Immigration, Assimilation, and the Future of Public Education*

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Abstract

This paper analyzes the effects of immigration on the size and quality of public education using a quantitative political economy model that allows for a heterogeneous immigrant population. Our analysis distinguishes between short and long-run effects and accounts for the consequences of naturalization and assimilation. We use the model to analyze Spain's large 2000-2008 immigration wave. We find that immigration led to a 15% increase in public enrollment in the short run, together with a 3% reduction in public education spending and almost a 1 percentage-point increase in the share of native households using private schools. Depending on the eventual degree of assimilation, these trends will be greatly intensified or mitigated once immigrants naturalize and gain the right to vote. Our analysis suggests that assimilation in terms of family size and the value assigned to children's education are the most relevant dimensions quantitatively. We also show that immigration policies that favor one group over another can significantly alter the overall effects of immigration on the schooling system.

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1 Introduction

Public education is one of the pillars of modern democracies. Besides educating voters so that they can delegate policy-making to effective politicians, public education plays an important economic role by helping rein in income inequality, facilitate upward mobility, and foster economic growth.[1]

For these reasons ensuring sufficient funding for high-quality public education is a fundamental policy issue in every country. From a political economy perspective, the key determinant of the quality of public education is the income distribution of voters and their preferences over public education. These preferences depend, in turn, on the choice to send one's children to tuition-free public schools or to private ones (Epple and Romano (1996b)). As a result of this feedback between policies and individual choices, shocks to voters' preferences may propagate into unexpectedly large changes in the quality of public education.

Rapid demographic changes can operate as one such shock. Specifically, when a country experiences a large immigration wave its domestic politics are likely to be profoundly reshaped, with wide-ranging consequences for public policies and the welfare state. In particular, there are a number of ways in which immigration may affect education policies. On the one hand, despite large disparities across immigrant groups, it is often the case that immigration tends to lead to a disproportionately large increase in enrollment in public schools, given the younger age of immigrant households, their higher fertility, and their relatively lower average income. This may lead native voters to change their preferences over the level of resources devoted to public education (Freeman (1986)). On the other hand, immigrants eventually affect the politics of the host country, either directly when they become naturalized (and gain the right to vote), or indirectly when forward-looking politicians cultivate their favor in anticipation of their enfranchisement (Ortega (2005)). In an influential study of the effects of immigration on the education system, Coen-Pirani (2011) argues that the large immigration wave experienced by California between 1970 and 2000 may have been responsible for a 24% reduction in the quality of public education, measured by spending per student in public schools, and a reduction in the share of native students enrolled in public schools.

Naturally, the effects of immigration on the education system of the host country depend

[1]See, for instance, Glomm and Ravikumar (1992), Galor and Zeira (1993), Fernandez and Rogerson (1996), Gradstein and Justman (2002), Blankenau et al. (2007), Takii and Tanaka (2009) , and Takii and Tanaka (2013), among many others.

crucially on the characteristics of the immigrant population, such as their income (Dottori et al. (2013)) and their aspirations and attitudes toward education (Goyette and Xie (1999), Hsin and Xie (2014)). Thus it is important to recognize that the immigrant population is rarely a monolithic entity. Instead it is often composed of multiple groups, that vary by country of origin, skills, demographics, cultural affinity to the host country, and potential for assimilation. As a result the effects of immigration are likely to differ substantially across immigration episodes. This also raises the possibility of conducting immigration policies that favor some countries of origin or groups of immigrants over others, as is often the case with former colonies.

Likewise some features of the education system in the host country may also mediate the effects of immigration on voters' support for public education. One such feature is the cost incurred by households that want to send their children to private schools. In some countries private schools charge very high tuition and can only be afforded by an affluent minority. For instance, average private school tuition in the U.S. in 2007-2008 was $8,549 (18 percent of GDP per capita in that year).[2] In other countries governments subsidize private schools, keeping tuition affordable to a large swath of the population. For instance, in that year the average annual private school tuition in Spain was below 500 euros (2 percent of GDP per capita).[3]

This paper provides a new quantitative framework to assess how immigration affects the education system of the receiving countries. We present a political economy model of school choice *a la* Epple and Romano (1996b), adapted to the analysis of immigration as in Coen-Pirani (2011). Compared to the literature, our framework has three novel features. First, we allow for heterogeneity within the immigrant population in order to capture the large disparities in the school choices of Spanish immigrants on the basis of their country of origin. Importantly, this feature enables us to evaluate the effects of alternative immigration policies that favor some immigrant groups over others. Secondly, in line with the experience of Spain and several other countries, we assume that private schools are subsidized by the government, although they may also charge tuition.[4] Finally, we provide a comprehensive

[2]Table 63 in the Digest of Education Statistics 2010, National Center for Education Statistics. Includes elementary, secondary and high school. On average the tuitions charged by elementary, secondary, and high schools were $6,733, $10,549, and $10,045.

[3]In Spain in year 2007 average tuition in subsidized (concerted) schools was 260 euros and in fully private schools was 2,223 euros (Family Expenditure Survey), with wide regional variation. In that same year enrollment in the former was 88 percent of the combined enrollment in concerted and fully private schools (elementary and secondary education combined). As a result the average annual tuition in private schools (concerted or not) in Spain in 2007 was 476 euros.

[4]Subsidized private schools, often referred to as charter schools, are fairly ubiquitous. Countries differ in

analysis of the effects of immigrant assimilation. In particular, we distinguish between economic, demographic and cultural assimilation and quantify the effects of assimilation along each of these dimensions. By highlighting the dimensions of assimilation that are quantitatively more important, and by identifying the immigrant groups that are at a greater disadvantage in terms of those attributes, these findings are crucial in order to design cost-effective policies that enhance assimilation.

We focus on the recent experience of Spain, which experienced a large-scale immigration episode between the late 1990's and 2000's. In 1998 its foreign-born share was about 3 percent but rose by 10 percentage points over the course of a decade. Immigrants from a wide variety of countries were attracted to Spain because of its robust economic growth, with important consequences for Spain's labor market (Farre et al. (2011), Gonzalez and Ortega (2011)). The period of rising income and labor demand came to a halt in 2008 when the Great Recession and the subsequent austerity measures plunged the economy into a severe slump. A defining feature of Spain's education system is the large role played by private schools, which account for one third of the overall enrollment in compulsory education.[5] Underlying the high popularity of private schools among Spanish households is the large subsidy that most private schools receive from the government, which allows these schools to charge fairly low tuition (Arellano and Zamarro (2007)). While not unique to Spain, the presence of a subsidy to private education has not been taken into account in previous quantitative analyses of the effects of immigration on the education system. Thus one contribution of our work is to examine how the presence of the subsidy affects the political economy of public education and the effects of a large immigration wave.

In our benchmark we calibrate the model to match key moments of Spain's economy and education system in year 2008, at the end of the immigration wave. In line with the Spanish experience we assume that immigrants have access to free public schools and subsidized private schools, and pay taxes, just like natives. However, they are not allowed to vote in the short run. In the long run immigrants are naturalized and can directly influence the outcome of elections. In the long run these naturalized immigrants also experience some degree of assimilation in terms of income, number of children, and preferences for education.

First, we focus on the short-run effects of immigration. To do so we simulate a counter-

the degree of subsidization. For instance, charter schools are found in the United States, Australia, Chile and Colombia. Versions of charter schools are also present to varying degrees in European countries such as the United Kingdom, Germany, Sweden and Norway. Thus extending the previous models by including subsidized private schools makes them more in line with the educational system in many countries.

[5] In the United States private schools account for only 10 percent of the overall enrollment in pre-university education.

factual economy where we assume that the immigrant population in Spain had remained as in year 2000. By comparing this scenario to the benchmark for year 2008, we isolate the short-run effects of the 2000-2008 immigration wave. These effects arise from the increased demand for schooling by the immigrant households and their contribution to the public coffers through taxes. Our results reveal that the arrival of immigrant households had an effect on the education policy preferred by the median voter and on the school choices of native households. Immigration was responsible for a 3 percent reduction in the *quality* of public education, measured as public spending per student, and a large overall increase in the *size* of public education. The latter is the result of the large inflow of immigrant children into public schools, only partially mitigated by *native flight* away from public schools.

Second, we turn to medium-run effects arising from the enfranchisement of immigrants. To do so we consider a counterfactual scenario where the immigrant population in year 2008 is naturalized, but does not assimilate, and compare it to the 2008 benchmark. Since, on average, immigrants in Spain had lower income than natives, the median voter shifted down in the income distribution. As a result we find that naturalization is associated with an additional 7 percent reduction in public spending per student, and further native flight out of public schools. If, pessimistically, one believes that the immigrant population in Spain will not experience any assimilation then the combined long-run effect is given by the sum of the effects of immigration and assimilation. In this case the overall public spending per student will eventually fall by over 10 percent and there will be substantial native flight toward the private system. Specifically, the share of native households using public schools will decrease by 3 percentage-points.

Third, we turn to the effects of assimilation, gauged by comparing the previous naturalization scenario to alternative scenarios where the naturalized population assimilates along each of several dimensions. Assimilation is associated to increases in the quality of public education (in terms of public spending per student) and a reversal of native flows back toward public schools. It is helpful to report the effects of the combined long-run effects under the optimistic assumption that immigrants fully assimilate.[6] In this case the quality of public education would turn out to be slightly higher (by about 1 percent) than if the 2000-2008 immigrants had not migrated to Spain. In response to the enhanced quality, the share of native households using public schools would increase slightly, and overall enroll-

[6]These figures are the sum of the marginal effects of immigration, naturalization, and full assimilation. Naturally, in reality immigrant assimilation will most likely fall somewhere in between the two extremes reported here. But we find it useful to report the full range of outcomes. The existing empirical evidence suggests that incomplete assimilation is in fact the norm (De la Rica et al. (2015)).

ment in public schools would eventually be 16% higher than in the absence of immigration. Our results also indicate that the most important dimension of assimilation is cultural, and has to do with gaps in the preference for education relative to natives. Based on our calibration, Asian immigrants display the smallest gap along this dimension whereas African immigrants display the largest disadvantage. Naturally, the final degree of assimilation along each of the relevant dimensions is an empirical question, and will vary depending on the success of integration policies. We also use our model to conduct immigration policy experiments that are useful to evaluate the effects of favoring some groups of immigrants over others, a common practice in many countries. Our results suggest that the effects can vary substantially and may differ depending on the time horizon of interest.

Finally, it is also interesting to evaluate the role played by the subsidy to private schools, a key feature of Spain's education system. To do so we simulate the model eliminating the subsidy. Not surprisingly, we find that without the subsidy the native share in public schools would be 85 percent, far higher than the actual (65 percent), and public education spending per student would be slightly higher than without the subsidy. Most important for our analysis, we also examine how the availability of the subsidy mediates the effects of immigration. We find that while the level of public enrollment would be much higher without the subsidy, the effects of immigration would be largely unchanged except for a slightly larger native flight toward private schools.

Besides the work of Epple and Romano (1996b) and Coen-Pirani (2011), our paper is also related to studies that evaluate the effects of immigration on the size of government. Razin et al. (2002) argue that immigration is likely to lead to lower redistribution because of a 'fiscal leakage' effect. Along these lines, a recent empirical study by Speciale (2012) finds that immigration flows into European countries are associated with a reduction in public spending. Somewhat in opposition to these papers, the theoretical arguments in Ortega (2010) suggest that when voters are foresighted immigration may be key in order to sustain political support for income redistribution.

Our work is also related to Dottori et al. (2013) who theoretically characterize optimal immigration policies that take into account the effects of immigration on the school choices of natives. Their main finding is that the optimal policy is highly biased in favor of skilled immigrants. A recent study by Albornoz-Crespo et al. (2011) presents a model of endogenous migration at the household level where school quality and student outcomes are determined endogenously. In their model the key dimension of heterogeneity is parental motivation toward their children's education and they analyze which immigration policies

produce positive selection along this dimension. Our model also incorporates these dimensions of household heterogeneity, which play an important role in the quantitative evaluation of the impact of immigration on education policy.

Our paper is also related to Bearse et al. (2013) who analyze setups with heterogeneous households that can choose between public and private schools, and to studies that emphasize heterogeneity among immigrant populations, as in Borooah and Mangan (2007) and Desai et al. (2009). To the extent that ethnic heterogeneity in a society may affect trust, our paper relates to Daniele and Geys (2015) and Bergh and Bjornskov (2014) who argue that trust facilitates the adoption of welfare state policies that reduce income inequality. Our results suggest that immigration may increase income and ethnic segregation in schools unless assimilation takes place, which may result in increased income inequality. Our work is also related to the literature on how the use of public services by immigrants, relative to natives, affects attitudes toward immigration, as in Miguet (2008), Huber and Oberdabernig (2016) and Iturbe-Ormaetxe and Romero (2016).

The structure of the paper is as follows. Section 2 presents a concise description of the Spanish schooling system. In Section 3, we report summary statistics. Section 4 presents a simple theoretical framework based on the model by Epple and Romano (1996b). In Section 5 we explain our calibration strategy as well as the data for the calibration. Section 6 presents the results of our analysis regarding the short, medium, and long-run effects of immigration on the school system. Section 7 exploits the novel features of our model to simulate the effects of alternative immigration policies that would favor one immigrant group over another. Section 8 concludes.

2 Institutional Background: the Spanish Education System

Compulsory schooling in Spain is composed of two stages: six years of elementary (primary) school and four years of secondary schooling (known as E.S.O, or Compulsory Secondary Schooling in its Spanish acronym). As a result, students are required to be in school between the ages of 6 and 16.[7] Beyond compulsory schooling, pre-university education also includes two years of *Bachillerato*, which prepares students for college, or alternatively occupational training (*Formacion Profesional*).

