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# ABSTRACT

## Low-Skilled Immigration and the Expansion of Private Schools*

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 size 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 are consistent with empirical evidence from both the U.S. census data and the OECD Programme for International Student Assessment (2003).

JEL Classification: H42, H52, I21, D72, O15

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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 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

[1] Facchini and Mayda (forthcoming) 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 Petronicolos and New (1999)).

school (Betts and Fairlie 2003). They are also consistent with cross-country empirical evidence 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 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 increases, 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 large proportion 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

[3] See Section 5.

[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.

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 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

[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.

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. Notice that an increased skill premium due to low-skilled immigration is not required in order for this mechanism to operate; but it does reinforce the mechanism, as low-skilled parents become more dependent on public education.

This paper follows de la Croix and Doepke (2007) 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). If the opportunity cost of having children is greater for high-skilled parents, they might decide 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]

[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).

[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).

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. Section 3 formally presents the model economy, and Section 4 depicts each education regime and its existence conditions. Section 5 provides some empirical evidence on the predictions of our model. Finally, concluding remarks are given in Section 6.

# 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 fertility and education decisions (Becker and Barro 1988; Tamura 1994; de la Croix and Doepke 2003; de la Croix and Doepke 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.

[8]de la Croix and Doepke (2007) 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.

The structure of our model follows de la Croix and Doepke (2007), who show that in democracies a public regime tends to be established unless income distribution is too unequal, whereas in non-democracies, a multiplicity of equilibria may arise. Our model differs in that the economy includes low-skilled immigrants who cannot vote, but who contribute to the demand for, and the supply of, public education.[9] 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 has an impact on the income distribution of the electorate. We also consider explicitly the adjustment costs of migration. These affect the productivity of immigrants negatively, so that they receive a lower net wage than low-skilled locals. Therefore the only differences between low-skilled locals and low-skilled immigrants concern their voting rights and wages.

As policy variables have redistributive effects. This paper also relates to the literature on income redistribution, voting, and education policy. Whereas standard models of publicly provided private goods demonstrate a mechanism of redistribution from the rich to the poor (Atkinson and Stiglitz 1980), some studies of education suggest the reverse (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. In other words, the perhaps counter intuitive, but empirically supported (Peltzman 1973; Bishop 1977), result emerges that, in the case of education, redistributive policies tend to benefit the

[9]In order to study the implications for non-democracies de la Croix and Doepke (2007)consider the case of unequally distributed political power, where some electors have more control than others over the final outcome. Our framework incorporates asymmetries in the voting power of agents, but not of electors. In other words, all electors have the same political power, but not all agents are electors (we introduce a category of agents – immigrants – who cannot vote).

rich, thus exacerbating inequality. Unlike Fernández and Rogerson (1995)'s, our model does not specify a single regime for education, but allows the system to be endogenously determined. While resources are redistributed from the rich to the poor, the scale of redistribution varies with different regimes. Following de la Croix and Doepke (2007), we assume that education policy is determined by probabilistic voting, so that the outcome is equivalent to a smooth aggregation of preferences across all the electorate. It is not only the median voter, but the whole distribution of voters' preferences, that matters for policy making.

Our research is also related to the literature on the effect of migration on social policy at the destination (Borjas 1994; Benhabib 1996; Sand and Razin 2006). Razin, Sadka, and Swagel (2002) study the effect of migration on redistributive policies, by developing a model of low-skilled migration and human-capital formation. They consider two contrasting effects of migration. On the one hand, immigrants tend to support 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 a lower tax rate with more low-skilled immigration. 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. Our model assumes that immigrants are not entitled to vote, but their children cannot be excluded from public schools. With probabilistic voting, we predict that low-skilled immigration may result in a lower tax rate to finance public education; 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 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, Mieszkowski, and Sauvageau 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.[10] 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.[11] In contrast to the literature that studies sorting and education, we abstract from modeling neighborhood effects but allow for sorting into

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

[11] 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,

public and private schools, as in de la Croix and Doepke (2007).

# 3 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.

## 3.1 Households

The economy is populated by households with identical preferences over consumption $c$, number of children $n$, and children's human capital $\kappa$. 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.[12] 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.[13] Notice

local parents may find it more attractive to educate their children in private schools in the neighborhood than to move to another community.

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

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

that no exogenous difference in preferences between immigrants and locals is imposed on the model.[14]

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 $e^i$ denotes the quality of education purchased by parents on the private schooling market). Assuming that the cost of private education is not tax deductible, we can write the household budget constraint as:[15]

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

where $\tau \in ]0,1[$ is the proportional income tax rate that yields sufficient government revenue to finance public education. 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. 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,

[14] 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. $\eta$ is lower for immigrants than for locals) only strengthens our results.

[15] 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 (2007) 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.

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 Equation (1) subject to Equation (2). Parents anticipating public schooling, i.e. $[\kappa^i]^e = s$, choose the following fertility rate $\hat{n}$:

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

As expected, fertility is increasing in the child-caring parameter $\gamma$ and decreasing in the time cost of child-rearing $\phi$. 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 Equations (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.[16] 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 $\eta$ only appears in $\tilde{n}$.

Spending on private education $e^i$ increases with the taste for children's human capital $\eta$, household income $w^i$ and the time cost of child-rearing $\phi$. The last result occurs because, as child-rearing becomes more time-consuming, having one additional child is relatively more expensive than providing better education for the children who are already born. Further, it is observed that $e^i$ is decreasing in the tax rate $\tau$, 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.

