Low-skilled Immigration and the Expansion of Private Schools

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Abstract

This paper provides a political-economic model to study the impact of low-skilled immigration on the host country's education system, which is characterized by sources of school funding, the average expenditure per pupil, and the type of parents who are more likely to send their children to publicly or privately funded schools. Four main effects of immigration are considered: (1) greater congestion in public schools; (2) a lower average tax base for education funding; (3) reduced wages for low-skilled workers and so more dependence by low-skilled locals on public education; (4) a greater skill premium, which makes it easier for high-skilled locals to afford private education for their children, and hence weakens their support for financing public school. It is found that when the number of low-skilled immigrants is large, the education regime tends to become more segregated with wealthier locals more likely to opt out of the public system into private schools. The fertility differential between high- and low-skilled locals increases due to a quantity/quality trade-off. The theoretical predictions conform to stylized facts revealed in both the U.S. census data and the OECD Programme for International Student Assessment (2003).

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1. Introduction

> *I would support [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 S. Becker, in "Sell the Right to Immigrate" (2005).*

Immigration, particularly the inflow of low-skilled individuals, often causes concern that immigrants with low earning potential could become a heavy burden on the social welfare system.[1] Public education, as an important redistribution mechanism designed to facilitate social mobility for future generations, cannot 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 the public resources embodied in public schooling.[2] The aim of this paper is to study the impact of low-skilled immigrants, through their supply of taxes and demand for public education, on the education system of the destination country. We claim that increasing the stock of low-skilled immigrants may alter the schooling choices of other parents for their offspring, leading to a more segregated education system, where children from wealthy families attend private schools with a better quality of education. 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 stylized facts regarding migration and education revealed in both the U.S. census data and the OECD Programme for International Student Assessment (2003).[3] The major contribution of our paper is to provide a solid

[1] Facchini and Mayda (2009) find that, in countries where citizens are, on average, more highly skilled than immigrants, individual income is negatively correlated with pro-immigration preferences, after controlling for education. This is consistent with the authors' theoretical conjecture that wealthier citizens in a welfare state are concerned by the potentially increasing scale of income redistribution due to the arrival of immigrants.

[2] For instance, California's 1994 Proposition 187 (ballot initiative to limit the access of immigrants to public education, which was passed by a narrow majority) was declared unconstitutional by federal judge Mariana Pfaelzer in a March 1998 ruling (see also Petronicolos and New (1999)).

[3] See Section 3.

theoretical argument for the mechanism behind this phenomenon.

By education system, we refer to the combination of three features: 1) how schools are funded, from public or private sources, 2) expenditures per pupil in public and in private schools, and 3) the type of parents most likely to send their children to public (private) school. We argue that local parents foresee that, with more low-skilled immigration, resources per pupil in public school will decrease because the average tax base will be reduced by an increase in the low-paid population. As parents are concerned about their children's educational achievement, wealthier parents will choose to opt out of publicly funded education and send their children to private schools where they have to pay out of their own pockets. The reduced participation in public schooling has ambiguous effects: on the one hand, with some children leaving the public education system, the stress which immigration places on school resources is alleviated; on the other hand, parents who opt out are "double-taxed" for education, so they tend to be reluctant to support taxation for public education.[4] However, if the number of low-skilled immigrants keeps increasing, a large proportion of local parents may opt out and public-school resources per pupil will decline, compared to their initial level. At the aggregate level, from the model it turns out that having a relatively large stock of low-skilled immigrants in the population tends to be associated with a more segregated education regime, where children of wealthier parents are more likely to attend private schools and enjoy better school resources whereas students from poorer families, including those with low-skilled immigrant parents, stay behind in public schools. Finally, a purely private regime is theoretically possible with low-skilled immigration, unless there is a sufficiently high legal minimum to regulate public education expenditures or if immigrants are entitled to vote on education policy.

We focus on the immigration of low-skilled workers for two reasons. First, developed economies generally possess comprehensive public education systems; they are also destinations for large numbers of low-skilled migrant workers. Hence, low-skilled immigrants are a very relevant component of the local labor market, and to a certain extent, affect the constitution and

[4]See, for example, Shapiro (1986) where some arguments for using public funding to subsidize private schools are discussed. One of them is "double taxation" for parents who send children to private school. This argument has been used by interest groups that support vouchers for private schooling.

distribution of tax revenues.[5] Second, children who are most in need of integration into the school system are generally those whose parents do not speak the language of instruction in their new country, and these parents are most likely to be low-skilled.

As mentioned above, the arrival of immigrants may affect education policy by changing the support for public education. Immigrants are not immediately granted voting rights, to which only citizens are entitled, and obtaining citizenship takes a number of years. However, immigrants can influence voters' opinions about education policy in at least two ways. First, as argued earlier, immigrants have a different impact on the demand for and the supply of public resources in education. As voters become aware that they will have to proportion both the benefits and the burdens of public intervention in education with immigrants, 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 can occur through the effect they have on the income distribution of electors. An increase in proportion of low-skilled workers could lead to an increase in the premium for higher skills.[6] With their increased income, high-skilled parents are likely to want better education for their children. If public schools fail to provide the desired quality of education, these parents may choose to opt out, which in turn may affect voters' support for the funding for public schools.

This paper follows de la Croix and Doepke (2009) in incorporating endogenous fertility into the study of schooling choices. It is well documented that parents are faced with a quantity/quality trade-off for their children, which is to say, the expenditure that parents intend to devote on each child's education is negatively correlated with the number of children they would like to have (Becker and Barro, 1988; Hanushek, 1992). If the opportunity cost of having children is greater for high-skilled parents, they might decide

[5]Betts and Lofstrom (2000) found that in the U.S. the education level of immigrant declined, relative to that of natives, over the two decades before 1990. Using data from the U.S. census, Borjas (1995) showed that in both 1980 and 1990 about 37% of immigrants had not completed high school, compared to just 23% of American citizens in 1980 and 15% in 1990.

[6]For example, Mayda (2006) shows that high skilled locals are the most favorable to immigration in countries where immigrants are, on average, relatively less skilled than the locals. This is consistent with the idea of a rising skill premium. However, the issue of whether low-skilled immigrants adversely affect the wages of local counterparts is still unsettled. See Card (2005) for a survey of this literature.

to have fewer children but educate them better, and so fertility differentials may arise. In this respect, the arrival of low-skilled immigrants implies an increase in the size of population possibly featuring higher fertility rates and an increase in the opportunity costs of fertility for high-skilled workers as their wages rise. Notice, however, that we do not assume any exogenous difference in fertility behavior between locals and immigrants. Such culturally-based differences may exist, but if so they would only serve to strengthen our main conclusions. We do however assume that low-skilled immigrants are slightly less productive than locals, to reflect the adjustment costs of migration.[7]

Several elements are entwined in our model, so it is important to consider the timing of events. First, parents choose the optimal number of children consistent with their expected choices of schooling for their offspring. Second, locals vote over the proportional income tax rate and public expenditure per pupil. Finally, in accordance with the education policy implemented, each household chooses the type of school to which they will send their children. 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 driven by reasonable assumptions: fertility decisions usually take place before educational choices are made, and educational choices occur in a given framework of an education regime that is shaped by current education policy.[8]

We begin by relating our contribution to previous research in Section 2. Relevant stylized facts are then provided in Section 3. Section 4 formally presents the model economy, and Section 5 depicts each education regime and discusses how they are affected and possibly changed by low-skilled immigration. Finally, Section 6 concludes.

2. Literature Review

This study relates to several streams of literature. First there is the literature on quantity/quality trade-offs. This highlights the links between

[7]Theoretical models often assume that there is an adjustment cost of migration; the existence of such costs is also supported by empirical studies. See, for example, Batista (2008).

[8]de la Croix and Doepke (2009) consider both this timing and another timing, where educational choices are committed before voting takes place. They find that the quality of public schooling is the same or less when parents choose schooling after policy variables had been determined.

fertility and education decisions (Becker and Barro, 1988; Hanushek, 1992; Tamura, 1994; de la Croix and Doepke, 2003, 2004). When fertility is endogenous, parents who prioritize quality may choose to have fewer children for a given level of resources devoted to child rearing. Therefore, when education regimes are being compared, decisions on fertility and education should be considered jointly.

The structure of our model follows de la Croix and Doepke (2009), who show that in democracies a public regime tends to be established unless income distribution is too unequal, whereas a multiplicity of equilibria may arise in non-democracies characterized by a minimum-income restriction for voting. Since our model considers that low-skilled immigrants are different from low-skilled locals only in terms of their lack of voting rights and a lower wage, our set-up is readily comparable to the non-democracy framework of de la Croix and Doepke (2009), notwithstanding which, the focus of our work is rather different. Whereas they mainly focus on how an education regime may be affected by a mean-preserving change in income dispersion, we introduce the demographic impact of low-skilled immigration that leads to a more right-skewed income distribution with a lower average tax base. In addition, we remove the assumption of a linear production technology, thus allowing for a distributional effect of low-skilled immigration, which endogenously raises the skill premium and increases income inequality among the electorate. As a consequence, the direct impact of low-skilled immigration is that it reduces the provision of public education per pupil; meanwhile, increased income inequality polarizes local parents' demands for investment in their children's education. The latter impact is similar to the force at work in de la Croix and Doepke (2009) but not required in order for our mechanism to operate; however, it does reinforce the mechanism, as low-skilled parents become more dependent on public education. In Section 5, we will provide a detailed discussion of the various channels through which an increase in low-skilled immigration may affect the host country's education system. Moreover, with multiplicity of equilibria due to heterogeneity in voting rights, we will also explore the issue of Pareto-ranking between education regimes.[9]

[9]An additional difference between our setup and that of de la Croix and Doepke (2009) is that we consider the expenditure on private education being tax non-deductible. As tax codes vary from country to country, the extension to tax non-deductibility is a relevant robustness check because quantity-quality trade-off is then affected by the expected tax rate. This acts to slow down the opting-out process, but not to the effect of reversing the

As policy variables have redistributive effects, this work also relates to the literature on income redistribution, voting, and education policy. As in standard models of publicly provided private goods (Atkinson and Stiglitz, 1980), in our work redistribution occurs from the rich to the poor; however, the scale of redistribution varies with different education regimes.[10] Different from many studies in the literature (Glomm and Ravikumar, 1992; Fernández and Rogerson, 1995; Bénabou, 2000; de la Croix and Doepke, 2004), our model does not specify a given regime for education, but allows the system to be endogenously determined. We assume that education policy is formed through probabilistic voting, which captures the idiosyncratic component with regards to voting over education policy. Its voting outcome is equivalent to a smooth aggregation of preferences across all the electorate; therefore, it is not only the median voter, but the whole distribution of voters' preferences, that matters for policy making. Our research is related in this respect to Razin et al. (2002), who study the effect of low-skilled immigration on redistributive policies in a model with human-capital formation and majority voting for a lump-sum cash grant. There are two contrasting effects: on the one hand, immigrants tend to join the coalition supporting greater redistribution, but on the other hand, voters know that they will have to proportion tax revenues with immigrants. This latter effect, known as "fiscal leakage", may dominate, which would imply that a lower tax rate is voted with more low-skilled immigration.[11] Assuming that immigrants are not entitled to vote, but their children cannot be excluded from public schools, our model also predicts that low-skilled immigration may result in a lower tax rate to finance public education; however, the reasoning behind this is the "double taxation" argument.