Between years 2000 and 2009 public spending in education in Spain increased year after year. In 2009 the overall public spending in education was 52.5 billion (10^9) euros, 4.98%

[7]However, it is very common to begin school at age 3: in the academic year 2010-2011 the enrollment rate for 3-year olds was over 96 percent.

of GDP. The largest share of these funds are devoted to pre-university education (62.3% in year 2009).[8] A large share of the budget is used to directly finance public schools, which are free of tuition. But a sizable amount is also devoted to subsidizing private elementary and secondary schools (5.9 billion euros in 2009, about 18 percent of the pre-university public spending). As a result of the affordable tuition, private schools account for a large share of the student body in Spain. In academic year 2009-2010, about 1/3 of the pre-university students were enrolled in private schools. In comparison in the US the share of students in private schools is about 10 percent (National Center for Education Statistics, academic year 2009-2010).

The vast majority of private schools in Spain are subsidized by the government and are known as 'concerted' schools.[9] In exchange for government funding that supposedly covers the school's whole salary bill, concerted schools agree to conduct an admission policy on the basis of the same criteria as public schools and to closely follow the core curriculum of public schools. Concerted schools account for almost 90 percent of the private-school enrollment. The remaining students attend private schools that are not subsidized and therefore charge much higher tuition.

While, in theory concerted schools are not allowed to charge for tuition, in practice there are quasi-compulsory payments required from parents in terms of donations to the parents' association, building maintenance or financing of extracurricular activities. According to a 2012 study by the Association of Spanish Consumers (OCU (2012)), over 90% of concerted schools require payments that are perceived by households as compulsory. The average annual payment was 501 euros, much lower than the tuition charged by fully private schools.[10]

In practice there are important differences between public and private schools. First, some evidence points to better student outcomes in standardized tests in private schools, followed by private concerted schools, and last by public schools (Trillo del Pozo et al.

[8] Financing for public universities accounts for 20.7% of the budget. The source for this data is the report 'Datos y Cifras - Curso escolar 2011/2012' by the Ministry of Education.

[9] Concerted schools were introduced in 1985 to accommodate the increasing demand for education that resulted from the baby boom and the increase in compulsory schooling age, and the majority are Catholic. For more details see Arellano and Zamarro (2007) and Farre et al. (2015).

[10] In some neighborhoods in Barcelona and Madrid, students' families' payments in concerted schools can be as high as 200 euros per month. More systematic evidence is available in the 2007 supplement to the Family Expenditures Survey, which reported average annual household expenditures per student disaggregated by type of school. Focusing on expenditures in tuition (upfront or as monthly fees) and extracurricular activities taking place within the schools, the average expenses per student in compulsory secondary school in public, concerted, and private schools were, respectively, 10 euros, 260 euros, and 2,223 euros.

(2006)).[11] Second, the share of immigrant students in public schools is much higher than in private schools. In part this may be due to the larger out-of-pocket household expenses but it is also possible that the emphasis on Catholic education in concerted schools is an important deterrent for immigrant households with a different religious background.[12]

3 Summary statistics

Let us begin by illustrating the impact of immigration on the Spanish schooling system. Between year 2000 and 2010 the population of students with foreign nationality increased by a factor of 5.4, from 141,916 to over 770,384 students.[13] The rise in this segment of the student population was very rapid until 2008 (when it reached 755,587 students) and has plateaued since then, reflecting the sharp reduction in immigration flows as the Great Recession hit the Spanish economy.

The impact of immigration on public and private schools has been very uneven. In year 2000 the share of foreign students in public and private schools was similar (2.3 and 1.4 percent, respectively). By 2008 the corresponding figures were 11.9 and 5.6 percent (Spanish Ministry of Education, Culture and Sports). That is, approximately a 10 percentage-point increase in public schools compared to barely 4 in private schools. It is worth noting that this uneven expansion of enrollment in public and private schools in response to immigration is *not* due the concentration of immigrants in rural areas with no private-school options. Rather, the data suggest the opposite case. The data show that the immigrant population is disproportionately located in urban areas, where the availability of private schools is larger (see Figure 1).

The immigrant population in Spain is very diverse in terms of origin. In 2010 the breakdown of the foreign student population by origin was as follows: 40% originated from South and Central America, 29% from the rest of Europe, 23% from Africa, and about 6% from Asia. Among all of these students, the vast majority are in public schools (82%), with the remainder being accounted for by concerted schools (14%), and only 4% in fully private

[11] What is less clear is whether the source of the differences is due to sorting in ability and family background or to the value-added provided by the schools. For instance, Calero and Escardibul (2007) and Anghel and Cabrales (2010) find that differences in performance between public and concerted schools are largely accounted for by parental background.

[12] De la Rica and Ortega (2012) report that 11 percent of the foreign-born population in Spain in year 2008 originated in Morocco. Adding also other immigrants from majority Muslim countries or followers of other religions leads to an important share of the immigrant population that may be disinclined to attend Catholic schools.

[13] Importantly, these figures do not include students that have double nationality or second-generation immigrant children so it underestimates the impact of immigration on the schooling system in Spain.

schools. In comparison, the breakdown for the overall student population, including native students, is approximately 68%, 27%, and 5%, respectively.

The inflows of immigrants may affect not only the size but also the quality of education. Between the years 2000 and 2010, increasing government funding has led to a general reduction in student-teacher ratios, a commonly used proxy for the quality of education (16 percent). However, this quality improvement has been much more muted in high immigration regions. Farre et al. (2015) document that the reductions in student-teacher ratios have been much smaller in regions that have experienced a large increase in their foreign-born share over the decade. This is illustrated in (Figure 3).

We next present some of the main variables that our analysis will focus on. The data have been collected from numerous sources, combining administrative education data provided by the Ministry of Education with a variety of household-level surveys. Details on the data sources and on the construction of these variables are collected in Appendix A.

Table 1 provides some descriptive statistics for years 2000 and 2008. The latter is the key year used in the calibration of our model since it corresponds to the end of the wave of immigration received by Spain.[14] Between years 2000 and 2008 Spain experienced robust economic growth, with real GDP increasing by 32 percent in this 8-year period. This was the continuation of an economic expansion that had begun in the early 1990s. This economic bonanza, combined with troubled economies in some low-income countries with ties to Spain, led to a large immigration wave. Between 2000 and 2008 the working-age population in Spain increased by almost 15 percent, or about 4 million individuals due to immigration. Between 2000 and 2008 the foreign-born share of the population increased by almost 10 percentage points, reaching 13 percent in year 2008.

In our paper, households are the main unit of analysis. Between years 2000 and 2008, the number of households in Spain increased by almost 35 percent (3.3 million), with a large share of the increase being driven by immigration. In 2008 the Spanish economy had 12.7 million households and about 13.8 percent of all households where headed by a foreign-born individual. Besides its large size, this immigration wave was characterized by its wide variation in terms of country of origin. In terms of countries of origin, Romania, Ecuador, Morocco and China are the main countries in each group (De la Rica and Ortega (2012)). For our purposes, it helps to subdivide the immigrant population in four groups according to the continent of origin. Between 2000 and 2008, the number of households headed by

[14] Between 2008 and 2013 the Spanish economy has suffered a severe recession that has led to net population outflows.

an immigrant from Europe increased from 1.38 to 5.09 percent of the overall number of households. Similarly, the number of immigrant households with American origin (North, South and Central) increased from less than 1 percent to 5.62 percent of all households in year 2008. Though also sizable, the increases in the numbers of households headed by Africans and Asians were much smaller, reaching 2.62 and 0.48 percent of all households, respectively, in year 2008.

The data also show that immigrant households had lower income than native households, though the differences were relatively small In year 2008 the average native household earned 28,715 euros, about 9 percent more than the average immigrant household.[15] However, this masks substantial heterogeneity across immigrant groups in education levels. De la Rica and Ortega (2012) report that the share of the population (males, age 25-50) with at most primary schooling was 63% among Moroccans, 41% among Eastern Europeans, and 33% among Latinos, compared to just 18% among Spanish natives.

Not surprisingly, differences in socio-economic status are also mapped into differences in the share of students in each group attending public schools. As reported in Table 1, the share of native students enrolled in public schools in year 2008 was 65 percent, compared to 83 percent for immigrant children. Among these, the public school enrollment share ranged from 75 percent for Asian children to 90 percent for African children. It is also interesting to note that the overall share of students in public schools increased by 3.5 percentage points between years 2000 and 2008, from 66.2 to 69.7 percent. Among natives the share of students enrolled in public schools actually fell by 1 percentage point in this period. Therefore the overall increase in the share of students in public schools is due to a composition effect: the large increase in immigrant children combined with their higher propensity to attend public schools.[16]

Let us now turn to public expenditure in education. Adding all education levels, public expenditure in education reached 4.58 percent of GDP in year 2008 (50.9 billion euros). This is a significant improvement since year 2000, when it was 4.35 percent of GDP, and leaves Spain just below the average of the European Union (27 member states) which was about 5 percent in year 2008. Given our focus on compulsory schooling, it is more relevant to report the spending that corresponds to pre-university education only in Table 1. Spending in pre-university education in year 2000 amounted to 2.70 percent of GDP, and increased

[15]The data for year 2000 cannot be disaggregated by nativity because the Family Expenditure Survey only identified immigrant households from year 2006 onward.

[16]In addition there has been an increase in the public school shares for all immigrant groups between years 2000 and 2008.

to 2.93 percent in year 2008. Spending in subsidizing private schools, which is about 18 percent of all pre-university spending, also increased as a share of GDP over these years.

4 The Model

In this section, we extend the school choice model developed by Epple and Romano (1996b) along two dimensions. First, we introduce household heterogeneity in preferences for education. This was also a feature of the extension proposed by Coen-Pirani (2011), who allowed for parameter heterogeneity between natives and immigrants. We extend the model further by allowing for group-specific parameters within the immigrant population in order to accommodate the wide diversity of Spain's immigrant population.

Our second point of departure is that our framework includes a public subsidy to private schools, which is a defining feature of the Spanish education system. As we have seen in Section 2, the Spanish education system is characterized by high enrollment in private schools compared to other countries, driven by the highly subsidized tuition in most private schools.[17]

4.1 Set up

The economy is populated by a unit measure of households that differ in income (wealth) y, number of children n, country of origin m, and in their preference for education relative to consumption. Native households are indexed by $m = 0$, and $m = 1, 2, 3, \ldots, M$ denotes immigrant households from origin country m.

Households derive utility from consumption c and from the per-child units of education received by their children, E. We assume that all children in a household attend the same school. The utility function is given by:

$$u(c, E, z, \lambda, m) = \frac{c^\alpha}{\alpha} + \gamma_m \lambda \frac{E^\alpha}{\alpha}, \tag{1}$$

where $\alpha < 1$, $\gamma_m > 0$, and $\lambda > 0$. While γ_m is a preference parameter for education that is common to all households from the same origin country, λ allows for heterogeneity across households within the same origin group. These terms will allow us to match differences across groups in their educational investments over and above those induced by differences in household income and household size.

[17] As will become clear later, formally the subsidy to private education renders our model more similar to the so-called 'topping-on' education models, while Coen-Pirani (2011) and Epple and Romano (1996a) are 'opting-out' models of school choice.

There are two types of schools: public and private. All public schools are homogeneous in quality, that is, children attending any public school receive e units of education. In contrast there is a range of private schools of varying quality. All private schools receive a per-student subsidy from the government, denoted by $b \geq 0$, which can also be interpreted as a private education voucher. In addition households pay tuition $z \geq 0$, which together with the subsidy determines the education units (quality) of private schools, given by $b+z$. We also assume that both natives and immigrants are eligible to send their children to tuition-free public schools and to subsidized private schools, in line with the institutional arrangements in Spain. Finally, we assume that public expenditure in education, which is the sum of direct expenditure on public schools and the subsidies to private education, is financed with a linear tax s on household income y.

Conditional on sending children to public school, the household's indirect utility is given by:

$$u(y(1-s), e, 0, \lambda, m) = \frac{(y(1-s))^{\alpha}}{\alpha} + \gamma_m \lambda \frac{e^{\alpha}}{\alpha}, \tag{2}$$

which is increasing in disposable income and in the quality of public education. We also note that the number of children in the household does not enter into the previous equation because households derive utility from the *per-child* units of education.

Conditional on private school, households choose their preferred school among a range of options indexed by the quality premium relative to public schools z. As a result, the household's indirect utility is given by:

$$V(y(1-s), n, b, \lambda, m) = \max_{z \geq 0} \frac{[y(1-s) - p_m z n]^{\alpha}}{\alpha} + \gamma_m \lambda \frac{(b+z)^{\alpha}}{\alpha}, \tag{3}$$

where $p_m z$ is the tuition per student in group m. We refer to p_m is an origin-specific 'price' of education. This parameter allows us to consider the possibility that because of, say, language barriers, children of a particular immigrant group may require a larger investment in order to acquire the same units of education as a native child in the same school. Within private schools this means that this child's parents have to spend more in order to provide their child with the same education units as a native child.[18] Symmetrically, we assume that the same costs of education for each group m apply to public schools as well. That is, there are no technological differences between public and private schools.

[18] We acknowledge that it is not entirely realistic to assume that schools charge different tuition to different groups of students. However, we follow Coen-Pirani (2011) and make this assumption on the basis of its convenience. At any rate, our baseline model will assume that $p_m = 1$ for all m.

4.2 School choices given policies

The education policy in this economy is summarized by the tax rate used to finance public education expenditures (s), the quality of public schools (e), and the subsidy received by private schools (b).