[16] 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, i.e. $\frac{1-\tau}{1+\gamma}$.

## 3.2 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. 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.[17] 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.

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:

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

[17]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.

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 $\xi$, and the ratio of immigrants to low-skilled locals by $\mu$. 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 $\psi^i$ denotes the proportion of parents type $i$ who anticipate educating their children in public schools. The following restrictions are imposed: $\xi \in ]0, \left(\frac{\alpha(1+\delta\mu)}{(1-\alpha)(1+\gamma\eta)}\right)[$ and $\mu \in [0,1]$. The first condition ensures a skill premium by assuming that high-skilled labor is always scarcer.[18] The second restriction avoids the implausible situation in which there are more low-skilled immigrants than low-skilled locals, but can be easily relaxed.[19] It follows that $w^M = \delta w^L < w^L < w^H$.[20]

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

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

[20] 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 $\xi$.

### 3.3 Political Mechanism

As explained in Section 1, we assume that the quality of public schooling $s$ and the proportional income tax rate $\tau$ are determined via probabilistic voting, which displays convenient properties that take the whole distribution of preferences into account. It can be shown that the political outcome under probabilistic voting corresponds to implementing the following social welfare function $\Omega$:[21]

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

where $\hat{U}^i$ and $\tilde{U}^i$ denote respectively the (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 revenue:

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

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:

[21] See de la Croix and Doepke (2007) for further details on the mechanism of probabilistic voting.

**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:*

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

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

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

*Proof:* Equations (13) and (14) 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 $\tau$, the second order condition for a maximum is satisfied. In order for Equation (13) to represent a tax rate, it has to satisfy $\tau^* \in [0, 1]$. The fact that $\tau^*$ 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: $\frac{\gamma\eta}{1+\gamma\eta}$ and $\frac{\xi\psi^H+\psi^L}{1+\xi}$ with $\psi^i \in [0, 1]$. The comparative statics are obtained by taking derivatives of Equation (13). ■

Intuitively, the tax rate depends positively on the propensities to spend on children, $\gamma$ and $\eta$, and on local parents' anticipated participation in public schooling, $\psi^H$ and $\psi^L$. 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, $\xi$, 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 $\xi$ implies that the proportion of the electorate who favor less redistribution increases.

The denominator of Equation (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 ($\psi^i$) 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 Equations (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 ($\mu$) 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).[22]

Notice that the tax rate chosen by voters is not directly affected by the number of low-skilled immigrants, or by the proportion of them anticipating sending their children to public schools. In fact, $\mu$ and $\psi^M$ only affect the quality of public school. This is because the socially determined tax rate reflects the aggregated preferences of locals

[22] 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.

about the allocation of income between consumption and child-caring. With the assumed homothetic utility function in Equation (1), this rule of allocation is not affected by the income level, but is determined by preferences and the composition of the electorate.[23] The weight that a society places upon education as opposed to consumption, can be denoted by $\Gamma = \frac{\gamma\eta}{1+\gamma\eta} \in ]0,1[$. If all voters expect to make use of public schools for their children, the tax rate they choose will correspond exactly to $\Gamma$. 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 4, we will show how low-skilled immigration alters local parents' expectations about the schooling of their children. That is to say, we will show that $\mu$ and $\psi^M$ indirectly affect the tax rate $\tau^*$.

## 3.4 Equilibria

In this subsection we will characterize the equilibria. Up to now, $\psi^i$ 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. $\psi^i$ 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 participation 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*

[23] Note that the technology parameter $\alpha$ and the adjustment costs $\delta$, 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 $\mu$ by either the skill premium or the tax base.

*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 (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.[24]

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 $s$:

$$\tau(s) = s \cdot T(\psi^H, \psi^L, \psi^M) \quad \text{where} \quad T(\cdot) = \frac{\hat{n}(\xi\psi^H + \psi^L + \mu\psi^M)}{y(\psi^H, \psi^L, \psi^M)} \geq 0.^{25} \tag{15}$$

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 Equations (3), (4) and (5)). In this way, indirect utilities depend only on the policy variable $s$ and

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

[25] The denominator of $T(\cdot)$ expresses the total production in terms of public participation rates: $y = y(\psi^H, \psi^L, \psi^M) > 0$ (see Section 3.2).

on public school enrollment rates $\psi^i$:

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

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 participation rates $\left\{\psi^H, \psi^L, \psi^M\right\}$ is affected by the socially determined quality of public schooling, $s^*$.

**Lemma 3 (Opting-out and participation rates)**

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

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

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

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

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

$$\bar{s}^i(\psi^H, \psi^L, \psi^M) = \left( \frac{(1-\eta)^{1-\frac{1}{\eta}}}{\eta \, \phi \, w^i} + T(\psi^H, \psi^L, \psi^M) \right)^{-1}. \tag{16}$$

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

$$\frac{\partial \Delta^i}{\partial s} = \frac{\gamma\, \eta}{s(1 - s\, T(\cdot))} > 0, \quad \forall\, s \in [0, 1/T(.)], \tag{17}$$

which shows that $\Delta^i$ is monotonically increasing for all feasible $s$. Thus, $\bar{s}^i$ is unique. Equation (17) also implies that $\Delta^i > 0$ *iff* $s > \bar{s}^i$, which proves Point 2. Moreover $\bar{s}^i$ is positive and increasing in $w^i$, which proves Point 3. Point 4 follows from the definition of $\Delta^i$, and from Points 2 and 3. The reverse direction of the final part of Point 4 comes from Lemma 2 which states that, if $\psi^L = \psi^H = 0$, $\tau^* = 0$ and consequently $s^* = 0$. ■

