Low-skilled Immigration and Education Policy with Endogenous Fertility

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Preliminary Version
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Abstract

This paper studies the impact of low-skilled immigration on the host country's education policy, which is formulated by the natives via voting and refers to both school funding sources and resources in the public funded schools. When the size of low-skilled immigrants is large, it is found that wealthier natives are likely to opt out from public into private school. The effects of immigration are four-folds: (1) it increases congestion in public school while (2) decreasing the average tax base for education funding; moreover, (3) it reduces the low-skilled wage and so amplifies low-skilled natives' dependence on public education whereas (4) by raising skill premium, it induces high-skilled natives to privately invest in their children's education and hence weakens their support to finance public school. The theoretical predictions are consistent with cross-country stylized facts revealed in both micro and macro data. Moreover, with endogenous fertility, the opting-out decision taken by some native parents results in the empirically observed fertility differential between natives and immigrants.

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1 Introduction

> *I would support [the 19th century-style unlimited immigration] if we lived in the 19th century world where government spending was tiny. But governments now spend huge amounts on medical care, retirement, education, and other benefits and entitlements.*
>
> – Gary Becker, in "Sell the Right to Immigrate" (2005).

Immigration, particularly the inflow of low-skilled individuals, often causes the concern of natives that immigrants with low earning potentials could become a heavy burden on the social welfare system. Public education, as an important redistribution mechanism designed to facilitate social mobility for the upcoming generations, can not but be part of the immigration debate. On the supply side, immigrant workers contribute to tax revenues that can be used to finance public schooling in the destination country. Yet on the demand side, children of immigrants generally have equal access to public resources offered in public school.[1] The aim of this paper is to study how low-skilled immigrants, through their supply of taxes and demand for public education, impacts education policy in the destination country. We claim that, by altering schooling choices of native parents for their offspring, an increasing stock of low-skilled immigrants may lead to a more segregated education system, where native children from wealthy families attend privately funded school with better education quality. Our predictions echo the empirical evidence in the United States that immigration induces "native flight" from public into private school (Betts and Fairlie 2003). They are also consistent with cross-country stylized facts regarding migration and education. The major contribution of our paper is to provide a solid theoretical argument for the mechanism behind.

[1] For instance, California's 1994 Proposition 187, a narrowly-passed ballot initiative to limit the access of immigrants to public education, was declared unconstitutional by federal judge Mariana Pfaelzer in a March 1998 ruling (see Petronicolos and New (1999)). Nevertheless, each state can still manage extracurricular and tutorial services as long as it provides a basic education.

By education system, we refer to the combination of three educational outcomes: 1) how schools are funded, from public or private sources, 2) expenditures per pupil in public and in private schools, and 3) types of parents who send children to public (private) school. We argue that native parents foresee that, with more low-skilled immigration, resources per pupil in public school are decreased because the average tax base is reduced by an increased population with lower wages. As parents are concerned of children's educational achievement, wealthier parents choose to opt out of publicly funded education and send their children to private school where they have to pay out of their own pockets. The reduced participation in public schools has ambiguous effects: on one hand, with some native children leaving public education the stress put on school resources by low-skilled immigration is alleviated; on the other hand, parents who opt out become "double-taxed" for the education of their children, so they tend to be reluctant in supporting taxation for publicly financed education.[2] However, if the number of low-skilled immigrants gets larger, more parents will opt out and public school resources per pupil will surely decline when compared to the initial level. At the aggregate level, it turns out that a larger proportion of low-skilled immigrants among the whole population at destination is associated with a more segregated education regime, where children of wealthier parents are more likely to attend private school and enjoy better school resources whereas students from poorer families, including those with low-skilled immigrant parents, stay behind in public school. Finally, a pure private regime is always possible with low-skilled immigration if there is not a sufficiently high legal minimum to regulate public education expenditures.

We focus in particular on low-skilled immigration based on two considerations. First,

[2]See, for example, Shapiro (1986) where the author discusses the arguments put forward for using public funding to subsidize private schools. One of them is "double taxation" for those parents who send children to private school. This very argument is indeed used by several interest groups that support private school vouchers.

developed economies generally possess the most comprehensive public education system; in the meantime, they are also destinations where large numbers of low-skilled migrant workers arrive. Hence, low-skilled immigrants are matter-of-factly a very relevant component in the local labor market and to a certain degree affect the constitution and distribution of tax revenues.[3] Second, children who are most critically needed to be integrated in the school system are generally those whose parents do not speak the instruction language at destination, and these parents are most likely to be low-skilled immigrants. In this sense, our prediction that wealthier parents opt out first in response to low-skilled immigration is well supported by the evidence provided by Betts and Fairlie (2003) that "native flight" is mostly white students respond to immigrant children who speak foreign languages at home.

As already mentioned, the arrival of immigrants may affect education system through voting support for public education. In practice, immigrants are not immediately granted voting rights, to which only citizens are entitled, and obtaining citizenship can take several years or longer. However, immigrants can soon influence native voters' preferred education policy at least through two channels. First of all, as argued earlier, immigrants have contrasting impacts on the demand and the supply for public resources in education. As soon as voters realize and take into account the fact that they have to share with immigrants both the benefits and the burdens of public intervention in education, their preferred education policy is likely to be affected (Sand and Razin 2006). Second, immigrants may alter the characteristics of the electorate even though they are not part of it. This second channel works through effects on income distribution among the electors. Theoretically and supported by some empirical evidence, an increase in the low-skilled

[3]Betts and Lofstrom (1998) find that the immigrants' level of education relative to the natives' has declined over the two decades before 1990. Borjas (1995) documents that, in the U.S. Census, about 37% of immigrants in both 1980 and 1990 were high school dropouts, compared to just 23% of natives in 1980 and 15% of natives in 1990.

proportion of workforce could imply a higher skill premium.[4] With their increased income, high-skilled parents are likely to prefer better education for their children. When public schools fail to provide their desired quality of education, these parents will choose to opt out, which in turn affects the voting outcome over the funding for public schools. Notice that an increased skill premium due to low-skilled immigration is not required in order for the mechanism to deliver the above-mentioned predictions; rather, it reinforces the mechanism as low-skilled parents grow more dependent on public education.

This paper follows de la Croix and Doepke (2007) in incorporating endogenous fertility to study schooling choices. It is well documented that parents are faced with a quantity-quality trade-off for their children, which is to say, the amount of educational expenditures that parents desire to spend on their children are negatively correlated to the number of children they would like to have (Becker and Barro 1988). If the opportunity cost of having children is higher for high-skilled parents, they might decide to have less children but educate them better. Accordingly, fertility differentials may arise among parents with different levels of income. In this respect, the arrival of low-skilled immigrants implies an increase in the amount of population featuring a possibly higher fertility rate and an increase in the opportunity cost of fertility for high-skilled workers as their wage goes up (because skilled labour gets relatively scarcer). Notice that we do not assume any exogenous difference in fertility behaviour between natives and immigrants. Such culturally-based differences might exist in reality but they would only strengthen our main conclusions. We simply assume that low-skilled immigrants are slightly less productive than natives, to reflect at least the adjustment costs of migration.[5]

[4] As an example, Borjas, Freeman, and Katz. (1992) estimate that the arrival of less skilled immigrants could have decreased the wages of high school dropouts relative to high school graduates by about 3% between 1980 and 1988.

[5] Adjustment costs of migration is an assumption often used in characterizing immigrants in theoretical model; meanwhile, their existence is also supported by empirical studies. See, for example, Batista (2008).

As several elements entwines the model, it is important to set a timing structure for the events. First, parents choose the optimal number of children consistent with their expected schooling choices for their offspring. Second, natives vote over the income tax rate and public expenditures per pupil. Finally, in accordance with the education policy implemented, each household chooses the type of school where they would like their children to be educated. Since perfect foresight is assumed throughout the model, parents' expected schooling choices for their children must coincide with their *a posteriori* choices. This timing of events is motivated with reasonable considerations: fertility decisions usually take place before educational choices are made, and educational choices occur in a given framework of education regime that is shaped by the contemporary education policy.[6]

We begin by relating our contribution to previous streams of literature in Section 2. Section 3 describes stylized facts concerning migration and relevant variables for education policy in the destination country. Section 4 formally presents the model economy, then we depict each education regime and its existence conditions in Section 5. Finally, concluding remarks are given in Section 6.

2 Literature Review

This work relates to several streams of literature. First of all, we refer to the literature of quantity-quality trade-off, which highlights the interlink between fertility and education decisions (Becker and Barro 1988; de la Croix and Doepke 2003; de la Croix and Doepke 2004; Tamura 1994). When fertility is endogenous, parents who prefer higher quality of their offspring may choose to have less children for a given amount of resources to be

[6]de la Croix and Doepke (2007) consider both this same timing and another timing with educational choices committed before voting. They find that the quality of public school is lower or equal when parents make their schooling choices after the determination of policy variables.

devoted to child rearing. Therefore, when education regimes are to be compared, the decisions on fertility and education should be considered jointly.

The structure of our model follows de la Croix and Doepke (2007), who show that in democracies a public regime tends to be established unless income distribution is too unequal, whereas in non-democracies, a multiplicity of equilibria may arise. Our model differs by including in the economy low-skilled immigrants who do not vote but contribute to the demand and the supply for public education.[7] In addition, we remove the assumption of a linear production technology thus allowing for a distributional effect of low-skilled immigration, which endogenously raises skill premium and impacts the income distribution of the electorate. We also consider explicitly the adjustment costs of migration, which negatively affect the productivity of immigrants so that they receive a lower net wage than low-skilled natives do. Therefore, the only differences between low-skilled natives and low-skilled immigrants are with respect to voting rights and net wages.

As policy variables have redistributive effects, this paper also relates to the literature associating income redistribution, voting, and education policy. Whereas standard models of publicly provided private goods demonstrate a mechanism of redistribution that is from the rich to the poor (Atkinson and Stiglitz 1980), following works suggest a reverse direction (Johnson 1984; Benabou 2000). In particular, Fernandez and Rogerson (1996) model education as a good that is only partially publicly provided through a subsidy voted by the agents. Such a framework is able to generate the outcome that education of the rich is in fact subsidized by the poor who cannot afford the remaining (private) costs of education as long as income distribution is sufficiently unequal. In other words,

[7] de la Croix and Doepke (2007) consider the case of unequal distributed political power where some electors are more determinant than others for the final outcome in order to study the implications of their model for non-democracies. Our framework shares with it the asymmetry in voting power of agents, but not of electors: in other words, we introduce a further category of agents (immigrants) who cannot vote.

there emerges the - maybe counter intuitive, but empirically supported (Bishop 1977; Peltzman 1973) - result that redistributive policies tend to benefit the education of the rich thus exacerbating inequality. Different from Fernandez and Rogerson (1996), our model does not impose a unique education regime but makes it endogenously determined. While many works in the literature assume a majority voting mechanism, we follow de la Croix and Doepke (2007) in adopting probabilistic voting for the determination of education policy as it allows for solutions even when preferences are not single-peaked.[8] It is assumed that each voter has his/her own probability distribution of voting over the concerned policy variables. The voting outcome is equivalent to a smooth aggregation of preferences among all the electorate, so it is not the median voter but the whole distribution of voters that matters.

Our work is also related to the literature studying the effect of migration on social policy at destination (Borjas 1994; Benhabib 1996; Sand and Razin 2006). Razin, Sadka, and Swagel (2002) study the effect of migration on redistributive policies, by developing a model of low-skilled migration and human capital formation. They consider two contrasting effects of migration. On one hand, immigrants support the coalition claiming for greater redistribution, but on the other hand, voters know that they have to share tax revenues with immigrants. This latter effect, known as "fiscal leakage", may dominate and imply a lower tax rate with low-skilled immigration. In other words, even when the median voter is a low-skilled native, s/he will prefer less redistribution due to the fact that public resources are diluted with low-skilled immigration. In contrast, our model assumes that immigrants are not entitled to vote, but their children cannot be excluded from attending pubic school. With probabilistic voting, we also predict that

[8]The problem of non-single-peaked preferences over education policy is that, when applied to majority voting, the median elector theorem will fail to hold. This problem can be found in several contribution based on such an approach: Glomm and Ravikumar (1998), Epple and Romano (1996), Stiglitz (1974), Bearse, Glommb, and Ravikumarc (2005).

low-skilled immigration may result in a lower tax rate to finance public education, but the reasoning behind is the so-called "double taxation".

As already mentioned, Betts and Fairlie (2003) find evidence that inflows of immigrants encourage natives parents to send their children to private school at the secondary level of education. Using the U.S. Metropolitan Areas for 1980 and 1990, they estimate that for every four immigrants who arrive in public high schools, there is one native students who switches to private school. While some have suggested that such a result may be related to racial prejudice of the natives (Conlon and Kimenyi 1991) and others to a lower quality of expected attainments in public school through the so-called "peer-group" channel (Henderson, Mieszkowski, and Sauvageau 1978) or bad-signaling of academic quality, our model is able to provide a theoretical ground to the authors' conjecture that, by increasing the pressure on resources in public schools, the arrival of immigrants induces more native parents to opt out in favor of private schools; thus, it also lowers voters' support for public education funding. In this respect, the choice of focusing on low-skilled immigration is supported by the finding that "native flight" is more pronounced for white natives responding to immigrant children who do not speak English at home and thus more likely to come from low-skilled households.

