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July 3, 2009

Abstract

The evolution of education spending in California has received much attention from both academics and practitioners after education finance reform in the 1970's. This paper quantifies the contribution of immigration to the relative decline in elementary and secondary public education spending per student in California between 1970 and 2000. A quantitative model of school choice and voting over public education is used to perform the counterfactual experiment. The model predicts that education spending per student in California would have been 24 percent higher than in reality in the year 2000 if U.S. immigration had been restricted to its 1970 level.

Keywords: Immigration, Public Education, Private Education, Education Finance Reform, California.

JEL Classification: D7, F22, H52, H75, I22.

1 Introduction

In this paper I study the impact of immigration on spending on elementary and secondary public education in California over the period 1970–2000. In doing so the paper contributes to the debate on two important issues that have attracted much attention from policy makers and academics alike. The first debate concerns the effects of immigration on the well-being and economic outcomes of natives. While the literature has focused on the labor market impact of immigrants, less attention has been devoted to the interaction between immigrants and natives that occurs through government spending and taxes.[1] In particular, spending on public education is one of the most important items on the budget of state and local governments. The second debate concerns the significant decline in public education spending per student that occurred in California - the main immigrant-receiving state in the U.S. - relative to the rest of the country since the early 1970's. While the economics literature has emphasized the role played by education finance reform from a foundation system to a state system, little attention has been paid to the underlying demographic trends over this period.[2] According to the U.S. Census, school-age children from households whose head had immigrated to the U.S. after 1970 accounted for about 40 percent of California's total enrollment in elementary and secondary school in 2000 relative to 8 percent in 1970. The corresponding figure for the rest of the U.S. in 2000 was 13 percent. In all Census years, California households whose head had immigrated to the U.S. after 1970 had, on average, more school-age children than native households, and more than twice as many in 1990 and 2000. Immigrant-headed households accounted for about 30 percent of all households in California in 2000, while the corresponding figure for the rest of the U.S. was only 8 percent.[3]

[1] See Borjas (2003) and Ottaviano and Peri (2008) for different views on the effect of immigration on the wages of native workers. Borjas (1999) reviews the literature on immigration, and Borjas (1994) contains a review of the literature on the fiscal aspects of immigration.

[2] See Silva and Sonstelie (1995) and Fernandez and Rogerson (1999) for analysis of education finance reform in California.

[3] In the rest of the paper I refer to an "immigrant-headed" or simply "immigrant" household as a household headed by an immigrant who immigrated to the U.S. after 1970 and to a "native-headed" or simply "native" household as a household headed by either a native or a pre-1970 immigrant. According to the 2000 Census, each immigrant-headed household in California had on average 1 school-age child while a native household

The paper develops a quantitative political-economy model of education spending to answer the following counterfactual question: "what would have been the level of education spending per student in California in 1980–2000 if U.S. immigration had been restricted to its 1970 level?" The main result is that immigration has played a quantitatively important role in the decline in education spending per student. Specifically, I find that in the academic year 1999–2000 education spending per student in California was about $1,459 (in 1999 dollars) lower than it would have been if U.S. immigration had been restricted to its 1970 level. This represents about 24 percent of actual education spending per student in California in 2000. For sake of comparison, education finance reform is estimated to have reduced education spending per student in California by 10–15 percent (Fernandez and Rogerson, 1999 and Hoxby, 2001).

In order to answer the counterfactual question above, I employ a political-economy model where California households who are U.S. citizens vote over expenditures on public education in a state-wide voting round. The latter setting is consistent with the institutional setup of education finance in California where since the early 1980's current spending for elementary and secondary public education has been largely equalized across students and spending decisions are centralized at the state-level.[4] In the model, households are assumed to be heterogeneous with respect to their income, number of school-age children, immigration status, citizenship status, and the weight they attach to education relative to consumption in their utility function. Households with school-age children choose between private and public education.

had 0.45 school-age children. Out of native households only 26 percent had school-age children in 2000, against 52 percent among immigrant-headed households. Conditional on having at least a school-age child, immigrant-headed households had on average 1.93 school-age children against 1.70 among native households. The fertility differential between natives and immigrants is partly due to demographic differences such as age between the two populations. The argument in the paper does not hinge on the specific reason for the observed difference in fertility.

