\alpha_L - \alpha_K\alpha_L}{s\alpha_P\left(\alpha_P-1\right) + \alpha_P L^{1-\beta} - \alpha_K\alpha_P} - \frac{1}{k}\cdot\frac{sk^*\alpha_P\alpha_K - \alpha_K\left(\alpha_K-1\right)}{s\alpha_P\left(\alpha_P-1\right) + \alpha_P L^{1-\beta} - \alpha_K\alpha_P}\right]$$

If economies of scale are large and the population L large enough, $s \approx L^{1-\beta}$ and the membership fee would be:

$$p^* \approx p\left[\frac{\beta\alpha_P - \alpha_P\alpha_L}{\alpha_P\left(\alpha_P-1\right) + \alpha_P} - \frac{1}{k}\cdot\frac{k^*\alpha_P\alpha_K}{\alpha_P\left(\alpha_P-1\right) + \alpha_P}\right] = \tag{A.157}$$
$$= p\left[\frac{\beta - \alpha_L - \frac{k^*}{k}\alpha_K}{\alpha_P}\right] \tag{A.158}$$

This membership fee is equal to that of the case when the interest rate is endogenously determined; the reasson being that all the partial derivatives on r_K are unaffected by s, and hence have only a marginal impact.

A.23.3.5. Allocative efficiency effects: infinite periods, complementarity, exogenous discount rate

Denoting $\hat{r}$ as the exogenously given return on capital, equation (5.24) turns:

$$I = \frac{w}{\hat{r}} + \overline{k} + \frac{P}{L^\beta} \tag{A.159}$$

The optimization problem would be in this case given by[2]:

$$\frac{\partial I}{\partial L} = \frac{1}{\hat{r}}.\frac{\partial w}{\partial L} + \frac{\frac{\partial P}{\partial L}L^\beta - \beta PL^{\beta-1}}{L^{2\beta}} = 0$$

As w and r are functions of L, K and P:

[2] This looks similar to that of the one period for the case when there are no complementarities between private and public capital, however, it is explicitely calculated to prove it

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial w}{\partial P}\frac{\partial P}{\partial L} + \frac{\partial w}{\partial L}$$

And as private and public capital are assumed to be different complementary factors: the change in capital K and P for an increase in L can be expressed as:

$$\frac{\partial K}{\partial L} = k^*$$
$$\frac{\partial P}{\partial L} = p^*$$

where p^* and k^* are the public and private capital brought by the new member.

The previous equations can be re-written as follows:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}k^* + \frac{\partial w}{\partial P}p^* + \frac{\partial w}{\partial L}$$

And the change in income for an increase in L turns:

$$\begin{aligned}\frac{\partial I}{\partial L} &= \frac{1}{\hat{r}}\cdot\left[\frac{\partial w}{\partial K}k^* + \frac{\partial w}{\partial P}p^* + \frac{\partial w}{\partial L}\right] + \left(\frac{p^*L - \beta P}{L^{\beta+1}}\right) = \\ &= p^*\left[\frac{1}{\hat{r}}\cdot\frac{\partial w}{\partial P} + \frac{1}{L^\beta}\right] + k^*\left[\frac{1}{\hat{r}}\cdot\frac{\partial w}{\partial K}\right] + \frac{1}{\hat{r}}\cdot\frac{\partial w}{\partial L} - \beta\frac{P}{L^{\beta+1}}\end{aligned}$$

The membership fee in terms of public capital contribution can be expressed as:

$$p^* = \frac{\beta\frac{\hat{r}P}{L^{\beta+1}} - \frac{\partial w}{\partial L}}{\frac{\partial w}{\partial P} + \frac{\hat{r}}{L^\beta}} - k^*\cdot\frac{\frac{\partial w}{\partial K}}{\frac{\partial w}{\partial P} + \frac{\hat{r}}{L^\beta}} \tag{A.160}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.8 for the mathematical proof):

$$\frac{\partial w}{\partial K}=-\frac{\partial r_K}{\partial K}\cdot\frac{K}{L}-\frac{\partial r_P}{\partial K}\cdot\frac{P}{L}$$
$$\frac{\partial w}{\partial P}=-\frac{\partial r_K}{\partial P}\cdot\frac{K}{L}-\frac{\partial r_P}{\partial P}\cdot\frac{P}{L}$$
$$\frac{\partial w}{\partial L}=-\frac{\partial r_K}{\partial L}\cdot\frac{K}{L}-\frac{\partial r_P}{\partial L}\cdot\frac{P}{L}$$

And the membership fee can be simplified as follows

$$p^*=\frac{\beta\frac{\hat{r}P}{L^{\beta+1}}+\frac{\partial r_K}{\partial L}\cdot k+\frac{\partial r_P}{\partial L}\cdot p}{\frac{\hat{r}}{L^\beta}-\frac{\partial r_K}{\partial P}\cdot k-\frac{\partial r_P}{\partial P}\cdot p}+ \tag{A.161}$$
$$+k^*\cdot\frac{\frac{\partial r_K}{\partial K}\cdot k+\frac{\partial r_P}{\partial K}\cdot p}{\frac{\hat{r}}{L^\beta}-\frac{\partial r_K}{\partial P}\cdot k-\frac{\partial r_P}{\partial P}\cdot p} \tag{A.162}$$

Using a Cobb-Douglas production function with differentiation between public and private capital $F=K^{\alpha_K}P^{\alpha_P}L^{\alpha_L}$, the membership fee results:

$$r_P=\frac{\partial F}{\partial P}=\alpha_P\frac{F}{P}$$
$$r_K=\frac{\partial F}{\partial K}=\alpha_K\frac{F}{K}$$
$$\frac{\partial r_P}{\partial L}=\alpha_P\alpha_L\frac{F}{PL}=\frac{r_P\alpha_L}{L}$$
$$\frac{\partial r_P}{\partial K}=\alpha_P\alpha_K\frac{F}{PK}=\frac{r_P\alpha_K}{K}=\frac{\partial r_K}{\partial P}=\frac{r_K\alpha_P}{P}$$
$$\frac{\partial r_P}{\partial P}=\alpha_P\left(\alpha_P-1\right)\frac{F}{P^2}=\frac{r_P\left(\alpha_P-1\right)}{P}$$
$$\frac{\partial r_K}{\partial L}=\alpha_K\alpha_L\frac{F}{KL}=\frac{r_K\alpha_L}{L}$$
$$\frac{\partial r_K}{\partial K}=\alpha_K\left(\alpha_K-1\right)\frac{F}{K^2}=\frac{r_K\left(\alpha_K-1\right)}{K}$$
$$\frac{\partial r_K}{\partial P}=\alpha_K\alpha_P\frac{F}{KP}=\frac{r_K\alpha_P}{P}=\frac{\partial r_P}{\partial K}=\frac{r_P\alpha_K}{K}$$

$$p^* = \frac{\beta \frac{\hat{r} P}{L^{\beta+1}} + \frac{\partial r_K}{\partial L} \cdot k + \frac{\partial r_P}{\partial L} \cdot p}{\frac{\hat{r}}{L^\beta} - \frac{\partial r_K}{\partial P} \cdot k - \frac{\partial r_P}{\partial P} \cdot p} + \tag{A.163}$$

$$+ k^* \cdot \frac{\frac{\partial r_K}{\partial K} \cdot k + \frac{\partial r_P}{\partial K} \cdot p}{\frac{\hat{r}}{L^\beta} - \frac{\partial r_K}{\partial P} \cdot k - \frac{\partial r_P}{\partial P} \cdot p} = \tag{A.164}$$

$$= \frac{\beta \frac{\hat{r} P}{L^{\beta+1}} + \frac{r_K \alpha_L}{L} \cdot k + \frac{r_P \alpha_L}{L} \cdot p}{\frac{\hat{r}}{L^\beta} - \frac{r_K \alpha_P}{P} \cdot k - \frac{r_P (\alpha_P - 1)}{P} \cdot p} + \tag{A.165}$$

$$+ k^* \cdot \frac{\frac{r_K (\alpha_K - 1)}{K} \cdot k + \frac{r_K \alpha_P}{P} \cdot p}{\frac{\hat{r}}{L^\beta} - \frac{r_K \alpha_P}{P} \cdot k - \frac{r_P (\alpha_P - 1)}{P} \cdot p} = \tag{A.166}$$

$$= \frac{\beta p \hat{r} L^{1-\beta} + r_K \alpha_L \cdot k + r_P \alpha_L \cdot p}{\hat{r} L^{1-\beta} - r_K \alpha_P \cdot \frac{k}{p} - r_P \left(\alpha_P - 1\right)} + \tag{A.167}$$

$$+ k^* \cdot \frac{r_K \left(\alpha_K - 1\right) + r_K \alpha_P}{\hat{r} L^{1-\beta} - r_K \alpha_P \cdot \frac{k}{p} - r_P \left(\alpha_P - 1\right)} \tag{A.168}$$

$$= \frac{\beta p \hat{r} L^{1-\beta} + r_P \alpha_L \cdot p}{\hat{r} L^{1-\beta} - r_K \alpha_P \cdot \frac{k}{p} - r_P \left(\alpha_P - 1\right)} + \tag{A.169}$$

$$+ \frac{r_K \alpha_L \cdot k - r_K \alpha_L k^*}{\hat{r} L^{1-\beta} - r_K \alpha_P \cdot \frac{k}{p} - r_P \left(\alpha_P - 1\right)} \tag{A.170}$$

If economies of scale are large and the population L large enough, and the differences in private capital endowments are significant, the membership fee can be approximated as:

$$p^* \approx p \left(\beta + \frac{r_P}{\hat{r}} \cdot \frac{\alpha_L}{L^{1-\beta}} \right) - \frac{r_K}{\hat{r}} \cdot \frac{\alpha_L \left(k - k^*\right)}{L^{1-\beta}} \approx \tag{A.171}$$

$$\approx \beta p + \frac{r_K}{\hat{r}} \cdot \frac{\alpha_L \left(k - k^*\right)}{L^{1-\beta}} \tag{A.172}$$

A.24. Partial derivatives for CES production function with complementarity between public and private capital

If the production function has CES it can be expressed as:

$$F(K,P,L) = (\alpha_K K^r + \alpha_P P^r + (1-\alpha_K-\alpha_P)L^r)^{\frac{1}{r}} \tag{A.173}$$

And the the per capita equivalent will be:

$$f(k,p) = \frac{F(K,P,L)}{L} = (\alpha_K k^r + \alpha_P p^r + (1-\alpha_K-\alpha_P))^{\frac{1}{r}} \tag{A.174}$$

The partial derivatives will be:

$$\begin{aligned}
f_k &= \frac{\partial f}{\partial k} = \alpha_K k^{r-1} (\alpha_K k^r + \alpha_P p^r + (1-\alpha_K-\alpha_P))^{\frac{1-r}{r}} \\
f_p &= \frac{\partial f}{\partial p} = \alpha_P p^{r-1} (\alpha_K k^r + \alpha_P p^r + (1-\alpha_K-\alpha_P))^{\frac{1-r}{r}} \\
f_{kk} &= \frac{\partial^2 f}{\partial k^2} = (r-1)\,\alpha_K k^{r-2} (\alpha_K k^r + \alpha_P p^r + (1-\alpha_K-\alpha_P))^{\frac{1-r}{r}} + \\
&\quad + (1-r)\,\alpha_K^2 k^{2r-2} (\alpha_K k^r + \alpha_P p^r + (1-\alpha_K-\alpha_P))^{\frac{1-2r}{r}} \\
f_{pp} &= \frac{\partial^2 f}{\partial p^2} = (r-1)\,\alpha_P p^{r-2} (\alpha_K k^r + \alpha_P p^r + (1-\alpha_K-\alpha_P))^{\frac{1-r}{r}} - \\
&\quad - (1-r)\,\alpha_P^2 p^{2r-2} (\alpha_K k^r + \alpha_P p^r + (1-\alpha_K-\alpha_P))^{\frac{1-2r}{r}} \\
f_{kp} &= \frac{\partial^2 f}{\partial k \partial p} = (1-r)\,\alpha_K \alpha_P k^{r-1} p^{r-1} (\alpha_K k^r + \alpha_P p^r + (1-\alpha_K-\alpha_P))^{\frac{1-2r}{r}}
\end{aligned}$$