3 Cross-Country Stylized Facts

In addition to the empirical evidence provided by Betts and Fairlie (2003) that immigration is associated with natives opting out of public secondary schools in the U.S., we put forward in this section some cross-country stylized facts, which in general are in accordance with our theoretical predictions. In the first part, we present some correlations using aggregated country data from the United Nations Educational, Scientific and Cultural Organization (UNESCO) and from the Organisation for Economic Co-operation

and Development (OECD). The second part takes advantage of the micro data collected by the OECD Program for International Student Assessment (PISA), 2003.

3.1 Macro Data: UNESCO and OECD

How does immigration appear to be related with education policy at the macro level? Although a detailed empirical investigation of this issue goes far beyond the purpose of this work, it is however useful to present some stylized facts in order to address the correlations between changes in immigration and in variables related to the education system of destination countries, including public education expenditure per pupil, attendance rate in private school, private education expenditure and composition of education funding between private and public funds.

For this purpose, we use UNESCO data, combined with Docquier-Marfouk (2006) dataset on international migration by educational attainment. This dataset features the advantage of containing stocks of immigrants residing in major destination countries and it allows to distinguish immigrants according to their educational attainment.[9] Nevertheless, UNESCO data contain some limitations. For instance, they include in the category of private schools those that are publicly funded but privately managed, whereas the differentiation that is of our interest lies essentially in the source of funding. Moreover, both data on private share of education funding and data on private education spending are not provided with sufficient completeness.[10] For these reasons, we use a dataset

[9]Precisely, the dataset distinguishes immigrants who have completed tertiary, secondary, or lass than secondary education. Education can be used as a good - though imperfect - proxy of an immigrant's occupational skill. The following results are consistent with identifications of low-skilled immigrants either as those immigrants with less than secondary education or as those immigrants with less than tertiary education.

[10]In particular, the absolute amount of private expenditures in education is not provided at all, whereas data on private share of education funding are rounded to the first decimal, so that there are too few different data values (two at the primary level and four at the secondary level) .

created from the OECD data when developing the analysis for the variables concerning privately funded schools (participation rate in private school, private spending and share of private education expenditures), whilst we use the UNESCO data for public expenditures per pupil (normalized as share of GDP per capita).

The analysis is based on changes (i.e. differences[11]) rather than levels of the variables in order to reduce the spurious effect of country-specific time-invariant features and to make more proper cross-countries comparisons.[12] The span of the interval over which the changes in education variables are computed is taken as 5 years, from 1999 to 2004.[13] We take the variation in migration as slightly preceding that on education: i.e. the difference in the ratio of immigrants over total population refers to periods preceding 2000. Doing so allows both to mitigate the impact due to the reverse direction of causation and to be more consistent with the timing structure of the model described in Section 4.

In Figure 3, the change in the share of participation in publicly funded schools is plot against the change in the share of foreign born population.[14] The correlation is negative at the 90% significance level after the removal of an outlier; thus, it supports the hypothesis that an increase in immigration could be associated with a greater participation in privately funded schools. Figure 4 plots instead the change in the private share of education funding, where a positive slope is observed, which is again significant at the 90% level. Thus, an increase in immigration is correlated with a greater share of education expenditures coming from private sources. In Figure 5, we see also that the absolute level of private expenditure has grown with an increase in immigration. In

[11]For private expenditure per capita on education we use the growth rate as it is not normalized as a share.

[12]Other correlates could clearly continue to have an impact, but the main objective is to provide stylized empirical evidence; isolating rigorously the single effect of migration on education variables would require a very careful econometric analysis and more sophisticated techniques.

[13]Due to data availability, we choose changes over 1999-2004 in order to obtain the largest number of observations.

[14]See Fig. 3 for details on variable construction.

Figure 6, we take advantage of the UNESCO and Docquier-Marfouk dataset to address the correlation with public expenditures per pupil (as percentage of GDP per capita). At the 95% level of significance, a decrease in this variable is associated with a greater size of immigration.

Certainly, these graphs cannot - and are not meant to - provide a definitive answer, but they seem to suggest a consistent story: more immigration tend to be associated with a shift of pupils and resources into private schools so that the weight of private expenditure in education also increases. If so, we should observe that, *ceteris paribus*, countries with a larger presence of immigrants are associated on average with lower participation rates in public schools. We test this conjecture by dividing countries into four groups according to the percentile distribution of participation in public schools. In both year 2000 and year 2005, we observe that the average share of immigrants out of total population is decreasing as we pass from a group of countries with a lower participation rate to one with a higher participation rate. Further, the mean of immigrants' share is larger, at the 90% significant level, for the group with the lowest attendance rate than for the group with the highest rate (see Tables 1 and 2).[15]

Lastly, we conduct a similar mean-difference test for the hypothesis that countries experiencing negative changes in public expenditures per pupil are those with larger increases in the low-skilled immigrants' share of population. The one-tailed difference is significant at 95% for primary schools and 90% for secondary schools (see Table 3).[16] When we investigate the correlation between changes in public expenditures per pupil and past changes in the share of immigrants with tertiary education, we observe flat slopes at all

[15]It is checked that no country is infinitesimally excluded from a group. The use of of equal variance assumption is confirmed by the Kolmogorov-Smirnov test which can not reject such an hypothesis. Results are robust to other criteria for dividing the groups, such as quintiles or considering in one group all the countries with a full public system and in the opposite group those with less than a 95% attendance rate.

[16]Betts and Fairlie (2003) find significant evidence of "native flight" only for secondary but not for primary schools.

school levels. This implies that the negative correlation is indeed associated with immigrants characterized by lower skill/education. As a robustness check, we also study the correlation between pupil-teacher ratio and changes in immigrant share by educational attainment. Although the coefficients are not significant possibly due to less observations, the results conform to those shown with changes in public expenditures per pupil.

3.2 Micro Data: PISA 2003

In this part, we use micro data collected by PISA, an OECD program that conducts internationally standardized evaluation on the knowledge and skills of 15-year-olds in schools. Two datasets produced in 2003 are combined for our analysis. Data generated from the school questionnaire provides information on each sampled school, including shares of funding sources, public or private management, and percentage of students who have a first language other than the test language used in school. Data originating from the student questionnaire identifies the school attended by the respondent and details his or her family background, including foreign-born status of the student and of each parent, language spoken at home, each parent's occupation and educational attainment. The combined dataset covers 35 countries in total, 24 of them OECD members.[17]

As a first step of analysis, we identify three types of students by their immigration background and by their parents' occupational status.[18] We define an immigrant student as one whose parents are foreign-born. By this definition, we check that we include all samples who themselves are also foreign-born. In comparison, native students refer to

[17] Although there are 41 countries participating in PISA 2003, we find missing data on the interested variables for Austria, France, Italy, Spain, and the United Kingdom. Moreover, we find no Korean student sample who satisfies our definition as an immigrant student.

[18] In the model, occupational skill is the synonym of productivity that directly affects family earnings. However, occupational status in reality only serves as a rough measure of household income, which is not available in the PISA data. Notice that, for the purpose of this study, we disregard all samples of immigrant students with high-skilled parents.

the native-born samples with at least one native-born parent. With regard to parents' occupational status, PISA offers two alternative measures. Both measures are coded based on each respondent's description on his/her parent's main job and job functions. The first measure distinguishes four classifications: white-collar high-skilled, white-collar low-skilled, blue-collar high-skilled and blue-collar low skilled. The second measure maps each occupational code into the International Socioeconomic Index (ISEI) (Ganzeboom et al., 1992). In order to fit the occupational measure with the classification in the model, we consider only the students with at least one white-collar high-skilled parent as those with high-skilled parents and others are students with low-skilled parents. Alternatively, students with at least one parent who is assigned an above-national-sample-median ISEI are arbitrarily regarded as those with high-skilled parents and others as students with low-skilled parents. Since the results are very much consistent under both measures, we report below only the statistics produced with the ISEI alternative. Among the final sample of 197,736 observations in total, 5.89% are identified as immigrant students with low-skilled parents, 50.77% native students with low-skilled parents and 43.34% native students with high-skilled parents.

Table 4 presents the average public share of school funding for each type of students by country.[19] Figure 7(a) plots all 35 countries according to their average shares of public funding and the variations of the share of public funding across types of students within each country.[20] It is observed that there are approximately three clusters of countries. We define countries with lower than 60% of average shares as in the private regime. They are Indonesia, Mexico, Macao-China and Turkey, all characterized by low public shares of school funding for each type of students. On the other hand, we find there

[19]We follow the PISA 2003 Data Analysis Manual (OECD, 2005) in the computation of means, standard errors on the mean and the confidence intervals.

[20]The variation of public shares of school funding is defined as $\frac{S_{max}-S_{min}}{S_{max}}$, where S_{max} and S_{min} are respectively the maximum and the minimum of the average public shares for all three types of students.

is a cluster of countries with a variation less than 3% and high average public shares of school funding. We define these countries as in the public regime. Most of them are the Scandinavian countries or belong to the former USSR (Union of Soviet Socialist Republics). The rest of the countries are defined as in the segregation regime, with those carrying variations larger than 10% as severely segregated.

What we find the most interesting is that in all countries listed in the segregation regime, except for Tunisia, we observe that native students with high-skilled parents attend schools with the lowest average public share of total funding, or, in other words, they are more likely to attend private schools than the other types of students. For the majority of these countries, we can see that native students with low-skilled parents tend to go to schools with a lower average public share of funding when compared to immigrant students with low-skilled parents (see Table 4 and Figure 7 (b)).[21,22]

Next, we combine the PISA 2003 dataset with the Docquier-Marfouk dataset (2006) in order to take advantage of the information about skills of immigrants by destination. At the end, we have data on immigration stocks for eight countries listed under the public regime (Czech Republic, Finland, Hungary, Iceland, the Netherlands, Norway, Poland and Sweden) and 12 countries under the segregation regime (Australia, Belgium, Canada, Denmark, Germany, Greece, Ireland, Japan, New Zealand, Portugal, Switzerland and the United States). Table 5 provides the average values and the 10-years change of low skilled immigrants (measured both as a stock and as a share of total population) for

[21] For three out of five severely segregated countries, namely Australia, Tunisia and Uruguay, we observe that this does not hold true as it is the native students with low-skilled parents who go to school with the highest average public share of total funding. Though significance in the mean difference is an issue, one can still suspect that low-skilled immigrants in some countries might be on average wealthier than their native counterpart, despite the adjustment costs of migration. We find that, the average ISEI score is indeed higher for the low-skilled immigrants in Tunisia and Uruguay.

[22] As a robustness check, we also look at the average public share of school funding of students who speak a foreign language at home and those who speak at home the test language, i.e. the language in which school tests are conducted. We find that, for most of the countries, those who speak a foreign language at home attend schools with a higher average share of school funding coming from public sources.

public and segregation regimes, distinguishing two possible classification of "low skill" (less than secondary or less than tertiary education); in the last row, the correlations between regimes and immigration variables are provided. We find that the segregation regime is indeed positively correlated with both larger stocks and greater changes of low-skilled immigrants, despite the measure considered. Although correlations are generally non-significant largely because of the small sample size, it is worth highlighting that significance is obtained for the positive correlation of segregation with the change in the share of low-skilled (less than secondary education) immigrants, thus supporting that an increase in the relative size of low-skilled immigrants indeed tends to be associated with segregation in education regime. Finally, the test of proportions confirm that countries with segregation regimes exhibit significantly larger low-skilled immigrant share and larger increase in this share.

All these pieces of evidence seem to corroborate the idea that there exists a link between low-skilled immigration and the education system. In Section 4, consistently with what observed in the data, we put forward a general equilibrium model of rational expectations and voting, which predicts that a larger size of low-skilled immigration makes a public regime less likely to be an equilibrium as more parents send their children into private school.

4 Model Economy

In this section, we assess the building blocks of our model economy. Let us begin with household decisions, then we move to the production sector and finally to the political mechanism.

4.1 Households

The economy is populated by households who have identical preferences over consumption c, the number of children n and children's human capital κ. Part of the population is composed of immigrants (M). Natives are either high-skilled (H) or low-skilled (L). Since we focus on low-skilled immigration, we assume that all immigrants are low-skilled.[23] The objective function is written as follows:

$$U^i = \ln(c^i) + \gamma[\ln(n^i) + \eta \ln(\kappa^i)], \qquad i = \{M, L, H\} \tag{1}$$

The parameter $\gamma > 0$ captures the weight of child-caring in the household utility, whereas $\eta \in]0, 1[$ denotes the relative taste for child quality when compared to the quantity of children.[24] Notice that no exogenous difference in preferences is imposed between immigrants and natives.[25]

Each household is endowed with one unit of time. Raising one child is assumed to cost a fraction $\phi \in]0, 1[$ of parents' time so that the opportunity cost of having children is higher for parents with greater earning potentials. In addition, human capital is acquired through formal education, which incurs a pecuniary cost. Parents may choose to educate their children in public school so that $\kappa^i = s$, where s denotes the quality of public school financed by general income taxation, or in private school such that $\kappa^i = e^i$, where e^i denotes the quality of education purchased by parents on the private schooling market. Assuming that private education expenses are tax non-deductible, we write the

[23] Alternatively we can say that immigrants, though high-skilled, can have access only to low skill job.