[4] See Sonstelie et al. (2000) for a thorough account of education finance reform in California. As discussed by these authors there are components of education spending such as categorical aid that, although determined at the state level, are not by their nature equalized across students. Thus, more precisely equalization refers to regular per pupil spending, which represents 70–75 percent of education spending. In the rest of the paper I ignore this distinction.

The model's parameters are calibrated using micro data from the 1980 U.S. Census and data on public education spending from the National Center for Education Statistics (NCES). The model accounts well for the evolution of education spending in California in the subsequent Census years 1990 and 2000. The model is then used to compute counterfactual tax rates and private school enrollment rates for 1980, 1990, and 2000 by excluding from the economy households whose head immigrated to the U.S. after 1970. The model predicts increasingly higher levels of spending per student from 1980 to 2000 in the counterfactual economy, culminating with the gain of about $1,459 per student cited above. The estimated preferences are also used to compute the cost of immigration for native households, expressed as an equivalent variation. The estimated costs are about 60 percent larger than those obtained by keeping the level of education spending per capita constant in the economy with restricted immigration and simply reducing the tax burden on native households. The latter approach is commonly used in computing the fiscal cost of immigration (e.g. National Research Council, 1997).

As already mentioned above, this paper is related to both the literature on the fiscal impact of immigration and the literature on education finance reform. The former line of research takes an "accounting" perspective by computing the fiscal costs and benefits of immigration given the existing system of transfers, government spending, and taxes (see Borjas and Hilton, 1996, Clune, 1998 and Garvey and Espenshade, 1998). As argued by the National Research Council (1997 page 259) panel: "The assumption of exogenous fiscal policies provides useful short-term estimates for state and local government effects. Future work in this area could examine how much immigration affects fiscal policies ... and incorporate such endogenous effects into the modeling exercise." This paper represents a first step in this direction.[5]

[5] An exception is Dottori and Shen (2009) who model the impact of low-skill immigration on public education spending. In their model, as in mine, low-skill immigration reduces the average tax base from which public schools are founded and leads to lower support for public education and increased private school attendance by high-income natives. Differently from their theoretical paper I use the model to quantitatively assess these channels.

While the relationship between immigration and spending on public education in California has been largely ignored in the academic literature, some political commentators have emphasized this point before.[6] For example, Peter Schrag (1998, page 277) writes in his book *Paradise Lost* that "...the new California economy sits atop such a large immigrant population...whose presence, at least in the short run, not only depresses wage scales at the lower end but reduces the incentive to provide infrastructure and public services that would probably have been offered as a matter of course to groups considered genuinely "American"." One of the themes of Schrag's book is that the relative drop in spending per student in California is due to the lack of political representation of immigrants that, due to their lower incomes and higher number of children, would be the primary beneficiaries of additional spending on public education. My analysis confirms that increasing the political weight of immigrants by allowing them to vote in the political-economy model results in higher equilibrium spending per student. However, this effect is quantitatively small.

California represents the most prominent example of an education finance reform that shifted education funding from the local to the state level. This shift, which began in 1971 with the first *Serrano* ruling, led to the near-equalization of education spending per student by the early 1980.[7] Silva and Sonstelie (1995), Fernandez and Rogerson (1999), Sonstelie et al. (2000), and Hoxby (2001) point to this reform as the main reason for the observed decline in education spending per pupil in California in the 1980's and early 1990's. Murray et al. (1998), instead, estimate a positive effect of education finance reform on average spending per pupil using panel data on U.S. states. By focusing on the post-1980 period this paper eschews this debate. Instead, it argues that by the year 2000 immigration had become a

[6] Silva and Sonstelie (1995) do consider enrollment growth as a possible reason for the decline in public education spending per student in the 1980's. However, they restrict themselves to a model in which all households have the same number of children. Thus, in their model, the tax price of education spending does not change in response to an inflow of households.

[7] When the *Serrano* plaintiffs returned to court in 1983, the judge wrote, rejecting their case, that "It is this court's view that the proper standard for testing compliance with the judgement is whether the Legislature has done all that is reasonably feasible to reduce disparities in per-pupil expenditures to insignificant differences. As is discussed, the state has met this standard and surpassed it." (cited by Sonstelie et al., 2000, page 55).

more important factor in accounting for the drop in spending per student in California.