And it will hold that:

$$f_p \cdot f_k - f \cdot f_{kp} = r\alpha_K \alpha_P k^{r-1} p^{r-1} \left(\alpha_K k^r + \alpha_P p^r + (1 - \alpha_K - \alpha_P)\right)^{\frac{2-2r}{r}} \tag{A.175}$$

$$f_p^2 - f \cdot f_{pp} = (1-r)\alpha_P p^{r-2} \left(\alpha_K k^r + \alpha_P p^r + (1 - \alpha_K - \alpha_P)\right)^{\frac{2-r}{r}} + \tag{A.176}$$

$$+ r\alpha_P^2 p^{2r-2} \left(\alpha_K k^r + \alpha_P p^r + (1 - \alpha_K - \alpha_P)\right)^{\frac{2-2r}{r}} \tag{A.177}$$

$$f_k^2 - f \cdot f_{kk} = (1-r)\alpha_K k^{r-2} \left(\alpha_K k^r + \alpha_P p^r + (1 - \alpha_K - \alpha_P)\right)^{\frac{2-r}{r}} + \tag{A.178}$$

$$+ r\alpha_K^2 k^{2r-2} \left(\alpha_K k^r + \alpha_P p^r + (1 - \alpha_K - \alpha_P)\right)^{\frac{2-2r}{r}} \tag{A.179}$$

$$f \cdot f_p = \alpha_P p^{r-1} \left(\alpha_K k^r + \alpha_P p^r + (1 - \alpha_K - \alpha_P)\right)^{\frac{2-r}{r}} \tag{A.180}$$

$$f \cdot f_k = \alpha_K k^{r-1} \left(\alpha_K k^r + \alpha_P p^r + (1 - \alpha_K - \alpha_P)\right)^{\frac{2-r}{r}} \tag{A.181}$$

A.25. Partial derivatives for CES production function with non-complementarity between public and private capital

If the production function has CES it can be expressed as:

$$F(K,P,L) = (\alpha\,(K+P)^r + (1-\alpha)L^r)^{\frac{1}{r}} \tag{A.182}$$

And the the per capita equivalent will be:

$$f(k,p) = \frac{F(K,P,L)}{L} = (\alpha\,(k+p)^r + (1-\alpha))^{\frac{1}{r}} \tag{A.183}$$

The partial derivatives will be:

$$\begin{aligned}
f_k = f_p &= \alpha\,(k+p)^{r-1}\,(\alpha\,(k+p)^r + (1-\alpha))^{\frac{1-r}{r}} \\
f_{kk} = f_{pp} = f_{kp} &= (r-1)\,\alpha\,(k+p)^{r-2}\,(\alpha\,(k+p)^r + (1-\alpha))^{\frac{1-r}{r}} + \\
&+ (1-r)\,\alpha^2\,(k+p)^{2r-2}\,(\alpha\,(k+p)^r + (1-\alpha))^{\frac{1-2r}{r}}
\end{aligned}$$

And it will hold that:

$$f_p \cdot f_k - f \cdot f_{kp} = (1-r)\alpha\,(k+p)^{r-2}\,(\alpha\,(k+p)^r + (1-\alpha))^{\frac{2-r}{r}} + \tag{A.184}$$

$$+ r\alpha^2\,(k+p)^{2r-2}\,(\alpha\,(k+p)^r + (1-\alpha))^{\frac{2-2r}{r}} \tag{A.185}$$

$$f_p^2 - f \cdot f_{pp} = (1-r)\alpha\,(k+p)^{r-2}\,(\alpha\,(k+p)^r + (1-\alpha))^{\frac{2-r}{r}} + \tag{A.186}$$

$$+ r\alpha^2\,(k+p)^{2r-2}\,(\alpha\,(k+p)^r + (1-\alpha))^{\frac{2-2r}{r}} \tag{A.187}$$

$$f \cdot f_p = f \cdot f_k = \alpha\,(k+p)^{r-1}\,(\alpha\,(k+p)^r + (1-\alpha))^{\frac{2-r}{r}} \tag{A.188}$$

A.26. Partial derivatives for CES production function with labor productivity

If the production function has CES it can be expressed as:

$$F(K, AL) = [\alpha K^r + (1-\alpha)(AL)^r]^{\frac{1}{r}} \tag{A.189}$$

And the the per capita equivalent will be:

$$f(k) = \frac{F(K, P, L)}{AL} = (\alpha k^r + (1-\alpha))^{\frac{1}{r}} \tag{A.190}$$

The partial derivatives will be:

$$\begin{aligned}
f_k &= \frac{\partial f}{\partial k} = \alpha k^{r-1} (\alpha k^r + (1-\alpha))^{\frac{1-r}{r}} \\
f_{kk} &= \frac{\partial^2 f}{\partial k^2} = (r-1)\,\alpha k^{r-2} (\alpha k^r + (1-\alpha))^{\frac{1-r}{r}} + \\
&+ (1-r)\,\alpha^2 k^{2r-2} (\alpha k^r + (1-\alpha))^{\frac{1-2r}{r}}
\end{aligned}$$

And it will hold that:

$$\begin{aligned}
f \cdot f_{kk} k &= (r-1)\,\alpha k^{r-1} (\alpha k^r + (1-\alpha))^{\frac{2-r}{r}} + && \text{(A.191)} \\
&+ (1-r)\,\alpha^2 k^{2r-1} (\alpha k^r + (1-\alpha))^{\frac{2-2r}{r}} && \text{(A.192)} \\
f_k (f - f_k k) &= \alpha k^{r-1} (\alpha k^r + (1-\alpha))^{\frac{2-r}{r}} - && \text{(A.193)} \\
&- \alpha^2 k^{2r-1} (\alpha k^r + (1-\alpha))^{\frac{2-2r}{r}} && \text{(A.194)}
\end{aligned}$$

And:

$$\begin{aligned}
-f \cdot f_{kk} k &= -f_k (f - f_k k) - r\alpha k^{r-1} (\alpha k^r + (1-\alpha))^{\frac{2-r}{r}} + && \text{(A.195)} \\
&+ r\alpha^2 k^{2r-1} (\alpha k^r + (1-\alpha))^{\frac{2-2r}{r}} = && \text{(A.196)} \\
&= r\alpha k^{r-1} (\alpha k^r + (1-\alpha))^{\frac{2-r}{r}} \left[\alpha k^r (\alpha k^r + (1-\alpha))^{-1} - 1\right] && \text{(A.197)}
\end{aligned}$$

A.27. Linear models on β

A.27.1. Non-complementarity of private and public capital

A.27.1.1. One period membership

Assuming the economy is in equilibrium prior to the entry of new members, and restricting economies of scale exclusively to public capital, the income of an existing member can be described in the following way:

$$I = w + r\overline{k} + r\frac{P}{\beta L} \tag{A.198}$$

Where $\overline{k}$ is the private capital per capita of the existing population. Assuming private and public capital are effectively two components of the same factor of production (i.e., there is non-complementarity between them), $\overline{k}$ can be expressed as follows:

$$\overline{k} = \frac{K - P}{L} = k - p \tag{A.199}$$

The minimum membership fee can be derived as a result of an optimization problem where the income equation is invariant to changes in the number of members, assuming the amount of private capital of the incumbent population $\overline{k}$ remains constant (i.e., the private capital of the incumbent population does not change with the addition of new members):

$$\frac{\partial I}{\partial L} = \frac{\partial w}{\partial L} + \frac{\partial r}{\partial L}\left(\overline{k} + \frac{P}{\beta L}\right) + \frac{r}{\beta}\left(\frac{\frac{\partial P}{\partial L}L - P}{L^2}\right) = 0$$

As w and r are functions of L and K, the change in wages and return on capital caused by a new entrant can be expressed as:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial w}{\partial L}$$
$$\frac{\partial r}{\partial L} = \frac{\partial r}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial r}{\partial L}$$

As the new entrant can now bring private capital in different proportions, the change in capital K for an increase in L can be expressed as:

$$\frac{\partial K}{\partial L} = p^* + k^*$$

where p^* and k^* are the public and private capital brought by the new member.

The previous equations can be re-written as follows:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}(p^* + k^*) + \frac{\partial w}{\partial L}$$
$$\frac{\partial r}{\partial L} = \frac{\partial r}{\partial K}(p^* + k^*) + \frac{\partial r}{\partial L}$$

And the change in income for an increase in L turns:

$$\begin{aligned}\frac{\partial I}{\partial L} &= p^*\left[\frac{\partial w}{\partial K} + \frac{\partial r}{\partial K}\left(\overline{k} + \frac{P}{\beta L}\right) + \frac{r}{\beta L}\right] + \\ &+ k^*\left[\frac{\partial w}{\partial K} + \frac{\partial r}{\partial K}\left(\overline{k} + \frac{P}{\beta L}\right)\right] + \\ &+ \frac{\partial w}{\partial L} + \frac{\partial r}{\partial L}\left(\overline{k} + \frac{P}{\beta L}\right) - \frac{rP}{\beta L^2}\end{aligned}$$

The membership fee in terms of public capital contribution can be then expressed as:

$$p^* = \frac{\frac{rP}{\beta L^2} - \frac{\partial w}{\partial L} - \frac{\partial r}{\partial L}\left(\overline{k} + \frac{P}{\beta L}\right)}{\frac{\partial w}{\partial K} + \frac{\partial r}{\partial K}\left(\overline{k} + \frac{P}{\beta L}\right) + \frac{r}{\beta L}} - k^* \cdot \frac{\frac{\partial w}{\partial K} + \frac{\partial r}{\partial K}\left(\overline{k} + \frac{P}{\beta L}\right)}{\frac{\partial w}{\partial K} + \frac{\partial r}{\partial K}\left(\overline{k} + \frac{P}{\beta L}\right) + \frac{r}{\beta L}} \tag{A.200}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.8 for the mathematical proof):

$$\frac{\partial w}{\partial K} = -\frac{\partial r}{\partial K} \cdot \frac{K}{L} = -\frac{\partial r}{\partial K} \cdot k$$
$$\frac{\partial w}{\partial L} = -\frac{\partial r}{\partial L} \cdot \frac{K}{L} = -\frac{\partial r}{\partial L} \cdot k$$

And taking into consideration that $k = \overline{k} + p$ the membership fee can be simplified as follows

$$p^* = \frac{\frac{rP}{\beta L^2} + \frac{\partial r}{\partial L} \cdot k - \frac{\partial r}{\partial L}\left(\overline{k} + \frac{P}{\beta L}\right)}{-\frac{\partial r}{\partial K} \cdot k + \frac{\partial r}{\partial K}\left(\overline{k} + \frac{P}{\beta L}\right) + \frac{r}{\beta L}} - k^* \cdot \frac{-\frac{\partial r}{\partial K} \cdot k + \frac{\partial r}{\partial K}\left(\overline{k} + \frac{P}{\beta L}\right)}{-\frac{\partial r}{\partial K} \cdot k + \frac{\partial r}{\partial K}\left(\overline{k} + \frac{P}{\beta L}\right) + \frac{r}{\beta L}} = \tag{A.201}$$

$$= \frac{\frac{rP}{\beta L^2} - \frac{\partial r}{\partial L} \cdot p\left(\frac{1}{\beta} - 1\right)}{\frac{\partial r}{\partial K} \cdot p\left(\frac{1}{\beta} - 1\right) + \frac{r}{\beta L}} - k^* \cdot \frac{\frac{\partial r}{\partial K} \cdot p\left(\frac{1}{\beta} - 1\right)}{\frac{\partial r}{\partial K} \cdot p\left(\frac{1}{\beta} - 1\right) + \frac{r}{\beta L}} \tag{A.202}$$

or alternatively:

$$p^* = p\left[\frac{\frac{r}{L} - \frac{\partial r}{\partial L} \cdot (1-\beta) - k^* \frac{\partial r}{\partial K}(1-\beta)}{\frac{\partial r}{\partial K} \cdot p(1-\beta) + \frac{r}{L}}\right] \tag{A.203}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.8):

$$\frac{\partial r}{\partial L} = \frac{\partial w}{\partial K} = -\frac{\partial r}{\partial K} \cdot \frac{K}{L}$$

The membership fee then turns:

$$p^* = p\left[\frac{\frac{r}{L} + \frac{\partial r}{\partial K}(1-\beta)(k - k^*)}{\frac{\partial r}{\partial K} \cdot p(1-\beta) + \frac{r}{L}}\right] \tag{A.204}$$

Hence, assuming diminishing marginal returns on capital, if the new entrant is less endowed than the incumbent population ($k^* \leq \overline{k}$), the second term in the denominator will be negative helping to reduce the membership fee, and vice-versa which produces a result very similar to that of equation (5.7) in Chapter 5.