[24] It is constrained to be lower than one to guarantee the solution of parent's optimization problem. See de la Croix and Doepke (2007).

[25] Sand and Razin (2006) assume a higher exogenous fertility rate for immigrants than for natives. If we make a similarly assumption that immigrants have higher preferences for quantity over quality (i.e. a lower η for immigrants than for natives), we argue that it only strengthen our results.

household budget constraint as below:[26]

$$(1-\tau)(1-\phi n^i)w^i = c^i + \epsilon\, n^i \kappa^i \qquad \epsilon = \begin{cases} 1 & \text{if } \kappa^i = e^i \\ 0 & \text{if } \kappa^i = s \end{cases} \tag{2}$$

where $\tau \in]0,1[$ is the proportional income tax rate that raises government revenue to finance public education. Notice that enrolling in public schools is free of charge, and that parents opting for private schooling have to pay for the full expenses to educate their children in a private school. It is assumed that the costs of school quality per unit are unity.

The timing of events is as follows. First, each household makes their fertility decision, consistent with the expected schooling choice for their offspring. Next, natives vote over a proportional income tax rate and public school expenditures per pupil; consequently, the outcome of the voting stage determines the quality of public education. Measuring between the determined public school quality and their desired quality of education for offspring, each household (both natives and immigrants) then makes the final decision on whether to educate their children in public schools that are free of charge or in private schools where parents pay for children's education out of their own pockets. Note that perfect foresight is assumed for all individual decisions.

Before addressing the labor market block of the model, it is convenient to show the results of fertility decision by maximizing (1) subject to (2). Parents anticipating public

[26]Regulations vary from country to country on tax deduction of private school expenses. We assume non-deductibility bearing in mind that expenses paid for private elementary and secondary education in the United States are generally tax-nondeductible; de la Croix and Doepke (2007) assume instead full deductibility. The main difference is that, when private education expenses are tax deductible, the choice between quality and quantity of child-caring is not affected by taxation. However, the qualitative result maintains valid that low-skilled immigration may cause natives to opt out of public education.

schooling, i.e. $[\kappa^i]^e = s$, choose the following fertility rate $\hat{n}$:

$$\hat{n} \equiv \hat{n}^i = \frac{\gamma}{\phi(1+\gamma)}. \tag{3}$$

As expected, fertility is increasing in the child-caring parameter γ and decreasing in the time cost of child-rearing ϕ. On the other hand, parents anticipating private schooling choose $\tilde{n}$ with the expectation $[\kappa^i]^e = e^i$:

$$\tilde{n} \equiv \tilde{n}^i = \frac{\gamma(1-\eta)}{\phi(1+\gamma)} \tag{4}$$

$$e^i = \frac{(1-\tau)\,\phi\eta w^i}{(1-\eta)} \tag{5}$$

One can immediately observe the following lemma

Lemma 1 (Fertility Differential) *Parents who anticipate private schooling choose to have less children when compared to those who anticipate public schooling.*

$$\tilde{n} < \hat{n}$$

Proof: This inequality is immediately proved by comparing equations (3) and (4). ■

The intuition behind is that, given identical preferences, each household has the same optimal rule of allocation to distribute resources between child-caring and consumption.[27] Those parents who anticipate public schooling are faced only with time costs when having children since there is no direct costs associated with children's education. In comparison, parents anticipating private schooling expect to pay for the full pecuniary costs for their children to acquire human capital, and therefore, these parents save on

[27] More precisely, the total resources available to a household are the unity time endowment evaluated at the market wage, or w^i. The share of resources devoted to consumption is constantly $\frac{1-\tau}{1+\gamma}$.

time costs by having less children. This is why the quantity-quality trade-off parameter η only appears in $\tilde{n}$.

The private education spending e^i is increasing in the taste for children's human capital η, in household income w^i and in the time cost of child-rearing ϕ. The last result is so because, when child-rearing becomes more time-consuming, having one additional child is relatively more expensive than providing better education for the children who are already born. Further, it is observed that e^i is decreasing in the tax rate τ due to our tax non-deductibility assumption. In other words, making private education tax deductible will lead to a higher quality of private schooling in our model. Similarly, any policy tool that is made to reduce tuition and other charges of private education will have the same effect in increasing private school spending. Hence, for a given level of public school quality s, this implies an enlarged quality gap between private and public schools, inducing a stronger incentive to opt out of public education, especially for high-skilled parents who receive a higher wage rate and thus are more able to afford the expenses of private education.

4.2 Production

Let us now move to the labor market block of our economy. In order to capture the potential effect of low-skilled immigration on the skill premium, a cobb-douglas production function is assumed with high- and low-skilled labor as imperfect substitutes that are combined to produce a composite output. Later on, it will become clear that our theoretical predictions remain valid even if constant wages rates are assumed. However, an increased skill premium with low-skilled immigration reinforces the mechanism and speed up the transtion of education system in the host society. Additionally, it is assumed that immigrants bear adjustment costs of relocating to the destination coun-

try.[28] These costs are reflected in receiving lower wages than do low-skilled natives, or technically speaking, in the parameter $\delta \in]0,1[$ which denotes a lower productivity for low-skilled immigrants. This is the only exogenous difference between a low-skilled immigrant and a low-skilled native, except for that immigrants cannot vote.

Denote y as the amount of products, and h, l and m as total hours devoted to work by high-skilled natives, low-skilled natives and low-skilled immigrants respectively. Production then reads as:

$$y = h^{\alpha}(l + \delta m)^{1-\alpha} \qquad \alpha \in]0,1[$$

Under perfect competition, $y = mw^M + lw^L + hw^H$ with

$$w^M = \delta(1-\alpha)\left(\tfrac{h}{l+\delta m}\right)^{\alpha} \tag{6}$$

$$w^L = (1-\alpha)\left(\tfrac{h}{l+\delta m}\right)^{\alpha} \tag{7}$$

$$w^H = \alpha\left(\tfrac{h}{l+\delta m}\right)^{\alpha-1}. \tag{8}$$

Without loss of generality, we normalize the number of low-skilled natives to 1, and express the ratio of high- to low-skilled natives by ξ, and the ratio of immigrants to low-skilled natives by μ. Moreover, the total hours devoted to work for each household are the unity time endowment less time spent on child-rearing. Hence,

$$h = \xi\left[\psi^H(1-\phi\hat{n}) + (1-\psi^H)(1-\phi\tilde{n})\right] \tag{9}$$

$$l = \left[\psi^L(1-\phi\hat{n}) + (1-\psi^L)(1-\phi\tilde{n})\right] \tag{10}$$

$$m = \mu\left[\psi^M(1-\phi\hat{n}) + (1-\psi^M)(1-\phi\tilde{n})\right] \tag{11}$$

[28] For our purposes, the assumption of adjustment costs basically works to imply lower wages for immigrants. Evidence that immigrants receive *ceteris paribus* a lower wage than natives has been found in several studies (Borjas 1994). Using the 1970 U.S.A. Census that, Chiswick (1978) estimates that an immigrant at the time of arrival is rewarded 17% less of wage than is a native.

with ψ^i denoting the share of parents type i who anticipate to educate children in public schools. The following restrictions are imposed: $\xi \in]0, (\frac{\alpha(1+\delta\mu)}{(1-\alpha)(1+\gamma\eta)})[$ and $\mu \in [0,1]$. The former condition is made to ensure skill premium by assuming that high-skilled labor is always scarcer.[29] The latter restriction avoids the implausible outcome that there are more low-skilled immigrants than low-skilled natives, but it can be easily relaxed.[30] It is hence implied that $w^M = \delta w^L < w^L < w^H$.[31]

4.3 Political Mechanism

As explained in Section 1 we assume that public school quality s and the proportional income tax rate τ are determined via probabilistic voting, as it displays convenient properties that take into account all distributions of preferences. In principle, probabilistic voting is based on the idea that each agent has a probabilistic distribution over the preferred policy variable, which may reflect ideologies or other exogenous factors. It can be proved that the political outcome under probabilistic voting corresponds to implementing the following social welfare function Ω:[32]

$$\Omega[\tau, s] = \xi[\psi^H \hat{U}^H + (1-\psi^H)\tilde{U}^H] + [\psi^L \hat{U}^L + (1-\psi^L)\tilde{U}^L] \tag{12}$$

where $\hat{U}^i$ and $\tilde{U}^i$ denote respectively the (indirect) utility of native parents type i who anticipate public schooling ($n^i = \hat{n}$ and $[\kappa^i]^e = s$) and of those who anticipate private schooling ($n^i = \tilde{n}$ and $[\kappa^i]^e = e^i$). The maximization of $\Omega[\tau, s]$ is constrained to the

[29] The upper bound of ξ is derived from the sufficient condition for skill premium: $\frac{w^H}{w^L} = \frac{\alpha(l+\delta m)}{(1-\alpha)h} > 1$, or $\frac{\alpha}{1-\alpha} > [\frac{h}{l+\delta m}$.

[30] One can think that μ itself may be affected by education system in the receiving country. For the sake of simplicity, we consider μ as exogenous in a partial equilibrium set-up.

[31] Alternatively, we could have had introduced a skill productivity parameter which would have also guaranteed that high-skilled workers receive higher wages. For the sake of parsimony, we impose simply that reasonable restriction on ξ.

[32] See de la Croix and Doepke (2007) also for further details on probabilistic voting mechanism.

government budget balance, which requires that the tax revenue:

$$\tau\big\{\xi w^H\left[\psi^H(1-\phi\hat{n})+(1-\psi^H)(1-\phi\tilde{n})\right] + w^L\left[\psi^L(1-\phi\hat{n})+(1-\psi^L)(1-\phi\tilde{n})\right] + \mu w^M\left[\psi^M(1-\phi\hat{n})+(1-\psi^M)(1-\phi\tilde{n})\right]\big\}$$

equals public education expenditures:

$$s\,\hat{n}\left(\xi\,\psi^H+\psi^L\ +\mu\,\psi^M\ \right).$$

From this maximization problem we have the following lemma:

Lemma 2 (Voted Policy) *The proportional income tax rate determined via probabilistic voting is:*

$$\tau^* = \frac{\gamma\,\eta\,(\xi\,\psi^H+\psi^L)}{(1+\gamma\,\eta)(1+\xi)} \tag{13}$$

The tax rate exhibits the following properties:

- $\frac{\partial\tau^*}{\partial\gamma} = \frac{\partial\tau^*}{\partial\eta}\ > 0$
- $\frac{\partial\tau^*}{\partial\xi}\ < 0 \quad if \quad \psi^H < \psi^L; \qquad \frac{\partial\tau^*}{\partial\xi}\ = 0 \quad if \quad \psi^H = \psi^L$
- $\frac{\partial\tau^*}{\partial\psi^H} = \xi\,\frac{\partial\tau^*}{\partial\psi^L}\ > 0$

The corresponding quality of public school is tax revenue per public school pupil:

$$s^* = \frac{\tau^* y}{\hat{n}(\xi\,\psi^H+\psi^L+\mu\,\psi^M)} \tag{14}$$

Proof: Equations (13) and (14) results from the first order conditions of maximization. Since $\Omega\,[\tau, s]$ is a sum of concave utilities and the constraint is linear in s and τ, the

second order condition for a maximum is satisfied. In order for equation (13) to represent a tax rate, it has to satisfy $\tau^* \in [0,1]$. The fact that τ^* is non-negative is immediate. To prove it is no greater than 1, notice that it can be decomposed as the product of two non-negative terms both no grater than 1: $\frac{\gamma\eta}{1+\gamma\eta}$ and $\frac{\xi\psi^H+\psi^L}{1+\xi}$ with $\psi^i \in [0,1]$. The comparative statics are obtained by taking derivatives of Equation (13). ■

Intuitively, the tax rate depends positively on the propensities to spend for children, γ and η, and on native parents' anticipated participation in public school, ψ^H and ψ^L. Moreover, if compared to low-skilled natives, a less share of high-skilled natives anticipate public schooling for their children (as it will be shown to be always the case if the shares are not equal), then an increase in the relative size of high-skilled natives, ξ, will lead to a lower tax rate. The reason is that those parents who anticipate private schooling support less redistribution through public education provision, from which their children do not benefit. By the same token, an increase in ξ with $\psi^H < \psi^L$ implies that there will be an increase also in voting weight for the high-skilled voters who tend to ask for smaller redistribution.