Inspection of equations (2) and (3) reveals that there exists an income threshold $\hat{y}(n, s, e, b, \lambda, m)$ above which households send their children to private school. To derive this threshold, note that, conditional on choosing a private school, the utility-maximizing school chosen by the household is given by:

$$z(y(1-s), b, n, \lambda, m) = \frac{y(1-s) - \left(\frac{\gamma_m \lambda}{p_m n}\right)^{\frac{1}{\alpha-1}} b}{\left(\frac{\gamma_m \lambda}{p_m n}\right)^{\frac{1}{\alpha-1}} + p_m n}. \tag{4}$$

Thus calling a school private if it has strictly positive tuition ($z > 0$), households with higher (disposable) income or a higher taste for education will choose better private schools (i.e., higher $z > 0$). In contrast, households with more children or facing a higher 'price' of education will choose relatively worse (but cheaper) private schools (lower $z > 0$).

The threshold level of income of private school choice depends on the relative size of the quality of public education (e) and the amount of private education subsidy (b). In many empirically relevant cases, the amount of private education voucher does not exceed the quality of public education: $b \leq e$. In this case, the threshold is determined so that sending children to public and private schools are indifferent: $u(\hat{y}(1-s), e, 0, \lambda, m) = V(\hat{y}(1-s), n, b, \lambda, m)$. This income threshold depends on the household's number of children (n) and on it's preference for education relative to consumption ($\gamma_m \lambda$) as well as the quality of public education and the subsidy received by private schools. Application of the implicit function theorem reveals that this threshold is increasing in the quality of public education (e) and in the tax rate (s), and decreasing in the private school subsidy (b).

When the amount of private education voucher is set at the level of the quality of public education ($b = e$), it is straightforward to derive an expression for the threshold income $\hat{y}(n, s, e, b, \lambda, m)$:

$$\hat{y}(n, s, e, b, \lambda, m) \equiv \left(\frac{\gamma_m \lambda}{p_m n}\right)^{\frac{1}{\alpha-1}} \frac{b}{1-s} \tag{5}$$

where $b = e$. Note also that under the assumption of $\alpha < 0$, which is the empirically relevant range, the threshold is increasing in the number of children in the household (n) and the price of education (p_m), and decreasing in the household's taste for education relative to

consumption ($\gamma_m \lambda$).[19]

Let $f(y, n, \lambda, m)$ denote the joint density of income, number of children, idiosyncratic preference for education, and country of origin.[20] For a given public education policy (s, e), the number of students (enrollment) in public schools from households with origin m can be computed by:

$$n_m^{pub} = \sum_n \int_0^\infty \int_0^{\hat{y}(n,s,e,\lambda,m)} n f(y, n, \lambda, m) d\lambda dy. \tag{6}$$

for $m = 0, 1, 2, \ldots$.

Consequently, the enrollment in private schools from households with origin m is $\left(n_m - n_m^{pub}\right)$, where n_m is the total number of children from origin m. Naturally, if we let $h(n, m) = \int_y \int_\lambda f(y, n, \lambda, m) dy d\lambda$ denote the joint probability of n and m, we can compute the total number of children in each group by $n_m = \sum_n n h(n, m)$.

Let us now describe the government's budget constraint:

$$e \sum_m p_m n_m^{pub} + b \sum_m p_m (n_m - n_m^{pub}) = s\bar{y} \tag{7}$$

where $\bar{y}$ is the average (and total) household income and, thus, the right-hand side is the tax revenue. The left-hand side contains the two entries in the government's education budget. The first term is the direct expenditure needed to finance public schools with quality level e. The second term is the cost of subsidizing students in private schools at a rate b per student. Symmetrically to private schools, we allow for differences in the cost of educating children across the different groups (p_m). Of course, we can always focus on scenario $p_m = p$ where the cost of educating children is the same across all groups.

As noted earlier, an education policy consists of three variables, (s, e, b). One of these variables is pinned down by the government's budget constraint. Yet it is still the case that the voting problem (described below) is intractable without further restrictions. In order to make progress we link the level of the subsidy to the quality of public education. In particular, we assume that the (private education) subsidy per student is set at the same level as the spending in public education per student: $b = e$.[21] One implication of this assumption is that we are ruling out non-subsidized private schools. However, this type of

[19] In the case with $b > e$, all households choose "private" schools and thus $\hat{y}(n, s, e, b, \lambda, m) = 0$. Alternatively, applying our definition of private school with a strictly positive z, we have the threshold income level exactly same as in (5).

[20] The use of the term "density" is an abuse of terminology because y and λ are continuous (income and preference for education) whereas n and m are discrete (number of children and country of origin). This should be interpreted as probability density function when referring to the continuous random variables and as probability distribution function when referring to the discrete random variables.

[21] More generally, we could consider that $b = \phi e$, where $\phi \leq 1$.

schools accounts only for about 5 percent of the student population in Spain. Regarding the level of the subsidy, equal to the spending per student in public schools, we believe this feature to be rather realistic in the context of Spain where many private schools are heavily subsidized and set a very low tuition.[22]

4.3 Majority-vote equilibrium

Public education policy is determined by majority voting.[23] In our baseline model we assume that only natives vote, but both natives and immigrants pay taxes and are eligible to enroll in free public school and to receive the subsidy for private education. We define a majority voting equilibrium in a standard fashion.

Definition: $(s^*, e^*, z^*(y(1-s^*), n, \lambda, m), n_m^*)$ *is a* ***majority-voting equilibrium*** *if (i)* $z^*(y(1-s^*), n, \lambda, m)$ *is chosen optimally; (ii) the government budget constraint (7) is satisfied; (iii) the number of students in public schools for each groups is given by equation (6); and (iv) the equilibrium tax rate and education services per student* (s^*, e^*) *are preferred by at least 50 percent of the voters (natives) to any alternative feasible policy in any pairwise comparison.*

It is relatively easy to characterize the preferred tax rate for each household. Let us consider first households with children in private schools and in a high income bracket. It can be shown that for households with income $y > y^+(n, m) \equiv \frac{p_m n}{\sum_m p_m n_m} \bar{y}$, the preferred tax rate is zero.[24] This is not surprising since these individuals do not use public schools. They would prefer a world with zero taxes where they pay for their children's education purely through tuition since a positive tax rate implicitly redistributes income away from these households. Because of their high income and their choice of expensive private schools, when the tax rate is positive they end up paying more in taxes than what they receive through the subsidy.

Let us now turn to households with children but whose income is below $y^+(n, m)$. For

[22] In some provinces in Spain the average *annual* tuition charged by private schools is well below 200 euros (OCU (2012)), indicating that these schools are almost completely financed by the government.

[23] Since the subsidy is tied to the expenditure per student in public schools, $b = e$, we can omit it from the formal definition of equilibrium. Thus we are left with a two-dimensional policy but one of the variables is pinned down by the government's budget constraint. Thus a voting equilibrium will exist under some regularity conditions.

[24] This statement can be confirmed by solving the optimal tax choice problem that maximizes the indirect utility from private school choice under the assumption that the private school subsidy is equal to spending per student in public schools, $b = e$.

a given public education policy, some of these households send their children to public schools (those with relatively lower income) while others send their children to private schools. However, when they form their political preferences, we assume they all internalize the effect of their vote on education policy and choose a strictly positive tax rate that maximizes the gains from the public resources devoted to public schools and the subsidy. The intuition is that these households are relatively poor and therefore optimally choose a tax that allows them to redistribute income from the wealthier households and in their own benefit through the school subsidy. For these households, the preferred tax rate is given by

$$\hat{s}(y,\lambda) = \left[1 + (\gamma_0\lambda)^{\frac{1}{\alpha-1}} \left[\sum_m p_m n_m y/\bar{y}\right]^{\frac{\alpha}{1-\alpha}}\right]^{-1}. \tag{8}$$

Several points are worth noting. First, the only γ_m term that appears in the equation is for $m = 0$ because only natives are allowed to vote. Second, the preferred tax rate only varies across voters as a function of income y and the idiosyncratic preference parameter for education λ. In our calibration, parameter α will be negative. Under this restriction, individuals with higher income (up to threshold $y^+(n,m)$) or with a higher individual preference for education will support a higher tax rate. As income rises households demand higher education levels for their children since here education is a normal good. Their voting power is used to raise higher tax revenue to be devoted to education, directly in terms of better funded public schools or through a larger subsidy for private education. Third, the preferred tax rate does not depend on the number of children. The reason is that voters with income below threshold $y^+(n,m)$ prefer the tax rate that maximizes the utility from public school and, hence, their out-of-pocket educational expenses do not vary with the number of children.[25]

Let us now turn to households without children. As is typically the case in the data, this group is a majority among voters. Since these voters do not derive utility from education in our model the majority-vote tax rate will trivially be equal to zero. To address this issue we assume that the political preferences of childless households are the same as those with households with one child at the same level of income. The idea is that households without school-age children care about public education in the real world for a variety of reasons. For instance, because their unborn children or their grandchildren may attend public schools in the future.[26]

[25] Our analysis has abstracted from other educational expenses such as textbooks.

[26] Political support for public education for childless households can also be argued on the basis of external effects associated with a more educated population such as lower crime, positive productivity spillovers,

We can characterize the equilibrium education policy further. By solving equation (8) for household income, we obtain the income of the household that prefers that particular tax rate:

$$y^*(\hat{s};\lambda) = \frac{1-\hat{s}}{\hat{s}}(\gamma_0\lambda)^{\frac{1}{\alpha}}\frac{\bar{y}}{\sum_m p_m n_m}. \tag{9}$$

As noted earlier, under the assumption of a negative α, there is a monotone increasing relationship between a household's income and its preferred tax rate (provided $y \leq y^+(n,m)$). Thus we can compute the number of native households who prefer a tax rate lower than a given $\hat{s}$ by

$$\underline{n}_0(\hat{s}) = \sum_n \int_0^\infty \left(\int_0^{y^*(\hat{s};\lambda)} f(y,n,\lambda,0)dy + \int_{y^+(n,0)} f(y,n,\lambda,0)dy \right) d\lambda. \tag{10}$$

The first term inside the parenthesis accounts for the households with relatively low income (public school users) whose preferred tax rate is below $\hat{s}$. The second term computes the number of households whose income is high enough that their preferred tax rate is exactly zero. This coalition was referred to as *the ends against the middle* by Epple and Romano (1996b) because the lowest tax rates are preferred by the households at both extremes of the income distribution.

Similarly, we can also compute the number of native households who prefer a tax rate above $\hat{s}$:

$$\bar{n}_0(\hat{s}) = \sum_n \int_0^\infty \int_{y^*(\hat{s};\lambda)}^{y^+(n,0)} f(y,n,\lambda,0)dyd\lambda. \tag{11}$$

The majority-vote equilibrium tax rate must satisfy $\underline{n}_0(s^*) = \bar{n}_0(s^*)$. That is, the equilibrium tax rate s^* exactly balances the number of households who prefer a higher tax rate with those who prefer a lower tax rate. As discussed in Epple and Romano (1996b), for some parameter configurations this model may feature multiple equilibria. However, given a set of parameter values, it is possible to verify the existence and uniqueness of a majority voting equilibrium numerically. We shall do so for our calibrated model.

4.4 Comparative statics

Before turning to our quantitative analysis we conduct two exercises that will provide the intuition for the main mechanisms in the model, and discuss a few important implications of our model.

or a better informed electorate (Coen-Pirani (2011)). Ultimately, an assumption of this type is needed in practically all political-economy models of education that are calibrated with real-world data.

Let us begin by considering the effects of an inflow of immigrants characterized by lower average income than natives. In line with our previous assumptions, these immigrants have the right to enroll their children in public schools and in subsidized private schools, and have to pay income taxes just like natives (but do not vote). The equations presented earlier can be used to show that in our setup this leads to a reduction in spending per student.[27] The intuition is similar to the *fiscal leakage* in Razin et al. (2002). Voters reduce the degree of tax-based income redistribution because part of the benefits now 'leak' to the immigrant population.[28] Naturally, the lower quality of public education lowers the income threshold for using private schools and triggers a shift from public to private schools.[29]

Let us now turn to the effects of naturalization of the immigrant population already in the country. Because of their lower average income, when immigrants gain the right to vote the median voter will typically move down along the income distribution. Again by virtue of equation (8), the poorer decisive voter will choose a lower tax rate, which will lead to lower spending per student.[30] Thus if over time immigrants naturalize and gain the right to vote, the two effects just discussed will add up and result in a relatively large reduction in public education spending per student.

[27] Clearly, when these immigrants join the economy average household income falls. As a result, given the tax rate, public spending in education per child falls because of a tax-base effect. As seen in equation (8), because α is negative, the lower average income will lead to a higher preferred tax rate as the decisive voter partially offsets the reduction in public spending by raising the tax rate. Nonetheless it can be shown that the public spending per student falls. It is also worth noting that, even though immigrants cannot vote, the identity of the median voter is affected by immigration. The reduction in average income lowers threshold y^+ and increases the number of voters who prefer a tax rate below any given value, as seen in equation (10), which alters the identity of the median voter.

[28] In their paper the tax rate finances a redistributive transfer and immigrants can vote. Even though immigrants support higher redistribution, the median voter chooses to reduce the degree of income redistribution because of the leakage.

[29] An interesting extension of our setup would be to allow for public schools that differ in terms of perceived quality. This could happen even if all public schools refer the same financing per student but, for instance, parental involvement is also an input into the education production function and parents sort across schools on the basis of this trait. We hypothesize that, in this new environment, immigrant children would probably be disproportionately found in the low-quality public schools given the inexperience of their parents in identify the most attractive schools. As a result, immigration would trigger a shift from the worse public schools toward private schools.

[30] Even though the tax rate moves in the opposite direction than in the previous analysis of the effects of immigration without naturalization, it is also the case that the quality of public education (public spending per student) is reduced. Mechanically, the reason why the poorer median voter prefers a lower tax rate is because of the negative value of α. Intuitively, because of her lower income, the decisive voter cannot afford the prior level of taxes and, thus, chooses to lower the tax rate. This result depends, to some extent, on the tax instruments that are considered in the Epple and Romano economy. If lump-sum taxes were allowed, the median voter would be able to extract more from the wealthier households. One should keep in mind also that in our setup tax revenue can only be used to finance education, and cannot be directly translated into private consumption. Using data for Swedish municipalities Vernby (2013) found that enfranchising non-citizens led to higher social spending.