Figure 1: Critical levels of public school quality

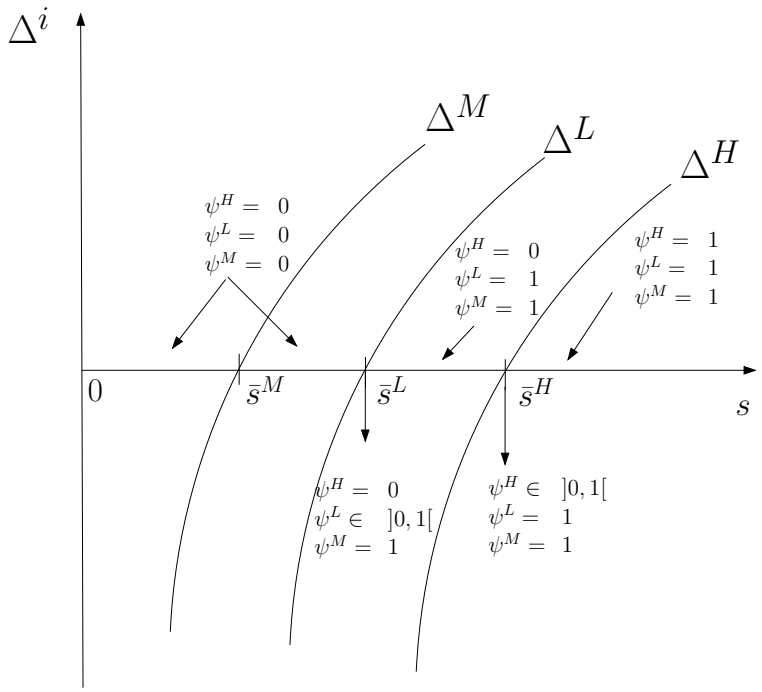


Figure 1 illustrates Lemma 3. It shows that, if the quality of public schooling is not satisfactorily high, parents will choose private schooling despite its cost. This is because parents' care about their children's human capital.[26] As the quality of public schooling declines, high-skilled parents are the first to opt out, followed by low-skilled locals and then by immigrants. Thus, as Point 4 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.

# 4 Education Regimes

In the previous section, we defined the equilibrium and discussed the important properties at equilibrium: 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 order for a configuration of $\{\psi^H, \psi^L, \psi^M, s^*, \tau^*\}$ to be an equilibrium outcome, the participation rates and the voted policy-variables must be reciprocally consistent. Let us call an equilibrium configuration an *education regime*. In this section, we assess whether, and under what conditions, a certain education regime will exist.

**Proposition 1 (Education regime)** *There are four possible education regimes that may exist*

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

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

Proposition 1 is a straightforward result derived from the combination of Lemmas 2 and 3. In Section 4.1, the existence conditions are computed for each education regime. The effects of low-skilled immigration are investigated within each regime, while the effects across regimes (i.e. how low-skilled immigration brings about changes in education regime) will be discussed in Section 4.2.

## 4.1 Existence Conditions of Each Regime

For ease of notation, let us define $\iota = \left(\frac{1}{1-\eta}\right)^{\frac{1}{\eta}-1}$. This can be considered as an exogenous indicator of parental preference for quantity of children over the quality of their education. $\iota$ decreases monotonically with $\eta$.

**Public Regime.** In this 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 (16), we can recast the inequality representing no opting out into the existence condition:

$$\frac{w^H}{w^L} \cdot \frac{1+\mu+\xi}{\frac{w^H}{w^L}\,\xi + (1+\delta\,\mu)} \;<\; \iota\;, \tag{18}$$

where $\frac{w^H}{w^L} = \left(\frac{\alpha}{1-\alpha}\right)\left(\frac{1+\delta\mu}{\xi}\right)$. The right-hand side (RHS) is decreasing in $\eta$ (the exogenous taste for childrens human capital). The larger $\eta$ is, the more difficult it is to satisfy the inequality, and the less likely the public regime is to exist. Intuitively, when parents care more about child quality, they are more willing to invest in their education privately. On

the left-hand side (LHS) we can observe that low-skilled immigration has two effects: an income effect through the rise in the wage premium $w^H/w^L$, and a direct demographic effect that affects the supply of (via $\delta\mu$) and the demand for (via $\mu$) public education.

In order to observe the demographic effect more clearly, we can rewrite the LHS as

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

On 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. 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. An analogous effect is produced through the income effect, as can be seen by examining equation (16).[27] In short, an increase in low-skilled immigration makes the public regime less likely to exist, i.e. $\mu \uparrow \Rightarrow (s^* - \bar{s}^H) \downarrow$.

**Partial Segregation Regime.** In this regime, some highly skilled parents opt out of public schooling, while the rest attend public schools with quality $s^* = \bar{s}^H$. The existence condition is:

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

[27] In equation (16), $\mu$ operates through the wage rate $w^i$ in an asymmetric way. It raises $w^H$ while depressing $w^L$ and $w^M$, which is a consequence of (imperfect) substitution in production. Since $\bar{s}^i$ is positively related to $w^i$, the wage 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.