Inspecting equation (14), one can see that at the denominator lies the total number of children expected to attend public school; thus, for a given amount of tax revenue, higher expected participation in public school (ψ^i) leads to a lower public school quality. Moreover, since $y = hw^H + lw^L + mw^M$ with h, l and m defined in equations (9), (10) and (11), higher expected participation in public school also results in a lower tax base because parents who anticipate public schooling give birth to more children, which requires more time devoted to child-rearing and less to work. Nevertheless, the income tax rate is as above-mentioned increasing in natives' anticipated participation in public education. While the expected participation of immigrant children unambiguously lowers public school quality *ceteris paribus*, the expected participation of native children

induces contrasting effect. Finally, an increase in the size of low-skilled immigrants (μ) positively contributes to public school quality through an increased tax base (a positive effect on the supply side); however, it lowers public school quality when children of new immigrants attend public schools (a negative effect on the demand side, or the congestion effect).[33]

Notice that the voted tax rate is not directly affected by the size of low-skilled immigrants, nor by the share of them anticipating public schooling. In fact, μ and ψ^M only affect the quality of public school. This occurs because the socially determined tax rate reflects aggregated preferences of natives over the allocation of income between consumption and child-caring. With the assumed homothetic utility function in equation (1), this rule of allocation is not altered by the income level but determined by preferences and electorate composition.[34] Denote $\Gamma = \frac{\gamma\eta}{1+\gamma\eta} \in]0,1[$, it can be regarded as the weight that a society places upon education as opposed to consumption. Indeed, if all voters expect public education, the voted tax rate corresponds exactly to Γ. However, as long as there are some native parents anticipating to opt out of public education and to choose private schooling, the tax rate decreases accordingly since these parents do not expect to benefit from public schools and thus tend to vote for a lower tax rate. In Section 5, we will show how low-skilled immigration alters native parents' schooling expectation; that is to say, μ and ψ^M enter indirectly into the voted tax rate τ^*.

[33] As it will be shown later, all children of low-skilled immigrants go to publicly funded schools as long as natives still support public expenditures for education.

[34] Indeed, it is noticed that the technology parameter α and the adjustment costs δ, which affect wages, play no role in determining the tax rate. In short, μ does not affect the tax rate through the skill premium and the tax base channels.

4.4 Equilibria

In this subsection, we characterize the equilibria. Up to now, ψ^i has been dealt with as an exogenous parameter that reflects the share of parents type i anticipating public schooling. Under the assumption of perfect foresight, parents' expected schooling choices will coincide with their *a posteriori* decisions. Hence, ψ^i is effectively also the public school participation rate. This is, as a matter of fact, an equilibrium outcome such that parents' preferences and the resulting education regime are consistent.

Definition 1 (Equilibrium) *A set of public school participation rates* $\{\psi^H, \psi^L, \psi^M\}$*, a set of policy variable* $\{s^*, \tau^*\}$ *and a set of households variables* $\{\hat{n}^i, \tilde{n}^i, e^i\}$ *constitutes an equilibrium if and only if:*

$$\begin{cases} \psi^i = 1 & \Leftrightarrow \ \hat{U}^i > \tilde{U}^i \\ \psi^i \in [0,1] & \Leftrightarrow \ \hat{U}^i = \tilde{U}^i \\ \psi^i = 0 & \Leftrightarrow \ \hat{U}^i < \tilde{U}^i \end{cases} , \quad \forall i.$$

The interpretation is that, given own fertility decision and the voting outcome, parents then make the decision on the third event: educational choices for their offspring, which are in effect the realization of self-fulfilling prophecy on anticipated schooling choices. Since all households have the same preferences and parents of the same type receive the same wage, parents type i will all choose public education if it renders higher utility, and the same goes for private education. However, when the resulting utility does not differ from one schooling choice to the other, some parents of type i will choose public education while others pay for children's education out of their own pocket.

In order to investigate further, we proceed as follows. First, we obtain from the government budget balance and write the tax rate as a linear function in s: $\tau(s) =$

$s \cdot T(\psi^H, \psi^L, \psi^M)$ where $T(\cdot) = \frac{\hat{n}(\xi\psi^H + \psi^L + \mu\psi^M)}{y(\psi^H, \psi^L, \psi^M)} \geq 0$.[35] Then $\tau(s)$ is plugged into the indirect utility function V^i where fertility and private education spending have been solved for parents with either schooling choices (see equations (3), (4) and (5)). In this way, indirect utilities depend only on the policy variable s and public school participation rates ψ^i:

$$V^i = \begin{cases} \hat{V}^i(s, \psi^H, \psi^L, \psi^M) \\ \tilde{V}^i(s, \psi^H, \psi^L, \psi^M) \end{cases} \quad \text{if} \quad \begin{array}{l} n^i = \hat{n} \text{ and } \kappa^i = s \\ n^i = \tilde{n} \text{ and } \kappa^i = e^i \end{array}, \qquad i = \{M, L, H\}.$$

Next, we define $\Delta^i = \hat{V}^i - \tilde{V}^i$. Therefore, at the equilibrium as defined in definition 1, it must be that

$$\begin{cases} \psi^i = 1 & \Leftrightarrow \quad \Delta^i(s, \psi^H, \psi^L, \psi^M) > 0 \\ \psi^i \in [0, 1] & \Leftrightarrow \quad \Delta^i(s, \psi^H, \psi^L, \psi^M) = 0 \\ \psi^i = 0 & \Leftrightarrow \quad \Delta^i(s, \psi^H, \psi^L, \psi^M) < 0 \end{cases}, \qquad \forall i.$$

It is clear that the set of equilibrium public school participation rates $\left\{\psi^H, \psi^L, \psi^M\right\}$ is affected by the socially determined quality of public school, s^*.

Lemma 3 *[Public school quality and participation rates]*

1. *There exists a unique and feasible level of public school quality, $\bar{s}^i(\psi^H, \psi^L, \psi^M)$, such that $\Delta^i = 0$, i.e. parents are indifferent between public and private school.*

2. *For any $s > [<] \bar{s}^i$, all parents of type i send children to public [private] schools.*

3. *It holds: $0 < \bar{s}^M < \bar{s}^L < \bar{s}^H$.*

[35] The denominator of $T(\cdot)$ expresses the total production in terms of public participation rates: $y = y(\psi^H, \psi^L, \psi^M) > 0$ (see Section 4.2).

4. $\psi^H > 0 \Rightarrow \psi^L = 1$, $\psi^L > 0 \Rightarrow \psi^M = 1$*;*

$\psi^L = 0 \Rightarrow \psi^H = 0$, $\psi^M = 0 \Longleftrightarrow (\psi^L = 0,\ \psi^H = 0)$.

Proof: Solving $\Delta^i(s, \psi^H, \psi^L, \psi^M) = 0$ with respect to s, we derive

$$\bar{s}^i(\psi^H, \psi^L, \psi^M) = \left(\frac{(1-\eta)^{1-\frac{1}{\eta}}}{\eta\, \phi\, w^i} + T(\psi^H, \psi^L, \psi^M) \right)^{-1}. \tag{15}$$

For $\bar{s}^i$ to be feasibly financed via tax, it must be: $\bar{s}^i \in [0, 1/T(\cdot)]$ such that $\tau(\bar{s}^i) \in [0, 1]$. Since $T(\cdot) \geq 0$, it is apparent that $\bar{s}^i$ is always positive. Moreover,

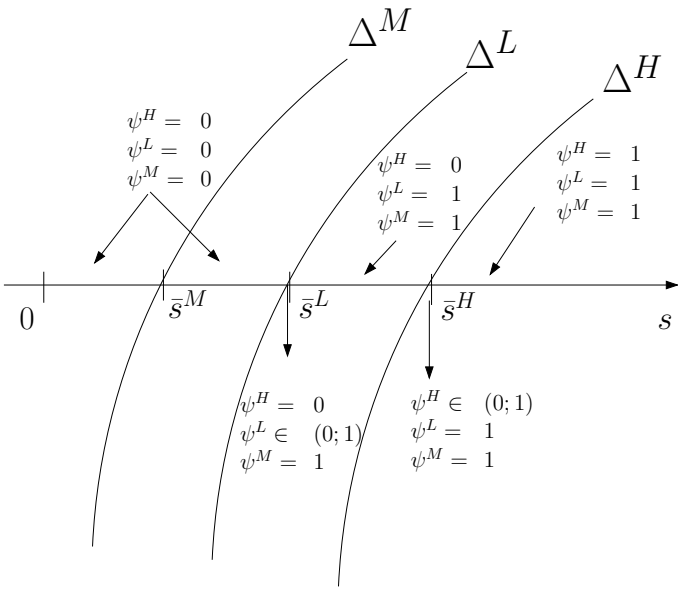
$$\frac{\partial \Delta^i}{\partial s} = \frac{\gamma\, \eta}{s(1 - s\, T(\cdot))} > 0, \quad \forall\ s \in [0, 1/T(.)], \tag{16}$$

or Δ^i is monotonically increasing for all feasible s. Thus, $\bar{s}^i$ is unique. Equation (16) also implies: $\Delta^i > 0$ *iff* $s > \bar{s}^i$, which proves point 2. Next, it is immediately observed that $\bar{s}^i$ is positive and increasing in w^i, which proves point (3). Point 4 follows from the definition of Δ^i, and points 2 and 3. The reverse direction of the last implication comes from Lemma 2 that, if $\psi^L = \psi^H = 0$, $\tau^* = 0$ and consequently $s^* = 0$. ■

Figure 1 illustrates Lemma 3. The interpretation is that, if the quality of public school is not satisfactorily high, parents will choose private schooling despite the costs incurred. The motive behind lies in parents' altruistic care for children's human capital.[36] Moreover, if public school quality continues to decline, high-skilled parents are those who opt out first, followed by low-skilled natives and then by immigrants. Thus, as point 4 states, whenever some parents of higher income choose public education, all parents of lower income follow suit. Notice that there is no public school participation at all below $\bar{s}^L$. This follows from the assumption that immigrants do not vote. In other

[36] It can be easily shown that $\bar{s}^i$ is increasing in the taste for quality, η.

Figure 1: Critical level of public school quality



words, no natives would choose public education if they expect public school quality to be below $\bar{s}^L$; consequently, natives then vote to have zero taxation, which disables public education.

5 Education Regimes

In the previous section, we have defined the equilibrium and shown the important properties at the equilibrium: Lemma 2 describes the voted policy for given participation rates of public school, while Lemma 3 gives the participation rates that result from a given policy. In order for a configuration of $\{\psi^H, \psi^L, \psi^M, s^*, \tau^*\}$ to be an equilibrium outcome, the participation rates and the voted policy must be reciprocally consistent. Let us call an equilibrium configuration as an *education regime*. In this section, we assess whether and under which conditions a certain education regime exists.

Proposition 1 *There are four possible education regimes that may exist:*

Education Regime	$\boldsymbol{\psi^H}$	$\boldsymbol{\psi^L}$	$\boldsymbol{\psi^M}$	$\boldsymbol{s^*}$	$\boldsymbol{\tau^*}$
Public	1	1	1	$s^* > \bar{s}^H$	Γ
Partial Segregation	$\in [0,1]$	1	1	$s^* = \bar{s}^H$	$\frac{\Gamma(1+\xi\psi^H)}{1+\xi}$
Segregation	0	1	1	$s^* \in (\bar{s}^L, \bar{s}^H)$	$\frac{\Gamma}{1+\xi}$
Private	0	0	0	$s^* < \bar{s}^L$	0

Proposition 1 is a straightforward result derived from the combination of Lemmas 2 and 3. Notice that once a low-skilled native parent opts out, all other low-skilled natives will follow suit, which disables public education due to lack of funding. We leave the discussion of this result to Section 5.1, where the existence conditions will be computed for each education regime.The effects of low-skilled immigration are investigated within each regime, while the effects across regimes, i.e. how low-skilled immigration brings about changes in education regime, will be discussed in Section 5.2.

5.1 Existence Conditions of Each Regime

For the ease of notation, let us define $\iota = \left(\frac{1}{1-\eta}\right)^{\frac{1}{\eta}-1}$. It can be considered as an exogenous indicator for children's quantity over quality: ι is decreasing in η.

Public Regime. In this regime, every child attends public school of high quality: $s^* > \bar{s}^H$ (i.e. nobody opts out). By replacing $\psi^H = \psi^L = \psi^M = 1$ in (14) and in (15), we recast the inequality representing no opting out into the existence condition:

$$\frac{w^H}{w^L} \cdot \frac{1+\mu+\xi}{\frac{w^H}{w^L}\,\xi + (1+\delta\,\mu)} \;<\; \iota\;, \tag{17}$$

with $\frac{w^H}{w^L} = (\frac{\alpha}{1-\alpha})(\frac{1+\delta}{\xi})$. The R.H.S. is decreasing in η, the exogenous taste for children's human capital. When η is larger, it is more difficult for the inequality to be satisfied and the public regime becomes less likely to exist. Intuitively, when parents care more about

child quality, they grow more willing to invest out-of-pocket in their education. On the L.H.S. we can observe that low skilled immigration apparently has two-fold effects: an income effect through the rise of wage premium w^H/w^L and a direct demographic effect that affects the supply (via $\delta\mu$) and the demand (via μ) for public education.

In order to observe the demographic effect more clearly, we rewrite the L.H.S. as

$$\frac{w^H(1-\phi\hat{n})}{\hat{n}} \cdot \frac{\hat{n}(1+\mu+\xi)}{(1-\phi\hat{n})(w^H\xi+w^l+w^M\mu)}$$

On one hand, low-skilled immigrants increase the supply of low-skilled labor, and therefore, they also enlarge the total production, or the tax base: $y = (1-\phi\hat{n})(w^H\xi + w^l + w^M\mu)$. On the other hand, however, immigrant children receive public education and thus increase the number of public school pupils: $\hat{n}(1+\mu+\xi)$. The net demographic effect is increased congestion in public school, as the average tax base is in fact decreased and school resources per pupil decline in accordance. Therefore, the demographic effect narrows the gap between the voted public school quality and the opt out threshold for the high-skilled. An analogous effect is produced also through the income effect, as can be seen by examining equation (15).[37] In short, an increase in low skilled immigration makes less likely the existence of the public regime. (i.e. $\mu \uparrow \Rightarrow (s^* - \bar{s}^H) \downarrow$).