An important implicit assumption of our model is that natives are unable to shield themselves from immigrants by moving to locations with a limited immigrant population. Otherwise, their response to immigration might not require switching to tuition-based private schools. The data suggest that this is not the case in Spain. The scatter plot in Figure 2 compares the 2000-2008 change in the native population against the change in the foreign-born population across Spanish provinces. The data show a clear positive relationship, indicating that the immigrant-receiving provinces also experienced an increase in the native population. Intuitively, regions with booming economies attracted both immigrants and natives and experienced an increase in the competition for schools among the population in those regions.

Finally, it is also important to discuss the role played by the subsidy to private schools, one of the novel features of our framework. Intuitively, the existence of subsidized private schools leads to a lower equilibrium *level* of enrollment in public schools given that private schools are now affordable to a large swath of the population. What is less obvious is how the availability of the subsidy mediates the effects of immigration on the schooling system. On the one hand the presence of inexpensive private schools makes it easier for native households to switch to private schools in response to immigration. But because the subsidy is financed through the same tax that funds public schools, political support for the subsidy is directly connected to support for a relatively high quality of public education, which in turn, reduces the incentives to switch to private schools. Thus the presence of the subsidy may increase or decrease native flight, depending on which of the two opposite effects dominates. Ultimately, the answer to this question depends on data and parameter values.

5 Empirical Implementation

5.1 Calibration strategy

The model is calibrated to Spain in year 2008. The reason we pick this year is that it marks the end of the immigration wave and the beginning of the Great Recession and the ensuing economic distress. Our baseline model assumes that private schools receive a subsidy per student equal to the spending per student in public schools. It also assumes that educating one immigrant child (of any group) has the same cost as educating a native child. This is a conservative choice that will lead to more muted effects of immigration on the quality of public education. We also provide several other calibrations where we vary

these assumptions.

To calibrate the model we need to specify the values of the time-invariant parameters and the joint density function $f^t(y, n, m, \lambda)$, which varies across years. We follow the calibration strategy proposed by Coen-Pirani (2011). Specifically, to calibrate the $f^t(y, n, \lambda, m)$ we assume that the taste parameter λ is independent of (y, n, m) in the population. The distribution of λ is taken to be lognormal with constant parameters $(\mu_\lambda, \sigma_\lambda)$. The parameter μ_λ is set at $-\sigma_\lambda^2/2$ so as to deliver a mean value for λ equal one. The joint distribution of (y, n, m) in year t can be decomposed as:

$$g^t(y|n, m)h^t(n, m) \tag{12}$$

where $h^t(n, m)$ is the joint probability of (n, m). The conditional density function $g^t(y|n, m)$ is assumed to be lognormal with parameters $\mu_y^t(n, m)$ and $\sigma_y^t(n, m)$. The latter are estimated for year 2008 by matching the conditional mean $E[y|n, m]$ and variance $V[y|n, m]$ of household income in the data for that same year.

Immigration status (m) takes five possible values according to whether the household head is native $(m = 0)$ or foreign-born $(m = 1, 2, 3, 4)$. Specifically, it takes the value of 1 for immigrants from European countries, 2 for those from Africa, 3 for America (North, Central or South), and 4 for Asia and Oceania. The number of children in a household (n) is assumed to take four possible values: 0, 1, 2, and 3+, where 3+ equals the average number of children in households with at least 3 children in the data. Distribution $h^t(n, m)$ is estimated non-parametrically using the frequency count of each cell (n, m) in the data.

The cost of education for a native household p_0 is normalized to one without loss of generality. The relative cost of education for an immigrant child is set conservatively to be equal to that of natives, namely $p_1 = p_2 = p_3 = p_4 = 1$, in the benchmark case. However, we will also consider scenarios where the cost of education for immigrants is higher than that for natives since it is often the case that remedial classes or extra help in the form of language instruction is provided to recently arrived immigrant children. For example, Coen-Pirani (2011) sets the cost of education for immigrant children in California to be four percent above that for native children.

We calibrate the seven parameters $(\alpha, \gamma_0, \gamma_1, \gamma_2, \gamma_3, \gamma_4, \sigma_\lambda)$ to match seven moments in the data. The first five moments are the number of native $(m = 0)$ and immigrant children $(m = 1, 2, 3, 4)$ enrolled in public schools in year 2008. Note that matching these moments implies that the model will also exactly match the enrollment of each group in private schools as well as the share of each group that attends public schools. These are important moments

since the data shows a large disparity in the share of children in each group attending public school, ranging from 65 percent (natives) to 90 percent (African immigrants), as documented in Table 3 (column 1, bottom panel).[31] The sixth targeted moment is the share of aggregate household income spent by the government to fund compulsory education, which includes both the direct funding of public schools as well as the subsidy to private schools. This value is directly related to the tax rate determined endogenously in the model and we refer to it as the implicit (education) tax rate. The seventh moment is the ratio between the average incomes of households with children in public and private schools in 2008.

While the seven-equation system is highly non-linear, let us try to provide some intuition on which are the key parameters involved in attaining this calibration targets. For the enrollment in public school for each group, the key parameter is γ_m, the group-specific parameter governing the taste for education relative to consumption. Higher values of γ_m are associated with a higher willingness to spend on education and thus *lower* public school attendance for children belonging to group m.[32] Parameter σ_λ determines the degree of income mixing in private schools, with higher levels of σ_λ associated with a higher ratio of average household income in public relative to private schools, namely, a lower degree of income segregation in schools. Finally, parameter α is crucial to determine the share of aggregate income devoted to education by the government, that is, the implicit tax rate because it determines the tax elasticity of the demand for education services.

5.2 Calibration results

Let us begin by presenting the 7 target data moments. These are reported in Table 3, column 1 (top panel).[33] The implicit education tax rate in the data is 5.93 percent. We calculate this by computing the overall public spending in compulsory education (including the subsidy to private schools) in year 2008 and dividing by household income in that same year. This is a reasonably good approximation to the tax rate in our model, which is used exclusively to finance education. The next five moments are the number of public school students (per 100 households) that belong to each group $m = 0, 1, ..., 4$. Obviously, these

[31] The number of students in public schools for each group m is estimated using the total number of children and the actual share of public school students for each group m. See Section A.3 for the detail.

[32] We will refer to parameter γ_m as the average preference for education for group m. It is worth noting though that many subsidized (concerted) private schools originated as Catholic schools, which may affect a group's average preference for education. Parameter γ_m may also capture cross-group differences in average education, if parental education matters for children's education through channels other than family income and household size.

[33] The public school students per 100 households (24.88) is not a targeted moment. We target the analogous moments for natives and the four immigrant groups, which can be added to obtain the overall 24.88.

figures are a function both of the absolute size of each group as well as of the group's preference for public schools.[34] Finally, we also target the relative income of households that use public school relative to those that use private school, which is 0.73. The second column in the table reports the same 7 moments in our calibrated model, which we are able to match with a high degree of accuracy.

We next comment on the specific values of the parameters that result from our moment matching exercise. Table 2 reports the calibration parameters. The first column presents the calibrated values in our main specification, where private schools receive a subsidy equal to the spending per student in public schools and we assume that the cost of educating immigrant children is the same as that of educating native children. The calibrated value of the parameter α is -0.87, which is negative (as anticipated) and in line with existing empirical estimates.[35] The table also reports the calibrated parameters that govern the distribution of household preference shocks for education (relative to consumption), which we denoted by λ. More importantly, the table also reports the values for the coefficients that govern the group-specific taste for education, γ_m. The lower values for these parameters relative to γ_0 imply that immigrant households have a smaller preference parameter for education (relative to consumption) than native households. This is an implication of the fact that immigrant households are less likely to have children in private school *conditional* on income and family size. The calibration procedure then accounts for the observed enrollment of immigrant children in public school by selecting a value for γ_m for $m = 1, 2, 3, 4$ smaller than the corresponding one for γ_0. For native households $\gamma_0 = 0.52$. Among immigrant groups the highest value is for Asians, with $\gamma_4 = 0.39$ and the lowest is for Africans ($\gamma_2 = 0.12$).

Column 2 in the Table reports the parameter vector that matches the seven target moments when we assume that the cost of educating one immigrant child is 10 percent higher than the cost of educating one native child.[36] Generally, the values of the parameters are very similar to those presented in the first column. However, the values for the group-specific taste for education, γ_m, are slightly higher for immigrants (and lower for natives) than in column 1. This is intuitive since stronger preference for education is needed to offset

[34] The bottom panel in the table reports the share of the students in each group that attend public schools. These shares are perfectly matched when the number of public school students for each group is matched.

[35] The price-elasticity (in absolute value) implied by this value of α is 0.53, only slightly higher than the range $(0.25, 0.50)$ reported by Bergstrom et al. (1982) in their survey of the literature, and smaller than the value implied by Fernandez and Rogerson (1998)'s calibration for California.

[36] In this case the number of education units received by immigrant children, which is what enters the utility function of the household, will differ from education spending per student. This was not the case for our main specification (column 1) because there we assumed an equal education cost for natives and immigrants (and normalized that cost to be one).

the higher cost but still attain the levels of school attendance targeted in the calibration.

We now turn to evaluate the performance of our calibrated model. The credibility of the counterfactual analysis in the next section crucially depends on the ability of the model to match the target moments as well as some other relevant moments that have not been used as calibration targets. As noted already, we are able to perfectly solve for the 7-equation system, namely, we find values for the 7 parameters that allow us to match with high accuracy the 7 target moments, as can be seen in columns 1 and 2 in Table 3. We now propose a more relevant validation exercise. We compute the equilibrium maintaining the values for the 7 key parameters but replacing the 2008 data for the distributions of income (conditional on number of children and group) and of the number of children and group for the corresponding values in year 2000, namely, $g^{2000}(y|n,m), h^{2000}(n,m)$. We then compare the resulting equilibrium predictions to data.

Columns 3 and 4 in Table 3 report the predictions of the model for year 2000 and the actual data for that same year. The model correctly predicts a higher number of native students (per 100 households) enrolled in public schools in year 2000 (26.59) than in 2008 (19.67). The model also reproduces the lower numbers of immigrant children enrolled in public schools in year 2000, relative to 2008. For instance, the data show a reduction from 1.55 immigrant children of European origin (per 100 households) in column 1 to 0.28 in column 3. According to the model, the corresponding figures are 1.55 and 0.31 (column 4).

Apparently, the model predictions do not fare as well regarding the share of native students enrolled in public schools. The data shows a slightly higher share in year 2000 (65.97%) than in year 2008 (64.67%). In contrast, according to the model the share of native students in public school in year 2000 should have been 4 percentage-points lower than in year 2008 (column 4), which is a bit puzzling.

In terms of data fed into the model, columns 2 and 4 differ both in demographics and in terms of the income distribution. However, the key difference lies in the demographic changes between the two years. But, perhaps surprisingly, the key change is unrelated to immigration. Rather, it has to do with the large reduction in the size of native households. While the average number of children per household was 0.45 in year 2000, the corresponding figure was 22 percent lower (at 0.35) in year 2008.[37] The large drop in the number of native school-age children between 2000 and 2008 overshadowed the increase in immigrant children during the same period. To prove this point, column 5 presents the results of a

[37]This sharp drop in household size was simply a reflection of the rapid reduction in the fertility rates among Spanish women during the previous decade, falling from 1.36 children per woman in 1990 to 1.16 in 1998 (World Development Indicators).

simulation where we keep the size and characteristics of the immigrant population at 2008 levels, along with the number of native households and the income distributions of natives and immigrants. That is to say, the only difference between columns 5 and 2 lies in the household size distribution for the native population. Because of the much higher number of school-age children in year 2000 (column 5), spending per student in public schools was much lower than in 2008 and, as a result, a much lower share of native households (of about 3.5 percentage points) chose to send their children to public schools.

While this reveals a weakness of our model, we note that our main interest is not to predict the effects of changes in the native population. What we are mainly concerned with is the response to changes in the immigrant population. Along this dimension, the model performs fairly well. In the data (columns 1 and 3) we observe lower public shares in year 2000, relative to 2008, for the 4 immigrant groups. Comparison of columns 2 and 4 shows that the model correctly predicts the direction of these changes.

The table also reports the public education spending per student and a measure of the quality of public education, namely, the number of education units received by students in public schools. For our main model, these two variables exactly coincide because the cost of educating immigrant children is taken to be the same as that of educating native children (and normalized to one). Importantly, our calibrated model predicts accurately the lower spending per student in public schools in year 2000 (2,276 euros compared to 2,337 euros in the data) compared to 2008 (4,582 euros both in data and model).[38] Overall these figures provide validation of the use of our model for quantitative analysis and, specifically, regarding its ability to produce reasonable predictions in response to changes in the immigrant population.

6 Main Results

We are now ready to tackle the main goal of the paper: the evaluation of the effects of the 2000-2008 immigration wave on the schooling system in the short, medium, and long runs. We shall focus on the effects on the school choices of the native population and on the consequences for the funding and quality of public education.

Immigration is a multi-faceted phenomenon and its effects are likely to be staggered over time. To clarify ideas we find it helpful to proceed in three stages, which we will later map

[38] Education expenditure per student was doubled over 8 years. This is a reflection of the increase of total public education spending for pre-university levels from 17 billion euros in 2000 to 32 billion euros in 2008 (National Education Indicators, 2012).

into short, medium and long-run effects of immigration. These three stages correspond to (1) the effects of immigration, focusing on the implications for educational spending when the children of immigrants enter the schooling system, (2) the effects of naturalization, which grants immigrants the right to vote, and (3) the effects of assimilation along all relevant dimensions.