As already mentioned, Betts and Fairlie (2003) find evidence that the influx of immigrants makes local parents more prone to send their children to

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results.

[10]Some studies in this literature propose the reverse direction of redistribution (Johnson, 1984; Bénabou, 2000). In particular, Fernández and Rogerson (1995) model education as a good that is only partially publicly funded by a subsidy voted for by the agents. Such a framework is able to generate the outcome that the education of the rich is in fact subsidized by the poor, who cannot afford the remaining (private) costs of education unless the income distribution becomes sufficiently equal.

[11]In other words, even when the median voter is a low-skilled local, s/he will prefer less redistribution because low-skilled immigration will dilute public resources.

private schools 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 local student who switches to a private school. Some authors have suggested that such a result may be related to racial prejudice among the locals (Conlon and Kimenyi, 1991), and others suggest that the cause is lower expected attainment in public school because of "peer-group" effects (Henderson et al., 1978), or bad signaling of academic quality. Our model is able to provide a theoretical basis for Betts and Fairlie (2003)'s conjecture that, by increasing the pressure on resources in public schools, the arrival of immigrants induces more local parents to opt out of the public system. In so doing, it also lowers voters' support for funding public education. In this respect, the decision to focus on low-skilled immigration is justified by the finding that "native flight" is more pronounced for white locals responding to immigrant children who do not speak English at home, who are more likely to come from low-skilled households where adults have low English-language skills.

Nevertheless, Betts and Fairlie (2003) do not find "native flight" at the primary school level, possibly due to neighborhood effects. These effects can be rather significant in a system, such as that in the U.S., where state schools are largely funded by local property taxes. This may lead to wide variations in the quality of public schools across communities, with richer districts having better-funded public schools, and vice versa (Bénabou, 1996; Fernández and Rogerson, 1996; Fernández, 2002). Therefore, native flight into private schools is more likely to occur in a system where public schools are all similarly resourced.[12] However, the evidence provided by Betts and Fairlie (2003) at the secondary school level suggests that residential segregation is of less importance when it comes to high school education.[13] In contrast to the literature that studies sorting and education, we abstract

[12]In a community funded system, however, native flight may take the form of residential segregation rather than lower enrollment in public schools.

[13]Betts and Fairlie (2003) argue that native flight is observed at the secondary school level for several reasons. We find the most pertinent to be the fact that U.S. high schools usually cover a larger area than primary schools, and have several "feeder" primary and middle schools. So residential segregation is less likely to imply schooling segregation in high school than in primary school. In response to immigration, local parents may find it more attractive to educate their children in private schools in the neighborhood than to move to another community.

from modeling neighborhood effects but allow for sorting into public and private schools.

3. Some Stylized Facts

In addition to the empirical evidence provided by Betts and Fairlie (2003) for the United States that immigration was associated with locals opting out of public secondary schools between 1980 and 1990, this section provides a number of stylized facts regarding how low-skilled immigration may be associated with local parents' schooling choices between 1990 and 2000 in the U.S.; moreover, we present evidence suggesting that the education and fertitlity are highly correlated, which lends support to our assumption that the two are jointly determined . Then, using the micro data collected by the OECD Programme for International Student Assessment (PISA) 2003, we take a cross-country snap shot of the schooling choices made by immigrants and locals of different skill types.

3.1. U.S., 1990 and 2000

With U.S. Census Data 1990 and 2000, we identify three types of students: immigrant students with low-skilled parents, local students with low-skilled parents and local students with high-skilled parents. Following Betts and Fairlie (2003), all the students are aged between 7 and 16, and were enrolled in either public or private schools. The residence of each student is identified by metropolitan areas. Skill type is defined on the basis of the total personal income of parents.[14] High-skilled parents are those with total income above the mean for their residential area, and those below the mean are considered as low-skilled. Students with immigrant parents are identified by checking that neither of his/her parents have U.S. citizenship (i.e., they are not entitled to vote).[15]

Tables 1 and 2 suggest that the three student groups are characterized by very different schooling choices and numbers of siblings. It is shown that that

[14] As a robustness check, we also included the highest educational attainment and the highest score on the Hauser and Warren socioeconomic index. These were used to investigate whether parental skill was positively correlated with enrollment in private school and negatively correlated with household fertility. All the correlations have the expected sign, and are significant.

[15] More descriptions of the data can be found in Appendix A.1.

students with high-skilled local parents have, on average, the highest rate of private school enrollment and their parents have the lowest level of fertility, while the opposite holds for students with low-skilled immigrant parents. While these tables are computed from the overall sample, a further step is to consider the averages of private school enrollment and of fertility rate for local students in each metropolitan area, and then check how frequently the sign of mean difference is consistent with the aggregate sample. It turns out that in a large majority of the areas (87% in 1990 and 97% in 2000) a higher proportion of students with high-skilled than with low-skilled local parents attended private schools; similarly, in 75 % of the areas in 1990 and 79% in 2000 the average fertility rates for the low-skilled locals were higher than those for high-skilled locals.[16]

Next, we utilize the geographical information about each student to study the impact of changes in the proportion of students with low-skilled immigrant parents in each area between 1990 and 2000. These changes are available for both years in 103 areas, and as shown in Figure 1, have a positive relationship with changes in the enrollment rate of local students at private schools. The correlation between the two variables is 0.371, which is statistically significant at the 99% level.[17] The positive correlation is supported by further refinements. When the definition is restricted to those parents with low English proficiency, (i.e. those who claim to speak English less than 'very well'), the correlation is 0.355, which is still significant. When we focus on those parents who arrived in the U.S. less than a decade prior to each census year, the relationship is even stronger, at 0.416, and becomes even more significant.

Finally, based on the quantity/quality trade-off argument, it is expected that increased enrollment in private school among locals should be associated with an enlargement of their fertility differential. To examine this relationship, we consider the correlation between variables measuring the changes in the differential in private-school enrollment rates among locals (i.e. changes in the average enrollment rate of students with high-skilled local parents mi-

[16]Note that the sample areas are not identically identified in these two years. In particular, the samples in 2000 are geographically much more concentrated, in the sense that they only spread over 106 metropolitan areas, while samples in 1990 spread over 297 metropolitan areas.

[17]All the correlations are weighted by the number of students with low-skilled immigrant parents in the respective area.

nus that of students with low-skilled local parents) and changes in the fertility differential (computed as changes in the average fertility rate of low-skilled locals minus that of high-skilled locals).[18] Figure 2 depicts a positive relation between these two inter-temporal changes in differentials. The correlation for a total of 104 areas is 0.210, and is statistically significant at the 95% level, suggesting that an increasing gap in private school participation is indeed associated with a widening in fertility differential.[19]

3.2. Cross Country, 2003

Are the stylized facts mentioned above specific to the U.S.? Although we cannot offer a definite answer, a similar pattern regarding schooling choice is however found in our crude analysis using the cross-country micro-data collected by the OECD Programme for International Student Assessment (PISA), 2003. The primary sampling unit in this dataset is individual 15-year-olds, and the main variable of interest for us is the proportion of public funding received by the school that a student attends. Three types of students are identified for 35 countries. As in the U.S. Census Data, we define an immigrant student as one for whom both parents are foreign born.[20] However, since PISA does not contain information about students' household income, parental occupational status is used instead to distinguish skill types.[21]

Table 3 shows the average public share of school funding for each type of student by country, grouped by regime.[22] Figure 3 plots all 35 countries according to the average share of public funding their schools receive, and the variations of the share between different types of students within each country. It is observed that there are three main clusters of countries. We

[18]There are two advantages to considering changes in differences over time. Firstly, by considering inter-temporal changes, the influences of cross-sectional and time-constant factors on the variables of interest can be limited. Secondly, the use of differences can partly offset the effect of any possible common time trends in the series.

[19]As before, the correlations are weighted by the number of students with low-skilled immigrant parents in each area. Notice that, while the mean private school enrollment rate is calculated across student samples, the average fertility is computed using households as the unit of analysis so that it is not upwardly biased by students coming from high-fertility households. As a robustness check, we also construct private-school enrollment rates at the household level. The correlation is lower, but still positive and significant.

[20]This category includes all students who themselves were foreign-born.

[21]See Appendix A.2 for a more detailed description of data.

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

define countries with lower than 60% of average public funding as being in the private regime. These countries are Indonesia, Mexico, Macao-China and Turkey; they are all characterized by a low public shares of funding for each type of student. On the other hand, there is a cluster of countries with high average proportions of public funding of schools, and a variation of less than 3% between the different types of student. We define these countries as in the public regime. Most of them are Northern or Central European countries or parts of the former U.S.S.R.. The remaining countries are defined as being in the segregation regime, with those having variations of more than 10% between different groups of students being defined as severely segregated.

What we find the most interesting is that, in 16 of the 17 countries in the segregation regime (Tunisia being the only exception), local students with highly skilled parents attend schools with the lowest average proportion of public funding. In other words, the children of local high-skilled parents are more likely to attend private schools than other types of students, which is consistent with the U.S. pattern summarized in Table 1.

Next, we combined data from the PISA 2003 study with the Docquier-Lowell-Marfouk (2009) dataset in order to take advantage of their information about the skills of immigrants by destination. At the end, we had data on immigration stocks for 8 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 3 provides the average level and 10-year change of low-skilled immigration (measured either as stocks or as proportions of the total population) for countries with public and segregation regimes. We find that these averages are larger for the group of countries classified in the segregation regime, consistent with the positive relationship between low-skilled immigration and private school enrollment which we observed in the U.S..[23]

[23]The analysis is carried out according to either a stricter definition of low-skilled immigrants as those with less than secondary education, or a broader one applying to those with less than tertiary education.

4. Model Economy

In this section, we assess the building blocks of our model economy. We put forward a general equilibrium model of rational expectations and voting, which predicts that a larger group of low-skilled immigrants makes it less likely that a public schooling regime is the equilibrium, as more local parents send their children into private school. We begin with household decisions, then move to the production sector and finally to the political mechanism.