The quantitative results of this paper are consistent with the empirical evidence in Poterba (1997) and Fernandez and Rogerson (2001). Using panel data on U.S. states these authors show that for given level of aggregate income, and controlling for state fixed-effects, the elasticity of education spending per student with respect to changes in the number of students enrolled in school is equal to about -1. Differently from this exclusively empirical work, I endogenize the choice of education spending and school choice and I focus on a specific demographic shock - immigration. The advantage of the structural model adopted here is that it can be used to evaluate the roles of immigrants' political power and of private school choice in performing the counterfactual experiments of interest.

The rest of the paper is organized as follows. Section 2 presents the basic trends about education spending in California and the rest of the U.S. Section 3 describes the model economy. Section 4 discusses the calibration of the model's parameters. Section 5 performs the counterfactual exercise, while Section 6 uses the model to compute the fiscal cost of immigration. Section 7 considers a number of extensions of the basic framework of Sections 3–5. Last, Section 8 concludes. A description of the data is contained in the Appendix.

2 Empirical Evidence

2.1 The Evolution of Spending per Pupil over Time

The key variable of interest in this study is current education spending per student enrolled in public elementary and secondary school in California.[8] In this section I consider the evolution of this variable over time in California relative to the rest of the U.S. and analyze its components. To fix ideas, it is convenient to denote aggregate nominal spending for public elementary and secondary education in location k at time t by E_k^t, where the index

[8] The NCES defines current expenditures as "The expenditures for operating local public schools, excluding capital outlay and interest on school debt. These expenditures include such items as salaries for school personnel, fixed charges, student transportation, school books and materials, and energy costs."

k equals CA (California) or US$^-$ (the U.S. excluding California). Let H_k^t denote the total number of households in k at time t, and let N_k^t stand for enrollment in public schools. Last, Y_k^t is a measure of total nominal income in k at time t.

By definition, log spending per student in CA relative to the rest of the US at time t can be decomposed in the following way:

$$\log \frac{E_{CA}^t/N_{CA}^t}{E_{US^-}^t/N_{US^-}^t} = \log \frac{E_{CA}^t/Y_{CA}^t}{E_{US^-}^t/Y_{US^-}^t} + \log \frac{Y_{CA}^t/H_{CA}^t}{Y_{US^-}^t/H_{US^-}^t} + \log \frac{H_{CA}^t/N_{CA}^t}{H_{US^-}^t/N_{US^-}^t}, \tag{1}$$

or, in words, as the sum of log relative education spending per unit of income, log relative income per household, and log relative number of households per student enrolled in public schools. I analyze the evolution of these variables starting from a given point in time, the school year 1969–70.[9] This initial date works well because the resurgence of large-scale immigration to the U.S. dates back to the *Immigration and Nationality Act Amendments* of 1965 which facilitated immigration for family unification purposes. Also, the major education reform that equalized spending per student in California occurred in the 1970's. Table 1 represents the *levels* of the main statistics about education spending, household income, and school enrollment in the different Census years for California and the rest of the U.S. Taking the difference between equation (1) in year t and its equivalent in 1970 provides the basis for the analysis of the determinants of the evolution of spending per student in California relative to the rest of the U.S. and relative to the year 1970. I implement this decomposition empirically using both yearly data for the period 1970–2005 (Figure 1) and decennial data for the period 1970–2000 (Figure 2).[10] According to both figures California's relative spending per student declines by more than 20 percent between 1970 and 2005, reaching a low point in the mid-1990's. These figures also suggest that this drop cannot be accounted for by a decline in the fraction of income spent on public education in California relative to the rest

[9] As a convention, in what follows I refer to the school year 1969-70 as 1970.

[10] This approach implicitly assumes that cost of living differentials between California and the rest of the U.S. are constant. If the price level has increased faster in California than in the rest of the U.S. then real education spending per student in California has declined faster than in Figures 1 and 2. The same adjustment would have to be made to average household income.

of the U.S.[11] The reason why per student spending exhibits such a large decline, instead, is mainly the increase in the student to household ratio in California relative to the rest of the U.S. For example, in 1970 there were 1.40 and 1.35 households in California and in the rest of the U.S., respectively, for each student enrolled in public school. In 2005, there were 2.34 households per student in the rest of the U.S., but only 1.97 in California. Notice how the cumulative change in the relative ratio E/N between 1970 and 2005 is almost identical to the cumulative trend followed by the relative ratio H/N.