Partial Segregation Regime. In this regime, some high-skilled parents opt out of public school while the rest, including all children of the low-skilled population, attend

[37] In equation (15), μ operates through the wage rate w^i in an asymmetric way: it raises w^H while depressing w^L and w^M, which is a consequence of (imperfect) substitution in production. Since $\bar{s}^i$ relates positively with w^i, the wage effect unambiguously increase the gap between $\bar{s}^L$, $\bar{s}^M$ on one side and $\bar{s}^H$ on the other side. Literally speaking, it makes high-skilled parents more capable of affording private schooling whereas low-skilled parents become more dependent on publicly financed education due to decreased income.

public school with quality $s^* = \bar{s}^H$. The existence condition is:

$$\frac{w^H}{w^L} \cdot \frac{(1+\mu)\left[(1+\xi)(1+\gamma\,\eta) - \gamma\,\eta\right]}{\frac{w^H}{w^L}\,\xi\,(1+\gamma\,\eta) + (1+\delta\,\mu)} \leq \iota \leq \frac{w^H}{w^L} \cdot \frac{1+\mu+\xi}{\frac{w^H}{w^L}\,\xi + (1+\delta\,\mu)}, \tag{18}$$

with $\frac{w^H}{w^L} = (\frac{\alpha}{1-\alpha})(\frac{1+\delta\mu}{\xi})(\frac{1}{1+\gamma\eta(1-\psi^{H*})})$.

Proof: Let us replace $\psi^L = \psi^M = 1$ into (14) and (15) and define the function $\Psi^H(\psi^H) \equiv (s^* - \bar{s}^H)$. It can be easily verified that $\Psi^H(\cdot)$ is composed of a strictly positive part times a concave second-order polynomial. Hence, if the solution to $\Psi^H(\cdot) = 0$ is stable, it must be identified by the larger root of the polynomial.[38] Moreover, this root must satisfy $\psi^H \in [0,1]$ for the partial segregation regime to be an equilibrium. The existence condition is then obtained. ■

The upper bound corresponds to the lower bound of the public regime. As the upper bound also the lower bound is affected by low skilled immigration through an income and a demographic effect. The net demographic effect (congestion in public school), as μ increases, pushes more and more high-skilled parents to opt out, and in so doing, they alleviate congestion such that $s^* = \bar{s}^H$ is maintained. At the bound, all the high skilled parents choose to opt out and the partial segregation regime is vanishes into a segregation regime. As long as the income effect is concerned, it moves in opposite directions: on one hand it increases the high skill reward thus making a greater education quality desirable, on the other hand it drives down ψ^{H*} as more high skilled parents devote more time to work and, anticipating private schooling, have less children. As long as the net income is of second order respect to the demographic effect, a greater μ enlarges the lower bound thus making the existence condition more difficult to be realized. Also the upper bound

[38] The intuition behind stability is that, since public school congestion is relieved with some pupils opting out, there may be a threshold of ψ^H beyond which the quality of public school is no worse than $\bar{s}^H$, so that there is no further flight into private education. Denoting ψ^{H*} as the stable root and $\psi^{H*'}$ the unstable one, we have indeed $\Psi^H(\cdot) = (s^* - \bar{s}^H) > 0,\ \forall\, \psi^H \in]\psi^{H*'}, \psi^{H*}[$.

raises with μ but not as fast as the lower bound; thus, it becomes impossible at one point that both inequalities hold true at the same time in the existence condition. Hence the existence condition for the partial segregation regime can be regarded as a condition that μ must not be too high.

Segregation Regime. In this regime, all the high-skilled parents opt out of public school whereas every child with low-skilled parents continue to receive public education with quality: $s^* \in]\bar{s}^L, \bar{s}^H[$. By replacing $\psi^H = 0$ and $\psi^L = \psi^M = 1$ in (14) and in (15), we can recast the school quality constraint into the existence condition for the segregation regime:

$$\frac{(1+\mu)\left[(1+\xi)(1+\gamma\,\eta)-\gamma\,\eta\right]}{\frac{w^H}{w^L}\,\xi\,(1+\gamma\,\eta)+(1+\delta\,\mu)} < \iota < \frac{w^H}{w^L}\cdot\frac{(1+\mu)\left[(1+\xi)(1+\gamma\,\eta)-\gamma\,\eta\right]}{\frac{w^H}{w^L}\,\xi\,(1+\gamma\,\eta)+(1+\delta\,\mu)}, \qquad (19)$$

with $\frac{w^H}{w^L} = (\frac{\alpha}{1-\alpha})(\frac{1+\delta\mu}{\xi})(\frac{1}{1+\gamma\eta})$. As far as the impact of low skilled immigration is concerned, the net demographic effect stays the same as before, i.e. increased congestion in public school, which lowers the public school quality s^* and makes it further away from $\bar{s}^H$ and closer to $\bar{s}^L$. However, the income effect is asymmetric on the extremes: w^H/w^L increases the upper bound, making the complete opt out of high-skilled parents more likely, while it decreases the lower bound because the reduced low-skilled wage translates into higher dependence of the low-skilled parents on public provision of education. Hence, the distance between the two extremes lengthens with growing skill premium.

If the income effect dominates, the segregation regime is likely to stay as the equilibrium because low-skilled natives will never find it affordable to pay for private education with quality higher than in public school. However, if congestion or the net demographic effect dominates, i.e. $\mu \uparrow \Rightarrow (s^* - \bar{s}^L) \downarrow$, even the low-skilled natives who are faced with a reduced wage will find it more and more attempting to opt out of public school since public resources per pupil are seriously degenerated.

Private Regime. In this regime, no children attend public school, and the voted public school quality must satisfy $s^* < \bar{s}^L$ as explained in the discussion of Lemma 3. In order to check for the existence of the private regime, we replace $\psi^i = 0,\ \forall i$ in (14) and obtain $s^* = 0$. Since $\bar{s}^L > 0$ always hold true, we have $s^* = 0 < \bar{s}^L$ and the private regime may exist at any positive level of μ.[39] The intuition behind is: in order to prevent a net redistribution toward immigrants, natives (even low-skilled) prefer not to be taxed and to finance their children's education out of their own pockets. Note that this result stems from the assumption that immigrants cannot vote.[40]

Lemma 4 *A configuration* $\left\{\psi^H, \psi^L, \psi^M, s^*, \tau^*\right\} = \left\{0, \psi^{L*}, 1, \bar{s}^L, \frac{\Gamma\psi^{L*}}{1+\xi}\right\}$ *with* $\psi^{L*} \in]0,1[$ *cannot be an equilibrium.*

Proof: Replace $\psi^H = 0$ and $\psi^M = 1$ into (14) and (15) and then define the function $\Psi^L(\psi^L) \equiv (s^* - \bar{s}^L)$. Following the same procedure in deriving condition (18), we obtain the existence condition for this configuration:

$$1 + \frac{\mu\,(1+\xi)(1+\gamma\,\eta)}{\gamma\,\eta} \leq\ \iota\ \leq \frac{(1+\mu)\left[(1+\xi)(1+\gamma\,\eta) - \gamma\,\eta\right]}{\frac{w^H}{w^L}\,\xi\,(1+\gamma\,\eta) + (1+\delta\,\mu)} \tag{20}$$

It can be easily shown that this condition is never satisfied since the lower bound is always larger than the upper bound. Thus, this particular configuration can not exist as an equilibrium. ■

Lemma 4 implies that, given all high-skilled natives already choosing private education, all low-skilled natives will opt out once one of them chooses to leave public school. This

[39] When there is no immigration, the private regime never arises since $\lim_{\psi^L \to 0} s^*\big|_{\{\mu=0,\psi^H=0\}} > \lim_{\psi^L \to 0} \bar{s}^L\big|_{\{\mu=0,\psi^H=0\}}$. This property is formally presented and discussed in de la Croix and Doepke (2007).

[40] An alternative assumption is that low-skilled immigrants possess less political power than natives. However, this does not change the qualitative result of our model.

is not a surprising result because, when low-skilled natives are indifferent between public and private schooling given a voted tax rate, they will be better off by choosing private education and pay no tax. It is so since public school resources funded by tax revenue are always shared by children of low-skilled immigrants.

With regard to fertility rates, we observe that in the (partial) segregation regime the average fertility of the natives is lower than that of the immigrants, because high-skilled native parents who opt out of public school have less children, as stated in Lemma 1. In the meantime, low-skilled parents who remain in public school choose the same fertility rate as do low-skilled immigrants. This is consistent with the findings in Kahn (1994). Using data from the U.S. Census and the Current Population Survey in the 1980's, they conclude that immigrants' higher fertility rates relative to the natives can be completely explained by their demographic, socioeconomic, and ethnic characteristics.

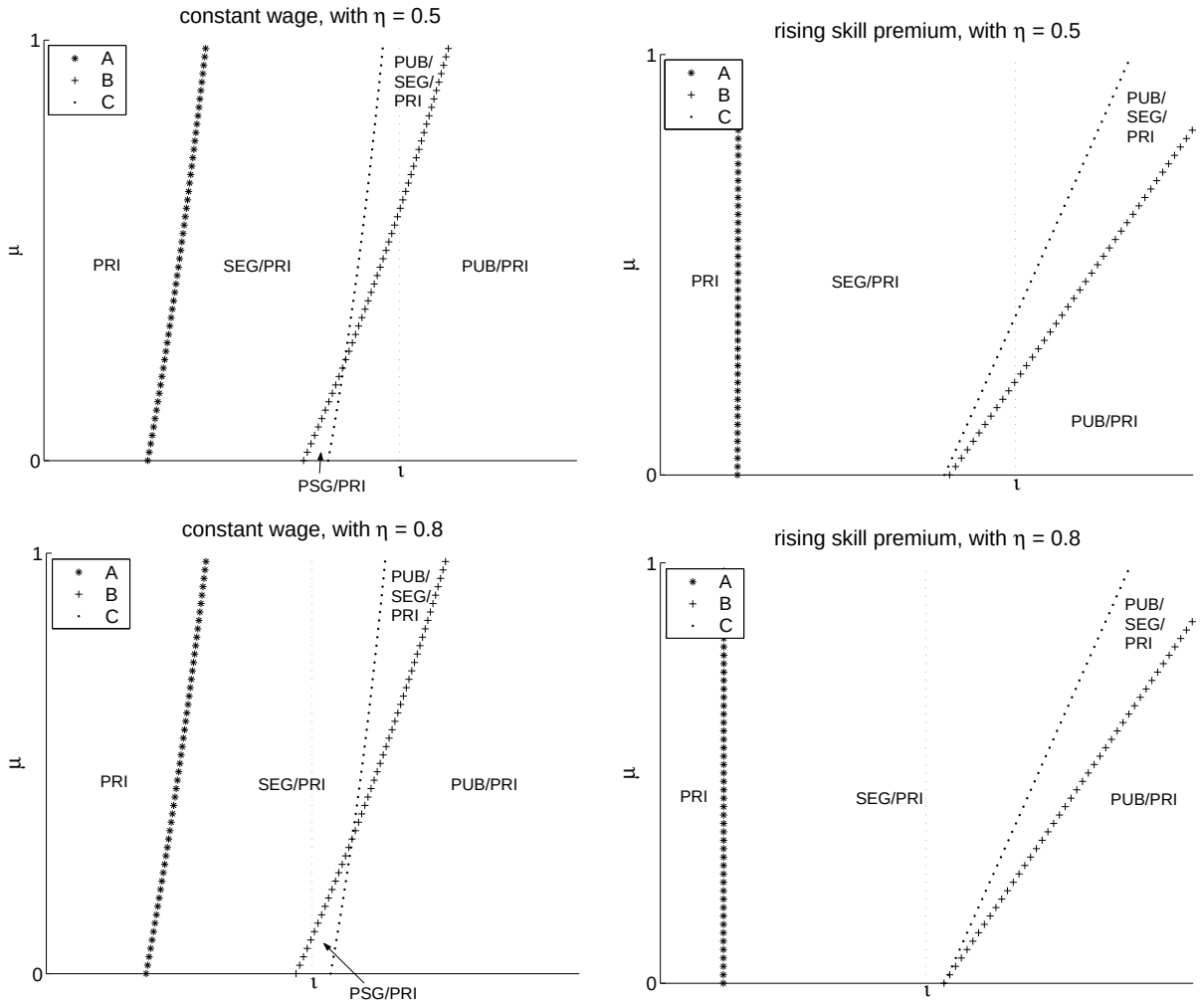
5.2 Low-skilled Immigration and Regime Change

Now, we discuss below how low-skilled immigration may cause changes of education regime in the host country.