4.1. Households

The economy is populated by households with identical preferences over consumption c, number of children n, and the investment in children's basic education κ. Part of the population is composed of immigrants (M). Locals are either high-skilled (H) or low-skilled (L). Since we are focusing on low-skilled immigration, we assume that all immigrants are low-skilled.[24] The objective function is written as:

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

The parameter $\gamma > 0$ captures the weight of child-caring in the household utility, whereas $\eta \in]0, 1[$ denotes the taste for child quality, relative to the quantity of children.[25] Notice that no exogenous difference in preferences between immigrants and locals is imposed on the model.[26]

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 potential. In addition, human capital is acquired through formal education, which incurs a pecuniary cost. Parents may choose to educate their children in public schools (so that $\kappa^i = s$, where s denotes the quality of public school financed by general income taxation), or in private schools (so that $\kappa^i = e^i$, where e^i

[24] Alternatively we can assume that the immigrants, although high-skilled, only have access to low-skill jobs.

[25] It is constrained to be less than one to guarantee an interior solution to parents' optimization problem.

[26] Sand and Razin (2006) assume a higher exogenous fertility rate for immigrants than for locals. Making the similar assumption in our model that immigrants are more likely than locals to favor quantity over quality (i.e., η is lower for immigrants than for locals) only strengthens our results.

denotes the quality of education purchased by parents on the private schooling market). A child who receives more investment in his/her basic education has a higher probability of finishing tertiary education and becoming a high-skilled adult.[27] It is assumed that the cost of private education is not tax deductible.[28] We can write the household budget constraint as:

$$(1-\tau)(1-\phi n^i)w^i = c^i + n^i e^i \tag{2}$$

where $\tau \in [0,1]$ is the proportional income tax rate that yields sufficient government revenue to finance public education. w^i denotes the wage rate rewarded to one unit of labor time devoted by adults of type i. Notice that enrolling in public school is free of direct charge, while parents opting for private schooling have to pay the full costs of educating their children. Clearly, parents choosing public education set $e^i = 0$. For the sake of simplicity, the cost of one unit of school quality is set to unity.

The timing of events is as follows. First, each household makes its fertility decision, consistent with the expected schooling choice for their offspring. Next, locals vote about income tax rates and public school expenditure per pupil; the outcome of this voting therefore determines the quality of public education. Depending on the difference between the quality of the determined public school education and the quality of education they want for their children, households (both local and immigrant) then make the final decision on whether to educate their children in public (free of charge) or private (paid for directly by parents) schools. 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 decisions by maximizing Eq. (1) subject to Eq. (2). Parents anticipating public schooling, i.e., $[\kappa^i]^e = s$, choose the following

[27] While it is assumed that, through κ^i, parents derive utility out of "joy of giving", this also implicitly captures the idea that parents care about their children's skill level.

[28] Regulations on the tax deductibility of private school expenses vary from country to country. We assume non-deductibility, as is the case in the U.S.; de la Croix and Doepke (2009) assume full deductibility. The main difference is that, when private education is tax deductible, the choice between the quantity of children and the quality of their education is not affected by taxation. However, the qualitative result that low-skilled immigration may cause locals to opt out of public education remain valid.

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 $\tilde{n}$ such that:

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

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

The following lemma then arises:

Lemma 1 (Fertility Differential). *Parents who anticipate private schooling choose to have fewer children than those who anticipate public schooling.*

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

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

The intuition underlying this is that, given identical homothetic preferences, each household uses the same optimal allocation rule to distribute resources between child-caring and consumption.[29] Those parents who anticipate sending their children to public schools are only faced with the opportunity costs (in terms of working time) of having children, since there are no direct costs associated with their children's education. In comparison, parents planning to use private schools expect to pay all the costs of their children acquiring human capital, and therefore, these parents reduce their opportunity costs by having fewer children. This is why the quantity/quality trade-off parameter η only appears in $\tilde{n}$.

Spending on private education e^i increases with the taste for children's human capital η, household income w^i and the time cost of child-rearing ϕ. The last result occurs because, as child-rearing becomes more time-consuming,

[29] More precisely, the total resources available to a household are the time endowment (unity) evaluated at the market wage, or w^i. Due to homothetic utility, the proportion of resources devoted to consumption is constant at a given tax rate, i.e., $\frac{1-\tau}{1+\gamma}$.

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, in our model making private education tax deductible will lead to a higher quality of private schooling. Similarly, any policy that reduces tuition and other costs of private education will have the effect of increasing the incentive to opt out of the public system.

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 with a price of unity.[30] Later on, it will become clear that our theoretical predictions remain valid even if constant wage rates are assumed. However, an increased skill premium with low-skilled immigration reinforces the mechanism and speeds up the transition of education systems in the host society. Additionally, it is assumed that immigrants bear the adjustment costs of relocating to the destination country.[31] These costs are reflected in lower wages for immigrants than for low-skilled locals, or technically speaking, in the parameter $\delta \in]0, 1[$ which denotes the lower productivity of immigrants. This, and the fact that immigrants cannot vote, are the only exogenous differences in our model between a low-skilled immigrant and a low-skilled local.

[30]The existence of a skill wage premium is well documented in the empirical studies. The recent work by Card (2009) estimates a college-to-high school wage premium that is consistent with an elasticity of substitution ranging from 1.5 to 2.5. Meanwhile, he finds high substitutability between natives and immigrants, especially for the less educated. In reality, skill wage premium could arise from a number of reasons (e.g., the host country's specialization in skill-intensive products and/or consumers' love for variety of sophisticated goods); however, since the exact form of the producer sector is not central to our analysis, for the sake of parsimony a one-good Cobb-Douglas production function is assumed with two skill types as inputs. Therefore, low-skilled natives and immigrants are perfect substitutes and the implied substitutability between skills is slightly lower than empirically observed.

[31]For our purposes, the adjustment costs assumption basically implies that immigrants receive lower wages. Evidence for this has been found in several studies (Borjas, 1994). Using the 1970 U.S. Census Data, Chiswick (1978) estimates that, at the time of arrival, an immigrant receives a wage 17% below that of a similarly skilled local.

Denoting production by y , and the total hours worked by high-skilled locals, low-skilled locals and low-skilled immigrants respectively by h, l and m, we can write:

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

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, the number of low-skilled locals can be normalized to 1, the ratio of high- to low-skilled locals expressed by ξ, and the ratio of immigrants to low-skilled locals by μ. The total hours devoted to work in each household are the unity time endowment, less the time spent on child-rearing. Hence,

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

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

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

where ψ^i denotes the proportion of parents type i who anticipate educating their children in public schools. The following restrictions are imposed: $\xi \in]0, \big(\alpha(1+\delta\mu)\big)/\big((1-\alpha)(1+\gamma\eta)\big)[$ and $\mu \in [0, 1]$. The first condition ensures a skill premium by assuming that high-skilled labor is always scarcer.[32] The second restriction avoids the implausible situation in which there are more low-skilled immigrants than low-skilled locals, but can be easily relaxed.[33] It follows that $w^M = \delta w^L < w^L < w^H$.

[32]The upper bound of ξ is derived from the sufficient condition for a skill premium: $w^H/w^L = \big(\alpha(l+\delta m)\big)/\big((1-\alpha)h\big) > 1$, or $\alpha/(1-\alpha) > h/(l+\delta m)$. We could have had introduced a skill productivity parameter which would also have guaranteed that high-skilled workers received higher wages. However, for the sake of parsimony, we simply imposed this reasonable restriction on ξ.

[33]μ itself may be affected by the education system in the receiving country. However, for the sake of simplicity, we consider μ as exogenous.

4.3. Political Mechanism

As explained in Section 1, we assume that the quality of public schooling s and the proportional income tax rate τ are determined via probabilistic voting, which displays convenient properties that take the whole distribution of preferences into account. While basic education is widely acknowledged as a fundamental human right,[34] less shared is the opinion on the right extent of public provision. It is likely that the utility parents derive from the amount of investment spent on their own children is not the only determinant in the voting behavior with respect to education policy, but other elements can play a role (e.g., ideologies, individual experience, local traditions, etc.). We implicitly capture this idiosyncratic component by adopting the probabilistic voting mechanism. It can be shown that the political outcome under probabilistic voting corresponds to implementing the following social welfare function Ω:[35]

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

where $\hat{U}^i$ and $\tilde{U}^i$ denote respectively the expected (indirect) utility of local parents of type i who anticipate using public ($n^i = \hat{n}$ and $[\kappa^i]^e = s$) and private ($n^i = \tilde{n}$ and $[\kappa^i]^e = e^i$) schooling. The maximization of $\Omega\left[\tau, s\right]$ is constrained by the government budget balance, which requires that the tax

[34]See, for example, Article 26 of the *Universal Declaration of Human Rights* by the United Nations (`http://www.un.org/en/documents/udhr/index.shtml#a26`).

[35]Probabilistic voting is based on the idea that political candidates are uncertain of voters' behavior. Summarize the probability that voter j votes for candidate A by the cumulative distribution function $F^j(U_A^j - U_B^j)$ and denote its density function by $f^j(\cdot)$: $F^j(\cdot)$ is increasing in the difference between j's utility level associated with candidate A's policy platform and that with candidate B's. Thus, candidate A's maximization of her vote share leads to the first order condition: $\sum_j f^j \cdot U_A^{j\prime} = 0$, with f^j evaluated at 0, for that candidate B faces the symmetric problem, and at equilibrium, both candidates choose the same platform under the assumption of simultaneous platform announcement. Hence, the determination of the policy variables is equivalent to maximizing a social welfare function where the utility of each voter is weighted by $f^j(0)$ (see Persson and Tabellini (2000) for a detailed discussion). In this paper, we assume for simplicity that $f^j(0)$ is identical for all voters.

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 the expenditure on public education:

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

From this maximization problem we have the following lemma:[36]

Lemma 2 (Voted policy). *The 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:

(i) $\frac{\partial\tau^*}{\partial\gamma}=\frac{\partial\tau^*}{\partial\eta}\ >0$;
(ii) $\frac{\partial\tau^*}{\partial\xi}\ <0$ *if* $\psi^H<\psi^L$ *and* $\frac{\partial\tau^*}{\partial\xi}\ =0$ *if* $\psi^H=\psi^L$;
(iii) $\frac{\partial\tau^*}{\partial\psi^H}=\xi\,\frac{\partial\tau^*}{\partial\psi^L}\ >0$.