The Cobb-Douglas specification produces the following membership fee (see Appendix sec. A.14):

$$p^* = p\left[\frac{1 + (1-\alpha)(1-\beta)\left(\frac{k^*}{\overline{k}+p} - 1\right)}{1 - (1-\alpha)(1-\beta)\frac{p}{k}}\right] \tag{A.205}$$

A.27.1.2. Infinite periods

Assuming the economy is in equilibrium prior to the entry of new members, and restricting economies of scale exclusively to public capital, the capitalized income per capita of a representative individual can be expressed as follows:

$$I = \frac{w}{r} + \overline{k} + \frac{P}{\beta L} \tag{A.206}$$

As in the previous section, the minimum membership fee can be derived from an optimization problem where the income equation is invariant to changes in the number of members, assuming the amount of private capital of the incumbent population $\overline{k}$ remains constant (i.e., the private capital of the incumbent population does not change with the addition of new members):

$$\frac{\partial I}{\partial L} = \frac{1}{r} \cdot \frac{\partial w}{\partial L} - \frac{w}{r^2} \cdot \frac{\partial r}{\partial L} + \frac{1}{\beta} \frac{\frac{\partial P}{\partial L} L - P}{L^2} = 0$$

As w and r are functions of L and K:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K} \frac{\partial K}{\partial L} + \frac{\partial w}{\partial L}$$
$$\frac{\partial r}{\partial L} = \frac{\partial r}{\partial K} \frac{\partial K}{\partial L} + \frac{\partial r}{\partial L}$$

And as the new entrant can now bring private capital in different proportions, the change in capital K for an increase in L can be expressed as:

$$\frac{\partial K}{\partial L} = p^* + k^*$$

where p^* and k^* are the public and private capital brought by the new member.

The previous equations can be re-written as follows:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}(p^* + k^*) + \frac{\partial w}{\partial L}$$
$$\frac{\partial r}{\partial L} = \frac{\partial r}{\partial K}(p^* + k^*) + \frac{\partial r}{\partial L}$$

And the change in income for an increase in L turns:

$$\begin{aligned}\frac{\partial I}{\partial L} &= p^* \left[\frac{1}{r} \cdot \frac{\partial w}{\partial K} - \frac{w}{r^2} \cdot \frac{\partial r}{\partial K} + \frac{1}{\beta L}\right] + \\ &+ k^* \left[\frac{1}{r} \cdot \frac{\partial w}{\partial K} - \frac{w}{r^2} \cdot \frac{\partial r}{\partial K}\right] + \\ &+ \frac{1}{r} \cdot \frac{\partial w}{\partial L} - \frac{w}{r^2} \cdot \frac{\partial r}{\partial L} - \frac{P}{\beta L^2}\end{aligned}$$

The membership fee in terms of public capital contribution can be expressed as:

$$p^* = \frac{w \cdot \frac{\partial r}{\partial L} + r^2 \frac{P}{\beta L^2} - r \cdot \frac{\partial w}{\partial L}}{r \frac{\partial w}{\partial K} - w \frac{\partial r}{\partial K} + \frac{r^2}{\beta L}} - k^* \cdot \frac{r \cdot \frac{\partial w}{\partial K} - w \frac{\partial r}{\partial K}}{r \frac{\partial w}{\partial K} - w \frac{\partial r}{\partial K} + \frac{r^2}{\beta L}} \tag{A.207}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.8 for the mathematical proof):

$$\frac{\partial w}{\partial K} = -\frac{\partial r}{\partial K} \cdot \frac{K}{L}$$
$$\frac{\partial w}{\partial L} = -\frac{\partial r}{\partial L} \cdot \frac{K}{L}$$

And the membership fee can be simplified as follows

$$p^* = \frac{\frac{\partial r}{\partial L}\left(w + r \cdot \frac{K}{L}\right) + r^2 \frac{P}{\beta L^2}}{\frac{r^2}{\beta L} - \frac{\partial r}{\partial K}\left(r \cdot \frac{K}{L} + w\right)} + k^* \cdot \frac{\frac{\partial r}{\partial K}\left(r \cdot \frac{K}{L} + w\right)}{\frac{r^2}{\beta L} - \frac{\partial r}{\partial K}\left(r \cdot \frac{K}{L} + w\right)} \tag{A.208}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.8):

$$\frac{\partial r}{\partial L} = \frac{\partial w}{\partial K} = -\frac{\partial r}{\partial K} \cdot \frac{K}{L}$$

The membership fee can be then expressed as:

$$p^* = \frac{r^2 \frac{P}{\beta L^2} + \frac{\partial r}{\partial K}\left(r \cdot \frac{K}{L} + w\right)(k^* - k)}{\frac{r^2}{\beta L} - \frac{\partial r}{\partial K}\left(r \cdot \frac{K}{L} + w\right)} \tag{A.209}$$

Assuming decreasing returns to scale, the second member of equation will be always negative as $\frac{\partial r}{\partial K} \leq 0$. Therefore, the membership fee will be reduced the larger the amount of private capital k^* brought by the new member.

Defining a Cobb-Douglas production function with no differentiation between public and private capital $F = K^\alpha L^{1-\alpha} = \left(\bar{K} + P\right)^\alpha L^{1-\alpha}$, the membership fee results (see Appendix sec. A.18 for a detailed calculation):

$$p^* = p + \frac{\beta(1-\alpha)\left(\bar{k} - k^*\right)}{\alpha + \beta(1-\alpha)} \tag{A.210}$$

If economies of scale are small $\beta \approx 1$, and the membership fee would be:

$$p^* \approx p + (1-\alpha)\left(\bar{k} - k^*\right) \tag{A.211}$$

However, if economies of scale are large $\beta \approx 0$, the membership fee would be:

$$p^* \approx p \tag{A.212}$$

It is worth noting that the membership fee is dependent on β but independent on L. The explanation for it is that by defining income like in (A.206) the parameter β acts like a scalar of the public capital per capita p. Hence, its effect is to alter the relative magnitude of income effects deriving from private and public capital, but shows no scalability to population size.

A.27.2. Complementarity of private and public capital

A.27.2.1. One period membership

Assuming the economy is in equilibrium prior to the entry of new members, and restricting economies of scale exclusively to public capital, the income of an existing member can be described as:

$$I = w + r_K \overline{k} + r_P \frac{P}{\beta L} \tag{A.213}$$

Where $\overline{k} = \frac{K}{L}$ is the private capital per capita of the existing population.

As in the previous sections, the minimum membership fee can be derived from an optimization problem where the income equation is invariant to changes in the number of members, assuming the amount of private capital of the incumbent population $\overline{k}$ remains constant (i.e., the private capital of the incumbent population does not change with the addition of new members):

$$\frac{\partial I}{\partial L} = \frac{\partial w}{\partial L} + \frac{\partial r_K}{\partial L}\overline{k} + \frac{\partial r_P}{\partial L}\frac{P}{\beta L} + \frac{r_P}{\beta}\left(\frac{\frac{\partial P}{\partial L}L - P}{L^2}\right) = 0$$

As w and r are functions of L, K and P:

$$\begin{aligned}
\frac{\partial w}{\partial L} &= \frac{\partial w}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial w}{\partial P}\frac{\partial P}{\partial L} + \frac{\partial w}{\partial L} \\
\frac{\partial r_K}{\partial L} &= \frac{\partial r_K}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial r_K}{\partial P}\frac{\partial P}{\partial L} + \frac{\partial r_K}{\partial L} \\
\frac{\partial r_P}{\partial L} &= \frac{\partial r_P}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial r_{KP}}{\partial P}\frac{\partial P}{\partial L} + \frac{\partial r_P}{\partial L}
\end{aligned}$$

And as private and public capital are assumed to be different complementary factors: the change in capital K and P for an increase in L can be expressed as:

$$\begin{aligned}
\frac{\partial K}{\partial L} &= k^* \\
\frac{\partial P}{\partial L} &= p^*
\end{aligned}$$

where p^* and k^* are the public and private capital brought by the new member.

The previous equations can be re-written as follows:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}k^* + \frac{\partial w}{\partial P}p^* + \frac{\partial w}{\partial L}$$
$$\frac{\partial r_K}{\partial L} = \frac{\partial r_K}{\partial K}k^* + \frac{\partial r_K}{\partial P}p^* + \frac{\partial r_K}{\partial L}$$
$$\frac{\partial r_P}{\partial L} = \frac{\partial r_P}{\partial K}k^* + \frac{\partial r_P}{\partial P}p^* + \frac{\partial r_P}{\partial L}$$

And the change in income for an increase in L turns:

$$\begin{aligned}
\frac{\partial I}{\partial L} &= \frac{\partial w}{\partial K}k^* + \frac{\partial w}{\partial P}p^* + \frac{\partial w}{\partial L} + \left(\frac{\partial r_K}{\partial K}k^* + \frac{\partial r_K}{\partial P}p^* + \frac{\partial r_K}{\partial L}\right)\overline{k} + \\
&+ \left(\frac{\partial r_P}{\partial K}k^* + \frac{\partial r_P}{\partial P}p^* + \frac{\partial r_P}{\partial L}\right)\frac{P}{\beta L} + \frac{r_P}{\beta}\left(\frac{p^* L - P}{L^2}\right) = \\
&= p^*\left(\frac{\partial w}{\partial P} + \frac{\partial r_K}{\partial P}\overline{k} + \frac{\partial r_P}{\partial P}\cdot\frac{P}{\beta L} + \frac{r_P}{\beta L}\right) + \\
&+ k^*\left(\frac{\partial w}{\partial K} + \frac{\partial r_K}{\partial K}\overline{k} + \frac{\partial r_P}{\partial K}\cdot\frac{P}{\beta L}\right) + \\
&+ \frac{\partial w}{\partial L} + \frac{\partial r_K}{\partial L}\overline{k} + \frac{\partial r_P}{\partial L}\cdot\frac{P}{\beta L} - \frac{r_P P}{\beta L^2} = 0
\end{aligned}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.9 for the mathematical proof):

$$\frac{\partial w}{\partial K} = -\frac{\partial r_K}{\partial K}\cdot\frac{K}{L} - \frac{\partial r_P}{\partial K}\cdot\frac{P}{L}$$
$$\frac{\partial w}{\partial P} = -\frac{\partial r_K}{\partial P}\cdot\frac{K}{L} - \frac{\partial r_P}{\partial P}\cdot\frac{P}{L}$$
$$\frac{\partial w}{\partial L} = -\frac{\partial r_K}{\partial L}\cdot\frac{K}{L} - \frac{\partial r_P}{\partial L}\cdot\frac{P}{L}$$