Proposition 2 *A sufficiently large increase in the size of low-skilled immigrants triggers native parents to opt out and lower public school participation, or* $\sum_i \psi^i,\ i = \{H, L, M\}$. *Moreover, if the education regime does not jump immediately to a private one in response to an increase in immigration, the change of regime follows the direction of: public* $\rightarrow$ *(partial segregation* $\rightarrow$*) segregation* $\rightarrow$ *private.*

Proof: See Figure 2. ■

Figure 2: Existence conditions of each regime



(PUB: public regime, PSG: partial segregation regime, SEG: segregation regime, PRI: private regime)

$$A = \frac{(1+\mu)[(1+\xi)(1+\gamma\,\eta)-\gamma\,\eta]}{\frac{w^H}{w^L}\,\xi\,(1+\gamma\,\eta)+(1+\delta\,\mu)},\ B = \frac{w^H}{w^L}\cdot\frac{(1+\mu)[(1+\xi)(1+\gamma\,\eta)-\gamma\,\eta]}{\frac{w^H}{w^L}\,\xi\,(1+\gamma\,\eta)+(1+\delta\,\mu)},\ C = \frac{w^H}{w^L}\cdot\frac{1+\mu+\xi}{\frac{w^H}{w^L}\,\xi+(1+\delta\,\mu)}.$$

Suppose that an economy is characterized by a public regime when it opens its door to low-skilled immigrants. With the demographic effect of μ that worsens public school congestion and the income effect which makes private education more affordable to high-skilled natives, we can expect that, when μ grows beyond a certain size, there will be a change into the partial segregation regime, or into the segregation regime when μ is sufficiently large as shown in Figure 2.[41]

If wage is assumed to be constant, or there is only demographic effect, a further increase in low-skilled immigration will deteriorate congestion in public school and induce the education regime to change from public, then (partial segregation,) segregation and finally end up in the private regime. However, when coupled with the income effect, the transition may linger at the segregation regime if μ raises the skill premium by a large degree and extends the lower bound of existence condition for the segregation regime. In any case, we find that the income effect is not essential to generate our theoretical predictions. Rather, it reinforces the demographic effect in many ways.

Comparing across all regimes, we find that the tax rate is decreasing in native participation in public education, or

$$\tau^*_{PRI} = 0 < \tau^*_{SEG} = \frac{\Gamma}{1+\xi} < \tau^*_{PSG} = \frac{\Gamma(1+\xi\psi^H)}{1+\xi} < \tau^*_{PUB} = \Gamma \quad (= \tfrac{\gamma\eta}{1+\gamma\eta}).$$

Knowing from Proposition 2 the direction of potential regime changes, we obtain the following corollary:

Corollary 1 *A sufficiently large increase in the size of low-skilled immigrants tends to lower the voted tax rate, τ^*.*

[41] Notice that it is theoretically possible that the public regime jumps to a private one for any positive level of μ; however, we do not observe a pure private regime (i.e. zero public education spending) in reality, as shown by the stylized facts in Section 3.

This echoes the finding in Razin, Sadka, and Swagel (2002) that low-skilled immigration may be associated with less redistribution. However, instead of the "fiscal leakage" motive proposed in their paper, the trigger behind Corollary 1 is that high-skilled natives who opt out of public school would like to minimize "double taxation", a phrase coined to describe the situation where parents with children educated in private school also pay for, via tax, public education expenditures.

Finally, notice that we always have multiple equilibria since the existence condition for the private regime is always satisfied as long as there are some low-skilled immigrants. Further, with a certain range of μ, an education regime may be either public, segregated, or private. This multiplicity of equilibria arises from our assumption that immigrants are not entitled to vote, i.e. immigration does not change the relative size of high- and low-skilled voters. Therefore, there is a strategic complementarity in schooling choices among voters of the same type. When all the high-skilled parents anticipate public schooling, the voted public school quality will be so high that no parents find it worth sending children to private school. Consequently, every child attends public school. By the same token, when all the high-skilled parents anticipating private schooling, it is not rational for any single high-skilled family to choose public education due to a low voted quality. In this case, whether the education regime ends up as a segregation or a private one will depend on the anticipated schooling choices of the low-skilled native parents.[42]

5.3 Regime Ranking

From above, we know that multiple equilibria always exist in our model. Given the size of low-skilled immigrants, it depends on the native parents' anticipated schooling choices which education regime the host country ends up with. Since natives do not coordinate

[42]See de la Croix and Doepke (2007) for more discussion on strategic complementarity.

and decisions are made in a decentralized way, the realized regime may not be optimal in terms of the aggregated welfare of all natives, i.e. Ω in equation (12). In this section, we investigate the cardinal ranking of regimes according to Ω.

Since the private regime can always exist with low-skilled immigration, we begin by pairwise ranking between the private regime and others. With *constant wages*, the necessary and sufficient conditions for the private regime to weakly dominate the public and the segregation regimes are respectively

$$s^*_{PUB} = \frac{y_{PUB}}{1+\mu+\xi} \cdot \frac{\tau_{PUB}}{\hat{n}} \leq \frac{w^L}{\iota(1+\gamma)} \cdot \left(\frac{w^H}{w^L}\right)^{\frac{\xi}{1+\xi}} \cdot (1-\tau_{PUB})^{\frac{-1}{\Gamma}} \cdot \frac{\tau_{PUB}}{\hat{n}}, \tag{21}$$

$$s^*_{SEG} = \frac{y_{SEG}}{1+\mu} \cdot \frac{\tau_{SEG}}{\hat{n}} \leq \frac{w^L}{\iota(1+\gamma)} \left[1+\xi(1+\gamma\eta)\right] (1-\tau_{SEG})^{\frac{-(1+\xi)}{\Gamma}} \cdot \frac{\tau_{SEG}}{\hat{n}}. \tag{22}$$

Therefore, if public school quality is lower than a certain threshold, the private regime gives rise to a higher level of aggregated native welfare when compared to the public (or segregation) regime. Notice that the thresholds (R.H.S. of inequalities (21) and (22)) do not depend on μ, but μ increases congestion and degenerates public school quality, s^*. As a result, low-skilled immigration makes the private regime more likely to dominate because, when public education exists, natives will have to spend part of their income to subsidize the education of immigrant children, which does not help to improve natives' welfare in our model and creates loss of efficiency. This is close to the spirit of "fiscal leakage" mentioned in Razin, Sadka, and Swagel (2002).

On the other hand, the private regime dominates the partial segregation regime if and only if

$$\frac{w^H}{w^L} \leq (1-\tau_{PSG})^{\frac{-(1+\xi)}{\Gamma}}. \tag{23}$$

That is, skill premium cannot be too large; otherwise, despite fiscal leakage, it is still worth of redistributing through public education from high- to low-skilled natives, which

is a standard result of concave utility. With constant wages, it is found that an increased number of low-skilled immigrants drives down the R.H.S. of inequality (23) since more high-skilled parents will opt out and result in lower support to fund public education. Although a lower tax rate alleviates efficiency loss, it also reduces the scale of redistribution and makes the private regime less likely to dominate.[43]

Now, suppose a larger size of low-skilled immigration increases skill premium as specified in Section 4.2. The effect of an increasing μ becomes two-folded: it worsens fiscal leakage onto immigrants while redistribution between natives is more worthy. Juggled between efficiency loss and equity concern, how μ affects the ranking of the private regime versus others turns out to be ambiguous.

From earlier discussion and as illustrated by Figure 2, with some sets of parameters (particularly with large μ), it is possible that an education system may end up in the public, the segregation, or the private regime. With constant wages, the segregation regime weakly dominates the public one if and only if

$$\frac{w^H}{\iota(1+\gamma)} \cdot \frac{\tau_{PUB}}{\hat{n}} \cdot \left[\frac{1}{1+\xi(1+\gamma\eta)} \cdot \frac{\tau_{PUB}}{\tau_{SEG}} \cdot s^*_{SEG} \right]^{\frac{1}{\xi}} \geq \left[(\frac{1-\tau_{PUB}}{1-\tau_{SEG}})^{\frac{1}{\Gamma}} \cdot s^*_{PUB} \right]^{1+\frac{1}{\xi}}.$$

While μ only affects public school quality s^* in this inequality, it lowers both its L.H.S. and its R.H.S. at the same time and does not give a clear picture how low-skilled immigration affects the ranking between the public and the segregation regimes.[44] With a

[43] Using the existence conditions (17) and (19), it is found that $\frac{w^H}{w^L} \leq (1-\tau)^{\frac{-(1+\xi)}{\Gamma}}$ is a necessary condition for inequality (21) while it is a sufficient condition for inequality (22).

[44] Using the condition for these multiple equlibria to exist (i.e. $B \geq C$ in Figure 2), we find that the necessary condtion for the segregation regime to offer a higher level of aggregated native welfare requires a low enough public school quality in the public regime:

$$s^*_{PUB} = \frac{y_{PUB}}{1+\mu+\xi} \cdot \frac{\tau_{PUB}}{\hat{n}} \leq \frac{w^H}{\iota(1+\gamma)} (\frac{1-\tau_{PUB}}{1-\tau_{SEG}})^{\frac{-(1+\xi)}{\gamma}} \cdot \frac{\tau_{PUB}}{\hat{n}},$$

which is more likely to be satisfied with a large μ. However, this intuitive condition is not sufficient due to equity reason (i.e. decline in the scale of redistribution).

rising skill premium, however, the necessary and sufficient condition becomes:

$$(1+\frac{\xi}{1+\mu})(1+\frac{1+\mu}{\xi})^{\xi} \;\geq\; (\frac{\iota}{\alpha})^{\xi}\left[1+\xi(1+\gamma\eta)\right](1+\gamma\eta)^{\frac{(1-\alpha)(1+\xi)-1}{\Gamma}}(\frac{1-\tau_{PUB}}{1-\tau_{SEG}})^{\frac{1+\xi}{\Gamma}}.$$

Since an increasing μ drives up the L.H.S. and does not affect the R.H.S., the segregation regime becomes more likely to dominate the public regime with increased low-skilled immigration. This result is partly due to our setting of quantity-quality trade-off; that is, in the segregation regime, high-skilled parents choose to have less children and have more time devoted to work. Accordingly, given the same size of low-skilled immigration, skill premium (and thus wage inequality) is lower in the segregation than in the public regime. As μ goes up and fiscal leakage becomes so severe that it greatly reduces the effective redistribution from high- to low-skilled natives, segregation regime will then yield a higher level of aggregated native welfare since it reduces efficiency loss and a lower skill premium makes redistribution less worthy.

6 Concluding Remarks

We have developed a political-economic model of joint education and fertility decisions which relates low-skilled immigration and education policy. In our framework, a larger size of low-skilled immigration implies an expected reduction on the average tax base, which has the effect of decreasing public expenditures per pupil. In such a situation, wealthier parents (i.e. high-skilled natives) prefer to invest in their children's education out of own pocket. Consequently, they opt out in favor of private school and consistently vote for a lower tax rate in financing public education. At the end, there may exist equilibria characterized by different degree of segregation featuring higher participation rates (of children from the wealthier native households) in private school and higher private

share of education expenditure. This mechanism is strengthened when we consider the increase in wage inequality brought by a larger supply of low-skilled labor force.

In order to relate the theoretical predictions to empirical evidence, one has to bear in mind that our model makes the simplification that schools are funded entirely by either public or private sources. In reality, many privately managed schools are subsidized by the government while students attending public schools may still need to pay for certain tuition fees. Therefore, the choice of private education has to be regarded as implying that children of wealthier parents tend to attend, on average, schools with lower public shares of funding. Moreover, the model assumes that parents make schooling decisions for their children. This can be a generally realistic and safe assumption if the empirical investigation is restricted to data concerning students attending primary and secondary schools.

Recall the discussion in Section 3. It is clear that our model predictions are not at odds with stylized facts based both on micro and on macro evidence; rather, those facts seem to support the theoretical implications that low-skilled immigration is positively correlated with private school participation rates and with the private share of education expenditure. Moreover, the predicted positive correlation between low-skilled immigration and segregation in education system is confirmed by data as children from low-skilled immigrant households are found to be more likely to attend schools with larger share of public funding.

It is worth remarking that these main implications do not emerge from any exogenous assumption on differences about preferences toward fertility or education among immigrants and natives.[45] In fact, the important assumption is that immigrants are not entitled to vote. In reality, this assumption is translated into the waiting period since

[45]We have assumed a productivity gap between immigrants and natives low-skilled but it is not essential for the main mechanism we put forward to work.

the time of entry until obtaining full citizenship, or the period when immigrants are restricted in their political participation. Depending on the country specific regulations and on the category of immigration, it can take from a few years to an indefinite amount of time. Furthermore, this work is not meant to take a position in the debate over open/close border, but rather to highlight the channels through which the education system in the destination countries can be affected by low-skilled immigration and rational responses of native voters caring for their own children.

Our findings give rise to a number of concerns in a dynamic perspective which are not considered in the present work due to the static framework of our model. For example, it suggests that there will be more persistence in income inequality as the better educated pupils are then more likely to acquire a higher-skill job. Actually, inequality may increase even further as this process goes on. Moreover, the ranking of regimes based on the aggregated native welfare can be arguably affected when efficiency is considered in a dynamic perspective. As Gradstein and Justman (2001) point out, public school can in fact play an important role in promoting social integration and cultural assimilation of immigrants, thus paving the way for greater cohesion in society, reducing social tensions and preventing possible obstacles to economic growth and development.[46] Such medium-term beneficial functions can become less and less effective with a progressive process of segregation. These concerns suggest a possible direction for future research to extend our work in a dynamic framework. A possible way of extension could be, for example, that a child who receives better basic education has a higher probability to finish tertiary education and become high-skilled, i.e. $p(\kappa^i) \in [0,1]$ with $p' \geq 0$ and $p'' \leq 0$.