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

*Proof:* If we replace $\psi^L = \psi^M = 1$ in Equations (14) and (16) and define 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, if the solution to $\Psi^H(\cdot) = 0$ is stable, it must be identified by the larger root of the polynomial.[28] This root must satisfy $\psi^H \in [0, 1]$ for the partial segregation regime to be an equilibrium. The existence condition is then obtained. ■

Notice that the upper bound of Condition (19) corresponds to the lower bound of the public regime Condition (18). Like the upper bound, the lower bound of the partial segregation regime is affected by low-skilled immigration through the income and the demographic effects. As $\mu$ increases, the net demographic effect (congestion in public school) pushes more and more highly skilled parents to opt out, and in so doing, they alleviate congestion such that $s^* = \bar{s}^H$ is maintained. Eventually at the lower bound, all the highly skilled parents have opted out and the partial segregation regime vanishes into the segregation regime. The income effect increases the reward for high levels of skill, and thus, high-skilled parents prefer better education quality. Moreover, it increases the opportunity cost of child-rearing so that the number of highly skilled parents choosing lower fertility and anticipating private schooling increases, which drives down $\psi^H$. Hence, the income effect reinforces the net demographic effect so that a greater $\mu$ lifts the lower bound and makes the existence condition more difficult to hold. The upper bound also rises with $\mu$, but not as fast as the lower bound. Therefore, when $\mu$ is sufficiently high, it becomes impossible for both inequalities to be true at the same time. In other words,

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

the existence condition for the partial segregation regime can be regarded as a condition that $\mu$ must not be too high.

**Segregation Regime.** In the segregation regime, all the highly skilled parents opt out of public schooling, 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 Equations (14) and (16), we can recast the school quality constraint as the existence condition for the segregation regime:

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

where $\frac{w^H}{w^L} = \left(\frac{\alpha}{1-\alpha}\right)\left(\frac{1+\delta\mu}{\xi}\right)\left(\frac{1}{1+\gamma\eta}\right)$. The net demographic effect is the same as in the partial segregation regime, i.e. increased congestion in public schools, which lowers their quality $s^*$ and increases the gap between it and $\bar{s}^H$, and brings it closer to $\bar{s}^L$. However, the income effect is asymmetrical at the extremes: $w^H/w^L$ increases the upper bound, making the complete withdrawal of highly skilled parents from the system more likely, while it decreases the lower bound because the reduced low-skill wage translates into greater dependence of low-skilled parents on the public provision of education. Hence, the distance between the two extremes increases with the skill premium.

If the income effect dominates, the segregation regime is likely to remain the equilibrium because low-skilled locals will never be able to pay for private education with a quality higher than the public schools. However, if congestion, or the net demographic effect, become 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.

**Private Regime.** In a private regime, no children attend public schools, and the

expenditure on public schools satisfies $s^* \leq \bar{s}^L$. In order to check for the existence of a private regime, we set $\psi^i = 0, \ \forall i$ in Equation (14) and obtain $s^* = 0 < \bar{s}^L$, which indicates that a private regime may exist at any positive level of $\mu$.[29] 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.[30]

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

*Proof:* Set $\psi^H = 0$ and $\psi^M = 1$ in Equations (14) and (16) and then define the function $\Psi^L(\psi^L) \equiv (s^* - \bar{s}^L)$. Following the procedure used in deriving Condition (19), we obtain the existence condition for this configuration:

$$1 + \frac{\mu\,(1+\xi)(1+\gamma\,\eta)}{\gamma\,\eta} \leq \ \iota \ \leq \frac{(1+\mu)\left[(1+\xi)(1+\gamma\,\eta) - \gamma\,\eta\right]}{\frac{w^H}{w^L}\,\xi\,(1+\gamma\,\eta) + (1+\delta\,\mu)} \tag{21}$$

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

Lemma 4 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

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

[30] Note that this result stems from the assumption that immigrants cannot vote. An alternative assumption is that low-skilled immigrants possess less political power than locals, so that the configuration in Lemma 4 comes into existence.

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.

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.[31]