We can rearrange:

$$\frac{\partial I}{\partial L} = p^* \left(-\frac{\partial r_K}{\partial P} \cdot \frac{K}{L} - \frac{\partial r_P}{\partial P} \cdot \frac{P}{L} + \frac{\partial r_K}{\partial P} \overline{k} + \frac{\partial r_P}{\partial P} \cdot \frac{P}{\beta L} + \frac{r_P}{\beta L} \right) +$$
$$+ k^* \left(-\frac{\partial r_K}{\partial K} \cdot \frac{K}{L} - \frac{\partial r_P}{\partial K} \cdot \frac{P}{L} + \frac{\partial r_K}{\partial K} \overline{k} + \frac{\partial r_P}{\partial K} \cdot \frac{P}{\beta L} \right) -$$
$$- \frac{\partial r_K}{\partial L} \cdot \frac{K}{L} - \frac{\partial r_P}{\partial L} \cdot \frac{P}{L} + \frac{\partial r_K}{\partial L} \overline{k} + \frac{\partial r_P}{\partial L} \cdot \frac{P}{\beta L} - \frac{r_P P}{\beta L^2}$$

$$\frac{\partial I}{\partial L} = p^* \left(p \frac{\partial r_P}{\partial P} \left(\frac{1}{\beta} - 1 \right) + \frac{r_P}{\beta L} \right) +$$
$$+ k^* \left(p \frac{\partial r_P}{\partial K} \left(\frac{1}{\beta} - 1 \right) \right) +$$
$$+ p \frac{\partial r_P}{\partial L} \left(\frac{1}{\beta} - 1 \right) - \frac{r_P p}{\beta L}$$

And the membership results:

$$p^* = p \left[\frac{\frac{r_P}{L} - \frac{\partial r_P}{\partial L} (1-\beta) - k^* \left(\frac{\partial r_P}{\partial K} (1-\beta) \right)}{p \frac{\partial r_P}{\partial P} (1-\beta) + \frac{r_P}{L}} \right]$$

Using a Cobb-Douglas production function with differentiation between public and private capital $F = K^{\alpha_K} P^{\alpha_P} L^{\alpha_L}$, the membership fee results (see Appendix sec. A.15 for a detailed calculation):

$$p^* = p \left[\frac{1 - \alpha_L (1-\beta) - \frac{k^*}{\overline{k}} (\alpha_K (1-\beta))}{1 + (\alpha_P - 1)(1-\beta)} \right] \tag{A.214}$$

A.27.2.2. Infinite periods

Assuming the economy is in equilibrium prior to the entry of new members, and restricting economies of scale exclusively to public capital, the capitalized income change, assuming that returns on wages and private capital are discounted at the private capital return rate r_K , and returns on public capital are discounted at the public capital return rate r_P , can accordingly be expressed as follows:

$$I = \frac{w}{r_K} + \overline{k} + \frac{P}{\beta L} \tag{A.215}$$

As in the previous sections, the minimum membership fee can be derived from an optimization problem where the income equation is invariant to changes in the number of members, assuming the amount of private capital of the incumbent population $\overline{k}$ remains constant (i.e., the private capital of the incumbent population does not change with the addition of new members):

$$\frac{\partial I}{\partial L} = \frac{1}{r_K} . \frac{\partial w}{\partial L} - \frac{w}{r_K^2} \cdot \frac{\partial r_K}{\partial L} + \frac{1}{\beta} \cdot \frac{\frac{\partial P}{\partial L} L - P}{L^2} = 0$$

As w and r are functions of L, K and P:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial w}{\partial P}\frac{\partial P}{\partial L} + \frac{\partial w}{\partial L}$$
$$\frac{\partial r_K}{\partial L} = \frac{\partial r_K}{\partial K}\frac{\partial K}{\partial L} + \frac{\partial r_K}{\partial P}\frac{\partial P}{\partial L} + \frac{\partial r_K}{\partial L}$$

And as private and public capital are assumed to be different complementary factors: the change in capital K and P for an increase in L can be expressed as:

$$\frac{\partial K}{\partial L} = k^*$$
$$\frac{\partial P}{\partial L} = p^*$$

where p^* and k^* are the public and private capital brought by the new member.

The previous equations can be re-written as follows:

$$\frac{\partial w}{\partial L} = \frac{\partial w}{\partial K} k^* + \frac{\partial w}{\partial P} p^* + \frac{\partial w}{\partial L}$$
$$\frac{\partial r_K}{\partial L} = \frac{\partial r_K}{\partial K} k^* + \frac{\partial r_K}{\partial P} p^* + \frac{\partial r_K}{\partial L}$$
$$\frac{\partial r_P}{\partial L} = \frac{\partial r_P}{\partial K} k^* + \frac{\partial r_P}{\partial P} p^* + \frac{\partial r_P}{\partial L}$$

And the change in income for an increase in L turns:

$$\frac{\partial I}{\partial L} = \frac{1}{r_K} . \left[\frac{\partial w}{\partial K}k^* + \frac{\partial w}{\partial P}p^* + \frac{\partial w}{\partial L}\right] - \frac{w}{r_K^2} \cdot \left[\frac{\partial r_K}{\partial K}k^* + \frac{\partial r_K}{\partial P}p^* + \frac{\partial r_K}{\partial L}\right] + \frac{1}{\beta} \cdot \left(\frac{p^* L - P}{L^2}\right) =$$
$$= p^* \left[\frac{1}{r_K} . \frac{\partial w}{\partial P} - \frac{w}{r_K^2} \cdot \frac{\partial r_K}{\partial P} + \frac{1}{\beta L}\right] + k^* \left[\frac{1}{r_K} . \frac{\partial w}{\partial K} - \frac{w}{r_K^2} \cdot \frac{\partial r_K}{\partial K}\right] +$$
$$+ \frac{1}{r_K} . \frac{\partial w}{\partial L} - \frac{w}{r_K^2} \cdot \frac{\partial r_K}{\partial L} - \frac{P}{\beta L^2}$$

The membership fee in terms of public capital contribution can be expressed as:

$$p^* = \frac{w \cdot \frac{\partial r_K}{\partial L} + r_K^2 \frac{P}{\beta L^2} - r_K . \frac{\partial w}{\partial L}}{r_K . \frac{\partial w}{\partial P} - w \cdot \frac{\partial r_K}{\partial P} + \frac{r_K^2}{\beta L}} - k^* \cdot \frac{r_K . \frac{\partial w}{\partial K} - w \cdot \frac{\partial r_K}{\partial K}}{r_K . \frac{\partial w}{\partial P} - w \cdot \frac{\partial r_K}{\partial P} + \frac{r_K^2}{\beta L}} \tag{A.216}$$

Assuming that the production function is homogeneous of degree one, it always holds that (see Appendix sec. A.8 for the mathematical proof):

$$\frac{\partial w}{\partial K} = -\frac{\partial r_K}{\partial K} \cdot \frac{K}{L} - \frac{\partial r_P}{\partial K} \cdot \frac{P}{L}$$
$$\frac{\partial w}{\partial P} = -\frac{\partial r_K}{\partial P} \cdot \frac{K}{L} - \frac{\partial r_P}{\partial P} \cdot \frac{P}{L}$$
$$\frac{\partial w}{\partial L} = -\frac{\partial r_K}{\partial L} \cdot \frac{K}{L} - \frac{\partial r_P}{\partial L} \cdot \frac{P}{L}$$

And the membership fee can be simplified as follows

$$p^* = \frac{\frac{\partial r_K}{\partial L}\left(w + r_K \cdot \frac{K}{L}\right) + r_K \frac{\partial r_P}{\partial L} \cdot \frac{P}{L} + r_K^2 \frac{P}{\beta L^2}}{\frac{r_K^2}{\beta L} - \frac{\partial r_K}{\partial P}\left(w + r_K \cdot \frac{K}{L}\right) - r_K . \frac{\partial r_P}{\partial P} \cdot \frac{P}{L}} + \tag{A.217}$$
$$+ k^* \cdot \frac{\frac{\partial r_K}{\partial K}\left(w + r_K \cdot \frac{K}{L}\right) + r_K . \frac{\partial r_P}{\partial K} \cdot \frac{P}{L}}{\frac{r_K^2}{\beta L} - \frac{\partial r_K}{\partial P}\left(w + r_K \cdot \frac{K}{L}\right) - r_K . \frac{\partial r_P}{\partial P} \cdot \frac{P}{L}} \tag{A.218}$$

Using a Cobb-Douglas production function with differentiation between public and private capital $F = K^{\alpha_K} P^{\alpha_P} L^{\alpha_L}$, the membership fee results (see Appendix sec. A.20 for a detailed calculation):

$$p^* = p + \beta \left[\frac{\alpha_L \overline{k} + k^* \left[\alpha_K + \alpha_P - 1 \right]}{\alpha_K} \right] \tag{A.219}$$

If we assume constant return to scale in the production function: $\alpha_K + \alpha_P + \alpha_L = 1$, the membership fee results:

$$p^* = p + \beta \frac{\alpha_L \left(\overline{k} - k^* \right)}{\alpha_K} \tag{A.220}$$

The membership fee is dependent on β but independent on L. The intuition for it is that by defining income like in (A.215) the parameter β acts like a scalator of the public capital per capita p. Hence, its effect is to alter the magnitude of income and dilution effects, but shows no scalability to population size.

A.28. Tables

Country	Kamps ($PPP)	Rank	Expenditure ($)	Rank	%Diff.	Consumption ($)	Rank	%Diff.
Japan	31’692.8	1	19’227.0	15	-39%	17’599.8	4	-44%
United States	16’397.4	2	18’375.7	16	12%	14’545.9	13	-11%
Switzerland	16’169.4	3	25’097.0	10	55%	14’694.2	10	-9%
Austria	14’719.5	4	34’448.8	3	134%	15’570.0	8	6%
New Zealand	14’532.8	5	15’782.6	19	9%	8’761.7	18	-40%
Netherlands	14’157.8	6	34’147.4	5	141%	16’428.3	6	16%
France	12’843.1	7	29’617.9	7	131%	14’054.2	14	9%
Iceland	12’429.0	8	24’617.5	11	98%	16’437.5	5	32%
Germany	11’841.0	9	28’358.4	8	139%	15’081.1	9	27%
Denmark	11’830.0	10	33’028.4	6	179%	20’534.1	3	74%
Norway	11’540.0	11	35’025.4	2	204%	21’851.1	1	89%
Finland	10’928.6	12	35’206.8	1	222%	15’656.4	7	43%
Italy	10’557.4	13	25’851.3	9	145%	10’395.4	16	-2%
Canada	10’124.8	14	16’641.3	17	64%	14’683.8	11	45%
Sweden	9’848.9	15	34’258.6	4	248%	20’785.9	2	111%
Australia	9’416.5	16	19’330.9	14	105%	13’580.0	15	44%
Belgium	9’272.4	17	12’578.3	22	36%	14’661.8	12	58%
United Kingdom	8’627.5	18	19’839.1	13	130%	9’983.8	17	16%
Spain	8’465.1	19	15’402.9	20	82%	7’095.9	20	-16%
Ireland	8’365.8	20	19’894.9	12	138%	8’324.5	19	0%
Greece	6’674.2	21	16’622.0	18	149%	5’760.6	21	-14%
Portugal	6’582.0	22	12’596.4	21	91%	5’577.4	22	-15%
Average					112%			19%
St. Dev.					69%			39%

Table A.1.: Public capital estimates for different estimates

Country	Program type	Source	Currency	Investment	Payment	Fees	Net assets	Income	Jobs	Citizenship
Andorra	Investment	Official	EUR	450'000	-	-	-		0	0
Antigua & Barbuda	Donation	Official	USD	-	250'000	57'500	-		0	1
Antigua & Barbuda	Real Estate	Official	USD	400'000	-	57'500	-		0	1
Antigua & Barbuda	Investment	Official	USD	1'500'000	-	57'500	-		0	1
Australia	Investment	Official	AUD	5'000'000	-	9'565	-		0	0
Australia	Designated Inv.	Official	AUD	1'500'000	-	9'565	-		0	0
Australia	Retirement	Henley & P.	AUD	750'000	-	13'315	750'000	65'000	0	0
Austria	Donation	Henley & P.	EUR	-	2'000'000	-	-		0	1
Austria	Investment	Official	EUR	6'000'000	-	-	-		0	1
Bahamas	Real Estate	Official	BSD	-	-	600	-		0	0
Bulgaria	Donation	Semi-official	LEV	-	350'000	-	1'000'000		0	0
Bulgaria	Investment	Semi-Official	LEV	1'000'000	-	-	-		0	0
Bulgaria	Investment	Semi-Official	EUR	1'024'000	-	-	-		0	1
Canada	Investment	Official	CAD	800'000	-	-	1'600'000		0	0
Cayman Islands	Inv. & RE	Official	KYD	500'000	-	21'000	-	125'000	0	0
Cayman Islands	Real Estate	Official	KYD	1'600'000	-	100'500	-	125'000	0	0
Cayman Islands	Investment	Official	KYD	1'000'000	-	21'000	1'000'000	125'000	1	0
Costa Rica	Investment	Official	USD	200'000	-	-	-		0	0
Costa Rica	Real Estate	Official	USD	200'000	-	50	-		0	0
Costa Rica	Retirement	Official	USD	-	-	50	-	30'000	0	0
Costa Rica	Retirement	Official	USD	-	-	50	-	12'000	0	0
Cyprus	In. & RE	Official	EUR	5'000'000		7'000	-	-	0	1
Cyprus	Real Estate	Official	EUR	5'000'000		7'000	-	-	0	1
Cyprus	Pre-Paid Taxes	Official	EUR	500'000	100'000	7'000	-	-	0	1