Note that the demographic shift that led to lower relative H/N ratios in California in 2005 did not start until about 1980. Figure 1 also shows how the ratio of education spending to income declined quickly in California between the mid-1970's and the early 1980's, remaining constant until the mid 1990's and then exhibiting an upward trend. Figure 2, which uses data from the U.S. Census to compute the income measure shows a further decline in spending relative to income for California until 1990. However, this decline is simply the counterpart of faster growth in income per household in the 1980's in California than in the rest of the U.S. as recorded by the Census, suggesting that education spending per household was actually fairly constant during the 1980's also according to the Census data (see footnote 11). It is fair to interpret these trends as suggesting that the effect of the *Serrano* ruling on education spending relative to income emphasized by Fernandez and Rogerson (1999) had already fully taken place by the early 1980's.[12]

How did the relative decline in education spending affect the education sector in California? Data on pupil-teacher ratios show a dramatic increase in average class size in California relative to the rest of the U.S. during the 1980's and up to the early 1990's when this figure stabilizes. Schrag (1998, page 15) describes informally some of the consequences of the

[11] According to Figure 1, in 2005 California was spending almost the same fraction of its income on public education relative to the rest of the U.S. as in 1970. Figure 2 instead shows a small decline in this indicator. However, the reason for this decline is the fact that relative income per household in California grew faster according to the U.S. Census measure of income than according to the CPS measure of income. In fact, when considering education spending *per household*, as opposed to *per student* enrolled, California does not seem to gain or lose relative to the rest of the U.S. between 1970 and 2005.

[12] Interestingly, during the period under consideration California did not experience a relative reduction in non-education spending per capita by state and local governments (Sonstelie et al., 2000, Figure 5.6).

relative decline in spending: "the unmaintained buildings with leaking roofs, falling ceiling tiles, and unusable toilets; the layoffs of school counselors, librarians and nurses; and the reductions in course offerings in everything from art to zoology. Writer Jonathan Kozol found rotting school facilities in the inner cities; California has them in the suburbs as well."[13]

2.2 Immigration

In this section I present results from a simple statistical counterfactual exercise in order to begin assessing the role played by immigration in generating the trends in Figures 1 and 2. Specifically, I generate a new series for the logarithm of relative (California vs the rest of the U.S.) spending per capita in public education replacing the term H_k^t/N_k^t in equation (1) with the ratio of the number of households headed by a U.S. native individual to the number of children living in such households and enrolled in elementary and secondary public schools.[14] Figure 3 reports the actual data series (solid line) of relative spending in public education per school-age child and the corresponding counterfactual series (dashed line). As the figure shows, relative education spending per student in California would have been about the same in 2000 as it was in 1970 if the ratio of households per public-school student in California had been equal to the value computed for native households only.

3 Model

In this section I introduce a simple political-economy model of spending on public education and household choice of public vs private education.[15] The model is then calibrated

[13] The available empirical evidence on educational outcomes in California also suggests a decline. A study by the Rand Corporation (Carroll et al., 2005) shows that California students taking national achievement tests in the period 1990–2003 scored worse than students from all other U.S. states except Louisiana and Mississippi. These relatively poor results could not be explained by students' family characteristics. Sonstelie et al. (2000) show that California's students performed better than average in earlier - although different - standardized tests administered between 1972 and 1980.

[14] Recall that "native households" also include households headed by a foreign-born individual who migrated to the U.S. before 1970. See footnote 3.

[15] I allow for a private school option because the latter provides a channel through which native households might react to the decline in education spending associated with immigration (Betts and Fairlie, 2003).

to the data and used to interpret the trends in public education spending per student.