## 4.2 Low-skilled Immigration and Regime Change

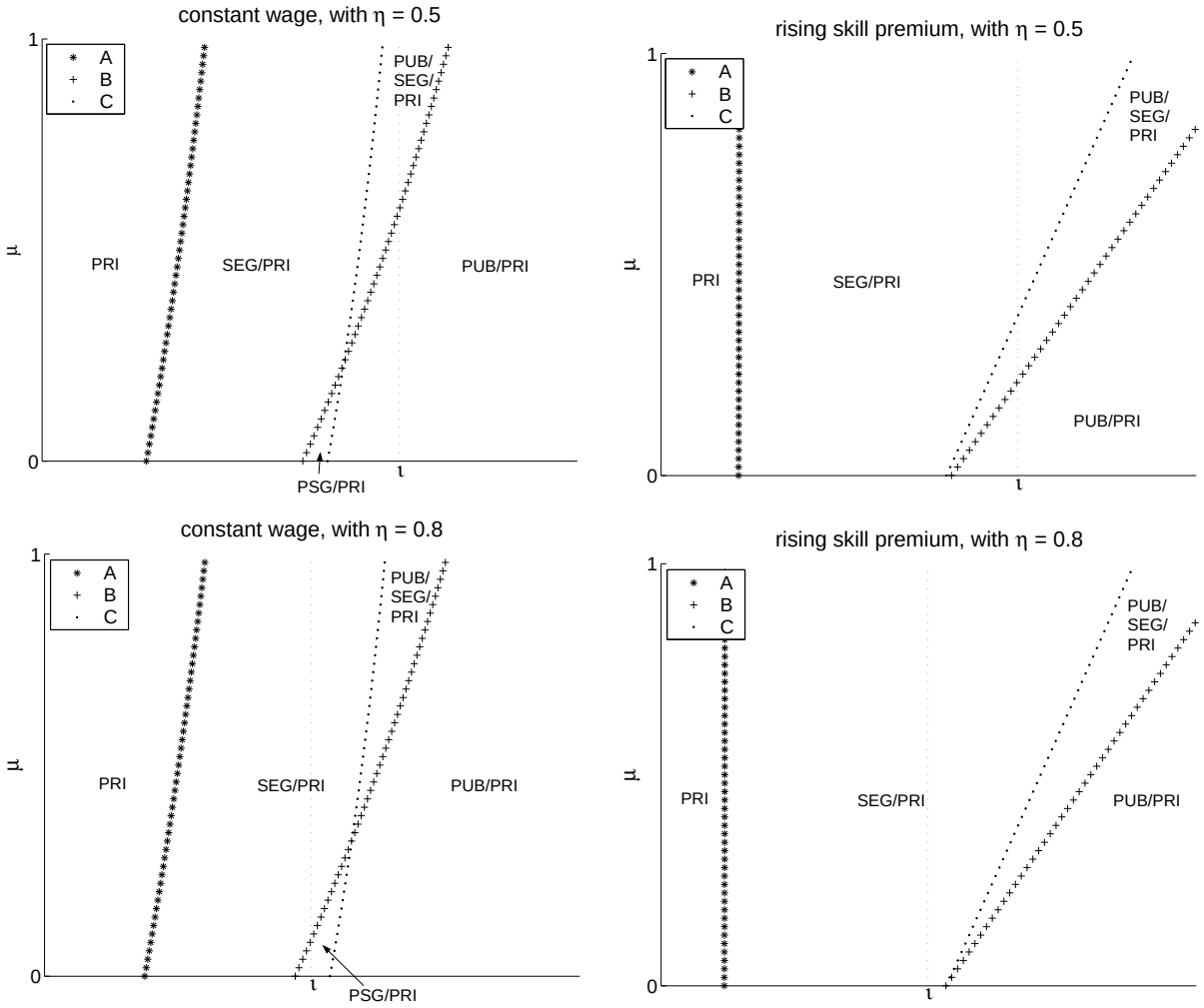
We will now discuss how low-skilled immigration may cause the education regime of the host country to change.

**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 2. ■

[31] 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 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.

Figure 2: Existence conditions 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

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

Suppose that an economy is characterized by a public regime when it opens its door to low-skilled immigrants. With the demographic effect of $\mu$ (that worsens public school congestion) and the income effect which makes private education more affordable for highly skilled locals, we can expect that, as $\mu$ grows beyond a certain size, there will be a gradual change into a partial segregation regime, or a segregation regime as shown in Figure 2.[32]

If wages are assumed to be constant, or if there is only the demographic effect, 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, the transition may linger at the segregation regime if $\mu$ raises the skill premium by a large degree and extends the lower bound of Condition (20). 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 increases (decreases) as more local children attend public (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 obtain the following corollary:

**Corollary 1 (Decreasing tax rate)** *A sufficiently large increase in the number of low-skilled immigrants tends to lower the tax rate that locals vote for, $\tau^*$.*

[32]Notice that it is theoretically possible for the public regime to jump to a private one at any positive level of $\mu$. As shown in Section 5, however, in reality we do not observe purely private regimes (i.e. zero spending on public education): minimum levels of public education usually exist.

This echoes Razin, Sadka, and Swagel (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 1 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, since, as long as there are some low-skilled immigrants, the existence condition for the private regime is always satisfied. This occurs since immigrants are not entitled to vote, i.e. immigration does not change the relative numbers of high- and low-skilled voters.[33] Within a certain range of $\mu$, 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.[34]

[33] 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.

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

## 4.3 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 ($\Omega$ in Equation (12)). In this section, we investigate the cardinal ranking of outcomes across regimes according to $\Omega$.

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). With *constant wages*, the necessary and sufficient conditions for the private regime to weakly dominate the public and the segregation regimes are given, respectively, by Conditions (22) and (23):

$$\begin{aligned}
\Omega_{PRI} &\geq \Omega_{PUB} \quad iff \\
s^*_{PUB} &= \frac{y_{PUB}}{1+\mu+\xi} \cdot \frac{\tau_{PUB}}{\hat{n}} \leq \frac{w^L}{\iota(1+\gamma)} \cdot \left(\frac{w^H}{w^L}\right)^{\frac{\xi}{1+\xi}} \cdot (1-\tau_{PUB})^{\frac{-1}{\Gamma}} \cdot \frac{\tau_{PUB}}{\hat{n}}, \qquad (22) \\
\Omega_{PRI} &\geq \Omega_{SEG} \quad iff \\
s^*_{SEG} &= \frac{y_{SEG}}{1+\mu} \cdot \frac{\tau_{SEG}}{\hat{n}} \leq \frac{w^L}{\iota(1+\gamma)} \left[1+\xi(1+\gamma\eta)\right] (1-\tau_{SEG})^{\frac{-(1+\xi)}{\Gamma}} \cdot \frac{\tau_{SEG}}{\hat{n}}. \qquad (23)
\end{aligned}$$

Therefore, if public school quality is below a certain threshold, the private regime gives a higher level of aggregated local welfare than the public (or segregation) regime. Note that the thresholds (RHS of Conditions (22) and (23)) do not depend on $\mu$, but $\mu$ increases congestion and decreases public school quality, $s^*$. As a result, low-skilled immigration makes the private regime more likely to dominate because, when public schools exist, locals will have to 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,

Sadka, and Swagel (2002).