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

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

[36]Notice that we do not distinguish the anticipated and the actual schooling choices in the maximization problem; in other words, ψ^i is not only the expected but also the realized public school enrollment rate for parents of type i. Nevertheless, given our timing of events with actual schooling choices made after the voting stage, the more rigorous treatment would be having the actual public school enrollment rates endogenously determined by the policy variables. We present the parametric treatment for its analytical tractability, and the voting outcome is valid as long as the perfect foresight assumption is maintained at equilibrium so that the expected and the actual choices coincide. Recall that fertility choices are made at the first stage, jointly with the anticipated schooling choices; therefore, the fertility differential between parents expecting public and private education (see Lemma 1) generates the lock-in effect that guarantees local stability of the equilibrium characterized by perfect foresight. A fully developed discussion is available from the authors upon request.

Proof: See Appendix B.1. ■

Intuitively, the tax rate depends positively on the propensities to spend on children, γ and η, and on local parents' anticipated participation in public schooling, ψ^H and ψ^L. If a lower proportion of high-skilled locals than of low skilled locals anticipate public schooling for their children (as will be shown to be true unless the proportions are equal), then an increase in the relative number of high-skilled locals, ξ, will lead to a lower tax rate. The reason is that those parents who anticipate private schooling for their children are less supportive of redistribution through the provision of public education, from which their children will not benefit. Hence, whenever $\psi^H < \psi^L$, an increase in ξ implies that the proportion of the electorate who favor less redistribution increases.

The denominator of Eq. (14) consists of the total number of children expected to attend public school. Thus, for a given tax revenue, higher expected participation in public school (ψ^i) leads to lower expenditure per pupil (used here as a proxy for quality) in public schools. Moreover, since $y = hw^H + lw^L + mw^M$ with h, l and m defined in Eqs. (9), (10) and (11), higher expected participation in public school also results in a lower tax base because parents who anticipate public schooling have more children, which requires more of their time to be devoted to child-rearing and less to work. Nevertheless, as mentioned above, the income tax rate increases with locals' anticipated participation in public education. Therefore, the expected participation of local children induces contrasting effects, while the expected participation of immigrant children unambiguously lowers the quality of public schools *ceteris paribus*. Finally, an increase in the number of low-skilled immigrants (μ) contributes positively to the quality of public schools through an increased tax base (a positive effect on the supply side), although it lowers quality when the children of new immigrants attend public schools (a negative effect on the demand side, or a congestion effect).[37]

Notice that the tax rate chosen by voters is not *directly* affected by the number of low-skilled immigrants (μ), or by the proportion of them anticipating sending their children to public schools (ψ^M). In fact, they only affect the quality of public school. This is because the socially determined tax rate

[37] As it will be shown later, all the children of low-skilled immigrants go to publicly funded schools as long as local voters support public expenditure for education.

reflects the aggregated preferences of locals about the allocation of income between consumption and child-caring. With the assumed homothetic utility function in Eq. (1), this rule of allocation is not affected by the income level, but is determined by preferences and the composition of the electorate.[38] The weight that a society places upon education as opposed to consumption, can be denoted by $\Gamma = \gamma\eta/(1+\gamma\eta) \in]0,1[$. If all voters expect to make use of public schools for their children, the tax rate they choose will correspond exactly to Γ. However, if some local parents anticipate opting out of public education and choosing private schooling, the tax rate will decrease 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 local parents' expectations about the schooling of their children (ψ^H and ψ^L). Through this channel, we will show that μ and ψ^M *indirectly* affect the voted tax rate $\tau^*\big(\psi^H, \psi^L\big)$, as expressed in Eq. (13).

4.4. Equilibria

In this subsection we will characterize the equilibria. Up to now, ψ^i has been dealt with as an exogenous parameter that reflects the proportion of parents of type i who anticipate making use of public schools. Under the assumption of perfect foresight, parents' expected schooling choices will coincide with their *a posteriori* decisions, i.e., ψ^i is effectively the public school enrollment rate. At equilibrium, parents' preferences and the education regime are mutually consistent.

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

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

This means that, given their own fertility decisions and the outcomes of the voting on tax rates, parents then decide on the schooling of their offspring

[38] Note that the technology parameter α and the adjustment costs δ, which affect wages, play no role in determining the tax rate. As long as the tax rate is independent of wages, it is not affected by μ by either the skill premium or the tax base.

(which is in effect the realization of their anticipated choices). Since all households have the same preferences, and parents of the same type receive the same wage, parents of type i will all choose public education if it yields higher utility (and the same goes for private education). However, when the resulting utility does not differ from one type of school to the other, some parents of type i will choose public education, while others will pay for their children's education from their own pockets.[39]

In order to investigate the situation further, we proceed as follows. First, we obtain the tax rate from the government budget balance and write it as a linear function in s:

$$\tau(s) = s \cdot T(\psi^H, \psi^L, \psi^M) \quad \text{where} \quad T(\cdot) = \frac{\hat{n}(\xi\psi^H + \psi^L + \mu\psi^M)}{y(\psi^H, \psi^L, \psi^M)} \geq 0.^{40} \tag{15}$$

Then $\tau(s)$ is plugged into the indirect utility function V^i, where fertility and private education spending are solved for parents with either schooling choice (see Eqs. (3), (4) and (5)). In this way, indirect utilities depend only on the policy variable s and on public school enrollment 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 $\Delta^i = \hat{V}^i - \tilde{V}^i$, which is the net gain from choosing public education. At 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 at equilibrium the set of public school enrollment rates $\{\psi^H, \psi^L, \psi^M\}$ is affected by the socially determined quality of public schooling, s^*.

Lemma 3 (Opting-out and enrollment rates).

(*i*) *There exists a unique and feasible level of public school quality,* $\bar{s}^i(\psi^H,$

[39] In other words, there could exist an interior value for ψ^i such that the marginal household is indifferent between private and public schools.

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

ψ^L, ψ^M), *such that* $\Delta^i = 0$, *i.e., parents are indifferent between public and private schools.*

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

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

(*iv*) $\psi^H > 0 \Rightarrow \psi^L = 1$, $\psi^L > 0 \Rightarrow \psi^M = 1$;
$\psi^L = 0 \Rightarrow \psi^H = 0$, $\psi^M = 0 \Longleftrightarrow (\psi^L = 0, \psi^H = 0)$.

Proof: See Appendix B.2. ■

Figure 4: Critical levels of public school quality

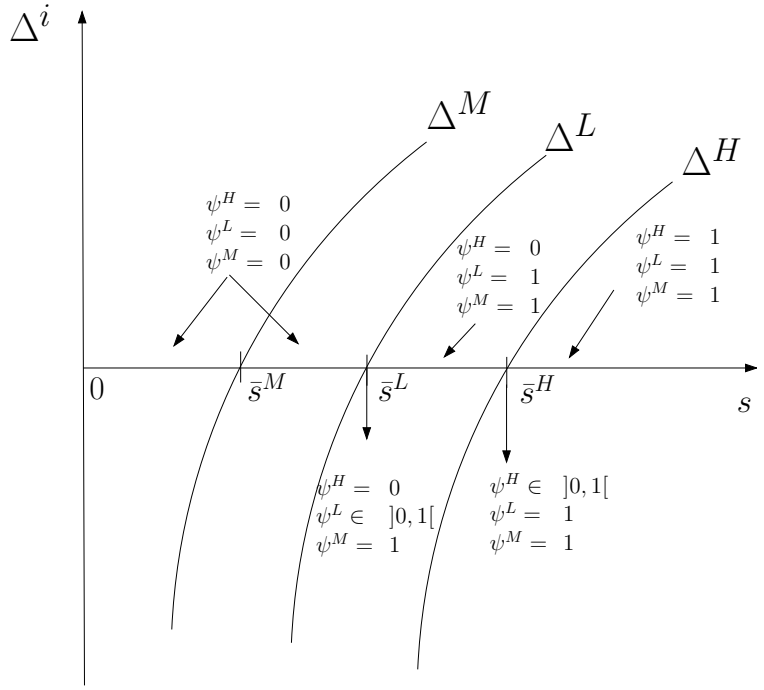


Figure 4 illustrates Lemma 3. It shows that, if the quality of public schooling is not satisfactorily high, parents will choose private schooling despite its cost. This is because parents care about their children's human capital.[41]

[41] It can easily be shown that $\bar{s}^i$ increases with the taste for quality, η.

As the quality of public schooling declines, high-skilled parents are the first to opt out, followed by low-skilled locals and then by immigrants. Thus, as Point (*iv*) states, when some high-income parents choose public education, all lower-income parents follow suit. Notice that no children at all enroll in public schools below a certain quality threshold, $\bar{s}^L$. This follows from the assumption that immigrants cannot vote. In other words, no locals choose public education if they expect its quality to be below $\bar{s}^L$, and they then vote to have zero taxation, which means that public education cannot be provided.

5. Education Regimes and Low-Skilled Immigration

In the previous section, the equilibrium was defined and its properties were discussed: Lemma 2 describes the voting behavior with given rates of participation in public schooling, while Lemma 3 gives the participation rates that result from a given expenditure on schools. In this section, we first use these results to assess whether, and under which conditions, a certain education regime emerges as a stable equilibrium. Then, the effects of low-skilled immigration are investigated both within each regime and across regimes (i.e., how low-skilled immigration brings about changes in education regime).

5.1. Education Regimes

An education regime is defined as a *stable* equilibrium where the participation rates $\{\psi^H, \psi^L, \psi^M\}$ and the policy variables $\{s^*, \tau^*\}$ are reciprocally consistent.[42] For ease of notation, let us define $\iota \equiv \big(1/(1-\eta)\big)^{(1/\eta)-1}$. This can be considered as an exogenous indicator of parental preference for quantity of children over the quality of their education (i.e., ι decreases monotonically with η). We summarize the possible education regimes in the following proposition.

Proposition 1 (Education regimes). *There are four possible education regimes. The features and the conditions under which each of them emerges are as follows:*

[42] An equilibrium is defined in Definition 1. On top of that, stability is required for an equilibrium to represent an economically sensible education regime.