6.1 The Effects of Immigration

In order to isolate the short-run effects of the 2000-2008 immigration wave we conduct the following simulation exercise. Starting from our baseline scenario (income and demographics as in year 2008), we solve for the equilibrium in a scenario where the income distribution is as in 2008 (g^{2008}) but where the size and composition of the *immigrant* population are as in year 2000 (h^{2000}). The comparison between the two scenarios identifies the effects of the arrival of immigrants (and their children), holding the income distribution of natives constant. The effects of immigration here will operate through the increase in the overall number of school-age children in the economy, and its effects on the key trade-off pondered by the median voter.

Table 4 presents our findings. The first column reports the actual data for year 2008 for the implicit tax rate, public school enrollment for each of the 5 groups, and public spending in education per student. Column 2 reports the same outcomes for the scenario where the foreign-born population in Spain equals, in size and origin composition, that of year 2000. As we discussed earlier, the implicit tax rate is lower in the counterfactual where the immigrant population is as in year 2000, but the reduction turns out to be small (5.90 versus 5.93 percent).

Let us now turn to the size of public education. In the counterfactual (without the immigration wave) the total enrollment in public schools is lower than in the benchmark. In other words, immigration has led to a sizable increase in the size of public education. Specifically, immigration has raised the number of public school students from 23.62 to 24.88 per 100 households. Given the large increase in the number of households due to immigration, overall public enrollment has increased by 0.94 million students.[39] At the same time there has been a significant native flight toward private schools: immigration has led to a 0.8 percentage-point reduction in the share of native students in public schools, amounting to 0.38 million students. Turning now to the effects of immigration on the quality

[39] In comparison, between the same period the number of students with foreign nationality in Spain increased by about 0.5 million.

of public education, measured by public spending per student, we find that if immigration had remained as in year 2000 spending per student would have been 4,727 euros, or 3.2 percent higher than in the benchmark.

Are these magnitudes large or small? To answer this question it is useful to compare our findings to those reported by Coen-Pirani (2011) in his analysis for California.[40] He reports that if the immigrant population had remained as in 1970, the share of native children enrolled in public schools in 1980 would have been 0.17 percentage points higher, and spending per student in public schools would have been 3 percent higher.[41] These figures are similar to our findings for Spain, particularly in regards to the change in public spending per student (3.17 percent reduction). The size of the native flight is substantially larger in our results (0.76 versus 0.17 percentage points), partly due to the larger immigration flow in Spain and partly because of the subsidy to private schools, as we discuss further below.

Let us now examine a few alternative counterfactual scenarios. In column 3 we consider the scenario where the whole immigrant population is removed, as opposed to going back to the year-2000 immigrant population. Not surprisingly, the results are magnified, with a 4.38 percent reduction in spending per student and a reduction in the share of natives attending public schools of 1.04 percentage points. The remaining columns in Table 4 present sensitivity analysis along two different dimensions. In column 4 we report the results when we allow for a higher cost of educating immigrant children (10 percent). In this case the share of native children in public schools would have been a bit higher in the absence of immigration (66.08 versus 65.71 percent) and the quality of public education slightly lower than in the previous column.

The rest of the Table is devoted to analyzing the role of the subsidy to private education and how it mediates the effects of immigration. Naturally, the subsidy makes private schools affordable to a large swath of the population and, hence, greatly increases the share of students that attend private schools. It is less obvious how the presence of the subsidy affects the effects of immigration on native flight or on the quality of public education. To evaluate quantitatively the role of the subsidy, we simulate the model exogenously setting

[40] He studies an immigration episode that lasted 3 decades, between 1970 and 2000. The most relevant comparison to our analysis is when we focus on his findings for the 1970-1980 period. During that period the share of immigrant children enrolled in Californian schools increased by about 7.5 percentage points. This is only a bit smaller than the 10 percentage-point increase in the immigrant share in schools (and in the working-age population) in Spain.

[41] Concerning his full period of analysis, Coen-Pirani (2011) reports that if immigration had remained at the 1970 level the share of native children enrolled in public schools in year 2000 in California would have been 1.12 percentage points higher and spending per student in public schools 24 percent higher than otherwise.

the level of the subsidy at zero (as in Coen-Pirani (2011)). Column 5 in Table 4 presents the results. This column can be compared to column 1 (Data). As expected, the share of native children in public schools would have been much higher without the subsidy (85 versus 65 percent), which accounts for the large differences in school choices between Spain and other countries, such as the United States, where the share of students in private schools is much lower than in Spain. In terms of public spending per student, the differences between columns 1 and 5 are small. Without the subsidy public spending per student would have been 1.15 percent higher. The reason is that households in the middle range of the income distribution would have switched from private to public schools. Since those households have relatively high income, they prefer higher quality of public education. Interestingly, this higher expenditure could be achieved with a lower tax rate because all tax revenues would now be used exclusively to finance public schools.

But how are the effects of immigration on public education affected by the availability of the subsidy? The comparison between column 5 (immigrants as in year 2008) and column 6 (immigrants as in year 2000) identifies these effects.[42] As it turns out the effects of immigration are very similar in the scenarios with and without the subsidy. In the absence of the 2000-2008 immigration wave, public spending per student would have been about 3 percent higher, similarly to what we found in the model with the subsidy. Turning now to the size of the native flight toward private schools, we find that in the absence of the subsidy there would have been a significantly larger native flight: the native share in public schools would have fallen by 0.56 percentage points (from 85.61 to 85.05), compared to the 0.76 percentage-point reduction in the model with the subsidy.

6.2 The Effects of Naturalization

We now focus on the effects of granting the right to vote to the immigrant population residing in Spain in year 2008. At this point the economy does not experience any changes in its demographic composition or in income. It is purely an exercise in franchise extension, keeping the characteristics of the immigrant population unchanged.[43]

From our political-economy perspective the fundamental implication is the resulting

[42] This is akin as comparing columns 1 and 2 for the model with the subsidy.

[43] In Spain most foreign citizens are allowed to apply for citizenship after 5 to 10 years of legal residence in Spain. In general foreign nationals can apply for Spanish citizenship after 10 years of legal residence. However, several groups can apply earlier. For instance, refugees can apply just after 5 years of residence. Citizens of Latin America, Portugal, the Philippines, Equatorial Guinea and those with sephardic origins can obtain Spanish nationality after two years. Foreign-born individuals married to Spanish citizens or children of Spanish citizens can apply after only one year of legal residence (Spanish Ministry of Justice).

change in the number and distribution of voters. To the extent that average household income is lower for immigrant households than for native ones, naturalization will lead to a downward shift of the median voter along the income distribution.[44] For short we refer to this exercise as the *effect of naturalization*.

Table 5 reports the results. Again, column 1 reports the actual values of the moments for year 2008. Column 2 reports the values for the counterfactual scenario where immigrants have been enfranchised according to our main specification, that is, when private schools are subsidized and the cost of education is the same for native and immigrant children. We find a significantly lower implicit tax rate, at 5.50 percent, as opposed to 5.93 in the data. This leads to a large reduction in the quality of public education, with spending per student in public schools falling by 7.68 percent. Naturally, we find a sizable reduction in the probability of using public schools for the native population, from 64.67 to 62.54 percent (2.13 percentage points). In comparison to the (short-run) effects of immigration discussed earlier, these figures indicate that the reduction in quality and the size of the native flight will be about twice as large when naturalization takes place.

Columns 3 and 4 provide robustness checks. In column 3 we assume that the cost of educating immigrants is 10 percent higher than the corresponding cost for natives. The results are largely unchanged. Again the native flight to private schools is about 2 percentage points and the quality of public education falls by about 7 percent following naturalization. Likewise the results in column 4 show that the effects of naturalization are similar in the variations of the model with and without the subsidy.[45]

In conclusion, our analysis predicts that naturalization will have larger effects on the schooling system than the direct effect of immigration. The next section asks whether assimilation of the immigrant population has the potential to alter these predictions.

6.3 The Effects of Assimilation

Traditionally, economists have focused on economic assimilation, that is, the rate of convergence of immigrant wages toward the wages of comparable natives. However, in the context

[44] Even when immigrants are not enfranchised, it is possible that they influence the domestic politics of the host country. This can be the case if politicians/voters are foresighted and try to court the sympathies of the soon-to-be franchised immigrant population (Ortega (2005), Ortega (2010)).

[45] Naturally, in this case the share of students in public schools would have been much larger. Compared to column 5 in Table 4 (where immigrants cannot vote) reveals that the share of native students in public schools would have fallen by 1.56 percentage points and public spending per student would have fallen by 7.2 percent. As discussed above, in the economy with the subsidy these figures would have been 2.13 percentage points and 7.7 percent, respectively. Thus, again, taking into account the presence of the subsidy does not alter much our predictions.

of our model there are other dimensions of assimilation that need to be taken into account: convergence in income, in family size, and in preferences toward education. We analyze the effects of the full assimilation of naturalized immigrants along each of these dimensions, which we refer to as the *effect of assimilation*.

In order to examine the effects of each dimension of assimilation we conduct a number of counterfactuals. Separately assessing each dimension is important because the policies that target assimilation along each dimension may differ widely.[46] In all cases our benchmark is the naturalization equilibrium where the immigrant population has naturalized but not assimilated, that is, its income distribution, family size, and preference parameters are as in the calibration of the model discussed earlier.

Table 6 presents the results. The first column reports again the results of the naturalization experiment (column 2 in the previous table). In this scenario 62.54% of the children of native households attended public schools and the average education spending by the public sector was 4,230 euros per student.

Column 2 reports the results of the naturalization experiment but now we endow the immigrant population with the same income distribution as the native population, leaving all other dimensions as dictated by the data. It is typically the case that immigrants upgrade their occupation with time in the host country, which is accompanied by gains in earnings, and has been corroborated for Spain by Amuedo-Dorantes and de la Rica (2007). Naturally, in reality income assimilation may not be complete since many low-education immigrants are unlikely to obtain more education, which may impose a ceiling on their earnings. Thus the values in columns 1 and 2 provide a range of outcomes, varying from no income assimilation (column 1) to full income assimilation (column 2). The figures show that income assimilation has noticeable but small effects. Even when the income distribution of immigrants is the same as natives, the share of natives in public schools goes up only by about half a percentage point to 62.99%, and average spending per student increases by 1.8% relative to the value in column 1. Intuitively, average income rises for the immigrant population, which reduces fiscal leakage, slightly increases public spending per student, and attenuates the native flight.

Column 3 assumes that immigrants fully assimilate in terms of demographics, that is, we assign to them the native distribution for family size. Thus the average number of children for immigrant families is now lower than in the data. The resulting changes are

[46] For instance, income assimilation entails providing further education or re-training programs, whereas convergence in preferences for education may have more to do with providing information on the returns to education and ensuring equality of opportunity in the labor market.

larger in magnitude than those implied by income assimilation. Specifically, the share of natives in public schools goes up to 63.52%, one full percentage point higher than in the naturalization scenario (column 1). Likewise average educational spending increases by 4% to 4,398 euros. The intuition is also straightforward. While average income for immigrants is the same as in column 1, their average number of school-age children is now lower. So their net contribution to the public coffers is significantly higher, leading to higher public spending per student.

Now we turn to preference assimilation (column 4). In this case we endow immigrants with the preference parameter for education of the native group, leaving the income and family size distributions as in the data. We now find the largest effects. The share of native students in public schools now becomes 64.67%, more than 2 percentage points higher than in column 1, and public spending per student is now 8.3% higher than in the naturalization scenario. Intuitively, now immigrants have a higher preference for education and, since they have the right to vote, the new median voter is more in favor of financing education, leading to a higher tax rate and better quality for public schools.

What if immigrants fully assimilated along all dimensions (income, demographics and preferences) and became indistinguishable from natives? Column 5 reports our findings. As expected, in this case the share of native students in public schools is the highest, at 65.71%, more than 3 percentage points higher than in column 1. Likewise, public spending per student is now 4,783 euros, 13 percent higher than in the naturalization (without assimilation) scenario. It is also worth noting that these results exactly coincide with those of column 3 in Table 4, the scenario depicting the equilibrium outcomes in the absence of any immigrants. In other words, the model is linearly homogeneous: cloning the native population leaves the tax rate, school choices, and the quality of public education unaffected.

Interestingly, our analysis of assimilation yields results that differ from those those reported by Coen-Pirani (2011) for California. He found that demographic assimilation was the most important driver of the effects of immigration in California. In contrast, the key dimension of assimilation is on the preference for education. Since our calibration revealed important differences in this parameter across immigrant groups, this finding underscores the importance of allowing for preference heterogeneity among the immigrant population.

6.4 Long-Run Scenarios

We find it useful to collect the key values from the earlier tables to produce a summary table of the long-run effects of immigration, after taking into account naturalization and

a range of assimilation outcomes. We focus on three key outcomes: public spending per student, overall enrollment in public schools, and the share of natives in public schools. Respectively, these variables summarize the quality of public education, its size, and the choices of the native population in each scenario.

Table 7 presents the results. The top panel of the Table simply collects the relevant values from the previous tables. The first row is the pre-immigration scenario, corresponding to the counterfactual scenario where immigration is assumed to be as in year 2000 (but with the 2008 income distribution). The second row (in italics) corresponds to our benchmark, which includes the 2000-2008 immigrants but these individuals are not allowed to vote. The third row depicts the scenario where the 2008 immigrant population has gained citizenship. Finally, the fourth row assumes that the naturalized population has fully assimilated.[47]

The middle panel presents a decomposition of the effects of immigration into the "pure" effect of immigration, the effect of naturalization, and the effect of (full) assimilation. The effect of immigration is computed as the difference between the benchmark outcomes (based on the immigrant population in 2008) and the counterfactual scenario where immigration is assumed to be as in year 2000. Our results imply a 3.2 percent drop in public spending per student.[48] Naturally, this leads to a reduction in the share of native households using public schools (by 0.8 percentage points). Despite this native flight, overall enrollment in public schools grows by 15.1% relative to the benchmark value due to the large inflow of immigrant children into the public system.