[46] Gradstein and Justman (2001) in this respect argues also that vouchers or public subsidies to private education may increase the incentive of parents to opt out thus damaging the society as a whole. On the other side, Epple and Romano (1998) claim that a voucher mechanism can favor a more efficient sorting and high ability students.

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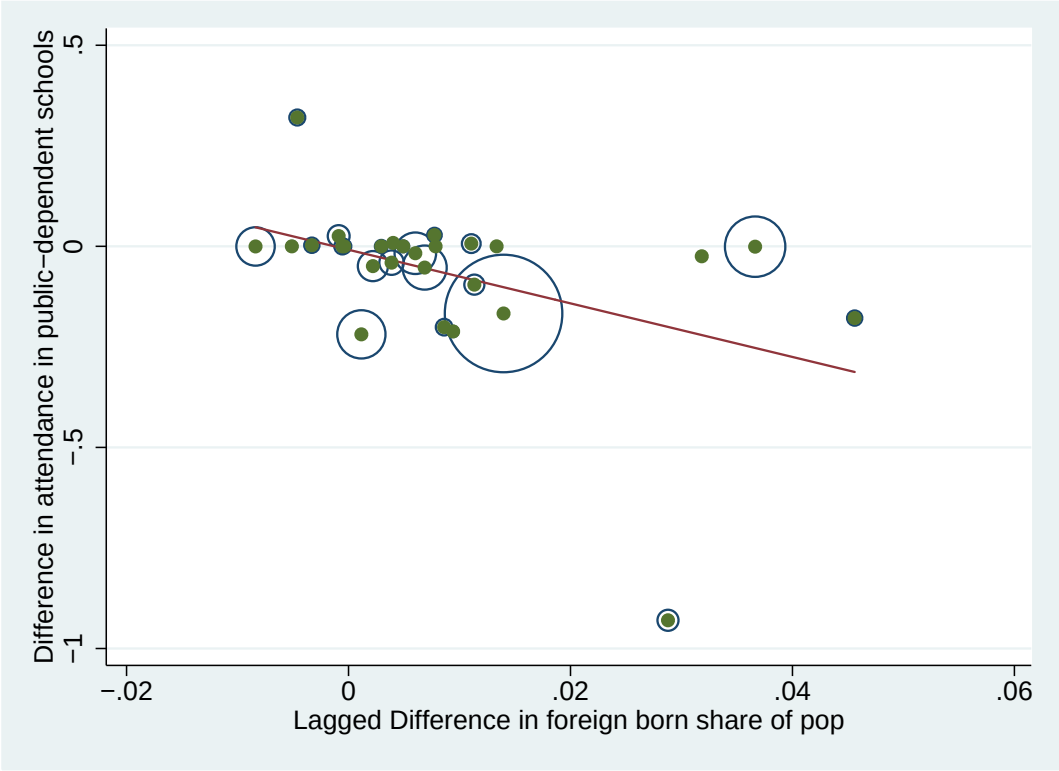
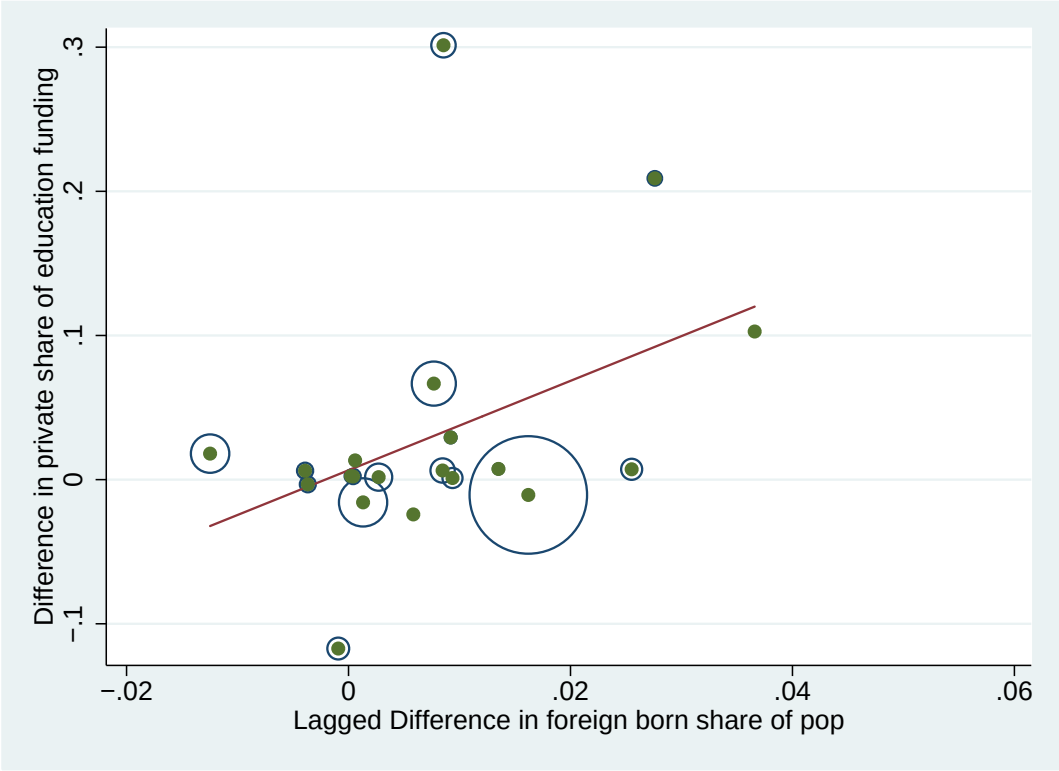
Figure 3: Change in public school attendance rate *vs* change in foreign born share of population



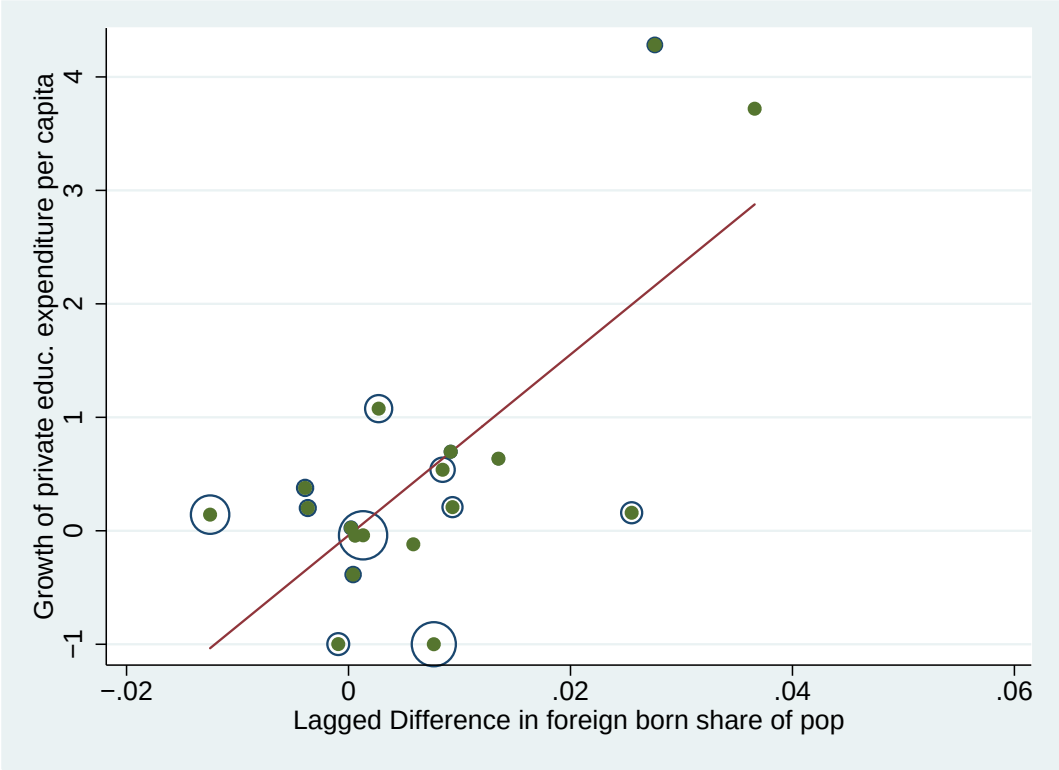
Difference in attendance in public-dependent schools computed as difference in participation rates in all public-dependent schools at primary and secondary level between 2004 and 1999. For USA, data are available only as public labeled school.
Lagged Difference in foreign born share of population computed as difference between the foreign born share of population between 1990 and 1995. Several lags and span have been considered in addition finding generally robust relations.
Circle areas are proportional to foreign born stocks.
Correlation (p-value): -0.430^{**} (.025). Removing outlier Austria: -0.338^{*} (.091).

Figure 4: Change in private share of education expenditure *vs* change in foreign born share of population



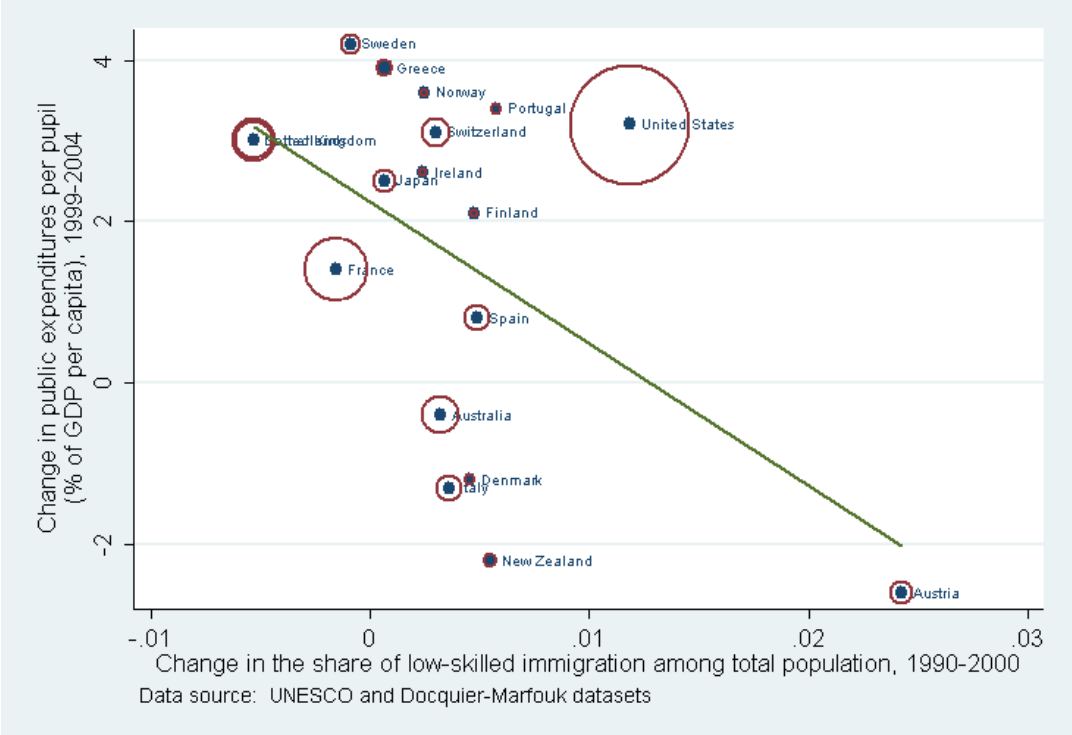
Difference in private share of total education expenditure at primary and secondary level between 2004 and 1999.
Lagged Difference in foreign born share of pop computed as difference between the foreign born popula- tion between 1995 and 2000. Several lags and span have been considered in addiction finding generally robust relations.
Circle areas are proportional to foreign born stocks.
Correlation (p-value): 0.415* (.069).

Figure 5: Change in private education expenditure per capita *vs* change in foreign born share of population



Growth private expenditure per capita: Growth rate of private expenditure per capita, at primary and secondary level, taken at PPP constant prices, between 2004 and 1999 (for population 2005 and 2000 used).
Lagged Difference in foreign born share of pop computed as difference between the foreign born popula- tion between 1995 and 2000.
Several lags and span have been considered in addiction finding generally robust relations.
Circle areas are proportional to foreign born stocks. Switzerland not included as a huge outlier (150%).
Correlation (p-value): 0.713^{***} (.001).