Table A.2.: Summary of countries offering investment programs (I)

Country	Program type	Source	Currency	Investment	Payment	Fees	Net assets	Income	Jobs	Citizenship
Dominica	Donation	Official	USD	-	100’000	1’500	-	-	0	1
Grenada	Real Estate	Official	USD	250’000	-	-	-	-	0	1
Grenada	Donation	Official	USD	-	200’000	-	-	-	0	1
Hong Kong	Investment	Official	HKD	10’000’000	-	160	-	-	0	0
Hungary	Inv. & Donation	Official	EUR	250’000	50’000	-	-	-	0	0
Ireland	Investment	Official	EUR	500’000	-	750	-	-	1	0
Ireland	Investment	Official	EUR	1’000’000	-	750	2’000’000	-	0	0
Ireland	Inv. & RE	Official	EUR	500’000	-	750	2’000’000	-	0	0
Ireland	Donation	Official	EUR	-	500’000	750	2’000’000	-	0	0
Ireland	Real Estate	Official	EUR	2’000’000	-	750	2’000’000	-	0	0
Latvia	Investment	Semi-Official	EUR	300’000	-	25’000	-	-	0	0
Latvia	Real Estate	Semi-Official	EUR	250’000	-	12’500	-	-	0	0
Malaysia	Investment	Official	USD	2’000’000	-	-	-	-	0	0
Malta	Donation & RE	Official	EUR	350’000	650’000	8’000	-	-	0	1
Mauritius	Investment	Official	USD	100’000	-	636	-	-	0	0
Mauritius	Investment	Official	USD	500’000	-	2’417	-	-	0	0
Mauritius	Retirement	Official	USD	-	-	636	-	40’000	0	0
Monaco	Real Estate	Semi-Official	EUR	500’000	-	-	500’000	-	0	0
Montenegro	Investment	Official proposal	EUR	500’000	-	-	-	-	0	1
New Zealand	Investment	Official	NZD	1’500’000	-	4’100	1’500’000	-	0	0
New Zealand	Inv. Plus	Official	NZD	10’000’000	-	4’100	-	-	0	0
New Zealand	Entrepeneur	Official	NZD	500’000	-	-	-	-	1	0
New Zealand	Retirement	Official	NZD	750’000	-	4’100	750’000	60’000	0	0

Table A.3.: Summary of countries offering investment programs (II)

Country	Program type	Source	Currency	Investment	Payment	Fees	Net assets	Income	Jobs	Citizenship
Panama	Retirement	Official	USD	100’000	-	700	-	9’000	0	0
Panama	Self-Economic	Official	USD	300’000	-	3’900	-	-	0	0
Panama	Self-Economic	Official	USD	300’000	-	3’900	-	-	0	0
Panama	Investment	Official	USD	160’000	-	1’900	-	-	1	0
Panama	Agricultural	Official	USD	60’000	-	1’900	-	-	0	0
Portugal	Real Estate	Official	EUR	500’000	-	6’000	-	-	0	0
Portugal	Investment	Official	EUR	1’000’000	-	6’000	-	-	0	0
Portugal	Job creation	Official	EUR	-	-	6’000	-	-	1	0
Saint Kitts & Nevis	Donation	Official	USD	-	250’000	4’000	-	-	0	1
Saint Kitts & Nevis	Real Estate	Official	USD	400’000	-	54’000	-	-	0	1
Singapore	Investment	Official	SGD	2’500’000	-	5’650	-	-	0	0
Singapore	Investment	Official	SGD	2’500’000	-	5’650	-	-	1	0
Spain	Inv. Govt. Bonds	Official	EUR	2’000’000	-	-	-	-	0	0
Spain	Inv.Shares & Bank	Official	EUR	1’000’000	-	-	-	-	0	0
Spain	Real Estate	Official	EUR	500’000	-	-	-	-	0	0
Spain	Job creation	Official	EUR	-	-	-	-	-	1	0
United Kingdom	Investment	Official	GBP	1’000’000	-	874	-	-	0	0
United Kingdom	Investment	Official	GBP	5’000’000	-	874	-	-	0	0
United States	Investment	Official	USD	1’000’000	-	165	-	-	0	0
United States	Investment	Official	USD	500’000	-	165	-	-	0	0

Table A.4.: Summary of countries offering investment programs (III)

MIPEX Access to Nationality Index	
Eligibility	First generation immigrants
	Periods of absence allowed previous to acquisition of nationality
	Requirements for spouses, partners and cohabitees of nationals (average)
	Second generation immigrants (born in the country)
	Third generation immigrants (born in the country)
Conditions for acquisition	Language requirements and exemptions (average)
	Citizenship/integration requirements and exemptions (average)
	Economic resources requirement
	Criminal record requirement
	Good character clause
	Maximum length of application procedure
	Costs of application and/or issue of nationality title
Security of status	Additional grounds for refusing status
	Discretionary powers in refusal
	Additional elements taken into account before refusal
	Legal guarantees and redress in case of refusal
	Grounds for withdrawing status
	Time limits for withdrawal
	Withdrawal that would lead to statelessness
Dual nationality	Requirement to renounce / lose foreign nationality upon naturalization for first generation
	Dual nationality for second and/or third generation

Table A.5.: MIPEX Access to Nationality Index

Country	β_{WGI}	β_{Govt}	ψ	Population	$L^{\beta_{WGI}+\psi-1}$	$L^{\beta_{Govt}+\psi-1}$	$L^{\widehat{\beta+\psi}-1}$
Antigua & Barbuda	33.62%	4.40%	22.86%	89'985	0.70%	0.02%	0.36%
Australia	18.17%	2.01%	29.45%	23'130'900	0.01%	0.00%	0.02%
Austria	19.91%	1.35%	18.89%	8'473'786	0.01%	0.00%	0.04%
Bahamas	32.42%	4.01%	37.67%	377'374	2.15%	0.06%	0.18%
Bulgaria	46.84%	1.79%	41.74%	7'265'115	16.46%	0.01%	0.04%
Canada	17.99%	2.84%	65.89%	35'158'304	6.08%	0.44%	0.02%
Costa Rica	37.46%	2.24%	14.08%	4'872'166	0.06%	0.00%	0.05%
Cyprus	28.68%	1.36%	24.52%	1'141'166	0.15%	0.00%	0.10%
Dominica	35.97%	3.75%	30.45%	72'003	2.34%	0.06%	0.40%
Grenada	42.00%	4.25%	39.62%	105'897	11.92%	0.15%	0.33%
Hong Kong	21.82%	3.02%	17.68%	7'187'500	0.01%	0.00%	0.04%
Hungary	37.29%	1.13%	13.33%	9'897'247	0.04%	0.00%	0.04%
Ireland	21.80%	1.41%	8.35%	4'595'281	0.00%	0.00%	0.05%
Latvia	37.19%	2.26%	57.38%	2'013'385	45.46%	0.29%	0.08%
Malaysia	43.93%	2.38%	61.59%	29'716'965	258.52%	0.20%	0.02%
Malta	26.59%	1.63%	7.72%	423'282	0.02%	0.00%	0.17%
Mauritius	33.48%	3.26%	51.24%	1'296'303	11.64%	0.17%	0.10%
Montenegro	47.42%	1.86%	57.36%	621'383	189.23%	0.43%	0.14%
New Zealand	14.10%	1.12%	37.64%	4'470'800	0.06%	0.01%	0.05%
Panama	49.14%	2.66%	41.50%	3'864'170	24.19%	0.02%	0.06%
Portugal	31.53%	1.14%	5.11%	10'459'806	0.00%	0.00%	0.03%
Saint Kitts & Nevis	33.18%	3.52%	34.90%	54'191	3.09%	0.12%	0.46%
Singapore	20.01%	4.19%	45.95%	5'399'200	0.51%	0.04%	0.05%
Spain	33.30%	1.47%	42.67%	46'647'421	1.44%	0.01%	0.02%
United Kingdom	23.15%	0.96%	16.48%	64'097'085	0.00%	0.00%	0.01%
United States	25.19%	1.89%	61.10%	316'128'839	6.83%	0.07%	0.01%

Table A.6.: Estimates for β, ψ and $L^{\beta+\psi-1}$

Country	Years	Dual	L	A	CR	CH	B	M	S	R	$1-\beta_{WGI}$	ψ
Afghanistan	5	0	0	0	0	0	0	0	0	0	13.9%	50.4%
Albania	5	1	1	0	1	0	1	1	1	0	44.4%	16.1%
Algeria	7	0	0	1	1	0	1	1	0	0	31.2%	11.1%
Angola	10	0	0	1	0	0	0	1	0	0	29.3%	73.0%
Antigua and Barbuda	6	1	0	0	0	1	1	0	0	0	66.4%	22.9%
Argentina	2	0	0	0	0	0	0	0	0	0	42.1%	15.2%
Armenia	3	1	0	0	0	0	0	0	0	0	45.9%	19.6%
Australia	2	1	1	0	0	1	1	0	0	1	81.8%	29.5%
Austria	10	0	0	0	0	0	0	0	0	0	80.1%	18.9%
Azerbaijan	71	0	0	0	0	0	0	0	0	0	32.7%	27.4%
Bahamas	6	0	1	1	0	1	1	0	0	1	67.6%	37.7%
Bahrain	25	0	1	0	0	1	1	0	0	0	44.8%	49.4%
Bangladesh	5	0	1	0	0	1	1	0	0	1	31.8%	9.6%
Belarus	7	0	1	0	0	0	0	1	0	0	31.9%	45.1%
Belgium	5	0	0	0	0	0	0	0	0	0	76.6%	40.0%
Belize	5	1	0	0	0	0	0	0	0	0	48.6%	63.6%
Benin	10	1	0	0	0	0	0	0	0	0	42.2%	70.1%
Bhutan	15	0	1	1	0	0	0	0	0	0	50.7%	51.8%
Bolivia	2	0	0	0	0	0	0	0	0	0	37.6%	32.6%
Bosnia and Herz.	8	0	1	0	1	0	1	0	1	0	44.1%	66.3%
Botswana	11	0	1	0	0	1	1	0	0	1	64.3%	46.6%
Brazil	5	0	0	0	0	0	0	0	0	0	50.8%	24.8%
Brunei Darussalam	71	0	0	0	0	0	0	0	0	0	61.8%	-
Bulgaria	5	0	0	0	0	0	0	0	0	0	53.2%	41.7%
Burkina Faso	10	1	0	0	0	0	0	0	0	0	41.0%	67.6%
Burundi	10	1	0	1	1	1	1	0	0	0	24.5%	35.7%
Cambodia	5	0	1	1	0	1	1	1	0	0	35.0%	16.2%
Cameroon	5	0	0	0	0	1	1	0	0	1	30.8%	82.6%
Canada	3	1	1	1	1	0	1	0	0	0	82.0%	65.9%
Cape Verde	5	1	0	0	0	1	1	1	0	0	60.1%	17.9%
Cayman Islands	12	1	0	0	1	0	1	0	0	0	70.2%	-
Central African Republic	7	1	0	0	0	0	0	0	0	0	22.3%	81.8%
Chad	15	0	0	0	0	1	1	0	0	0	24.2%	78.1%
Chile	5	0	0	0	0	0	0	0	0	0	73.2%	23.7%