Next, we turn to the marginal effect of naturalization, defined as the difference in outcomes between the naturalization scenario and the benchmark. In both scenarios, the immigrant population is exactly identical in both size and composition, and the only difference is that in the naturalization scenario immigrants participate in the electoral process. The table shows that naturalization entails a large reduction in public spending per student (by 7.7 percent of the benchmark value). Naturally, this leads to a strong response by the native population that reduces its share in public schools by 2.1 percentage points. This time overall enrollment in public schools falls, both because of the flight of natives and immigrants with relatively high incomes (and preference for education) toward private alternatives.

We now turn to the estimation of the marginal effect of assimilation, computed as

[47] It is worth recalling that the full assimilation scenario has the same public spending per student and school choices as the scenario with no immigration whatsoever (column 3 in Table 4).

[48] As explained in the footnote to the table, all changes in spending are reported relative to the benchmark value. This way the figures in the bottom panel can be obtained by simply adding the corresponding values in the middle panel.

the difference in outcomes between the full assimilation scenario and the naturalization scenario. According to our analysis, full assimilation entails a 12.1% increase in public spending per student, relative to the corresponding value in the naturalization scenario.[49] Not surprisingly, this large marginal increase in the quality of schooling triggers a large increase in the share of natives choosing public schools (by 3.2 percentage points), and increases overall enrollment in the public system by 4.9%.

The bottom panel of the table builds on the marginal effects of immigration, naturalization and assimilation to provide a range of values for the combined long-run effect, as a function of the degree of assimilation. Assimilation is better viewed as a *long-run* outcome that can take more than a decade to materialize and may even not be fully attained within a generation. In fact assimilation is not just a function of the length of stay in the host country. Rates of assimilation may be affected by public policies and often differ substantially across immigrant groups in the same country of origin, partly as a function of the cultural distance between the countries of origin and destination.[50]

The first row in the bottom panel provides our prediction under the pessimistic assumption of no assimilation. This prediction is computed by adding the effects of immigration and naturalization in the middle panel.[51] Under these conditions public spending per student would end up substantially lower than in the immigration-as-in-2000 scenario (by about 10 percent of the benchmark value) and, accordingly, native enrollment in public schools would decrease by almost 3 percentage points. Nevertheless the overall enrollment in public schools would increase by about 12 percent due to the inflow of immigrant children.

The second row of the panel reports the combined long-run effects under the optimistic scenario with full assimilation, computed by adding up the effects of immigration, naturalization, and (full) assimilation.[52] In this case public spending per student would end

[49] This figure is computed as the difference between 4,783 and 4,230 Euros, divided by the benchmark value (4,582 Euros).

[50] De la Rica et al. (2015) provide an extensive review of the literature on economic assimilation. They conclude that native-immigrant gaps in labor market outcomes are very persistent and report substantial heterogeneity across origin and destination countries. Amuedo-Dorantes and de la Rica (2007) study occupational upgrading among immigrants in Spain. They find evidence of substantial upgrading for Eastern Europeans and Latin Americans, but no progress for African immigrants. Algan et al. (2010) compare assimilation outcomes in the UK, France and Germany. They find that the UK is features the largest native-immigrant gaps. However, it is also the country showing a larger improvement in the outcomes of second-generation immigrants.

[51] Equivalently, the no-assimilation combined effect can be computed as the difference between the outcomes in the naturalization scenario and in the scenario that assumes that the immigrant population remains as in year 2000.

[52] Alternatively, it is the difference between the assimilation scenario and the scenario where the immigrant population remains as in year 2000.

up slightly above the value in the absence of the immigration wave (by about 1 percent), which pulls some natives into public schools (by 0.3 percentage points). As a result, overall enrollment in public schools grows strongly (by close to 17 percent).

In conclusion, the long-run effect of the immigration wave on the quality of public education will range between a substantial negative effect and a small positive one, depending on the degree of assimilation achieved by the immigrant population. Accordingly, this will determine whether native flight toward private school alternatives takes place or not. Either way, what seems sure is that overall enrollment in public schools will increase strongly, with enrollment growth being increasing in the degree of assimilation of the immigrant population. Naturally, the key question is how much assimilation is likely to take place. In light of international evidence (De la Rica et al. (2015)), most likely assimilation will be far from complete. To what extent it is attained is an empirical question, depending importantly on the composition of the immigrant population and the the policies adopted to facilitate assimilation.

7 Alternative Immigration Policies

One of the new features of our model is that we have allowed for multiple immigrant groups, differing in size, preferences, and composition (in terms of income and family size). This feature of the model makes it uniquely suited to evaluate the effects of alternative immigration policies on the education system of the receiving country, in the spirit of the theoretical exercise in Dottori et al. (2013).

Toward this goal we simulate a series of scenarios where we fix the level of immigration but vary its composition in terms of region of origin. The motivation is that immigration policies in many countries favor one group of immigrants over another, often stemming from colonial links, cultural affinity, or geopolitical proximity.[53]

Specifically, we consider four scenarios. Across all of these we keep constant the overall number of immigrants that arrived in Spain between 2000 and 2008 at its observed value, but assume that all these immigrants belong to a single region of origin. For example, in the first scenario all immigrants are assumed to originate from Europe and are characterized by the preferences for education and the distributions for income and family size described

[53]For instance, EU citizens enjoy free labor mobility within the Union, Latin American immigrants have a preferential treatment in Spain's immigration laws in terms of visa waivers and a fast track to citizenship (Bertoli et al. (2011), Bertoli et al. (2013)). Likewise the US favors the immigration of Cubans, and France, the UK, the Netherlands, and other former colonial powers grant similar rights to immigrants from countries that used to be under their influence.

earlier in the calibration section. Analogously, in the other scenarios we assume that all immigrants originated, in turn, from Africa, America and Asia.[54]

Table 8 presents our results. The first two columns report short-run effects and columns 3 and 4 report medium-to-long-run effects.[55] We focus on two key outcomes of interest: the share of children of native households that attend public schools, which can be used to quantify the size of the native flight, and the quality of public schools, measured by public spending per student. Glancing at columns 1 and 2 reveals that if all immigrants had originated from Europe, the share of native households using public schools and the quality of public education would have been the highest (65.16% and 4,676 Euros), significantly better than in the short-run benchmark. In contrast, in the short run, these outcomes would have been the worst with an immigration policy that admitted only African immigrants, even though the differences are not dramatic (64.24% and 4,504 Euros).

Interestingly, a different picture arises from the medium-run results (columns 3 and 4). In this case the best outcomes are obtained in the scenario where all immigrants originate from Asia. In this case public spending per student and the share of native households using public schools would be 4,384 Euros and 63.52%, respectively, which also improves upon the medium-run benchmark (naturalization but no assimilation). Again, the worst outcomes are obtained in the scenario of all-African immigration (61.67% and 4,091 Euros). The differences in outcomes between the two policies (all Asian versus all African immigrants) are now larger, almost a 2-percentage point difference in the share of native households using public schools and a 7% difference in public spending per student.

What accounts for these differences? Table 9 summarizes the characteristics of each of the groups of immigrants along the three relevant dimensions: average number of school-age children, household income, and preference for education. On average, household income for immigrant households is about 8 percent lower than for native households, with relatively small differences across immigrant groups. As a result, income differences across origin groups are not terribly important. Instead, what drives the finding that a policy admitting only European immigrants would deliver the best short-run outcomes is the fact that this group displays the lowest family size. Namely, the average number of school-age children

[54] Implicitly, we are assuming that the host country can increase the level of immigration from a particular origin region without affecting the pattern of selection. This assumption is plausible in our particular application because our regions are large (continents) and the overall level of immigration is relatively small.

[55] Recall that in our short-run scenarios we assume that immigrants do not vote and have the characteristics observed in the data. In our medium-run scenario immigrants naturalize and participate in elections, but their characteristics are kept fixed at the levels we observe in the data in year 2008. In the event that immigrants' characteristics remain fixed at these levels, the medium-run results can be interpreted as long-run results in the absence of further assimilation.

for European immigrants is 0.37, compared to 0.46 for the overall immigrant population.

From a long-run perspective, the role of demographics is dwarfed by the differences in preferences for education across immigrant groups. As shown in the Table (column 3), the calibrated education preference parameter, γ_m, is much lower than for natives. Interestingly, Asian immigrants display the highest value for this parameter (0.39 versus 0.16-0.21 for the other immigrant groups). Once immigrants are enfranchised this makes a material difference. The high preference for education of Asian immigrants leads to a more pro-education median voter than in the benchmark scenario with naturalization.[56] It is interesting to dig a bit deeper in the reasons for the less positive outcomes in the scenario with all-African immigration. As shown in Table 9, average household size is similar for Africans and Asians in Spain. In contrast the preference parameter for education is almost twice as large for Asian immigrants. This is an important insight that should be useful to policymakers in designing policies that help this group of immigrants assimilate. Our results suggests two policies that may be particularly helpful to promote the assimilation of African immigrants in Spain: dissemination of information regarding the returns to education and policies aimed at reducing labor-market discrimination for this group.[57]

Summing up, our analysis in this section has made full use of an important novel feature of our framework: allowing for multiple immigrant groups. We have learned that the immigration policy that Spain had in place during the period 2000-2008, favoring Latin American and intra-EU immigrants, had a significant effect on our predictions. It may have increased short-run outcomes by tilting inflows in favor of groups with fewer school-age children (like European immigrants). However, these groups may not assimilate as rapidly, or to the same extent, in terms of their preferences for education as some other groups of immigrants. As a result, the policy may have maximized short-term outcomes at the expense of long-term ones. It is important to note though that the predictions in this section cannot be extrapolated blindly to other countries. Differences in the immigrant mix in terms of countries of origin and prospects of assimilation across immigrant groups can

[56] The dominant role of the preference for education in driving the medium-run results is reminiscent of the work by Albornoz-Crespo et al. (2011). These authors stress that immigrants may self-select in terms of their preference for education, which has important implications for their effect on the school system that potentially surpass the effects of income. Our finding is also related to the discussion on the reasons behind the educational success of Asian immigrants in the United States (Goyette and Xie (1999), Hsin and Xie (2014)).

[57] Recall that because many private schools are Catholic, preference parameters $\{\gamma_m\}$ are likely influenced by the religious preferences of each group. In fact most African immigrants in Spain are Moroccan, an eminently Muslim country. From this point of view an additional policy to promote assimilation would be to require subsidized private schools to shed off religious content, or to give equal weights to the religions of the students attending that school.

have large impacts.

8 Conclusions

Classical analyses of the economic effects of immigration imply a net aggregate economic gain for the native population (Berry and Soligo (1969)), often referred to as the *immigration surplus*. However, the economic consequences of immigration are much less clear-cut in setups where important public policies may respond endogenously to immigration.

Eventually whether immigration delivers a net gain or loss will vary on a case by case basis, as a function of the characteristics of the immigrant population, and the size and design of the welfare state in the host country.[58] From this viewpoint the contribution of our paper is to analyze in detail a setup where the main public policy is the government's spending in compulsory education. We have provided a quantitative assessment of the effects of immigration in such a setup, taking into account that the immigrant population is not a monolithic entity. Rather, it is composed of groups that differ in many relevant dimensions. We have also tailored our model to Spain's education system, which is characterized by a large subsidy to private schools and, not surprisingly, a large share of the student body enrolled in private schools.

We find that immigration will lead to a large increase in public enrollment in the short run, together with a significant reduction in public education spending and a similarly sized increase in the share of native households using private schools. Depending on assimilation, these trends will be greatly intensified or mitigated once immigrants naturalize and gain the right to vote.[59] The long-run effects span a wide range of outcomes, including a large drop in public education spending per student followed by an intense native flight toward private schools if assimilation is non-existing or limited.

Our findings have important consequences for income inequality. They strongly suggest that, in the absence of intense assimilation, public schools will experience important pressures to teach larger numbers of students with smaller budgets. In addition the student body in these schools will be increasingly characterized by low-income, immigrant households. As a result, the quality of public education is likely to deteriorate, along with the

[58] In his classical piece, Freeman (1986) argued that large-scale immigration may be incompatible with the main welfare state policies. For a partially diverging view, see the political-economy model in Ortega (2010) where immigration is needed in order to sustain income redistribution policies.

[59] It is also possible that some of these effects materialize faster, since immigrants may influence politicians through means other than voting. Foresighted politicians may start courting the sympathy of the soon-to-be voters already prior to naturalization (Ortega (2005)).

chances of immigrant children to attend college and to succeed in the labor market.

Our analysis also has implications for the design of education policy. First, it should be a priority to promote educational investments among the immigrant population. Specifically, useful steps in this direction include the dissemination of information regarding the returns to education, adopting policies aimed at reducing labor-market discrimination, and making private schools more attractive to immigrants of diverse ethnic and religious backgrounds.

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Table 1: Descriptive statistics

Variable	2000	2008	Change
GDP	100	173	73%
Real GDP	100	132	32%
Population (working-age)	27,324,284	31,410,915	14.95%
Foreign-born share (%)	3.64	13.10	9.46
Number of households [1]	9,469,548	12,762,903	34.78%
Share (100)			
Native households	97.03	86.19	-10.84
Immigrant households[2]	2.97	13.81	10.84
Europe	1.38	5.09	3.71
Africa	0.79	2.62	1.84
America	0.61	5.62	5.01
Asia and Oceania	0.19	0.48	0.29
Average household income [3]	17,796 euros	28,391 euros	59.54%
Native households	.	28,715 euros	.
Immigrant households	.	26,364 euros	.
Share of students in public schools	0.66	0.70	0.04
Natives	0.66	0.65	-0.01
Immigrants	0.77	0.83	0.06
Europe	0.69	0.82	0.13
Africa	0.89	0.90	0.01
America	0.77	0.80	0.03
Asia and Oceania	0.67	0.75	0.08
Overall public spending in education / GDP[4] (%)	2.70	2.93	0.23
Public schools / GDP	2.24	2.39	0.15
Subsidy to private / GDP	0.46	0.54	0.09

Notes: (1) Estimated on the basis of the Labor Force Survey. (2) Europe includes all countries in the European continent except for Spain. America includes North, Central and South America. (3) Average household income computed using the Family Expenditure Survey for year 2008 at current prices (nominal income) with adjusted number of household from the Spanish Labor Force Survey. It includes salary, capital income and benefits. We multiplied the monthly income by 14 (12 months and double pay in August and December). (4) Overall public spending in education here covers pre-university education (preschool, elementary, secondary and special education) and includes the subsidies to private schools.