The economy (California) is populated by a measure one of households with preferences defined over a composite private good different from education, denoted by c for consumption, per-student spending on public education, denoted by e, and per child spending on private education, z. A household cannot consume both public and private education. Define an indicator variable $I(z) = 1$ if $z > 0$ and $I(z) = 0$ if $z = 0$. A household's utility function takes the following form:[16]

$$u(c, e, z, n, \lambda) = \frac{c^{\alpha}}{\alpha} + \begin{cases} \gamma\lambda e^{\alpha}/\alpha + \lambda\left(\left(1 - I\left(z\right)\right) e^{\alpha}/\alpha + I\left(z\right) z^{\alpha}/\alpha\right) \text{ if } n > 0 \\ \gamma\lambda e^{\alpha}/\alpha \text{ if } n = 0 \end{cases} \tag{2}$$

where n denotes the household's number of school-age children and $\alpha < 1$, γ, and λ are parameters. The functional form in equation (2) represents a generalization of the one adopted by Fernandez and Rogerson (1999, 2003) along three dimensions. First, I allow households with children to choose between private and public education. Second, there is unobserved heterogeneity about the intensity of preferences for education among households. The latter is captured by the household-specific parameter $\lambda \in (0, \infty)$. Last, the utility function differs from the one adopted by Fernandez and Rogerson, because the preference for public education depends on whether a household has or does not have school-age children. All households, including those without school-age children and those with children in private school are assumed to place a positive weight on public education spending per student. The size of this weight is represented by the constant γ multiplied by the household-specific parameter λ. The positive weight on education by all households can be thought of as

Census data shows that native households' private school enrollment rates in California *relative* to the rest of the U.S. increased significantly in the 1970's, and much less in the 1980's. Since 1990, private school enrollment rates for native households have stayed constant or slightly declined. Downes and Schoeman (1998) attribute the significant increase in private school enrollment in California during the 1970's to education finance reform.

[16] This class of preferences exhibits a unit elasticity of education spending relative to income. This is consistent with the empirical evidence in Fernandez and Rogerson (2001). In assuming that households care about public education spending per student, I am implicitly postulating a constant returns to scale technology in the provision of education, in which marginal and average production costs coincide.

reflecting the external effects associated with a more educated population such as lower crime, productivity spillovers, a more educated electorate, etc. (e.g., Lochner and Moretti, 2004).[17] In practice, this assumption is needed in order to generate some positive provision of public education in the majority-voting equilibrium of the model: according to the Census data, in any given year, about 70 percent of households have no children enrolled in primary or secondary school, both in California and in the rest of the U.S.[18]

Spending on public education is financed through a linear tax s on household income y. Spending on public education equals tax revenue per child attending public schools:

$$e = \frac{s\overline{y}}{\overline{n}_p}, \tag{3}$$

where $\overline{y}$ denotes average household income in the economy and $\overline{n}_p$ is the average number of children attending public school per household. Equation (3) assumes that the income of all households is taxed at the same rate s. In particular, the model abstracts from issues of tax evasion and illegal immigration for lack of reliable data. Note, however, that the explicit consideration of tax evasion is likely to generate larger declines in education spending associated with immigration than the numbers reported in this paper.

A household with children can also opt for private education (Epple and Romano, 1996). Thus, a household's consumption is equal to its after-tax income minus any spending on private education:

$$c = y(1-s) - nzI(z).$$

[17] Capitalization of education spending in property values is an often-cited reason for why households without school-age children support public education spending. This argument is less suitable to the case of California, though, where per student spending is equalized across school districts. The assumption that the external effect in equation (2) depends only on public education spending, as opposed to the sum of public and private spending is innocuous for the results of the paper.

[18] In the local public finance literature on education spending (see Epple and Nechyba, 2004 for a review) all households are assumed to have one child enrolled in school. This assumption is obviously less appropriate to study the consequences of immigration by households with a large number of children relative to native households. Poterba (1997) has shown how support for public education is lower in U.S. states with a higher percentage of population over 65 years old. Bergstrom et al. (1982) document, using survey data, that individuals with school-age children prefer significantly higher levels of school expenditures per student.

In case the household opts for private education, its indirect utility is defined as:

$$V\left(y\left(1-s\right),n,e,\lambda\right)\equiv\max_{z}\left\{u(y(1-s)-nz,e,z,n,\lambda)\right\}.$$

Conditional on opting for private education, the optimal amount of private education chosen by a household is given by:

$$z=\frac{(1-s)y}{n+(n/\lambda)^{\frac{1}{1-\alpha}}}. \tag{4}$$

Notice that the per-child optimal investment in private education is increasing in the household's after-tax income and in its idiosyncratic preference for education, and decreasing in the number of children. A household that chooses public over private education ($z=0$) receives utility:

$$U\left(y\left(1-s\right),n,e,\lambda\right)\equiv u(y(1-s),e,0,n,\lambda),$$

where the dependence of U on n is due to the fact that households with school-age children value public education differently from households without children. Of course, a household will choose public over private school if and only if:

$$U\left(y\left(1-s\right),n,e,\lambda\right)\geq V\left(y\left(1-s\right),n,e,\lambda\right).$$