A = Assimilation, CR = Criminal record, CH = Good character, B = Good behavior,
M = Own means, S = Security threat, R = Residence

Table A.7.: Naturalization requirements

Country	Years	Dual	L	A	CR	CH	B	M	S	R	$1-\beta_{WGI}$	ψ
China	1	0	0	0	0	0	0	0	0	0	37.2%	23.8%
Colombia	5	1	0	0	0	0	0	0	0	0	41.7%	12.0%
Comoros	10	1	0	1	1	1	1	0	1	1	29.9%	0.0%
Congo, Dem. Rep.	5	0	0	0	0	0	0	0	0	0	16.5%	81.2%
Costa Rica	7	1	0	0	0	0	0	0	0	0	62.5%	14.1%
Croatia	5	0	1	1	1	0	1	0	0	0	57.7%	23.2%
Cyprus	8	1	0	0	0	1	1	0	0	1	71.3%	24.5%
Czech Republic	5	0	1	0	1	0	1	0	0	0	67.0%	40.9%
Côte d'Ivoire	5	1	0	0	0	0	0	0	0	0	30.0%	78.6%
Denmark	7	0	0	0	0	0	0	0	0	0	84.8%	12.6%
Djibouti	10	0	0	0	0	0	0	0	0	0	35.4%	28.3%
Dominica	7	1	0	0	0	0	0	0	0	0	64.0%	30.4%
Dominican Rep.	5	0	0	0	0	0	0	0	0	0	42.8%	17.4%
Ecuador	3	0	1	1	1	1	1	1	0	0	35.2%	23.0%
Egypt	10	0	0	0	0	0	0	0	0	0	34.1%	9.5%
El Salvador	5	1	0	0	0	0	0	0	0	0	46.7%	26.5%
Equatorial Guinea	10	0	0	0	0	0	0	0	0	0	22.1%	23.7%
Eritrea	10	0	1	0	1	0	1	1	0	1	16.7%	56.6%
Estonia	4	0	1	0	1	0	1	0	0	0	70.4%	50.0%
Ethiopia	4	0	1	1	1	1	1	1	1	1	30.4%	71.5%
Fiji	5	0	0	0	0	0	0	0	0	0	37.4%	55.5%
Finland	5	0	0	0	1	0	1	1	0	0	87.1%	16.8%
France	5	1	0	0	0	0	0	0	0	0	73.3%	17.2%
Gabon	10	0	0	0	0	0	0	0	0	0	39.9%	73.8%
Gambia	5	1	1	0	0	1	1	1	0	0	38.5%	39.5%
Georgia	5	1	1	1	1	0	1	1	1	0	51.8%	53.5%
Germany	8	0	0	0	0	0	0	0	0	1	78.7%	26.3%
Ghana	6	0	1	1	1	1	1	0	0	1	51.3%	71.3%
Greece	10	0	1	1	1	0	1	0	0	0	54.1%	9.0%
Grenada	8	1	0	0	0	0	0	0	0	0	58.0%	39.6%
Guatemala	2	0	0	0	0	0	0	0	0	0	37.2%	44.5%
Guinea	5	0	0	0	0	0	0	0	0	0	25.8%	53.3%
Guinea-Bissau	5	0	0	0	1	0	1	1	0	0	24.5%	73.9%

A = Assimilation, CR = Criminal record, CH = Good character, B = Good behavior,
M = Own means, S = Security threat, R = Residence

Table A.8.: Naturalization requirements

Country	Years	Dual	L	A	CR	CH	B	M	S	R	$1-\beta_{WGI}$	ψ
Guyana	6	0	0	0	1	1	1	0	1	1	41.2%	32.3%
Haiti	5	0	0	0	0	0	0	0	0	0	26.7%	21.1%
Honduras	3	1	0	0	0	0	0	0	0	0	36.3%	13.5%
Hong Kong	1	0	0	0	0	0	0	0	0	0	78.2%	17.7%
Hungary	8	1	0	0	0	0	0	0	0	0	62.7%	13.3%
Iceland	7	0	0	0	0	0	0	1	0	0	79.0%	10.8%
India	5	0	0	0	0	0	0	0	0	0	41.3%	47.9%
Indonesia	5	0	1	1	1	1	1	1	0	0	41.9%	50.9%
Iran	5	0	0	0	1	0	1	0	0	0	27.1%	38.6%
Iraq	10	1	0	0	1	1	1	1	0	0	21.8%	40.4%
Ireland	4	1	0	0	0	0	0	0	0	0	78.2%	8.4%
Israel	3	1	1	0	0	0	0	0	0	1	59.6%	40.4%
Italy	10	1	0	0	0	0	0	0	0	0	59.3%	15.8%
Jamaica	5	1	0	0	0	0	0	0	0	0	49.5%	30.3%
Japan	5	0	0	0	1	1	1	1	1	0	74.8%	4.9%
Jordan	15	1	0	0	0	0	0	0	0	0	47.1%	11.6%
Kazakhstan	5	0	1	0	0	0	0	0	0	0	36.5%	62.2%
Kenya	8	0	1	0	0	1	1	0	0	1	34.4%	83.9%
Kuwait	71	0	0	0	0	0	0	0	0	0	48.4%	53.5%
Kyrgyzstan	5	1	1	1	0	0	0	1	0	0	33.6%	56.4%
Laos	10	0	1	1	1	0	1	0	0	1	31.5%	56.3%
Latvia	5	0	1	1	1	0	1	1	1	0	62.8%	57.4%
Lebanon	71	1	0	0	0	0	0	0	0	0	34.4%	23.9%
Lesotho	5	0	1	0	0	1	1	0	0	1	47.0%	36.0%
Liberia	2	0	0	1	0	1	1	0	1	1	34.2%	73.7%
Libya	10	0	0	0	1	1	1	1	1	1	22.2%	15.1%
Lithuania	10	0	1	1	0	0	0	1	0	0	65.5%	35.0%
Luxembourg	10	0	0	1	0	0	0	0	0	0	84.1%	31.4%
Macao SAR, China	1	0	0	0	0	0	0	0	0	0	62.0%	-
Macedonia	8	0	1	0	1	0	1	1	0	1	48.5%	53.0%
Madagascar	5	0	1	1	1	1	1	0	1	0	34.5%	21.0%
Malawi	7	0	1	0	0	0	0	0	0	1	42.6%	69.3%
Malaysia	12	0	1	0	0	1	1	0	0	0	56.1%	61.6%
Maldives	71	0	0	0	0	0	0	0	0	0	42.4%	-

A = Assimilation, CR = Criminal record, CH = Good character, B = Good behavior,
M = Own means, S = Security threat, R = Residence

Table A.9.: Naturalization requirements

Country	Years	Dual	L	A	CR	CH	B	M	S	R	$1-\beta_{WGI}$	ψ
Mali	5	0	0	0	0	0	0	0	0	0	29.4%	47.2%
Malta	5	0	0	0	0	0	0	0	0	0	73.4%	7.7%
Mauritania	5	0	1	1	1	0	1	0	0	0	32.8%	14.4%
Mauritius	71	1	0	0	0	0	0	0	0	0	66.5%	51.2%
Mexico	5	1	1	1	0	0	0	0	0	0	46.7%	24.5%
Moldova	10	0	0	0	0	0	0	0	0	0	44.1%	55.6%
Monaco	10	0	0	0	0	0	0	0	0	0	-	53.4%
Mongolia	5	0	1	1	1	0	1	1	1	0	45.3%	22.2%
Montenegro	10	0	1	0	1	0	1	1	0	1	52.6%	57.4%
Morocco	5	1	0	0	0	0	0	0	0	0	43.8%	9.3%
Mozambique	5	0	0	0	0	0	0	0	0	0	42.4%	72.5%
Namibia	5	0	0	0	0	0	0	0	0	0	56.6%	66.5%
Nepal	15	0	1	0	0	0	0	1	0	0	31.3%	40.7%
Netherlands	5	0	1	0	0	0	0	0	0	0	84.2%	34.0%
New Zealand	3	1	1	1	0	1	1	0	0	1	85.9%	37.6%
Nicaragua	4	0	1	1	1	1	1	1	0	0	37.8%	21.4%
Niger	71	0	0	0	1	1	1	0	0	0	35.3%	44.1%
Nigeria	15	0	1	1	0	1	1	1	0	1	25.0%	80.7%
Norway	7	0	0	0	1	0	1	0	0	0	85.4%	9.3%
Oman	71	0	0	0	0	0	0	0	0	0	51.7%	40.7%
Pakistan	5	0	1	0	0	1	1	0	0	1	-	58.1%
Panama	5	0	1	1	0	0	0	0	0	0	50.9%	41.5%
Papua New Guinea	8	0	1	1	0	1	1	1	0	1	36.6%	37.5%
Paraguay	3	1	0	0	1	0	1	1	0	0	36.5%	27.8%
Peru	2	1	0	0	1	1	1	1	0	0	44.2%	35.3%
Philippines	10	0	1	1	0	0	0	1	0	0	41.3%	39.4%
Poland	5	0	0	0	0	0	0	0	0	0	66.7%	9.8%
Portugal	10	1	1	0	1	1	1	1	0	0	68.5%	5.1%
Qatar	25	0	1	0	0	1	1	1	0	0	62.6%	32.4%
Rep. of the Congo	10	0	0	1	1	1	1	0	1	0	27.8%	73.6%
Romania	5	1	1	1	0	0	0	0	0	0	50.8%	23.2%
Russia	5	1	1	1	1	0	1	1	1	0	35.0%	29.9%
Rwanda	10	0	0	0	0	0	0	0	1	0	44.4%	40.5%
Saint Kitts & Nevis	71	1	0	0	0	1	1	0	0	0	66.8%	34.9%
Saudi Arabia	10	0	1	0	1	1	1	1	0	0	39.9%	12.9%

A = Assimilation, CR = Criminal record, CH = Good character, B = Good behavior, M = Own means, S = Security threat, R = Residence

Table A.10.: Naturalization requirements

Country	Years	Dual	L	A	CR	CH	B	M	S	R	$1-\beta_{WGI}$	ψ
Senegal	5	0	0	0	1	1	1	0	0	0	45.4%	41.9%
Serbia	3	0	0	0	0	1	1	0	0	0	46.7%	57.4%
Seychelles	5	0	1	0	0	1	1	0	0	1	53.6%	19.6%
Sierra Leone	5	0	0	0	1	0	1	0	0	0	34.9%	69.6%
Singapore	10	0	1	0	0	1	1	0	0	1	80.0%	46.0%
Slovakia	5	1	1	0	1	0	1	0	0	0	64.3%	33.2%
Slovenia	10	0	1	0	1	0	1	1	1	0	67.6%	24.1%
South Africa	5	1	0	0	0	0	0	0	0	0	53.7%	82.4%
South Korea	5	0	1	1	1	0	1	1	0	0	64.2%	1.4%
Spain	10	1	0	0	0	0	0	0	0	0	66.7%	42.7%
Sri Lanka	71	1	0	0	0	0	0	0	0	0	43.0%	45.4%
St. Lucia	8	0	1	1	0	1	1	0	0	1	-	-
St. Vincent & G.	9	1	1	1	0	1	1	0	0	1	-	-
Sudan	10	0	1	0	1	1	1	0	0	1	15.5%	60.5%
Suriname	5	1	0	0	0	0	0	0	0	0	48.2%	57.7%
Swaziland	6	0	1	0	0	1	1	1	0	1	37.7%	16.5%
Sweden	5	1	0	0	1	0	1	0	0	0	86.2%	14.0%
Switzerland	12	1	1	1	1	0	1	0	1	0	85.1%	56.0%
Syria	5	1	1	0	1	1	1	1	0	0	-	34.8%
Taiwan	5	0	0	0	0	1	1	1	0	0	69.2%	45.5%
Tajikistan	3	0	0	0	1	0	1	0	1	0	27.1%	45.6%
Tanzania	5	0	0	0	0	0	0	0	0	0	40.5%	74.8%
Thailand	5	0	1	0	1	0	1	1	0	0	43.3%	34.2%
Timor-Leste	10	1	1	1	1	0	1	1	0	0	33.4%	47.3%
Togo	5	1	0	0	1	0	1	0	0	0	31.1%	74.9%
Tonga	5	0	1	0	0	1	1	0	0	1	50.9%	27.3%
Trinidad & Tobago	8	0	1	0	0	1	1	0	0	1	52.0%	40.1%
Tunisia	5	1	1	0	1	1	1	0	0	0	44.9%	1.7%
Turkey	5	1	1	0	0	1	1	1	0	1	47.0%	7.0%
Turkmenistan	5	1	1	1	0	0	0	1	0	0	18.0%	33.1%
Uganda	20	1	1	0	0	1	1	0	0	1	38.0%	81.6%
Ukraine	5	1	1	0	0	0	0	0	0	0	38.2%	51.7%
United Arab Emirates	30	0	1	0	1	1	1	1	0	0	59.0%	46.5%
United Kingdom	5	1	1	0	0	1	1	0	0	1	76.9%	16.5%
United States	5	1	1	1	1	1	1	0	0	0	74.8%	61.1%