Table 2: Calibration parameters

	(1)	(2)
Specification	Main	Higher cost immig.
Relative cost of education immig.	1	1.10
α	-0.87	-0.84
μ_λ	3.33	3.22
σ_λ	2.58	2.54
γ_0 (Native)	0.52	0.48
γ_1 (Imm. Europe)	0.16	0.17
γ_2 (Imm. Africa)	0.12	0.13
γ_3 (Imm. America)	0.21	0.22
γ_4 (Imm. Asia and Oceania)	0.39	0.40
p_0	1	1
p_1	1	1.10
p_2	1	1.10
p_3	1	1.10
p_4	1	1.10

Notes: Specification (1) assumes identical cost of education for all 5 groups, and subsidy equal to spending per student in public schools. Specification (2) assumes that the cost of education for immigrants is 10 percent higher than for natives. Specification (3) refers to the opting-out model. Here there is no subsidy for private schools. The implied price-elasticities (in absolute terms) are 0.53, 0.54, and 0.58, respectively.

Table 3: Model predictions - Validation

	(1)	(2)	(3)	(4)	(5)
Natives	2008	2008	2000	2000	2000[a]
Immigrants	2008	2008	2000	2000	2008
	Data	Model	Data	Model	Model
Implicit tax rate[b] (%)	5.93	5.93	5.99	5.83	6.08
Public school students per 100 households	24.88	24.88	30.29	27.83	27.98
Natives	19.67	19.67	29.06	26.59	23.92
Immigrants					
Europe	1.55	1.55	0.28	0.31	1.50
Africa	1.16	1.16	0.54	0.52	0.83
America	2.31	2.31	0.27	0.26	1.61
Asia and Oceania	0.18	0.18	0.13	0.14	0.12
Ratio public-private household income	0.73	0.73	0.75	0.68	0.73
Share of the students in group in public schools (%)					
Natives	64.67	64.67	65.97	60.36	61.12
Immigrants					
Europe	81.89	81.89	69.13	76.76	79.19
Africa	89.53	89.53	89.21	86.28	85.01
America	79.78	79.78	77.27	74.44	76.92
Asia and Oceania	75.39	75.39	67.04	72.50	67.82
Public education spending per student[c] (euros)	4,582	4,582	2,337	2,276	3,948
Quality of public education[d]	4,582	4,582	2,337	2,276	3,948

Notes: (a) In column 5 the number of native households is the same as in year 2008, but the household size distribution is that of year 2000. The immigrant population is taken from the data for year 2000, both in number of households and in terms of the distribution of household size; (b) The implicit tax rate is equal to the overall public spending on education over aggregate household income; (c) Total public expenditure in education (including subsidy to private schools) divided by the enrollment in public and subsidized (concerted) private. Both the numerator and denominator refer to all pre-university education levels. In our model it coincides with the education services per student in public schools; (d) We define the quality of public education as the number of education units per student received in public schools. The cost of one education unit equals one for natives and p_m for immigrants of group m. In this table $p_m = 1$ for all groups.

Table 4: Counterfactual Experiments: Immigration

	(1)	(2)	(3)	(4)	(5)	(6)
Specification	Data	Main	Main	Main	No Subsidy	No Subsidy
Immigrant population	2008	2000	None	None	2008	2000
Relative cost immigrants	.	1	1	1.10	1	1
Implicit tax rate[1] (%)	5.93	5.90	5.88	5.87	5.20	5.13
Public school students per 100 households	24.88	23.62	23.19	23.32	31.85	30.71
Natives	19.67	22.52	23.19	23.32	25.87	29.46
Immigrants						
Europe	1.55	0.28	0	0	1.78	0.32
Africa	1.16	0.46	0	0	1.27	0.50
America	2.31	0.24	0	0	2.71	0.28
Asia and Oceania	0.18	0.13	0	0	0.22	0.15
Share of the students in public schools (%)						
Natives	64.67	65.43	65.71	66.08	85.05	85.61
Immigrants						
Europe	81.89	81.84	.	.	93.80	93.77
Africa	89.53	89.83	.	.	97.79	97.96
America	79.78	79.95	.	.	93.48	93.57
Asia and Oceania	75.39	78.57	.	.	91.81	94.17
Public education spending per student[2] (euros)	4,582	4,727	4,783	4,774	4,635	4,779
Quality of public education[3]	4,582	4,727	4,783	4,774	4,635	4,779
Pct. chg. quality of public education[4]	.	3.17%	4.38%	4.18%	1.15%	4.30%

Notes: Income distribution is fixed at 2008 level across all specifications. In column 1, the immigrant population is as in the data for year 2008. In columns 2 and 5, the immigrant population is as in the data in year 2000. In columns 3 and 4 we assume that there are no immigrants. (1) The implicit tax rate is equal to the overall public spending on education over aggregate household income; (2) Total public expenditure in education (including subsidy to private schools) divided by the enrollment in public and subsidized (concerted) private. Both the numerator and denominator refer to all pre-university education levels. In our model it coincides with the education services per student in public schools. (3) We define the quality of public education as the number of education units per student received in public schools. The cost of one education unit equals one for natives and p_m for immigrants of group m. (4) This is the change in the average education services per student between the value in the corresponding column and the value in the first column (actual in 2008) as a percent of the value in the first column.

Table 5: Counterfactual Experiments: Naturalization

	(1)	(2)	(3)	(4)
Specification	Data	Main	Main	No Subsidy
Immigrant population	2008	2008	2008	2008
Relative cost immigrants	.	1	1.10	1
Implicit tax rate[1] (%)	5.93	5.50	5.55	4.75
Public school students per 100 households	24.88	24.25	24.33	31.33
Natives	19.67	19.03	19.10	25.40
Immigrants				
Europe	1.55	1.56	1.56	1.76
Africa	1.16	1.15	1.15	1.26
America	2.31	2.33	2.33	2.69
Asia and Oceania	0.18	0.18	0.18	0.22
Share of the students in public schools (%)				
Natives	64.67	62.54	62.77	83.49
Immigrants				
Europe	81.89	82.29	82.45	93.03
Africa	89.53	88.87	88.99	97.40
America	79.78	80.29	80.47	92.61
Asia and Oceania	75.39	74.92	75.12	90.79
Avg. education spending per student[2]	4,582	4,230	4,195	4,302
Quality of public education[3]	4,582	4,230	4,268	4,302
Pct. chg. quality of public education[4]	.	-7.68%	-6.86%	-6.10%

Notes: The immigrant population and the income distribution are kept fixed at their 2008 level. The counterfactual in columns 2-4 assumes that all immigrants gain the right to vote. (1) The implicit tax rate is equal to the overall public spending on education over aggregate household income; (2) Total public expenditure in education (including subsidy to private schools) divided by the total enrollment (public and subsidized private). Both the numerator and denominator refer to all pre-university education levels. (3) Analogous to (2) but now in terms of the education units received by each student. (4) This is the change in the average education services per student between the value in the corresponding column and the value in the first column (actual in 2008) as a percent of the value in the first column.

Table 6: Counterfactual Experiments: Assimilation

Assimilation	(1) None	(2) Income	(3) Demographic	(4) Preference	(5) Complete
Implicit tax rate[1] (%)	5.50	5.50	5.47	5.93	5.88
Public school students per 100 households	24.25	24.04	23.26	24.18	23.19
Natives	19.03	19.16	19.32	19.67	19.99
Immigrants					
Europe	1.56	1.47	1.45	1.32	1.18
Africa	1.15	1.08	0.80	0.99	0.61
America	2.33	2.15	1.56	2.02	1.30
Asia and Oceania	0.18	0.17	0.12	0.18	0.11
Share of the students in public schools (%)					
Natives	62.54	62.99	63.52	64.67	65.71
Immigrants					
Europe	82.29	77.46	81.00	69.57	65.71
Africa	88.87	83.23	86.12	76.55	65.71
America	80.29	74.29	78.78	69.73	65.71
Asia and Oceania	74.92	69.32	71.78	71.99	65.71
Avg. education spending per student[2]	4,230	4,307	4,398	4,581	4,783
Quality of public education[3]	4,230	4,307	4,398	4,581	4,783
Pct. chg. quality of public education[4](%)	.	1.81	3.97	8.30	13.07

Notes: The number of immigrant households is kept fixed at the 2008 level. The cost of educating the child of an immigrant family is assumed to be the same as for a native family. Throughout all columns we assume that all immigrants vote. (1) The implicit tax rate is equal to the overall public spending on education over aggregate household income; (2) Total public expenditure in education (including subsidy to private schools) divided by the total enrollment (public and subsidized private). Both the numerator and denominator refer to all pre-university education levels. (3) Analogous to (2) but now in terms of the education units received by each student. (4) This is the change in the average education services per student between the value in the corresponding column and the value in the first column (main specification assuming immigrants naturalize but do not assimilate) as a percent of the value in the first column.

Table 7: Counterfactual Experiments: Summary Table

Scenario	Public spending per student (Euros)	Enrollment public Millions students	Pct. share Natives in Public Schools
Immigration as in 2000	4,727	2.13	65.43
Benchmark (Immigration as in 2008)	*4,582*	*2.51*	*64.67*
Naturalization	4,230	2.43	62.54
Assimilation	4,783	2.55	65.71
Decomposition Effects	Rel. chg. (pct of Benchmark)	Rel. chg. (pct of Benchmark)	Chg. p.p.
Effect of Immigration = Benchmark - Immig. As in 2000	-3.2%	15.1%	-0.8
Effect of Naturalization =Naturalization - Benchmark	-7.7%	-3.3%	-2.1
Effect of (Full) Assimilation =Assimilation - Naturalization	12.1%	4.9%	3.2
Combined Long-Run Effects			
No Assimilation =Effect Immig. + Effect Natz.	-10.8%	11.8%	-2.9
Full Assimilation =Effect Immig. + Effect Natz.+Effect Assim.	1.2%	16.7%	0.3

Notes: The benchmark scenario is computed on the basis of the immigrant population and income distribution in year 2008. The immigration as in 2000 scenario has the same income distribution as in the benchmark but immigration is as in year 2000. The naturalization scenario has the same income distribution and immigration as in the benchmark, but all immigrants are granted the right to vote. The assimilation scenario assumes that immigrants have been naturalized and have the same income distribution, household size distribution and preference parameters as natives. In all cases we focus on the main model, featuring the subsidy to private schools and assuming an equal cost of education for the children of natives and of immigrants. Relative changes in columns 1 and 2 are computed as the difference between the Euro amount in the two scenarios involved, divided by the Euro value in the benchmark (4,582 Euros).

Table 8: Counterfactual Experiments: Selective Immigration Policy

Horizon	Short run	Short run	Medium run	Medium run
Outcome	Public Share Natives	Quality Public[1]	Public Share Natives	Quality Public[1]
Units	%	Euros	%	Euros
Benchmark	64.67	4,582	62.54	4,230
All European	65.16	4,676	62.76	4,271
All African	64.16	4,489	61.67	4,091
All American	64.27	4,509	62.74	4,258
All Asian	64.24	4,504	63.52	4,384
Naturalization	no	no	yes	yes
Assimilation	no	no	no	no

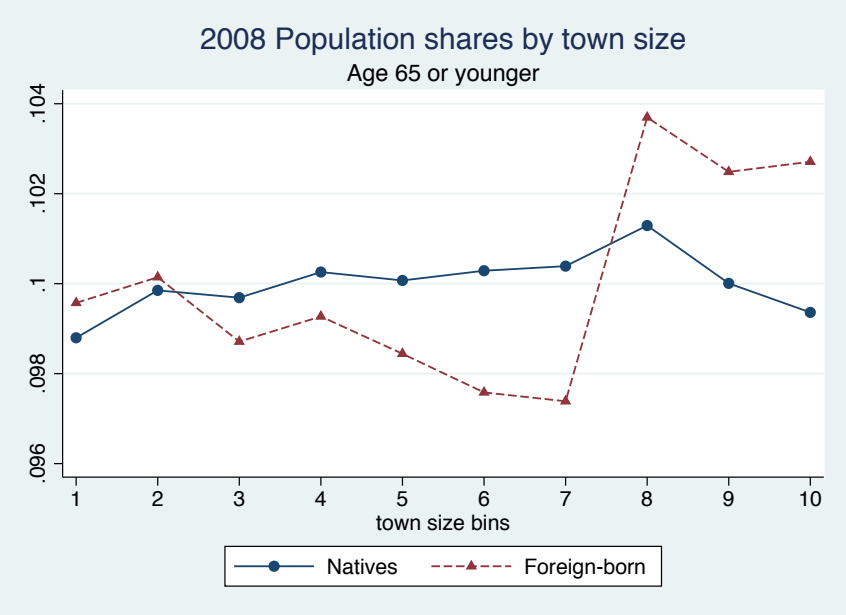
Notes: The short-run benchmark scenario is computed on the basis of the immigrant population and income distribution in year 2008, assuming immigrants cannot vote. The medium-run benchmark is the naturalization scenario, where immigrants vote but keep their characteristics fixed at their 2008 values. In all cases we focus on the main model, featuring the subsidy to private schools and assuming an equal cost of education for the children of natives and of immigrants. (1) Public spending per student is our measure of quality of public education.