Education Regime	ψ^H	ψ^L	ψ^M	s^*	τ^*	***Condition***
Public	1	1	1	$s^* > \bar{s}^H$	Γ	$C < \iota$
Partial Segregation	$\in [0,1]$	1	1	$s^* = \bar{s}^H$	$\frac{\Gamma(1+\xi\psi^H)}{1+\xi}$	$B \leq \iota \leq C$
Segregation	0	1	1	$s^* \in]\bar{s}^L, \bar{s}^H[$	$\frac{\Gamma}{1+\xi}$	$A < \iota < B$
Private	0	0	0	$s^* \leq \bar{s}^L$	0	

with

$$A \equiv \frac{(1+\mu)[(1+\xi)(1+\gamma\,\eta)-\gamma\,\eta]}{\frac{w^H}{w^L}\,\xi\,(1+\gamma\,\eta)+(1+\delta\,\mu)}, \quad \frac{w^H}{w^L} = \left(\frac{\alpha}{1-\alpha}\right)\left(\frac{1+\delta\mu}{\xi}\right)$$

$$B \equiv \frac{w^H}{w^L}\cdot\frac{(1+\mu)[(1+\xi)(1+\gamma\,\eta)-\gamma\,\eta]}{\frac{w^H}{w^L}\,\xi\,(1+\gamma\,\eta)+(1+\delta\,\mu)}, \quad \frac{w^H}{w^L} = \left(\frac{\alpha}{1-\alpha}\right)\left(\frac{1+\delta\mu}{\xi}\right)\left(\frac{1}{1+\gamma\eta(1-\psi^H)}\right)$$

$$C \equiv \frac{w^H}{w^L}\cdot\frac{1+\mu+\xi}{\frac{w^H}{w^L}\,\xi+(1+\delta\,\mu)}, \quad \frac{w^H}{w^L} = \left(\frac{\alpha}{1-\alpha}\right)\left(\frac{1+\delta\mu}{\xi}\right)\left(\frac{1}{1+\gamma\eta}\right)$$

Proof: See Appendix C.1. ■

From Proposition 1, we can immediately observe at least three implications. First, public school enrollment is increasing in ι This is because, when parents care more about child quality (i.e., a lower ι), they are more willing to invest in their education privately *ceteris paribus* and thus more likely to opt out of the public system in favor of a private school.

Second, in the (partial) segregation regime the average fertility of locals is lower than that of immigrants, because highly skilled local parents who opt out of public schooling have fewer children, as stated in Lemma 1. Fertility differentials between low-skilled and highly skilled locals arise in all the segregation regimes, and widen with the degree of segregation. Low-skilled locals whose children remain in public schools have the same fertility rate as low-skilled immigrants.[43]

[43]To a certain degree, Kahn (1994)'s findings lend support to this result. Using data from the U.S. Census and Current Population Survey, she concludes that, by the late

Finally, Proposition 1 also implies the following corollary:

Corollary 1. *An equilibrium* $\left\{\psi^H, \psi^L, \psi^M, s^*, \tau^*\right\} = \left\{0, \psi^{L*}, 1, \bar{s}^L, \frac{\Gamma\psi^{L*}}{1+\xi}\right\}$ *with* $\psi^{L*} \in [0,1]$ *is unstable; therefore, it fails to qualify as an education regime.*

Proof: See Appendix C.2. ■

Corollary 1 implies that, if all the highly skilled locals choose private education for their children, all low-skilled locals will follow suit as soon as one of them decides to leave the state system. This is not a surprising result because, when low-skilled locals expect to have no preference for public or private schooling at a given tax rate, they are better off choosing private education and paying no tax. This is because public school resources funded by tax revenue are always shared with children of low-skilled immigrants.

5.2. Effects of Low-Skilled Immigration

In this section, we discuss the impact of increasing low-skilled immigration on each education regime and show whether and how a regime change may take place. More precisely, we investigate the effect of an increase in μ on A, B, C, which determine the conditions under which an education regime serves as a stable equilibrium.

With close inspection, how low-skilled immigration impacts the host country's education system can be decomposed into two main channels: the demographic effect and the income effect. The former is related to the their supply of and their demand for public education, while the latter concerns the rise of high-skilled wage and the fall of low-skilled wage, thus widening the skill premium w^H/w^L. Since $\bar{s}^i$ is positively related to w^i (see Eq. (B.1)), the income effect unambiguously increases the gap between $\bar{s}^L$, $\bar{s}^M$ on one side and $\bar{s}^H$ on the other side. It makes highly skilled parents more capable of affording private schooling, whereas low-skilled parents become more dependent on publicly financed education due to their decreased income.

1980s, the standardized fertility levels of locals and immigrants were virtually identical, and that immigrants' higher fertility rates were due to the composition of this group in terms of demographic, socioeconomic and ethnic characteristics. Our model suggests that, other things being equal, the higher average fertility rate of immigrants may be the result of both their lower income and their choice of public schooling.

As for the demographic effect, it can be observed more clearly by rewriting, for instance, the lower bound of the **Public Regime** (C) as follows:

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

On the one hand, low-skilled immigrants increase total production, and the tax base: $y = (1-\phi\hat{n})(w^H\xi + w^l + w^M\mu)$. On the other hand, 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 schools, as the average tax base is in fact decreased and so school resources per pupil decline; that is to say, the second factor of C' increases. Therefore, the demographic effect narrows the gap between the expenditure on public schools (i.e., their quality) resulting from voting and the opt-out threshold for highly skilled parents. We have shown that an analogous effect is produced through the income effect, specifically via increasing the first factor of C'. Recall that $C = C' < \iota$ is required for the education system to be a public regime. Hence, increasing low-skilled immigration makes it more and more likely that high-skilled locals choose to opt out of public schools (i.e., $\mu \uparrow \Rightarrow (s^* - \bar{s}^H) \downarrow$), thus destituting the public regime.

Similarly, the lower bound of the **Partial Segregation Regime** (B) is positively affected by both the net demographic effect (congestion in public school) and the income effect. As congestion and skilled wage both increase due to an increase in μ, more and more highly skilled parents prefer to opt out, and in so doing, they alleviate congestion such that $s^* = \bar{s}^H$ is maintained. With a growing number of highly skilled parents choosing lower fertility and private schooling, ψ^H becomes lower. Eventually when all the highly skilled parents have opted out, the partial segregation regime then vanishes into the segregation regime. Notice that, in this regime, the income effect is partially counteracted by the increased supply of high-skilled labor, which occurs owing to the greater opportunity cost of child-rearing.[44] In addition, while both the upper bound (C) and the lower bound (B) of the partial segregation regime rise with μ, C does not increase as fast as B. Therefore, when μ is sufficiently high, it becomes impossible for the condition

[44]This counteracting effect is peculiar to partial segregation regime, since in other regimes the skill premium is not dependent on ψ^i (see the definition of B in Proposition 1).

of partial segregation regime – $B \leq \iota \leq C$ – to hold true.

In the **Segregation Regime**, the net demographic effect of school congestion is present as usual. It raises both the upper and the lower bounds in the condition – $A < \iota < B$ – by deteriorating school quality s^* (which already lies below $\bar{s}^H$) and bringing it closer to $\bar{s}^L$. In comparison, the income effect is asymmetrical at the extremes. While, as seen above, it increases B (making the complete withdrawal of highly skilled parents from the state system more likely), it decreases A because the reduced low-skill wage translates into greater dependence of low-skilled parents on the public provision of education. Hence, the income effect tends to widen the distance between the boundaries. If the income effect dominates, the segregation regime is more likely to remain as the stable equilibrium even with a large increase in low-skilled immigration, since low-skilled locals will never be able to pay for private education with a quality higher than the public schools. If instead the net demographic effect (greater congestion) becomes dominant, i.e., $\mu \uparrow \Rightarrow (s^* - \bar{s}^L) \downarrow$, even low-skilled locals who receive a reduced wage will find it more and more tempting to opt out of public schooling since public resources per pupil will decline substantially.

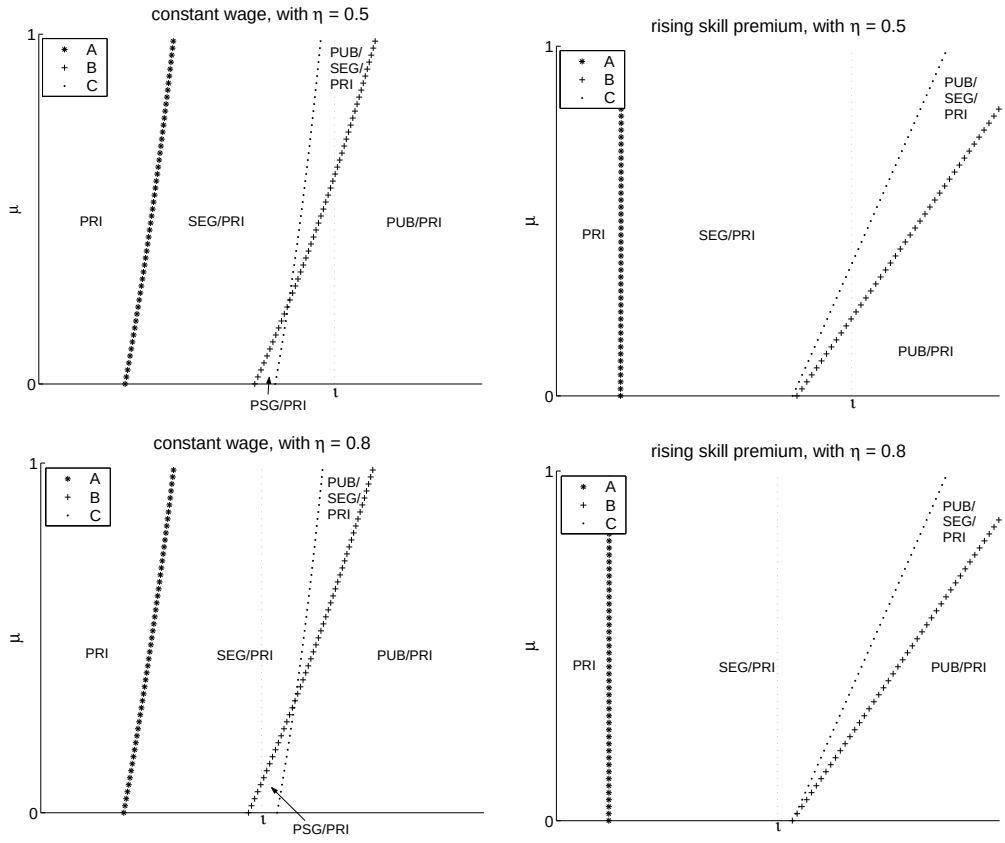
Finally, notice that a **Private Regime** may exist at any positive level of μ.[45] This means that, when all the locals anticipate opting out of public schooling because of their low expectations of its school quality, they choose to finance their children's education out of own pockets. To prevent a net redistribution toward immigrants, locals vote not to be taxed. This occurs since immigrants are not entitled to vote; in other words, immigration does not change the relative size of high- to low-skilled voters.[46]

The analysis performed so far suggests that changes in low-skilled immigration may alter the education regime. Indeed, this is confirmed in the following proposition:

[45] When there is no immigration, the private regime never arises since $\lim_{\psi^L \to 0} s^*|_{\{\mu=0,\psi^H=0\}} > \lim_{\psi^L \to 0} \bar{s}^L\big|_{\{\mu=0,\psi^H=0\}}$. This property is formally presented and discussed by de la Croix and Doepke (2009).