A = Assimilation, CR = Criminal record, CH = Good character, B = Good behavior,
M = Own means, S = Security threat, R = Residence

Table A.11.: Naturalization requirements

Country	Years	Dual	L	A	CR	CH	B	M	S	R	$1-\beta_{WGI}$	ψ
Uruguay	5	1	0	0	1	0	1	1	0	0	64.5%	19.4%
Uzbekistan	5	0	0	0	0	0	0	1	0	0	22.9%	33.1%
Vanuatu	10	0	1	1	0	1	1	1	0	1	53.2%	25.6%
Venezuela	10	1	0	0	0	0	0	0	1	0	24.3%	16.6%
Vietnam	5	0	1	0	0	0	0	0	0	0	38.1%	30.6%
Yemen	10	0	1	0	1	0	1	1	0	0	16.0%	0.4%
Zambia	10	0	1	0	0	1	1	0	0	1	45.3%	79.5%
Zimbabwe	5	0	0	0	1	1	1	0	0	1	21.8%	50.3%

A = Assimilation, CR = Criminal record, CH = Good character, B = Good behavior, M = Own means, S = Security threat, R = Residence

Table A.12.: Naturalization requirements

Country	K^K	K^P	N^K	N^P	F^K	F^P	I^K	I^P	Π^K	Π^P
Afghanistan	728	97	-	-	-	-	-	-	-	-
Albania	10’236	1’178	4’493	575	2’433	-2’819	17’819	23’620	34’980	22’554
Algeria	16’634	3’347	2’138	13’677	-269	1’404	969	1’280	19’472	19’712
Angola	4’274	1’273	2’175	11’132	647	-1’660	-596	-790	6’499	9’954
Antigua and Barbuda	49’145	11’001	-	-	-	-	-	-	-	-
Argentina	24’891	3’241	7’220	3’047	6’394	-6’605	21’664	28’717	60’169	28’400
Armenia	8’129	1’205	2’650	489	897	-1’386	9’613	12’743	21’289	13’051
Australia	135’936	28’875	16’718	23’261	-11’371	-7’854	166’144	220’237	307’427	264’519
Austria	110’815	25’798	5’227	3’838	18’207	-26’239	196’434	260’389	330’682	263’786
Azerbaijan	10’258	1’348	2’277	9’407	-208	-906	84	111	12’410	9’960
Bahamas	78’284	11’741	-	-	-	-12’067	-	-	-	-
Bahrain	68’216	12’172	557	83’105	23’854	-8’301	25’482	33’779	118’109	120’755
Bangladesh	1’767	99	1’188	206	-131	0	-2’080	2’758	4’905	3’063
Belarus	16’541	3’487	4’639	1’333	-415	0	-13’940	18’479	34’705	23’299
Belgium	93’763	27’640	4’710	222	48’904	-37’809	192’431	255’083	339’808	245’136
Belize	11’157	2’007	17’258	6’468	-598	-3’776	15’444	20’472	43’261	25’171
Benin	1’564	218	2’064	562	67	-262	2’598	3’444	6’293	3’962
Bhutan	9’229	2’313	11’598	2’407	1’708	-1’801	-1’637	-2’170	20’897	749
Bolivia	3’746	585	5’671	2’634	-540	-315	2’416	3’202	11’293	6’106
Bosnia and Herz.	7’247	2’064	-	-	-	-1’794	-	-	-	-
Botswana	19’554	5’218	3’551	1’869	5’632	-1’092	12’017	15’930	40’755	21’926
Brazil	15’806	3’819	11’615	3’364	2’211	-3’946	23’465	31’104	53’097	34’340
Brunei Darussalam	61’061	15’326	1’722	181’296	122’577	-928	-62’875	-83’347	122’484	112’347
Bulgaria	16’653	3’246	4’065	1’495	-2’352	699	21’503	28’503	39’869	33’943
Burkina Faso	1’375	332	1’128	211	78	-189	2’818	3’736	5’400	4’090
Burundi	519	134	2’682	15	-59	-86	-227	-300	2’915	-237
Cambodia	1’455	124	-	-	-	-	-	-	-	-
Cameroon	2’902	384	3’123	2’075	-217	-195	4’347	5’763	10’156	8’026
Canada	105’307	27’805	12’988	23’936	14’981	-17’958	178’423	236’515	311’699	270’298

K = Produced capital, N = Natural capital, F = Financial capital, I = Intangible capital,Π = Total capital
^{K} = Private, ^{P} = Public

Table A.13.: Private and public capital stocks by type of capital

Country	K^K	K^P	N^K	N^P	F^K	F^P	I^K	I^P	Π^K	Π^P
Cape Verde	14’138	3’060	-	-	-	-3’681	-	-	-	-
Cayman Islands	-	-	-	-	-	-	-	-	-	-
Central African Republic	-	-	3’854	2’007	-134	-102	243	322	-	-
Chad	2’213	165	2’265	2’372	-134	-360	-196	-260	4’148	1’916
Chile	27’359	3’593	7’514	11’356	-3’233	1’226	28’281	37’489	59’922	53’663
China	15’035	2’412	3’101	912	1’839	-1’555	3’836	5’085	23’811	6’853
Colombia	12’154	2’257	5’133	2’481	1’071	-1’925	17’504	23’203	35’862	26’016
Comoros	1’623	458	1’436	330	130	-381	5’037	6’677	8’226	7’083
Congo, Dem. Rep.	779	83	1’504	95	-19	-164	291	386	2’554	402
Costa Rica	16’316	2’966	8’410	1’026	1’994	-3’546	25’807	34’209	52’528	34’656
Croatia	26’892	7’339	3’192	2’367	2’167	-7’615	60’696	80’458	92’948	82’549
Cyprus	55’066	12’113	-	-	-	-21’766	-	-	-	-
Czech Republic	40’088	10’528	3’340	1’255	4’797	-8’138	58’184	77’128	106’409	80’773
Côte d’Ivoire	2’270	294	3’484	503	-594	0	-4’127	5’471	9’286	6’268
Denmark	105’967	38’234	8’617	10’999	5’779	-4’491	254’226	336’998	374’589	381’739
Djibouti	3’446	1’275	-	-	-	-644	-	-	-	-
Dominica	14’953	3’301	5’187	5’206	748	-5’059	23’903	31’685	44’791	35’133
Dominican Rep.	9’621	760	3’304	1’446	683	-1’951	24’007	31’824	37’616	32’078
Ecuador	12’381	1’830	6’289	16’165	-778	-1’065	6’632	8’791	24’523	25’721
Egypt	4’995	706	2’681	1’989	2’218	-2’281	5’960	7’900	15’853	8’315
El Salvador	6’129	710	3’923	18	841	-1’997	19’333	25’628	30’226	24’359
Equatorial Guinea	88’986	5’224	-	-	-	-1’682	-	-	-	-
Eritrea	447	231	-	-	-	-684	-	-	-	-
Estonia	35’905	8’481	-	-	-	-464	-	-	-	-
Ethiopia	1’037	117	859	264	-6	-91	898	1’191	2’788	1’481
Fiji	10’430	1’951	10’899	717	478	-2’144	10’475	13’885	32’282	14’409
Finland	96’067	28’007	15’429	3’791	-29’692	24’050	197’848	262’263	279’652	318’111
France	82’173	25’179	5’893	2’717	37’382	-34’820	207’113	274’545	332’560	267’620

K = Produced capital, N = Natural capital, F = Financial capital, I = Intangible capital,Π = Total capital
^{K} = Private, ^{P} = Public

Table A.14.: Private and public capital stocks by type of capital

Country	K^K	K^P	N^K	N^P	F^K	F^P	I^K	I^P	Π^K	Π^P
Gabon	32'677	4'153	7'405	34'659	2'558	-2'546	-3'006	-3'985	39'634	32'281
Gambia	1'322	214	1'220	10	-172	-382	1'890	2'506	4'261	2'348
Georgia	7'286	1'415	3'005	329	249	-1'179	8'203	10'873	18'743	11'438
Germany	88'596	21'013	3'246	2'470	32'019	-25'799	187'902	249'079	311'763	246'763
Ghana	2'909	478	2'635	23	726	-983	2'510	3'328	8'781	2'845
Greece	55'206	11'512	7'117	863	18'043	-34'044	140'438	186'162	220'803	164'493
Grenada	22'233	3'948	2'018	66	2'729	-8'866	25'245	33'464	52'224	28'612
Guatemala	5'723	541	15'898	793	504	-873	9'370	12'421	31'496	12'882
Guinea	1'305	136	1'686	253	-130	-227	1'682	2'229	4'542	2'391
Guinea-Bissau	898	116	1'993	85	-299	-301	713	945	3'305	845
Guyana	6'751	1'392	21'073	809	211	-2'219	-2'051	-2'719	25'983	-2'737
Haiti	2'364	216	1'255	4	-38	-127	3'292	4'364	6'874	4'458
Honduras	5'619	982	9'999	2'013	205	-794	4'225	5'600	20'047	7'801
Hong Kong	101'405	9'690	10	0	-75'618	-12'349	94'622	125'429	271'654	122'769
Hungary	26'454	5'980	4'431	1'543	133	-9'558	60'757	80'539	91'775	78'504
Iceland	106'232	32'288	3'981	8'382	-15'113	-30'8837	343'623	455'500	438'724	465'280
India	3'846	490	2'206	498	895	-1'002	2'563	3'398	9'510	3'384
Indonesia	7'544	726	3'042	1'884	311	-834	4'901	6'497	15'798	8'273
Iran	16'434	2'457	3'679	14'254	986	-58	1'746	2'314	22'845	18'967
Iraq	7'741	1'540	-	-	-	-2'280	-	-	-	-
Ireland	94'106	19'771	10'595	594	38'073	-48'501	208'972	277'009	351'746	248'873
Israel	56'997	19'819	3'289	1'554	21'862	-25'357	119'923	158'968	202'072	154'984
Italy	76'716	18'610	4'819	2'683	31'197	-35'730	174'343	231'105	287'074	216'669
Jamaica	14'195	2'420	3'967	1'405	4'914	-7'755	26'996	35'785	50'072	31'856
Japan	123'304	25'402	1'920	175	63'624	-51'705	171'514	227'356	360'363	201'228
Jordan	11'507	3'084	1'858	833	157	-3'907	19'764	26'199	33'286	26'208
Kazakhstan	17'617	2'195	-	-	-	2'252	-	-	-	-
Kenya	1'760	3627	2'181	559	346	-429	2'894	3'836	7'180	4'327
Kuwait	76'736	17'453	876	212'235	66'841	-4'365	-3'175	-4'208	141'279	221'115

K = Produced capital, N = Natural capital, F = Financial capital, I = Intangible capital, Π = Total capital
^{K} = Private, ^{P} = Public