Table 9: Immigrant Characteristics by Group

Group	Children[1]	Household Income[2]	Preference for education[3]	Rel. frequency Households[4]
Natives	0.35	1	0.52	0.87
All Foreign-born	0.46	0.92	0.23	0.13
All Europeans	0.37	0.93	0.16	0.05
All Africans	0.49	0.85	0.12	0.03
All American	0.52	0.94	0.21	0.05
All Asians	0.52	0.93	0.39	0.01

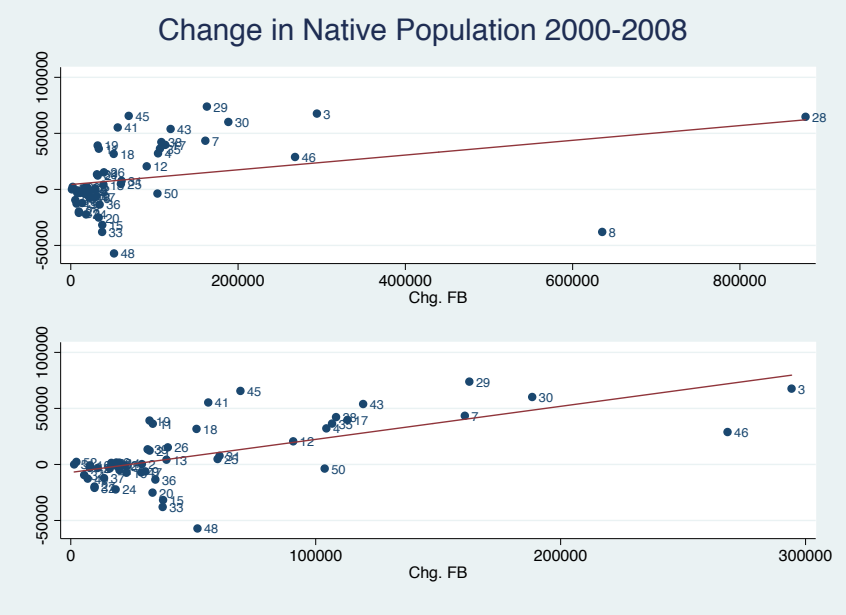
Notes: (1) Number of school-age children obtained from the Family Expenditure Survey (FES) survey. (2) Household income normalized by native household income. Data sources are the Family Expenditure Survey for year 2008 with adjusted number of household from the Spanish Labor Force Survey. (3) Refers to parameter γ in the utility function. The value for the foreign-born population as a whole is the weighted average of the four groups of immigrants, not the result of calibration. (4) The relative frequency of households by birth origin in year 2008 from the Labor Force Survey.

Figure 1: Distribution of native population and foreign-born population by size of municipality.



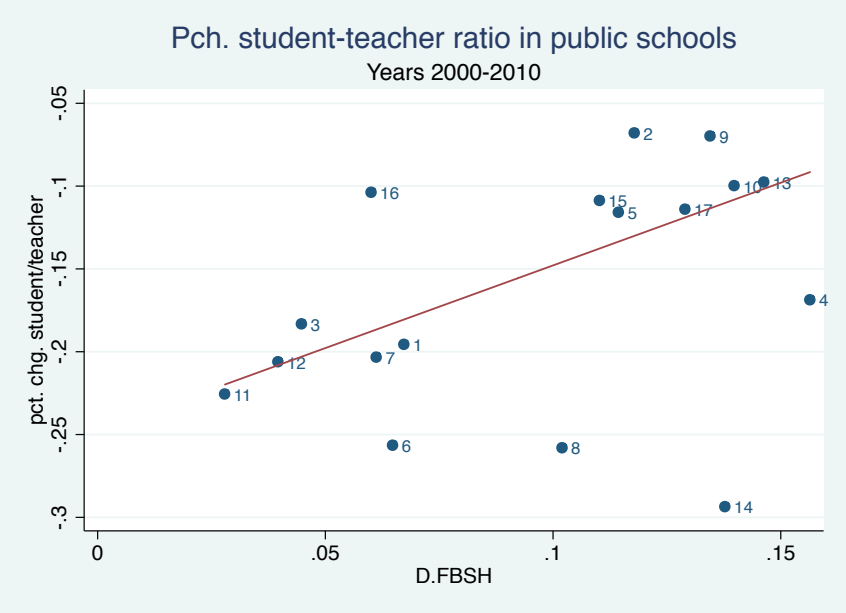
Notes: Data for year 2008 from the Population Registry. Municipality of residence is reported in 10 categories, ranging from smallest to largest: 1-100 inhabitants (bin 1), 101-200 inhabitants (bin 2), ..., 10,001-20,000 inhabitants (bin 9), and province capitals (bin 10). The latter range in population from 35,000 to 3 million.

Figure 2: Change in native and foreign-born populations across Spain's provinces



Notes: The top panel in the figure contains the 52 Spanish provinces. The bottom panel excludes the two provinces that attracted the largest numbers of immigrants (code 8 for Barcelona and 28 for Madrid). In the bottom panel the slope coefficient is 0.30, statistically significant at the usual significance levels.

Figure 3: Percentage change in the student-teacher ratio between 2000 and 2010 against the change in the foreign-born share in the region.



Notes: In linear regression fit each region is weighted by its year-2000 population. Next we list all regions (autonomous communities) and their numerical code: Andalucia (1), Aragon (2), Asturias (3), Balearic Islands (4), Canary Islands (5), Cantabria (6), Castilla Leon (7), Castilla La Mancha (8), Catalonia (9), Valencia (10), Extremadura (11), Galicia (12), Madrid (13), Murcia (14), Navarra (15), Basque Country (16), La Rioja (17).

Appendices

A Data appendix

In this appendix, we provide further detail on the data sources and the construction of our variables.

The number of households in each group (Labor force Survey), enrollment by type of school (Ministry of Education), the income distribution at the household level (Family Expenditure Survey and National Immigrant Survey), and public spending in education (Ministry of Education).

The Family Expenditure Survey (hereafter FES) contains income data but only identifies immigrant households from year 2006 onward. In addition, the level of disaggregation of the immigrant population is very limited. To overcome this limitation we also use the 2007 National Immigrant Survey to compute household income for each immigrant group. We provide more detail in Appendix B.

A.1 Household distribution

The distribution of households is estimated on the basis of the micro-data from the Spanish Labor Force Survey using the appropriate weights. We only include households headed by individuals age 65 or younger.

A.2 Income distribution

Our primary source of information for income distributions is the Family Expenditure Survey (FES). This survey reports monthly household income, which includes labor income, capital income, and government cash benefits. To produce an annual value we multiplied monthly income by 14 to take into account double the widespread double-pay in August and December. Prior to year 2006 the FES did not identify immigrant households. From 2006 onward it includes a variable reporting on the nationality of the household head. However, this variable provides very little disaggregation of the immigrant population. Thus we use the 2007 National Immigrant Survey (NIS) to compute the average and standard deviation of household income for each of our four immigrant groups (European, American, African and Asian) by the number of children in the household. Since it only surveyed the immigrant population, the NIS did not provide information on the native population. One additional difference between the two surveys is that the FES reports household income whereas the NIS reports the income of one individual chosen randomly in each household and thus does not always correspond to the household head. We make some adjustments to the NIS data to make it more consistent with the income data in the FES. The details of our imputation are reported in Appendix B.

A.3 The share of public and private school students

Our model is tailored to compulsory education. Thus it is natural to focus on enrollment in primary and secondary education. Specifically, our enrollment variables include the following education levels: preschool, elementary, compulsory secondary education (known as E.S.O. in Spanish), non-compulsory secondary education (both the so-called 'bachillerato' and occupational training i.e. 'formation profesional'), and special education. The enrollment data are provided by the Ministry of Education and made publicly available on their website.[60]

[60] http://www.mecd.gob.es/horizontales/estadisticas/no-universitaria.html. Specifically, the files referring to pre-university education studies, 'Alumnado. Regimen General'.

Breakdown of Foreign Student Population by Continent of Origin is available only for all school levels together (infantil, primary, secondary part1, secondary part2, bachillerato and FP). Disaggregation of the data by levels is not available in the Ministerio Tables. We know that primary+ESO accounted for 68.76 percent of the total enrollment of foreign students in 2008. Since breakdown by origins is unavailable, we use this information to map total enrollment of foreigners into total enrollment in primary+ESO. We are ignoring that this rate may apply differently to different immigrant groups.

Throughout our paper private schools refer to the sum of subsidized (concerted) private schools and non-subsidized private schools. The number of students in public schools for each group m in the column 1 of the Table 3 is estimated using the data of total number of children and the actual share of public school students for each group m. Specifically, the household distribution $h^t(n,m)$ and the total number of household provide the total number of children for each m, and the number of public school students is obtained from this total number of children multiplied by the actual share of public school enrollment for each m provided by provided by the Ministry of Education. This adjustment is important to make it consistent with the overall number of children implied by our household distribution and the share of public (and private) school students in the model.

A.4 Education expenditure

The information on public spending in education is obtained from the Statistics on Public Education Expenditure produced by the Ministry of Education. We report spending for the pre-university education levels: preschool, elementary, compulsory secondary education (known as E.S.O. in Spanish), non-compulsory secondary education (both the so-called 'bachillerato' and occupational training i.e. 'formation profesional'), and special education.

B Imputation of income distributions

For our calibration and simulation exercises we need to obtain income distributions for each population group ($m = 0$ for natives, 1 for European immigrants, 2 for African immigrants, 3 for American immigrants, and 4 for immigrants from Asia and Oceania.

We firstly calculate the mean and the coefficient of variation of household income, conditional on number of children and on immigration status from NIS. Secondly we calculate the average income for immigrants from the FES. This is the average income of all immigrants, so we want to disaggregate it for each immigration status (i.e., $m = 1, 2, 3$, and 4).[61] Note that there is the following relationship between the average income from the FES and the mean income from the NIS:

$$\bar{y}_{imm} = \frac{1}{h_1 + h_2 + h_3 + h_4} \sum_{m=1}^{4} h_m \bar{y}_m \tag{13}$$

where $\bar{y}_{imm}$ is the average income of all immigrants calculated from the FES, h_m is the number of households with immigration status m, and $\bar{y}_m$ is the average income of type m households calculated from the NIS.

However, we suspect that our measure of household income based on the NIS is an underestimate. Hence we estimate the mean income consistent with the relative income among the four types of immigrants as follows. Let $\hat{y}_m$ denote the estimate of mean household income of immigrants with type m. We impose a condition that $\hat{y}_m$ relative to any other mean income is consistent with the relative mean income from the NIS:

$$\frac{\hat{y}_m}{\hat{y}_n} = \frac{\bar{y}_m}{\hat{y}_n} \tag{14}$$

[61] Income distribution for natives can be calculated directly from the FES.

for all m and n. Without loss of generality, set $n = 1$. Replacing $\bar{y}_m$ with $\hat{y}_m$ in this equation, we obtain the following expression:

$$\bar{y}_{imm} = \frac{1}{h_1 + h_2 + h_3 + h_4} \sum_{m=1}^{4} h_m \hat{y}_m = \frac{1}{h_1 + h_2 + h_3 + h_4} \sum_{m=1}^{4} \left(h_m \frac{\bar{y}_m}{\bar{y}_1} \right) \hat{y}_1. \tag{15}$$

Hence we obtain

$$\hat{y}_1 = \bar{y}_{imm} \left(\frac{1}{h_1 + h_2 + h_3 + h_4} \sum_{m=1}^{4} \left(h_m \frac{\bar{y}_m}{\bar{y}_1} \right) \right)^{-1}, \tag{16}$$

$$\hat{y}_m = \frac{\bar{y}_m}{\bar{y}_1} \hat{y}_1 \tag{17}$$

for $m = 1, 2, 3, 4$. These estimates of mean income for each m generate weighted mean income consistent with that from the FES.

The standard deviation of household income for each m is estimated using the coefficient of variation. Let $\hat{\sigma}_m$ denote an estimate of standard deviation of household income with type m. We obtain this estimate by:

$$\hat{\sigma}_m = cv_m \hat{y}_m \tag{18}$$

for $m = 1, 2, 3, 4$ where cv_m is the coefficient of variation for type m calculated from the NIS.

We impute income distributions for each region using the same method described above. In the imputation of regional income distribution, we allow regional variation of average household income for natives and immigrants, but we impose the two conditions that the coefficient of variations are same for all regions, and that relative mean income among immigration status is constant across regions.

B.1 Alternative measure of spending per student in public schools

In our tables we report the 'actual' public education spending per student (for pre-university education, that is, pre-school, elementary, secondary and special education). This is the overall public spending in pre-university education (including the subsidy to concerted schools) over the enrollment in public schools plus the enrollment in concerted schools. Note that the denominator includes all students that receive public financing, either directly because they attend public schools or indirectly through the subsidy received by their private schools.

Alternatively, we can report the actual spending per student in public schools, where the numerator includes only spending directly used to finance public schools (thus excluding the subsidy to private schools) and the denominator is the enrollment in public schools. This figure is always larger because the data shows that the subsidy per student is lower than the spending per student in public schools. The table below summarizes these variables for year 2008.

Table B.1: Public spending per student. Pre-university levels.

Year 2008 (pre-uni.)	Overall	Public schools	Concerted
Public spending (10^9 of euros)	31.13	25.71	5.42
Enrollment (10^6 students)	6.95	5.01	1.95
Public spending / Enrollment (euros)	4,475	5,133	2,783

Notes: *Sistema Estatal de Indicadores de la Educacion*, 2012, and Enrollment general regime data. Pre-university education includes pre-school, elementary, secondary, and special education.