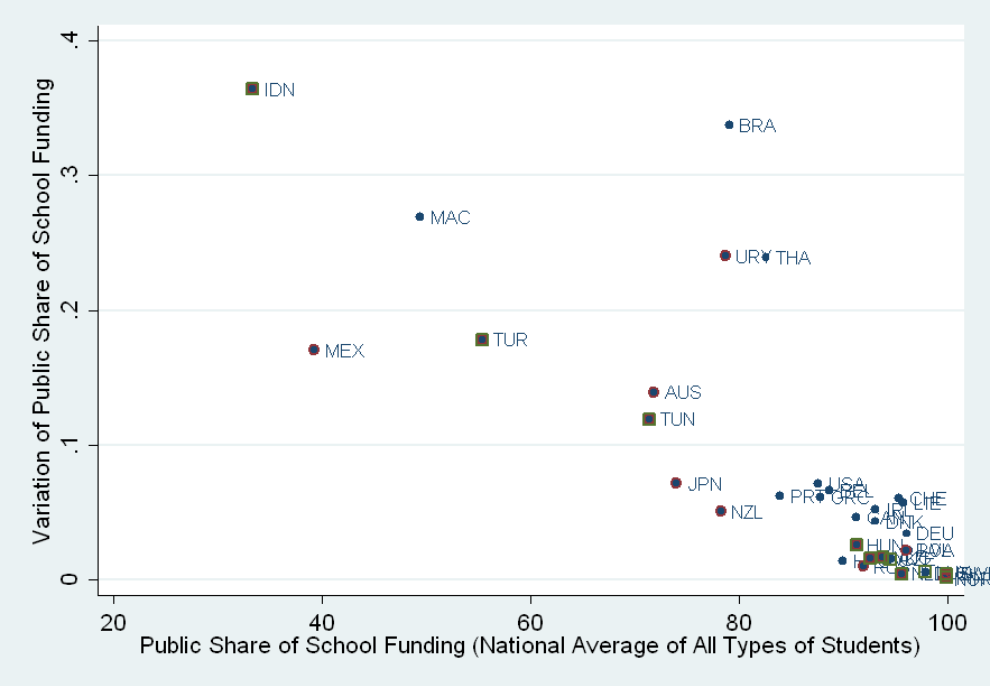
Figure 6: Change in public education expenditure per pupil *vs* change in low-skilled foreign-born share of population



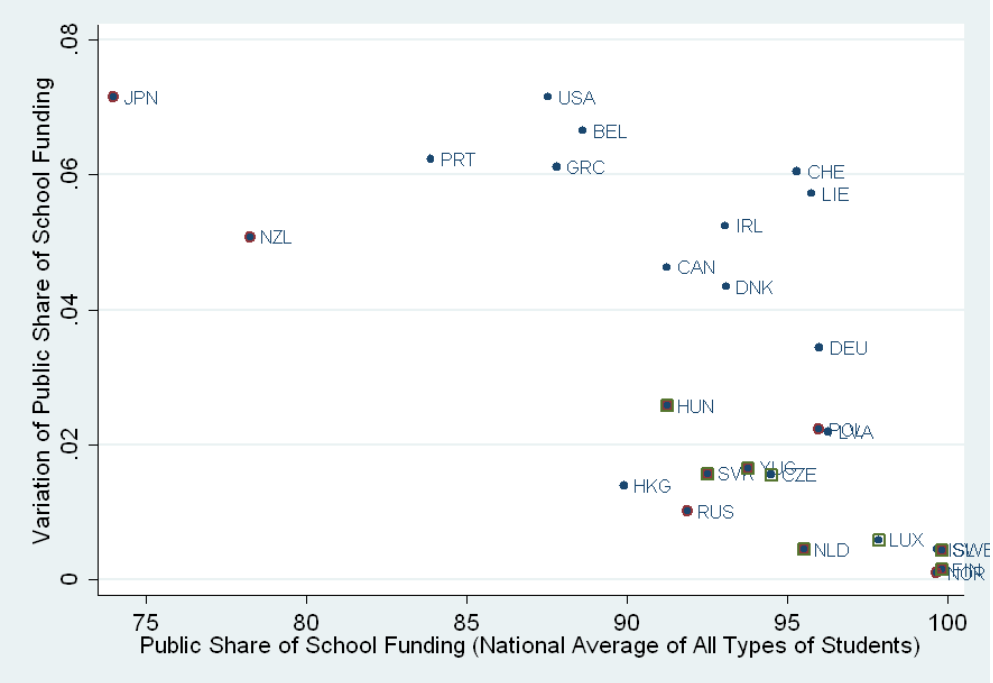
Change of public expenditures per pupil for all school levels, taken as ratio of GDP per capita, between 2004 and 1999.
Lagged Difference in low-skilled foreign-born share of population computed as difference between 1990 and 2000.
Circle areas are proportional to low-skilled foreign-born stock.
Correlation (p-value): -0.5209^{**} (.0267).

Figure 7: Distribution of countries by regime

(a) All countries



(b) Countries in the public and the segregation regimes



A hollow circle around a dot indicates that immigrant students with low-skilled parents do not have the highest average public share of school funding. A hollow square indicates that native students with high-skilled parents do not have the lowest average public share of school funding.

Table 1: Means of foreign born share of population by groups of attendance rates in public education

2000		2005	
attendance rates in public school (percentile groups)	mean of migrants' share of populat.	attendance rates in public school (percentile groups)	mean of migrants' share of populat.
Lowest	13.156%	Lowest	11.642%
Med-Low	8.916%	Med-Low	10.226%
Med-High	7.811%	Med-High	9.716%
Highest	6.566%	Highest	7.868%

Table 2: Test of difference in means of foreign-born share of total population between countries in different regimes of public school attendance

Attendance Group	Obs	Mean	Std. Err. Std. Dev.	[95% Conf. Interval]
Lowest	7	0.1315563	.0444336 .1175604	.0228312 .2402815
Highest	10	0.065661	.0189756 .0600062	.0227351 .1085868
combined	17	0.0927944	.02213 .0912445	.0458808 .139708
diff		0.0658954	0.0432115	-.0262078 .1579986
diff = mean(1) - mean(4)		t = 1.5249		
Ho: diff = 0		d.o.f. = 15		
Ha: diff $<$ 0		Ha: diff $\neq$ 0		Ha: diff $>$ 0
Pr(T $<$ t) = 0.9260		Pr(T $>$ t) = 0.1481		Pr(T $>$ t) = 0.0740
Two-sample Kolmogorov-Smirnov test for equality of distribution functions:				
Smaller group	D	P-value	Exact	
1:00	0.1429	0.845		
4:00	-0.5571	0.078		
Combined K-S:	0.5571	0.155	0.117	

Table 3: Test of difference in mean of low-skilled foreign-born share of total population between countries with in- and decreases in public expenditures per pupil (% of GDP per capita)

Primary School

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Increase	16	0.002655	0.0011965	0.004786	0.0001047	0.0052052
Decrease	3	0.0109911	0.0066701	0.0115529	-0.0177079	0.0396902
combined	19	0.0039712	0.0015161	0.0066084	0.000786	0.0071563
diff		-0.0083362	0.0037704		-0.0162909	-0.0003814

diff=mean(0)-mean(1)	t = -2.2110	
Ho: diff = 0	d.o.f.=17	
Ha: diff < 0	Ha: diff! =0	Ha: diff > 0
Pr(T $<$ t) = 0.0205	Pr(T $>$ t)= 0.0410	Pr(T $>$ t) = 0.9795

Two-sample Kolmogorov-Smirnov test for equality of distribution functions:

Smaller group	D	P-value	Exact
0:	0.5625	0.202	
1:	0.0000	1.000	
Combined K-S:	0.5625	0.401	0.303

Secondary Schools

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Increase	13	0.0022638	0.0014589	0.0052603	-0.0009149	0.0054426
Decrease	6	0.0076705	0.0033368	0.0081735	-0.000907	0.012648
combined	19	0.0039712	0.0015161	0.0066084	0.000786	0.0071563
diff		-0.0054067	0.0036418		-0.0140211	0.0032078

diff=mean(0)-mean(1)	t = -1.4846	
Ho: diff = 0	Satterthwaite's d.o.f.=6.988	
Ha: diff < 0	Ha: diff! =0	Ha: diff > 0
Pr(T $<$ t) = 0.0906	Pr(T $>$ t)= 0.1813	Pr(T $>$ t) = 0.9094

Two-sample Kolmogorov-Smirnov test for equality of distribution functions:

Smaller group	D	P-value	Exact
0:	0.6923	0.020	
1:	-0.0641	0.967	
Combined K-S:	0.6923	0.039	0.011

Table 4: Average public shares of school funding by student type

Regime	Country	Immigrant students with low-skilled parents	Native students with low-skilled parents	Native students with high-skilled parents
Public	Czech Republic	95.947868	94.455482	94.491226
		(1.49884)	(0.75120)	(0.95114)
	Finland	99.705894	99.859612	99.76329
		(0.21604)	(0.06989)	(0.12451)
	Hong Kong, China	90.362579	90.300293	89.101669
		(0.71049)	(0.76235)	(1.03829)
	Hungary	89.461647	90.797348	91.828087
		(1.74355)	(0.96053)	(1.04546)
	Iceland	99.951324	99.82151	99.497459
		(0.04844)	(0.04090)	(0.10513)
	Latvia	97.44603	96.811264	95.309799
		(0.84557)	(0.53616)	(1.32920)
	Luxembourg	98.262581	97.684868	97.727051
		(0.15186)	(0.17642)	(0.14725)
	Netherlands	95.499214	95.30101	95.734619
		(0.78485)	(0.72313)	(0.52036)
	Norway	99.6166	99.696068	99.591499
		(0.26743)	(0.20762)	(0.26739)
	Poland	95	97.005188	94.845886
		(0.00000)	(0.43540)	(0.79274)
	Russian Federation	92.18248	92.281113	91.347771
		(1.54375)	(1.10452)	(1.39742)
	Serbia and Montenegro	92.439629	93.723763	93.995689
		(1.25150)	(0.87957)	(0.63648)
	Slovak Republic	93.032448	91.837425	93.303055
		(2.64327)	(0.90203)	(0.76817)
	Sweden	99.468834	99.914383	99.75779
		(0.29455)	(0.03420)	(0.13790)

Segregation	Belgium	92.970215	89.557091	86.785774
Regime		(1.09799)	(0.91271)	(1.13165)
	Canada	93.834282	92.389626	89.493698
		(0.73521)	(0.51115)	(0.84146)
	Denmark	96.998848	92.920151	92.788795
		(1.18401)	(0.88155)	(1.29765)
	Germany	97.919785	96.71534	94.55452
		(0.49344)	(0.50523)	(0.77876)
	Greece	91.242668	89.450066	85.663513
		(1.30087)	(1.27673)	(3.58973)
	Ireland	95.617073	95.129005	90.606308
		(1.04415)	(0.50559)	(1.41699)
	Japan	72.268036	76.384232	70.925522
		(8.43649)	(1.41331)	(1.91171)
	Liechtenstein	99.966019	95.998367	94.248375
		(0.01923)	(0.86398)	(1.07504)
	New Zealand	77.494125	80.100792	76.031754
		(1.25158)	(0.86149)	(1.14851)
	Portugal	86.659126	85.87606	81.260452
		(3.08535)	(1.65654)	(2.58895)
	Switzerland	98.901016	96.968895	92.92453
		(0.33304)	(0.48104)	(1.36581)
	United States	92.208778	88.422775	85.61586
		(1.82975)	(1.76358)	(2.41584)
Severely	Australia	73.738464	76.311218	65.669144
Segregated		(1.22751)	(0.91294)	(1.29929)
	Brazil	98.669655	88.048607	65.418968
		(0.84375)	(1.45130)	(4.23931)
	Thailand	100.000000	87.511017	76.087975
		(0.00002)	(1.55778)	(1.99347)
	Tunisia	66.404343	68.561096	75.390099

		(7.35852)	(1.64594)	(1.03259)
	Uruguay	86.23951	88.014587	66.863541
		(5.97201)	(1.15223)	(2.19179)
Private	Indonesia	21.599062	33.002502	33.966629
Regime		(9.97910)	(2.08754)	(2.65803)
	Macao, China	53.021244	45.711414	38.762604
		(0.83486)	(2.45105)	(1.69494)
	Mexico	42.020725	42.115124	34.941616
		(8.07494)	(3.40941)	(2.74917)
	Turkey	47.327709	57.608212	51.505253
		(9.59675)	(2.55671)	(3.47479)

The associated stand errors on the mean are included in the parentheses.

Table 5: Correlation between the segregation regime and low-skilled immigration

Low-skilled immigrants as those with less than secondary education

Regime	*Change in average stock 1990-2000*	*Average stock ratio (in proportion to the total population) in 2000*	*Change in average stock ratio 1990-2000*
Public	-39784.49	1.97794%	-0.05711%
Segregation	383054.60	3.14551%	0.42906%
Correlation with Segregation	0.2740	0.2854	0.5383**

Low-skilled immigrants as those with less than tertiary education

Regime	*Change in average stock 1990-2000*	*Average stock ratio (in proportion to the total population) in 2000*	*Change in average stock ratio 1990-2000*
Public	2664.21	3.90396%	0.57015%
Segregation	564021.90	5.21762%	0.77263%
Correlation with Segregation	0.2441	0.2042	0.1336

20 country observations.

**: at the 0.05 significance level.

For the average stock ratio in 2000, we alternatively conduct a test of proportions, using the pooled immigrant share of each regime. It is found that the pooled ratio of the segregation regime (2.77127% with the first measure of the low-skilled; otherwise 4.12529%) is significantly higher, at the 0.01 level, than the ratio of the public regime (2.01763% with the first measure of the low-skilled; otherwise 3.4616%). However, these ratios have the problem of being dominated by large countries.