Denote by $\widehat{y}$ the level of income at which a household with n children is indifferent between private and public schools:

$$\widehat{y}\left(n,s,e,\lambda\right)=\frac{e}{1-s}\left[\frac{\lambda}{\left(\lambda^{\frac{1}{1-\alpha}}n^{-\frac{\alpha}{1-\alpha}}+1\right)^{1-\alpha}-1}\right]^{\frac{1}{\alpha}}. \tag{5}$$

The income cut-off for attending private school increases with the level of public education spending per student, the tax rate, and the household's number of children. The private

school cut-off is lower for households with larger idiosyncratic preference for education.

In addition to the vector of characteristics (y, n, λ), households differ in two other dimensions. First, I distinguish between households headed by a citizen ($x = 1$) and households headed by a non-citizen ($x = 0$). Citizenship allows a household to vote for spending on public education, but does not directly affect any other aspect of its preferences or budget constraint. Second, in order to conduct counterfactual experiments, I distinguish between native and pre-1970 immigrant households ($m = 1$) on the one hand and post-1970 immigrant households ($m = 0$) on the other. Let $f(y, n, x, m, \lambda)$ denote the joint density of income, number of children, citizenship, immigration status, and the parameter λ in the population of households. For given s and e, the per household measure of children attending public school is then given by:

$$\overline{n}_p = \sum_{n,x,m} \int_0^{\infty} \int_0^{\widehat{y}(n,s,e,\lambda)} n \times f(y, n, x, m, \lambda) dy d\lambda. \tag{6}$$

The tax rate s is assumed to be determined by majority voting by households headed by a U.S. citizen.[19] In what follows I focus on a majority-voting equilibrium in which, when voting, households take as given their own choice of school as well as the choice of all other households. This guarantees that household preferences are single-peaked over tax rates. Formally, a majority-voting equilibrium is comprised of a tax rate s^*, a level of public school spending per student, e^*, private school spending $z^*(y, n, \lambda)$, and a measure of students attending public school $\overline{n}_p^*$, such that: 1. Private school spending per student, $z^*(y, n, \lambda)$ is given by equation (4) if $y > \widehat{y}(n, s^*, e^*, \lambda)$ and zero else; 2. The government's budget constraint, equation (3), is satisfied; 3. Public school attendance $\overline{n}_p^*$ is given by equation (6); 4. The equilibrium tax rate and level of spending (s^*, e^*) are preferred by at least 50 percent of the citizen-voters to any alternative $(\widehat{s}, \widehat{e})$ such that $\widehat{e} = \widehat{s}\overline{y}/\overline{n}_p^*$. The majority-

[19] In reality the amount of education spending in California is determined by the interaction of the legislature and the governor. Education spending represents one dimension of the overall budget process. While more sophisticated modelling of the legislative process might be feasible, here I adopt the median voter approach to aggregation of policy preferences to keep comparability with the previous literature which uses the same framework (e.g. Fernandez and Rogerson, 1999).

voting equilibrium tax rate s^* is the median tax rate when *citizen* households' preferred rates are sorted from lowest to highest.[20]

It is straightforward to show that, at a majority-voting equilibrium, the preferred tax rate by a household takes the general form:

$$s\left(y, n, \lambda; s^*, e^*, \overline{n}_p^*\right) = \frac{1}{1 + \Psi\left(y, n, \lambda; s^*, e^*\right)\left(\overline{n}_p^* y / \overline{y}\right)^{\frac{\alpha}{1-\alpha}}} \tag{7}$$

with:

$$\Psi\left(y, n, \lambda; s^*, e^*\right) \equiv \begin{cases} \left[(1+\gamma)\lambda\right]^{\frac{1}{\alpha-1}} \text{ if } n > 0 \text{ and } y \leq \widehat{y}\left(n, s^*, e^*, \lambda\right) \\ \left(1 + \lambda^{\frac{1}{1-\alpha}} n^{-\frac{\alpha}{1-\alpha}}\right)(\gamma\lambda)^{\frac{1}{\alpha-1}} \text{ if } n > 0 \text{ and } y > \widehat{y}\left(n, s^*, e^*, \lambda\right) \\ (\gamma\lambda)^{\frac{1}{\alpha-1}} \text{ if } n = 0 \end{cases}$$