[46] In reality, this assumption is translated into the waiting period between the time of entry and obtaining full citizenship, or the period when immigrants are restricted in their political participation. Depending on the country-specific regulations, and the category of immigration, this can be from a few years to an indefinite period of time. If low-skilled immigrants were granted voting rights, a configuration such as the one in Corollary 1 could emerge as an education regime.

Figure 5: Existence condition for each regime



$(\gamma = 1,\ \xi = 0.6,\ \alpha = 0.6,\ \delta = 0.9)$

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

Proposition 2 (Regime change). *A sufficiently large increase in the number of low-skilled immigrants triggers local parents to opt out of the public school system and lowers enrollment at these schools (i.e.,* $\sum_i \psi^i$, $i = \{H, L, M\}$*). Moreover, if the education regime does not immediately become private 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 5. ■

Suppose that an economy is characterized by a public regime when it opens its door to low-skilled immigrants. As μ grows beyond a certain size, it is expected that, through the demographic effect (worsened public school congestion) and the income effect (private education becoming more affordable for highly skilled locals), there will be a gradual change into a partial segregation regime, or a segregation regime as shown in Figure 5.[47]

The left panel of Figure 5 allows us to disentangle the demographic from the income effect, by keeping wages constant. It can be seen that an increase in low-skilled immigration will deteriorate congestion in public schools and induce the system to change from a public regime, to a (partially segregated,) segregated, and finally end up in a private regime. However, when coupled with the income effect (see the right panel of Figure 5), the transition may linger at the segregation regime if μ raises the skill premium by a large degree,which acts to decrease the lower bound for the condition of segregation regime (A) thus offsetting the demographic effect that tends to raise this boundary. In any case, the income effect is not essential to generate our theoretical predictions. Rather, it reinforces the demographic effect that leads to a more segregated education regime.

Comparing all the regimes, we find that the tax rate decreases as more local children attend private schools. This can be written as:

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

Knowing the direction of potential regime changes from Proposition 2, we

[47] Notice that it is theoretically possible for the public regime to jump to a private one at any positive level of μ. As shown in Section 3, however, in reality we do not observe purely private regimes (i.e., zero spending on public education): minimum levels of public education usually exist.

obtain the following corollary:

Corollary 2 (Decreasing tax rate). *A sufficiently large increase in the number of low-skilled immigrants tends to lower the tax rate that locals vote for,* τ^*.

This echoes Razin et al. (2002)'s finding that low-skilled immigration is associated with less redistribution. However, instead of the "fiscal leakage" motive they propose, the trigger behind Corollary 2 is that highly skilled locals who opt out of public schooling would like to minimize "double taxation", a phrase used to describe the situation where parents with children in private schools also pay (via tax) for public schools.

Note that multiple equilibria are always possible. For example, within a certain range of μ, an education regime may be either public, segregated, or private because of self-fulfilling prophecies, and the strategic complementarity among voters of the same type with respect to schooling choices. When all highly skilled parents anticipate public schooling, voters will set the budget for public schools so high that no parents will find it worthwhile to send their children to private schools. Consequently, every child will attend public school. By the same token, when all the highly skilled parents anticipate private schooling, the resulting budget for public schools will be so low that all highly skilled parents indeed opt out of public schooling. In this case, whether the education regime ends up as a segregated or a private one will depend on the choices made by low-skilled local parents.[48]

5.3. Regime ranking

Since multiple equilibria always exist in our model but locals do not coordinate their actions and decisions are made in a decentralized way, the actual regime may not be optimal in terms of the aggregated welfare of all the locals (Ω in Eq. (12)). In this section, we investigate the cardinal ranking of outcomes across regimes according to Ω.

We begin by considering the pairwise ranking between the private regime and the other regimes (because the private regime can always exist with low-skilled immigration). Let us abstract for the moment from the impact of immigration on wages (i.e., constant wages) so that a larger size of low-skilled immigration has simply the effect of increasing congestion and decreasing

[48] See de la Croix and Doepke (2009) for more discussion of strategic complementarity.

education quality s^* in public school. It turns out that the necessary and sufficient conditions for the private regime to weakly dominate the public and the segregation regimes are given, respectively, by Conditions (16) and (17):

$\Omega_{PRI} \geq \Omega_{PUB} \quad iff$

$$\begin{aligned} s^*_{PUB} &= \frac{y_{PUB}}{1+\mu+\xi} \cdot \frac{\tau_{PUB}}{\hat{n}} \\ &\leq \frac{w^L}{\iota(1+\gamma)} \cdot \left(\frac{w^H}{w^L}\right)^{\frac{\xi}{1+\xi}} \cdot (1-\tau_{PUB})^{\frac{-1}{\Gamma}} \cdot \frac{\tau_{PUB}}{\hat{n}}, \end{aligned} \tag{16}$$

$\Omega_{PRI} \geq \Omega_{SEG} \quad iff$

$$\begin{aligned} s^*_{SEG} &= \frac{y_{SEG}}{1+\mu} \cdot \frac{\tau_{SEG}}{\hat{n}} \\ &\leq \frac{w^L}{\iota(1+\gamma)} \left[1+\xi(1+\gamma\eta)\right] (1-\tau_{SEG})^{\frac{-(1+\xi)}{\Gamma}} \cdot \frac{\tau_{SEG}}{\hat{n}}. \end{aligned} \tag{17}$$

They imply that public (or segregation) regime outperforms the private one as long as it provides a public school quality s^* above a certain threshold. The private regime becomes more likely to dominate when immigration increases and congestion exacerbates in public school, which leads to the decline of school quality. This occurs because, through the public system, locals spend part of their income to subsidize the education of immigrant children, which, in our model, does not improve locals' welfare and creates a loss of efficiency. This is close to the spirit of "fiscal leakage" mentioned by Razin et al. (2002). With non-constant wages, an increase in low-skilled immigration enlarges the skill premium and lowers w^L. In Condition 17, this introduces an advantage for the segregation regime over the private one since the low-skilled locals become more dependent on public provision of education, and therefore, the beneficial effect of redistribution is higher. While this is also true for Condition 16, the picture is complicated by the fact that high-skilled locals, when enjoying a larger skill premium, would prefer a higher school quality that becomes less likely to be satisfied by the public system owed to worsening congestion. In summary, fiscal leakage and declined public school quality make it more likely that the private regime yields greater

welfare from the locals' point of view, unless the low-skilled wage is so negatively impacted that redistribution from high to low-skilled locals becomes highly preferable.

Let us now move to the comparison between the private and the partial segregation regimes. The condition for the weak dominance of the private regime is as follows

$$\Omega_{PRI} \geq \Omega_{PSG} \quad iff \qquad \frac{w^H}{w^L} \leq (1-\tau_{PSG})^{\frac{-(1+\xi)}{\Gamma}}. \tag{18}$$

Condition 18 looks quite different from Conditions 16 and 17 because, in the partial segregation regime, increasing immigration induces a growing share of high-skilled parents to opt for private school, which then alleviates public school congestion. Condition 18 shows that the partial segregation regime dominates the private one if wage inequality (the LHS) is so large that it is worth redistributing resources from the the more to the less wealthy locals, notwithstanding the efficiency loss due to fiscal leakage towards the immigrants (the RHS, which is increasing in τ_{PSG}). Hence, by widening the wage gap among locals and by inducing a lower voted tax rate, increased low-skilled immigration makes it more likely that the partial segregation regime is socially more preferable than a purely private system.

From the previous discussion, and as illustrated by Figure 5, with some sets of parameters (particularly with large μ), it is possible for the education system to end up in the public, the segregation, or the private regime. The following inequality expresses the condition under which the segregation regimes weakly dominates the public one:[49]

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

Since an increase in μ drives up the LHS and does not affect the RHS, it makes the segregation regime more likely to dominate. This is because fiscal leakage may become so severe in the public regime that it greatly reduces the effective redistribution from high- to low-skilled locals . Moreover, in the segregation regime, the impact of migration on wage inequality is partly

[49]The condition is directly obtained by taking wages as endogenously determined.

mitigated by the fact that high-skilled locals have less children and supply more labor.[50]

6. Conclusion

We have presented a political-economic model relating low-skilled immigration and the education system, where education and fertility are jointly determined. In our framework, a larger size of low-skilled immigration implies an expected reduction of the average tax base, which has the effect of decreasing public expenditure per pupil on education. In such a situation, wealthier parents (i.e., high-skilled locals) prefer to invest in their children's education out of their own pockets. As a consequence, they choose private schooling, and consistently vote for lower tax rates to finance public education. Eventually, equilibria characterized by different degrees of segregation may arise, featuring high private school enrollment rates and high proportions of education expenditure in the private sector. This mechanism is strengthened by the increase in wage inequality brought about by an increased supply of low-skilled labor.

In order to compare the theoretical predictions to empirical observations, it should be borne in mind that our model makes the simplification that schools are funded entirely by either public or private sources. In reality, many private schools are subsidized by the government, while students attending public schools may still need to pay for certain fees. Therefore, the choice of private education has to be interpreted as implying that children of wealthier parents are more likely to attend schools with lower proportions of public funding. Moreover, the model assumes that parents make schooling decisions for their children. This is generally a realistic and safe assumption when the empirical investigation is restricted to students attending primary and secondary schools.[51]

We have seen that the model's predictions are supported by the empirical evidence shown in Betts and Fairlie (2003). Moreover, they conform to the stylized facts revealed in both U.S. census data and the cross-country dataset of PISA 2003. The U.S. data documents the highest private school enrollment and the lowest fertility rates for the high-skilled locals, and the

[50] This effect is related to the quantity/quality trade-off.

[51] This is also consistent with our interpretation of κ^i as the investment in children's basic education.

opposite for low-skilled immigrants. Between 1990 and 2000, it demonstrates a positive correlation between increases in low-skilled immigration and the overall enrollment in private schools; furthermore, it points to a widening fertility differential among locals. Consistent with the ordering of private school enrollment in the U.S., PISA 2003 shows that children from high-skilled local households are more likely, on average, to attend schools with the lowest proportion of public funding. In addition, the tabulation of low-skilled immigration and segregation in education system is also in accordance with the positive relationship between the two. All these phenomena can be predicted by our theoretical framework: an increase in low-skilled immigration induces high-skilled local parents to purchase private schooling instead of using the state system, and in so doing, they have less children so as to compensate for the larger expenditure invested on their children's education.