Table A.15.: Private and public capital stocks by type of capital

Country	K^K	K^P	N^K	N^P	F^K	F^P	I^K	I^P	Π^K	Π^P
Kyrgyzstan	2'570	634	2'828	164	-	-	2'879	3'817	-	-
Laos	2'506	275	3'890	554	-	-	1'260	1'671	-	-
Latvia	29'992	5'963	3'902	3'444	95	-4'085	40'703	53'955	74'692	59'277
Lebanon	20'779	3'478	-	-	-	-13'321	-	-	-	-
Lesotho	2'680	1'397	324	1	-1'318	23	7'177	9'514	8'863	10'934
Liberia	717	136	3'185	16	-1'747	38	714	946	2'868	1'135
Libya	27'886	4'716	-	-	-	11'563	-	-	-	-
Lithuania	23'020	5'469	4'709	1'305	2'370	-5'499	46'769	61'996	76'867	63'271
Luxembourg	211'402	41'004	4'679	1'413	122'946	-23'497	257'382	341'181	596'410	360'100
Macao SAR, China	95'185	8'923	-	-	-	-	59'382	78'716	-	-
Macedonia	9'242	2'154	3'407	235	141	-1'407	20'384	27'020	33'173	28'003
Madagascar	1'309	158	1'877	41	16	-180	509	675	3'711	694
Malawi	768	159	1'110	60	-129	-116	868	1'150	2'617	1'254
Malaysia	22'616	3'268	1'769	10'981	5'082	-5'832	15'455	20'487	44'923	28'904
Maldives	16'946	3'481	990	0	-4'439	-5'165	8'130	10'777	30'505	9'093
Mali	1'452	206	1'842	64	-50	-192	1'832	2'429	5'077	2'507
Malta	34'593	8'267	4'246	37	19'916	-16'524	88'249	116'981	147'005	108'761
Mauritania	3'441	877	2'594	1'421	-388	-853	2'806	3'719	8'452	5'165
Mauritius	19'667	3'128	9'091	288	5'051	-4'631	25'609	33'946	59'417	32'731
Mexico	23'539	2'937	2'800	3'841	832	-3'917	45'798	60'710	72'970	63'571
Moldova	4'434	1'021	4'090	58	93	-532	4'265	5'654	12'882	6'202
Monaco	-	-	-	-	-	-	-	-	-	-
Mongolia	13'558	2'864	3'848	1'629	-	-546	-2'053	2'722	18'913	7'215
Montenegro	9'798	2'840	-	-	-	-	-	-	-	-
Morocco	8'368	1'845	2'358	90	1'455	-1'836	10'159	13'467	22'340	13'566
Mozambique	1'314	187	1'118	130	-32	-276	1'647	2'183	4'046	2'224
Namibia	11'008	3'028	4'134	1'058	2'180	-1'333	19'452	25'786	36'774	28'538
Nepal	1'698	180	2'030	433	198	-230	1'000	1'325	4'926	1'708
Netherlands	89'027	29'907	5'050	8'143	13'800	-15'477	203'120	269'251	310'997	291'825
New Zealand	73'449	16'695	29'909	23'070	-10'294	-10'977	131'633	174'491	224'697	203'277

K = Produced capital, N = Natural capital, F = Financial capital, I = Intangible capital,Π = Total capital
^{K} = Private, ^{P} = Public

Table A.16.: Private and public capital stocks by type of capital

Country	K^K	K^P	N^K	N^P	F^K	F^P	I^K	I^P	Π^K	Π^P
Nicaragua	4'751	528	4'160	570	206	-964	5'373	7'122	14'489	7'255
Niger	1'132	180	1'270	160	-126	-18	1'229	1'630	3'506	1'952
Nigeria	2'612	300	2'085	3'957	349	-399	1'416	1'876	6'461	5'735
Norway	188'204	49'369	5'668	104'493	-130'427	166'863	228'812	303'309	292'258	624'034
Oman	45'752	11'132	2'047	75'087	3'754	-1'358	19'369	25'675	70'921	110'536
Pakistan	2'017	237	2'602	753	559	-764	3'268	4'332	8'446	4'558
Panama	19'203	2'745	5'333	2'611	37	-4'282	25'764	34'152	50'336	35'227
Papua New Guinea	3'551	824	5'632	2'937	-543	-	-681	-903	7'958	2'858
Paraguay	6'108	643	-	-	-	-500	-	-	-	-
Peru	11'812	1'427	4'167	1'650	-939	-297	14'263	18'907	29'304	21'687
Philippines	4'923	555	3'027	441	567	-1'159	6'053	8'023	14'570	7'860
Poland	21'012	4'720	5'462	3'432	178	-3'592	47'272	62'663	73'924	67'223
Portugal	48'067	11'215	3'512	692	11'107	-23'466	109'240	144'807	171'926	133'248
Qatar	233'126	46'049	-	-	-	-29'793	-	-	-	-
Rep. of the Congo	7'011	1'151	2'853	11'827	-1'361	-670	-4'846	-6'423	3'657	5'884
Romania	20'119	1'809	6'408	2'650	2'116	-3'518	25'352	33'606	53'995	34'547
Russia	23'044	5'321	4'699	26'618	1'362	-1'589	10'477	13'888	39'582	44'237
Rwanda	1'111	128	2'833	114	65	-177	861	1'142	4'871	1'207
Saint Kitts & Nevis	54'557	7'715	4'395	-	-4'804	-12'243	41'299	54'746	95'447	50'218
Saudi Arabia	49'098	14'044	1'302	95'710	-2'445	13'630	2'111	2'798	50'065	126'182
Senegal	2'634	469	1'512	108	172	-482	4'655	6'170	8'972	6'265
Serbia	9'474	2'419	-	-	-	-3'376	-	-	-	-
Seychelles	0	0	498	1'357	-2'924	-9'880	60'609	80'342	58'182	71'818
Sierra Leone	1'287	139	1'355	8	-306	0	1'168	1'549	3'505	1'695
Singapore	135'115	14'950	0	2	115'981	-61'262	70'885	93'964	321'981	47'654
Slovakia	33'958	8'073	2'687	2'292	4'433	-9'257	47'413	62'850	88'492	63'958
Slovenia	54'406	12'760	-	-	-	-11'958	-	-	-	-
South Africa	13'666	3'253	3'036	2'687	1'586	-2'353	30'167	39'989	48'455	43'577
South Korea	70'020	11'438	2'294	348	-	-	81'766	108'388	-	-
Spain	74'445	16'918	6'318	1'153	8'946	-20'945	142'209	188'509	231'917	185'636

K = Produced capital, N = Natural capital, F = Financial capital, I = Intangible capital,Π = Total capital
^{K} = Private, ^{P} = Public

Table A.17.: Private and public capital stocks by type of capital

Country	K^K	K^P	N^K	N^P	F^K	F^P	I^K	I^P	Π^K	Π^P
Sri Lanka	5'686	887	1'434	640	-476	0	7'168	9'502	13'813	11'029
St. Lucia	-	-	-	0	-	-	35'042	46'451	-	-
St. Vincent & G.	-	-	2'466	599	-	-	21'565	28'586	-	-
Sudan	2'930	381	5'062	1'849	822	-1'712	1'992	2'640	10'806	3'159
Suriname	11'919	3'934	-	-	-	-1'985	-	-	-	-
Swaziland	4'608	936	10'563	17	1'096	-231	9'917	13'146	26'183	13'868
Sweden	94'992	34'032	8'023	7'650	-18'607	10'274	227'093	301'030	311'500	352'986
Switzerland	182'926	22'853	5'890	3'521	77'958	-22'747	217'843	288'769	484'617	292'397
Syria	6'820	1'125	3'188	4'721	625	0	3'494	4'632	14'127	10'477
Taiwan	-	-	-	-	-	-16'211	-	-	-	-
Tajikistan	1'921	231	1'301	461	118	-337	1'742	2'310	5'082	2'664
Tanzania	-	-	-	-	-	-288	-	-	-	-
Thailand	13'389	1'822	4'360	3'450	1'653	-2'557	9'094	12'055	28'495	14'770
Timor-Leste	-137	4'412	-	-	-	0	-	-	-	-
Togo	1'290	188	1'067	44	-42	-297	2'172	2'879	4'486	2'813
Tonga	9'568	2'073	4'444	28'471	-1'184	0	8'043	10'661	20'870	41'205
Trinidad & Tobago	27'909	3'835	554	44'724	623	-5'354	21'821	28'925	50'907	72'130
Tunisia	10'994	2'209	3'310	1'103	-2'912	0	16'111	21'356	27'503	24'668
Turkey	18'818	2'807	4'838	518	629	-3'043	42'137	55'856	66'422	56'138
Turkmenistan	15'961	1'893	-	-	-	-1'264	-	-	-	-
Uganda	1'111	138	2'814	558	32	-197	931	1'234	4'888	1'732
Ukraine	7'111	1'618	4'662	2'236	1'063	-1'374	6'658	8'826	19'495	11'307
United Arab Emirates	157'320	13'610	2'279	118'711	5'514	41'399	46'836	62'086	211'949	235'806
United Kingdom	70'079	18'203	2'363	3'900	25'275	-32'565	248'880	329'911	346'597	319'449
United States	123'410	22'727	6'718	7'1030	39'744	-46'691	269'716	357'530	439'588	340'670
Uruguay	21'501	3'102	8'269	19	5'072	-5'941	29'895	39'628	64'737	36'808
Uzbekistan	3'026	624	2'186	5'466	170	-162	-1'671	-2'216	3'711	3'712
Vanuatu	8'105	2'091	6'700	251	-192	-661	7'540	9'995	22'153	11'676

K = Produced capital, N = Natural capital, F = Financial capital, I = Intangible capital,Π = Total capital
^{K} = Private, ^{P} = Public

Table A.18.: Private and public capital stocks by type of capital

Country	K^K	K^P	N^K	N^P	F^K	F^P	I^K	I^P	Π^K	Π^P
Venezuela	28'118	3'784	3'341	27'227	9'489	-8'258	9'518	12'616	50'465	35'369
Vietnam	3'781	246	2'595	1'036	635	-937	1'804	2'392	8'815	2'736
Yemen	2'116	350	-	-	-	-660	-	-	-	-
Zambia	2'840	614	1'668	474	-545	-362	2'993	3'968	6'956	4'693
Zimbabwe	2'030	410	1'811	154	205	-547	1'091	1'446	5'137	1'463

K = Produced capital, N = Natural capital, F = Financial capital, I = Intangible capital,Π = Total capital
^{K} = Private, ^{P} = Public

Table A.19.: Private and public capital stocks by type of capital

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Curriculum Vitae

Born May 30, 1972, in Madrid (Spain)

Education

- University of St. Gallen (St. Gallen, Switzerland)	Since 09/2010
PhD in International Affairs and Political Economy	
- IMD (Lausanne, Switzerland)	01/2008 - 11/2009
Executive MBA	
- CFA Institute (Virginia, EEUU)	06/1999 - 06/2001
Chartered Financial Analyst® (CFA)	
- Escuela de Finanzas BBVA (Bilbao, Spain)	09/1998 - 08/2000
Master in Financial Markets	
- Universidad Complutense de Madrid (Madrid, Spain)	09/1990 - 07/1995
Master in Physics	
- U.N.E.D. (Madrid, Spain)	09/1992 - 09/1997
Bachelor in Mathematics	

Work Experience

- Mora Wealth Management AG (Zurich, Switzerland)	Since 01/2015
Head Investment Advisory	
- Deloitte Consulting (Zurich, Switzerland)	03/2012 - 12/2014
Senior Manager - Strategy Consulting, Financial Services Industry	
- ABN AMRO Private Banking (Zurich, Switzerland)	07/2010 - 11/2011
Head Investment Products & Investment Advisory - Executive Director	

- ABN AMRO Private Banking (Zurich, Switzerland) 04/2007 - 06/2010

  Head Investment Office
- ABN AMRO Private Banking (Zurich, Switzerland) 07/2006 - 03/2007

  Senior Manager Structured Products - Vice President
- Clariden Bank (Zurich, Switzerland) 08/2004 - 06/2006

  Deputy Head Structured Products - Vice President
- BBVA Private Banking (Zurich, Switzerland) 09/2000 - 07/2004

  Portfolio Manager
- Meta4 (Madrid, Spain) 06/1996 - 07/1998

  Software Engineer
- Universidad Complutense de Madrid (Madrid, Spain) 06/1994 - 09/1995

  Physics Faculty Research Assistant