On the other hand, the condition required for the private regime to weakly dominate the partial segregation regime is:

$$\Omega_{PRI} \geq \Omega_{PSG} \quad iff \qquad \frac{w^H}{w^L} \leq (1-\tau_{PSG})^{\frac{-(1+\xi)}{\Gamma}}. \tag{24}$$

That is, the skill premium cannot be too large. If it exceeds a certain threshold it is worth redistributing through public education from high- to low-skilled locals, despite the efficiency loss due to fiscal leakage (i.e. the standard result of concave utility holds). A similar reasoning focused on the RHS of Inequality (24) (which is increasing in $\tau_{PSG}$) shows that the private regime only dominates when the efficiency loss of taxation in the partial segregation regime is greater than a certain threshold. Since an increased number of low-skilled immigrants induces more high-skilled parents to opt out of public education and results in less support for its funding, the RHS of the Condition decreases, and accordingly, the private regime becomes less likely to dominate.[35]

Now, suppose a greater number of low-skilled immigrants increases the skill premium as specified in Section 3.2. The effect of an increasing $\mu$ becomes two-fold: it worsens fiscal leakage to immigrants, whereas redistribution between locals becomes more worthwhile. Given the contradictory effects of efficiency loss and equity concerns, the way in which $\mu$ affects the ranking of the private regime versus others turns out to be ambiguous.

From the previous discussion, and as illustrated by Figure 2, with some sets of parameters (particularly with large $\mu$), it is possible for the education system to end up in the public, the segregation, or the private regime. With *constant wages*, the segregation regime

[35]Using the existence Conditions (18) and (20), we find that $\frac{w^H}{w^L} \leq (1-\tau)^{\frac{-(1+\xi)}{\Gamma}}$ is a necessary condition for Inequality (22) to hold, while it is a sufficient condition for Inequality (23).

weakly dominates the public one when:

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

While $\mu$ only affects public school quality $s^*$ in this inequality, it lowers both the LHS and the RHS, and so does not give a clear picture of how low-skilled immigration affects the ranking of the public and the segregation regimes.[36] With a *rising skill premium* the necessary and sufficient condition becomes:

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

Since an increase in $\mu$ drives up the LHS and does not affect the RHS, it makes the segregation regime more likely to dominate the public one. This result is partly due to the way we have set the quantity/quality trade-off; that is, in the segregation regime, high-skilled parents choose to have fewer children and devote more time to working. Accordingly, given the same level of low-skilled immigration, the skill premium (and thus the wage inequality) is lower in the segregation than in the public regime. As $\mu$ rises and fiscal leakage becomes so severe that it greatly reduces the effective redistribution from high- to low-skilled locals, the segregation regime will yield a higher level of aggregated local welfare (since it reduces the efficiency loss and a lower skill premium makes redistribution less worthwhile).

[36] Using the condition for these multiple equilibria to exist (i.e. $B \geq C$ in Figure 2), we find that the necessary condition for the segregation regime to offer a higher level of aggregated local welfare is that expenditure on public schooling in the public regime be low enough. This is similar to Conditions (22) and (23), and is more likely to be satisfied with a large $\mu$. However, this condition is not sufficient due to equity reasons (i.e. the decline in the scale of redistribution).

# 5 Some Empirical Evidence

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, in this section we provide some more empirical support for our theoretical predictions. In the first part, the analysis is conducted with the U.S. census data for the years 1990 and 2000. The second part takes advantage of the micro data collected by the OECD Programme for International Student Assessment (PISA), 2003. Although a thorough econometric investigation is beyond the scope of this work, all the evidence seem to corroborate the idea that there is a link between low-skilled immigration and the education system.

## 5.1 U.S. Census Data 1990, 2000

In accord with the specification of the model, 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.[37]

First of all, Lemmas 1 and 3 suggest that students with high-skilled local parents will, on average, have the highest rate of private school enrollment and their parents have the lowest level of fertility. Tables 1 and 2 show that it is indeed the case. While these tables are computed from the overall sample, another way of addressing the same issue is to consider the area averages of private school enrollment and fertility rate for each type of student, and then check how frequently the predictions are true. It turns out that in a large majority of the areas (87% in 1990 and 97% in 2000) a higher proportion of

[37]Detailed descriptions of the data can be found in Appendix A.1.

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.