It is worth remarking that these main implications do not emerge from any exogenous assumption about differences in preferences for fertility or education among immigrants and locals.[52] In fact, the main distinction is that immigrants are not entitled to vote, or less strictly, possess less political power. Even if this distinction is removed, congestion in schools may still lead to segregation in school enrollment, although the process will occur less rapidly as low-skilled immigrants, if granted voting rights, tend to vote in favor of public education and this counteracts high-skilled locals' preference for a lower tax rate. This study is not meant to take a position in the debate over open/closed borders; rather, it highlights the channels through which the education system in receiving countries can be affected by low-skilled immigration and the rational responses of local 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 study, due to the static framework of the model. For example, it suggests that, as low-skilled immigration intensifies schooling segregation, income inequality might become more persistent as the better-educated pupils are more likely to complete tertiary education and acquire better jobs. Inequality may increase even further as this process continues, and the attenuated social mobility could fuel pervasive "social segregation" with an underclass of poorly-educated families, be them locals

[52]We have assumed a productivity gap between immigrants and low-skilled locals, but this is not essential for the main mechanism to work.

or immigrants. Moreover, the ranking of regimes based on aggregated local welfare can arguably be affected when efficiency is considered in a dynamic perspective. As Gradstein and Justman (2001) suggest, public schools can play an important role in promoting social integration and the 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.[53] Such medium-term beneficial functions can become less and less effective with a progressive process of segregation. These issues seem to suggest a promising direction for future research to extend our work in a dynamic framework.

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Appendices

A. Data Description

A.1. U.S. Census Data, 1990 and 2000

Using the 1% sample U.S. census data for years 1990 and 2000 provided by the Integrated Public Use Microdata Series (IPUMS), we construct a dataset containing students aged between 7 and 16 who were children, step children or adopted

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

children of the head of household. Each child was assigned to a category that describes the skill type and the immigration status of his/her parents. There were three such categories: students with low-skilled immigrant parents, students with low-skilled local parents, and students with high-skilled local parents. The sample sizes of each category were respectively 15,394 (4.86%), 163,930 (51.78%), 137,256 (43.36%) in 1990, and 24,300 (6.47%), 211,349 (56.27%), 139,947 (37.26%) in 2000.[54] Since our model studies the relationship between low-skilled immigration and local parents' schooling and fertility choices, we treat as missing values students with high-skilled immigrant parents.

Parents' schooling choices are indicated by the type of school their children attend. Treating non-enrollment as missing data, students go to either public or private schools.[55] The household fertility rate is constructed taken to be the number of siblings.[56] Finally, in order to produce the scatter plots, the student data was collapsed by year and metropolitan area. Special attention is paid to ensuring that each household is given the same weight when computing the means of fertility for each skill group.

A.2. PISA Data, 2003

PISA is an OECD program that conducts internationally standardized studies of the knowledge and skills of 15-year-olds in schools. Two datasets produced in 2003 are combined for our analysis. Data from the school questionnaire provides information on each school in the sample, including the proportion of funding it received from each source, whether the management was public or private, and the percentage of students who have a first language other than the test language used in school. Data from the student questionnaire identifies the school attended by the respondent, and details of his or her family background, including whether the student and each parent was born in the present country of residence or elsewhere, language spoken at home, parental occupations and educational attainment. The combined dataset covers 35 countries in total, 24 of them OECD members.[57]

[54] See Footnote 16.

[55] Although in many countries, private school management does not necessarily imply private school funding, the PISA data shows that the two definitions usually coincide for U.S. schools.

[56] Only 0.0003% of the sample were students who report a different number of siblings than the number reported by their sampled sibling(s).

[57] Although 41 countries participated in PISA 2003, data on some of the variables of interest was missing for Austria, France, Italy, Spain, and the United Kingdom. Moreover, there were insufficient Korean students who satisfied our definition of an immigrant to provide a sample.

We identify three types of students by their immigration background and their parents' occupational status.[58] With regard to parental occupational status, PISA offers two alternative measures, both based on respondents' descriptions of their parents' 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 into the classification in the model, we only counted the students with at least one white-collar high-skilled parent as having highly skilled parents; the others were all taken as students having low-skilled parents. Alternatively, students with at least one parent in an above-national-sample-median ISEI score can be arbitrarily regarded as having highly skilled parents, and the others as having low-skilled parents. Since the results from the two measures are more or less consistent, we report only the statistics produced by the ISEI alternative. In the final sample of 197,736 observations, 5.89% are identified as immigrant students with low-skilled parents, 50.77% as local students with low-skilled parents and 43.34% as local students with high-skilled parents.

B. Proofs for Section 4

B.1. Proof of Lemma 2

Eqs. (13) and (14) result 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 Eq. (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 into the product of two non-negative terms both no greater than 1: $\gamma\eta/(1+\gamma\eta)$ and $(\xi\psi^H + \psi^L)/(1+\xi)$ with $\psi^i \in [0, 1]$. The comparative statics are obtained by taking derivatives of Eq. (13). ■

[58] In the model, occupational skill is taken as a synonym of productivity that directly affects the earnings of the family. Of course in reality occupational status is only a rough measure of household income, which is not available in the PISA data. For the purposes of this study, we excluded all with highly skilled parents.

B.2. Proof of Lemma 3

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

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

For $\bar{s}^i$ to be feasibly financed via tax, we must have $\bar{s}^i \in [0, 1/T(\cdot)]$ such that $\tau(\bar{s}^i) \in [0, 1]$. It is immediately seen that the upper bound is satisfied. Moreover, since $T(\cdot) \geq 0$, it is apparent that $\bar{s}^i$ is always positive. Furthermore

$$\frac{\partial \Delta^i}{\partial s} = \frac{\gamma\, \eta}{s(1 - s\, T(\cdot))} > 0, \quad \forall\, s \in [0, 1/T(.)], \tag{B.2}$$

which shows that Δ^i is monotonically increasing for all feasible s. Thus, $\bar{s}^i$ is unique. Eq. (B.2) also implies that $\Delta^i > 0$ *iff* $s > \bar{s}^i$, which proves Point (*ii*). Moreover $\bar{s}^i$ is positive and increasing in w^i, which proves Point (*iii*). Point (*iv*) follows from the definition of Δ^i, and from Points (*ii*) and (*iii*). The reverse direction of the final part of Point (*iv*) comes from Lemma 2 which states that, if $\psi^L = \psi^H = 0$, $\tau^* = 0$ and consequently $s^* = 0$. ■

C. Proofs for Section 5

C.1. Proof of Proposition 1

In the public regime, every child attends a 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 (B.1), the inequality representing no opting out can be recast into the condition: $C < \iota$.

In the partial segregation regime, some highly skilled parents opt out of public schooling, while the rest attend public schools with quality $s^* = \bar{s}^H$. Replacing $\psi^L = \psi^M = 1$ in Eqs. (14) and (B.1) and defining the function $\Psi^H(\psi^H) \equiv (s^* - \bar{s}^H)$, it can easily be verified that $\Psi^H(\cdot)$ is composed of a strictly positive part times a concave second-order polynomial. Hence, the stable solution to $\Psi^H(\cdot) = 0$ must be identified by the larger root of the polynomial.[59] This root must satisfy $\psi^H \in [0, 1]$ for the partial segregation regime to be a stable equilibrium. By recasting this constraint, the condition $B \leq \iota \leq C$ is then obtained.

[59] Intuitively, since public school congestion is relieved with some pupils opting out, there is a threshold 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 $\psi^{H*'}$ as the unstable one, we have $\Psi^H(\cdot) = (s^* - \bar{s}^H) > 0$, $\forall\, \psi^H \in]\psi^{H*'}, \psi^{H*}[$.

In the segregation regime, all the highly skilled parents opt out of public schools, 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 Eqs. (14) and (B.1), the constraint on school quality can be recast into the condition: $A < \iota < B$.

In the private regime, no child attends public schools, and the expenditure on public schools satisfies $s^* \leq \bar{s}^L$. By setting $\psi^i = 0, \ \forall i$ in Eq. (14), we obtain $s^* = 0 < \bar{s}^L$, which indicates that a private regime may emerge at any positive level of μ. ■

C.2. Proof of Corollary 1

Set $\psi^H = 0$ and $\psi^M = 1$ in Eqs. (14) and (B.1) and then define the function $\Psi^L(\psi^L) \equiv (s^* - \bar{s}^L)$. Using the same procedure for deriving the condition of the partial segregation regime, $\Psi^L(\cdot)$ can be rewritten as a product of a strictly positive factor and a concave second-order polynomial. This implies that, if there are two distinct roots, the smaller one (denoted by $\psi^{L*'}$) is unstable while the larger (denoted by ψ^{L*}) is stable. In order for the latter to represent an education regime it must be admissible, i.e., it must locate within $[0, 1]$, the domain of ψ^L.

Next, it can be proven that the polynomial associated with $\psi^L(\cdot)$ is negative when evaluated at 0. Hence, if there is an admissible stable equilibrium, there must also exist an admissible unstable equilibrium, i.e., $0 < \psi^{L*'} < \psi^{L*} \leq 1$. It can be proven by contradiction, however, that this is never the case. In fact, the only admissible equilibrium is represented by the unstable smaller root, and its existence requires that the polynomial is non-negative when evaluated at 1. This condition yields the following inequality: $\iota \geq A$, where A is at the same time the lower bound of the segregation regime. Therefore, we conclude that, as long as the segregation regime exists ($A < \iota < B$), an equilibrium also exists with all high-skilled and some low-skilled locals opting out of public schools, but this equilibrium is not stable and thus fails to qualify as an education regime. ■