Everything else equal, the tax rate preferred by households with children in private school is smaller than the tax rate preferred by households without children, which, in turn, is smaller than the tax rate preferred by households with children in public school. The term $\overline{n}_p^* y / \overline{y}$ in equation (7) is the tax price of spending per student for a household with income y. It represents the amount by which this household's taxes would increase for a unit increase in e. The effect of a change in the tax price on a household's preferred tax rate is governed by the sign of the parameter α. Specifically, in the borderline case in which $\alpha = 0$ (log utility), the preferred tax is independent of the tax price, while if $\alpha < 0$, as will be assumed in the empirical section of the paper, a higher tax price increases the household's preferred tax rate.[21]

[20] As it is well-known, in this class of models the existence of a private alternative opens the door to multiplicity or non-existence of an equilibrium. None of these two problems emerged in the numerical analysis of the model.

[21] The sign of the parameter α determines whether the substitution or income effect of higher income y prevails. Since education is a normal good, a household would like to purchase more of it as its income increases. However, its tax price also increases with y, generating a substitution effect in the opposite direction. The former effect prevails if the parameter α is negative.

4 Empirical Implementation

The model is calibrated to the beginning of the post-education reform period in California, around 1980. To calibrate the economy I need to specify the values of the two preference parameters α and γ that are common to all households in the population and constant over time, and the joint density $f(y, n, x, m, \lambda)$ for each Census year.

The parameter α determines the tax price elasticity of the demand for education for the median voter through the following equation:

$$\text{median voter's tax price elasticity} = -\left(\frac{1-\alpha s^*}{1-\alpha}\right).$$

Lower values of α are associated with a more price-inelastic demand. Here I adopt the value of α preferred by Fernandez and Rogerson (1999) in their study of education finance reform in California. Their preferred value, $\alpha = -0.25$, is such that their model generates the best fit for the observed distribution of spending per student across students in California before education finance reform. The implied tax price elasticity of education is about -0.81. This value is a bit higher in absolute value than the range $(-0.25, -0.5)$ reported by Bergstrom et al. (1982) in their survey of the literature. In Section 7, I re-calibrate the model assuming that $\alpha = -1$, with an associated price elasticity of -0.52. It turns out that the benchmark version of the model accounts better for the evolution of education spending in California in 1990 and 2000 than the version with a more price-inelastic demand.

To calibrate the density $f(y, n, x, m, \lambda)$, write the latter as:

$$f(y, n, x, m, \lambda) = f(y, \lambda | n, x, m) h(n, x, m), \tag{8}$$

where $h(n, x, m)$ is the joint density of (n, x, m). The conditional density of (y, λ) is assumed

to take the following bivariate lognormal form:

$$f(y,\lambda|n,x,m) = \frac{1}{2\pi\sigma_y(n,x,m)\,\sigma_\lambda\sqrt{1-\rho^2}y\lambda}\times$$
$$\exp\left\{-\frac{1}{2(1-\rho^2)}\left[\left(\frac{\log y-\mu_y(n,x,m)}{\sigma_y(n,x,m)}\right)^2-2\rho\frac{\left(\log y-\mu_y(n,x,m)\right)(\log\lambda-\mu_\lambda)}{\sigma_y(n,x,m)\,\sigma_\lambda}+\left(\frac{\log\lambda-\mu_\lambda}{\sigma_\lambda}\right)^2\right]\right\}.$$

Notice that the parameters σ_y and μ_y are a function of n, x, and m, while the preference parameters $\sigma_\lambda, \mu_\lambda$, and ρ are not. The parameters σ_y and μ_y are estimated by matching the conditional mean ($E[y|n,x,m]$) and variance ($V[y|n,x,m]$) of household income in the population:

$$\mu_y(n,x,m) = \ln E[y|n,x,m] - \frac{1}{2}\ln\left[1+\left(\frac{V[y|n,x,m]}{E[y|n,x,m]^2}\right)\right], \tag{9}$$

$$\sigma_y(n,x,m) = \left\{\ln\left[1+\left(\frac{V[y|n,x,m]}{E[y|n,x,m]^2}\right)\right]\right\}^{\frac{1}{2}}. \tag{10}$$

Citizenship (x) and immigration status (m) take two possible values each, while a household's number of children (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.