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, according to Proposition 2, are expected to have a positive relationship with changes in the enrollment rate of local students at private schools. This is supported by Figure 3, where data is available for both years in 103 areas. The correlation between the two variables is 0.371, which is statistically significant at the 99% level.[38] 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, a joint implication of Lemma 1 and Proposition 2 is that increased segregation in school regime should be associated with an enlargement of the fertility differential among locals, due to the quantity/quality trade-off. 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 minus 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). Our model predicts

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

a positive relation between these two intertemporal changes in differentials.[39] Figure 4 shows that this is indeed what the data show. 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.[40]

## 5.2 Cross Country: PISA 2003

In this section, we use micro-data collected by the OECD Programme for International Student Assessment (PISA), 2003. The primary sampling unit 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.[41]

Table 3 shows the average public share of school funding for each type of student by country, grouped by regime.[42] Figure 5 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 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

[39] 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.

[40] 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.

[41] See Appendix A.2 for details of classification.

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

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.

Next, we combined data from the PISA 2003 study with the Docquier-Lowell-Marfouk (2008) 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 values and the average changes over ten years in the numbers of low skilled immigrants (defined as those with less than secondary education, measured either as stocks or as proportions of the total population) for countries with public and segregation regimes. The bottom row shows the correlations between the segregation regime and the immigration variables. We find that the segregation regime is positively related with a change in the proportion of low-skilled immigrants. This supports the hypothesis that an increase in the relative number of low-skilled immigrants tends to be associated with segregation in

the education regime.[43]

# 6 Concluding Remarks

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 evidence, 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.

[43]The correlation is still positive when the definition of low skill is extended to less than tertiary education.

In Section 5 we have seen that the model's predictions are supported by empirical evidence from both U.S. Census Data and PISA 2003. The U.S. data lends support to our theoretical hypothesis that increases in low-skilled immigration are positively correlated with enrollment in private schools. Moreover, it points to a widening fertility differential among locals, as high-skilled local parents decrease the number of children they have and increase their 'quality' by purchasing private schooling. The predicted positive correlation between low-skilled immigration and segregation in education system is also confirmed by the cross-country data. 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.

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.[44] 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 the persistence of income inequality will increase as the better-educated

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

pupils are more likely to acquire a better job. Inequality may increase even further as this process continues. 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.[45] 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.[46]

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[45] 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.

[46] One possible extension could be, for example, that a child who receives a better basic education has a higher probability of finishing tertiary education and becoming high-skilled.

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# A Data Description

## A.1 U.S.: Census Data 1990, 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 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.[47] Since our model predicts the relationship between

[47]Note that in 2000 the samples 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.

low-skilled immigration and local parents' schooling and fertility choices, we treat as missing values students with high-skilled immigrant parents.

Skill type is defined on the basis of the total personal income of parents.[48] 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). 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.[49] The household fertility rate is constructed taken to be the number of siblings.[50] 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 Cross Country: PISA 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

[48] 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.

[49] 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.

[50] Only 0.0003% of the sample were students who belonged to the same household but were not siblings.

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.[51]

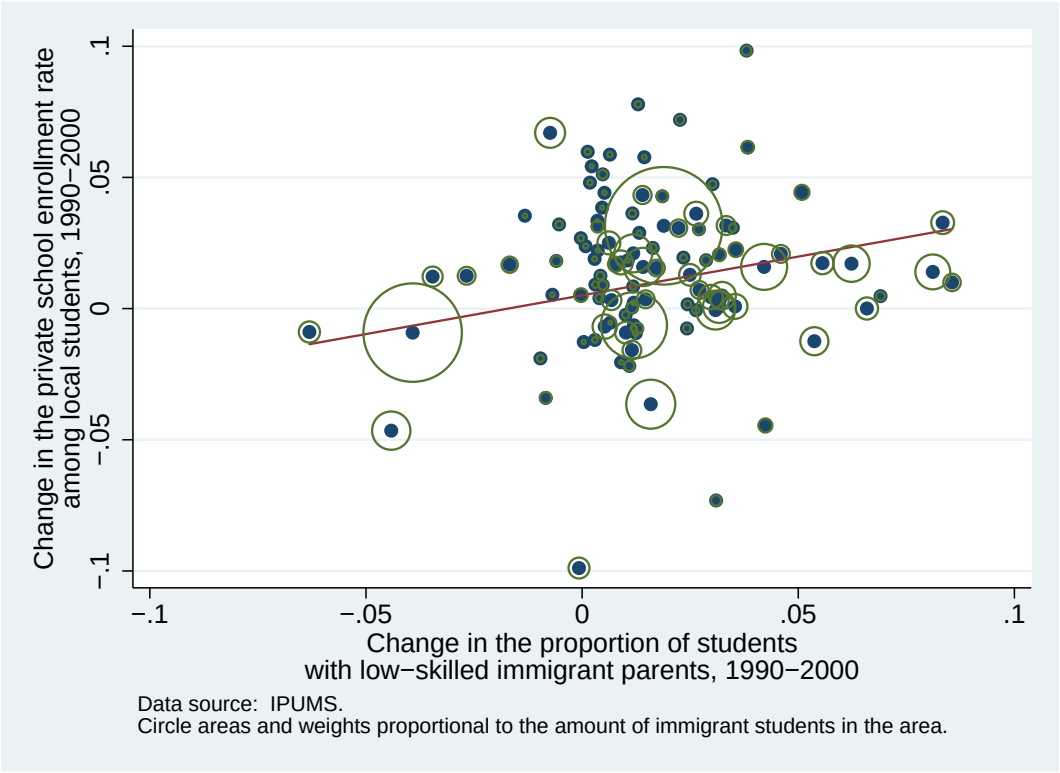
We identify three types of students by their immigration background and their parents' occupational status.[52] We define an immigrant student as one who was foreign born and both whose parents were foreign born. By comparison, local students are those with at least one local-born parent. With regard 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

[51] 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.