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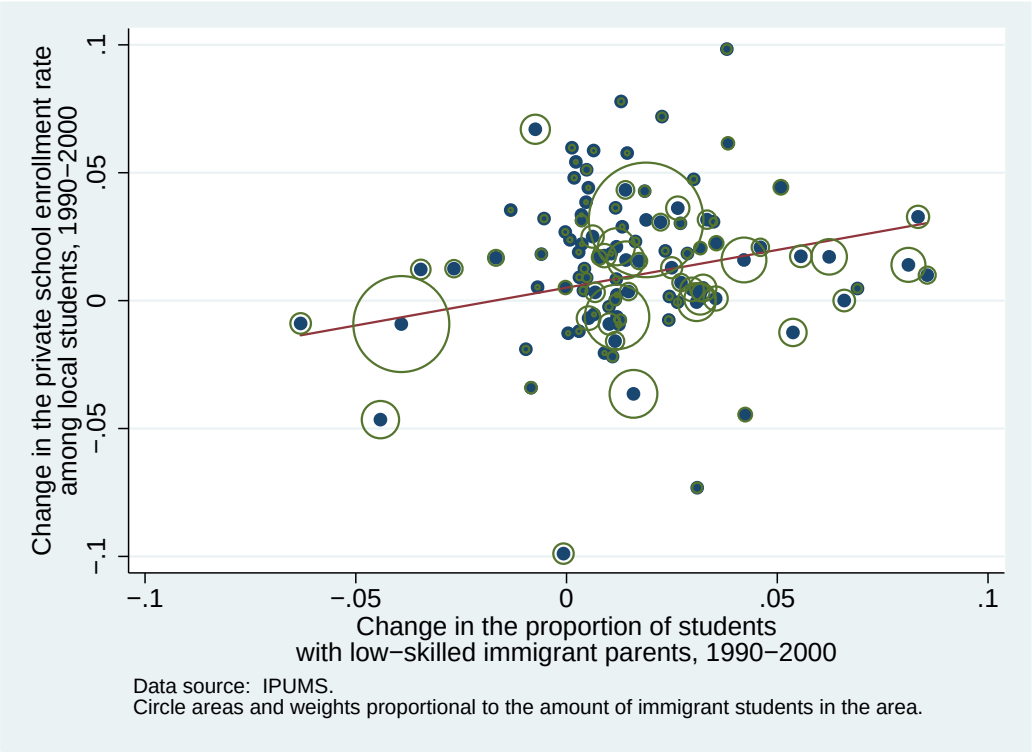
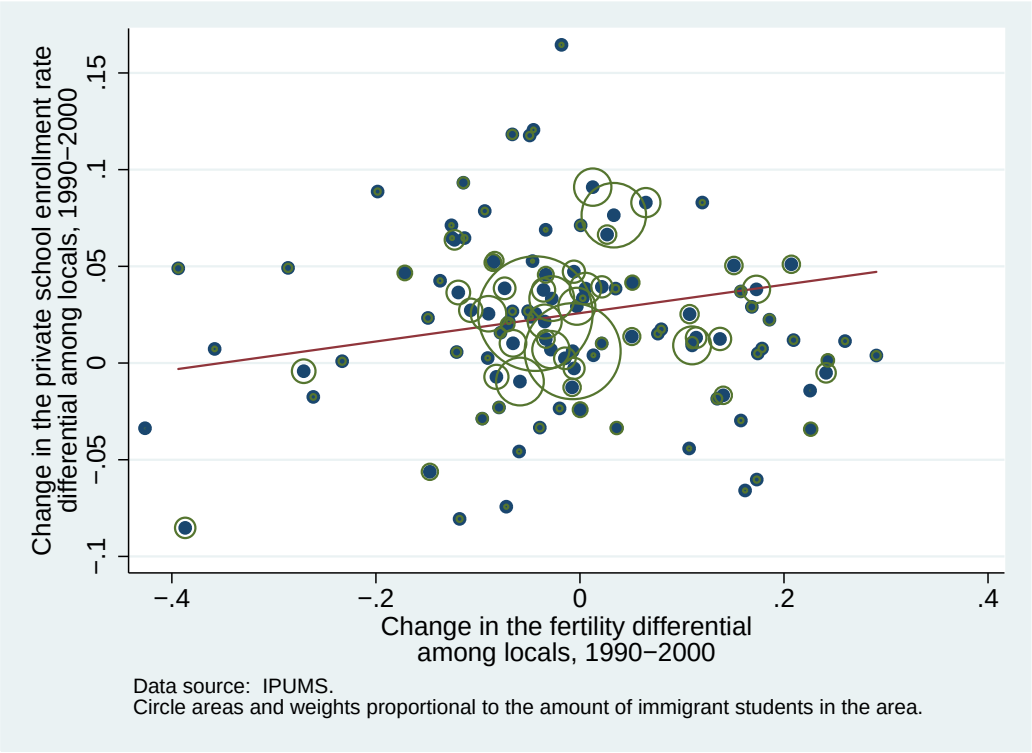
Figure 1: The relationship between changes in the proportion of students with low-skilled immigrant parents and changes in the private school enrollment rate among local students



Correlation (p-value): 0.3707^{***} (.0001).

Hollow circles are proportional to the number of students with low-skilled immigrant parents in each area in 2000. The correlation is weighted by these numbers.

Figure 2: The relationship between changes in the fertility differential and changes in the private school enrollment rate differential among locals

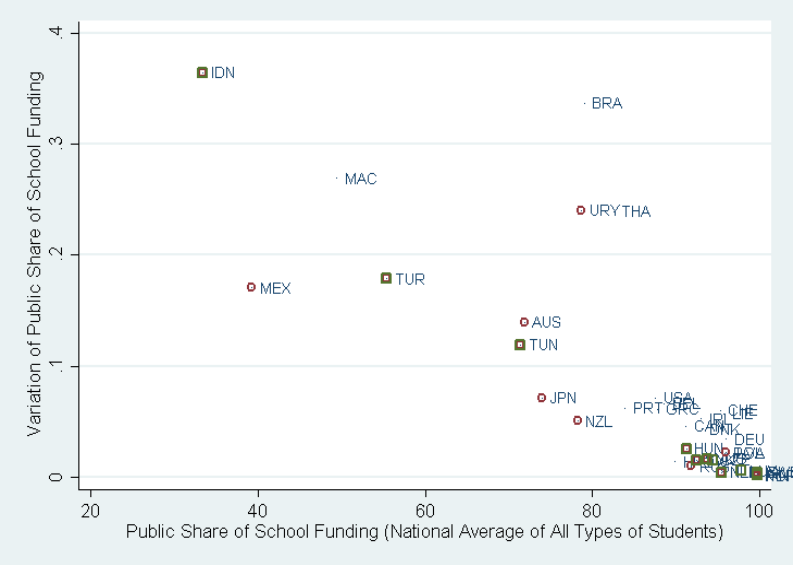


Correlation (p-value): 0.2096** (.0327).

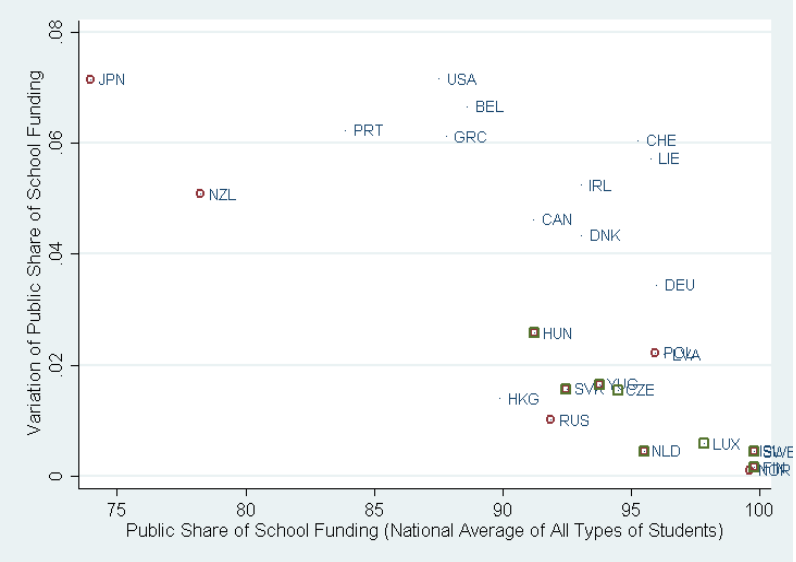
Hollow circles are proportional to the number of students with low-skilled immigrant parents in each area in 2000. The correlation is weighted by these numbers.

Figure 3: The distribution of countries by regime

(a) All countries



(b) Countries in the public and the segregation regimes



The variation in the proportion of public funding for schools is defined as $\frac{S_{max}-S_{min}}{S_{max}}$, where S_{max} and S_{min} are respectively the maximum and minimum of the average proportion for all three types of students. A hollow circle around a dot indicates that immigrant students with low-skilled parents do not have the highest average proportion of public funding for schools. A hollow square indicates that local students with high-skilled parents do not have the lowest average proportion of public funding for schools .

Table 1: Private school enrollment rate by type of parent

Parent Type	Obs.	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
low-skilled immigrants	39694	.0574646	.0011681	.2327311	.055175	.0597542
low-skilled locals	375279	.0749283	.0004298	.2632759	.0740859	.0757706
high-skilled locals	277203	.1402294	.0005595	.3472255	.1389368	.141522
diff = mean(low-skilled immigrants) - mean(low-skilled locals)						t = -14.0306
Ho: diff = 0						Satterthwaite's degrees of freedom = 51066.8
Ha: diff < 0			Ha: diff ≠ 0			Ha: diff > 0
Pr(T < t) = 0.0000			Pr(T > t) = 0.0000			Pr(T > t) = 1.0000
diff = mean(low-skilled locals) - mean(high-skilled locals)						t = -82.9568
Ho: diff = 0						Satterthwaite's degrees of freedom = 496490
Ha: diff < 0			Ha: diff ≠ 0			Ha: diff > 0
Pr(T < t) = 0.0000			Pr(T > t) = 0.0000			Pr(T > t) = 1.0000

Table 2: Fertility rate by type of parent

Parent Type	Obs.	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
low-skilled immigrants	39694	3.198594	.0077865	1.551325	3.183333	3.213856
low-skilled locals	375279	2.664394	.002123	1.300551	2.660233	2.668555
high-skilled locals	277203	2.472527	.0020421	1.075164	2.468525	2.47653
diff = mean(low-skilled immigrants) - mean(low-skilled locals)						t = 67.2521
Ho: diff = 0						Satterthwaite's degrees of freedom = 47300.6
Ha: diff < 0			Ha: diff ≠ 0			Ha: diff > 0
Pr(T < t) = 1.0000			Pr(T > t) = 0.0000			Pr(T > t) = 0.0000
diff = mean(low-skilled locals) - mean(high-skilled locals)						t = 65.1339
Ho: diff = 0						Satterthwaite's degrees of freedom = 644288
Ha: diff < 0			Ha: diff ≠ 0			Ha: diff > 0
Pr(T < t) = 1.0000			Pr(T > t) = 0.0000			Pr(T > t) = 0.0000

Table 3: Average proportion of public funding for schools, by student type

Regime	Country	Immigrant students with low-skilled parents	Local students with low-skilled parents	Local 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 Regime	Belgium	92.970215	89.557091	86.785774
		(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 Segregated	Australia	73.738464	76.311218	65.669144
		(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 Regime	Indonesia	21.599062	33.002502	33.966629
		(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 4: Low-skilled immigration and education regime

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 (8 countries)	-39784.49 (79846.49)	1.98% (1.69%)	-0.06% (0.41%)
Segregation (12 countries)	383054.60 (978392.40)	3.16% (2.21%)	0.43% (0.38%)

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 (8 countries)	2664.21 (109170.20)	3.90% (2.83%)	0.57% (0.78%)
Segregation (12 countries)	564021.90 (1470442.00)	5.22% (3.50%)	0.77% (0.78%)

Standard deviations are included in the parentheses.