[52] 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.

parents and 43.34% as local students with high-skilled parents.

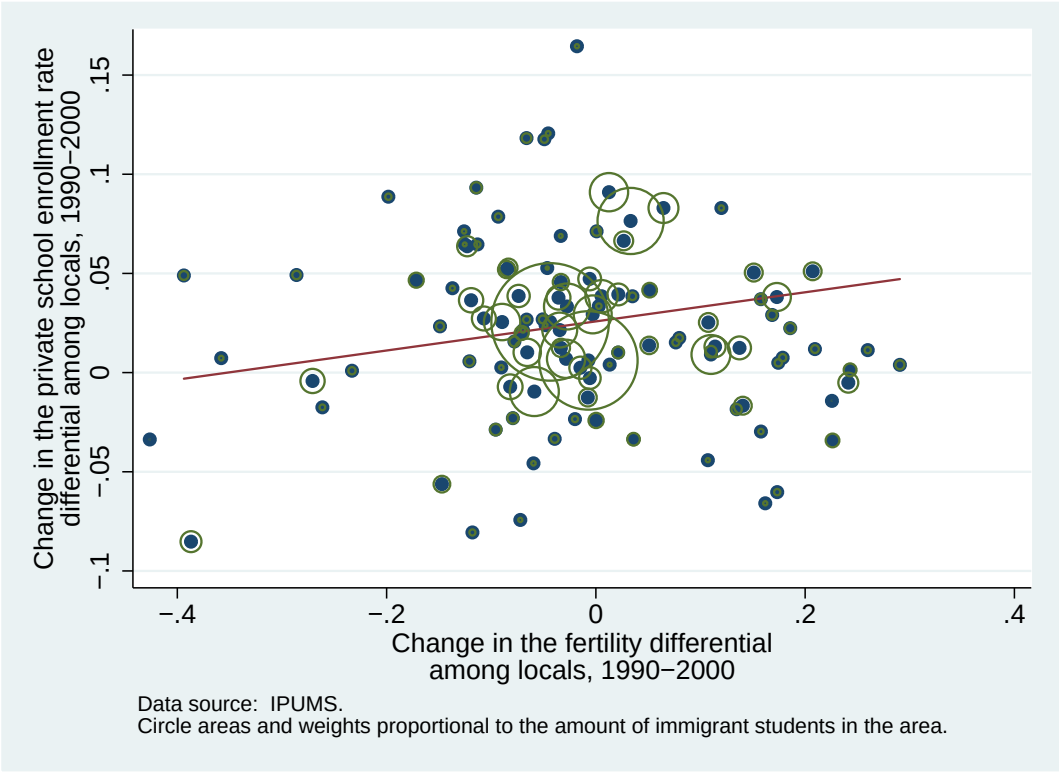
Figure 3: The relationship between changes in the proportion of students with low-skilled immigrant parents and changes in the private school enrollment rate among local students




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 4: 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 5: 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 | Belgium | 92.970215 | 89.557091 | 86.785774 |
| Regime | | (1.09799) | (0.91271) | (1.13165) |
| | Canada | 93.834282 | 92.389626 | 89.493698 |
| | | (0.73521) | (0.51115) | (0.84146) |
| | Denmark | 96.998848 | 92.920151 | 92.788795 |
| | | (1.18401) | (0.88155) | (1.29765) |
| | Germany | 97.919785 | 96.71534 | 94.55452 |
| | | (0.49344) | (0.50523) | (0.77876) |
| | Greece | 91.242668 | 89.450066 | 85.663513 |
| | | (1.30087) | (1.27673) | (3.58973) |
| | Ireland | 95.617073 | 95.129005 | 90.606308 |
| | | (1.04415) | (0.50559) | (1.41699) |
| | Japan | 72.268036 | 76.384232 | 70.925522 |
| | | (8.43649) | (1.41331) | (1.91171) |
| | Liechtenstein | 99.966019 | 95.998367 | 94.248375 |
| | | (0.01923) | (0.86398) | (1.07504) |
| | New Zealand | 77.494125 | 80.100792 | 76.031754 |
| | | (1.25158) | (0.86149) | (1.14851) |
| | Portugal | 86.659126 | 85.87606 | 81.260452 |
| | | (3.08535) | (1.65654) | (2.58895) |
| | Switzerland | 98.901016 | 96.968895 | 92.92453 |
| | | (0.33304) | (0.48104) | (1.36581) |
| | United States | 92.208778 | 88.422775 | 85.61586 |
| | | (1.82975) | (1.76358) | (2.41584) |
| Severely | Australia | 73.738464 | 76.311218 | 65.669144 |
| Segregated | | (1.22751) | (0.91294) | (1.29929) |
| | Brazil | 98.669655 | 88.048607 | 65.418968 |
| | | (0.84375) | (1.45130) | (4.23931) |
| | Thailand | 100.000000 | 87.511017 | 76.087975 |
| | | (0.00002) | (1.55778) | (1.99347) |
| | Tunisia | 66.404343 | 68.561096 | 75.390099 |

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

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

Table 4: The correlation between the segregation regime and low-skilled immigration

Low-skilled immigrants as those with less than secondary education

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

Low-skilled immigrants as those with less than tertiary education

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

20 country observations.

**: at the 0.05 significance level.

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