I calibrate the remaining three parameters ($\sigma_\lambda, \mu_\lambda, \rho$) to match three key moments in the data (Table 3). First, since a lower average level of λ implies higher public school attendance (see equation 5), it is natural to set the parameter μ_λ to match the per household number of children in public school in 1980. The parameter ρ determines the degree to which preferences for education spending and income are correlated across households. For example, if $\rho < 0$, households with relatively low income tend to have higher values of λ and are therefore more likely to have children attending private school than their income level alone would predict. In practice, I set ρ to match the ratio between the average incomes of households with children in public and private schools in 1980. The parameter σ_λ determines the dispersion of λ in the population. Higher values of σ_λ are associated with more dispersion in household

income within private or public schools. This parameter is set to match the coefficient of variation of income across households with children in public schools in 1980. Finally, the density $h(n, x, m)$ is estimated non-parametrically using the frequency count of each cell (n, x, m).

Note that the parameters of the density $f(y, n, x, m, \lambda)$ can be calibrated independently of the value of the parameter γ because the choice of school does not depend on γ. Higher values of γ are associated with higher preferred tax rates by all households. This, in turn, translates into majority-voting equilibria characterized by higher spending on public education. It is then possible to pin down the value of γ at which the median voter chooses to spend exactly 4.94 percent of its income on public education in 1980 ($s^* = 0.0494$, Table 1).

Table 2 reports the calibrated values of the parameters. Notice that the calibrated value of ρ is negative to rationalize the fact that relatively poor households are observed attending private school in the data.[22] Also, notice that the calibrated value of the parameter γ is smaller than one, which is consistent with the idea that, everything else equal, households without school-age children care less about public education spending than households with school-age children.

The calibrated model can be used to predict the income share of spending in education, enrollment in public schools, and other moments of interest for the Census years 1990 and 2000. In using the model to predict outcomes for 1990 and 2000, I use the same parameters $(\alpha, \gamma, \sigma_\lambda, \mu_\lambda, \rho)$ from Table 2, and re-calibrate the conditional density $f(y, \lambda | n, x, m)$ for 1990 and 2000 along the lines described above for 1980.

Table 3 summarizes the moments predicted by the model and presents them together with the actual data for California. Notice that the model accounts reasonably well for the evolution of the triple $(e, s, \overline{n}_p)$ observed in California in 1990 and 2000. Specifically, the

[22] One interpretation of $\rho < 0$ has to do with peer effects in education. If peer effects are related to average income within a school and schools differ in this dimension, high income households should be expected to attend public schools more often than what predicted by a version of this model in which $\rho = 0$. An alternative explanation is that households have preferences for religious education and the intensity of these preferences is stronger for lower income households.

model correctly predicts the reduction in the share of income devoted to public education between 1980 and 1990 and the subsequent rise between 1990 and 2000. There are two main forces that drive the dynamics of s in the model. The first one is the variation over time in average income per public school student, $\overline{y}/\overline{n}_p$. Equation (7) and the assumption $\alpha < 0$ imply that as average income per student in public school rises, voters prefer a higher level of spending per student but a smaller tax rate s. From Table 1, we know that the ratio $\overline{y}/\overline{n}_p$ went from \$97,308 in 1980 to \$132,365 in 1990 and subsequently fell to \$125,124 in 2000. This pattern is consistent with the qualitative variation in s generated by the model over this period. The second major force that determines the dynamics of s is private school attendance by citizen households. Higher private school attendance reduces the support for public education and tends to lower the equilibrium tax rate. Notice that the model correctly predicts higher private school enrollment by native households in 2000 than in 1980, even if it incorrectly gives rise to a decline in private enrollment between 1980 and 1990. The model-predicted pattern of private school attendance by native households tends to offset the dynamics implied by the ratio $\overline{y}/\overline{n}_p$ by increasing the equilibrium s in 1990 and decreasing it in 2000.

Table 3 contains additional information about average incomes of public and private school households and their average number of children. Note that, consistently with the data, the model predicts a decline in public school households' income relative to their private school counterpart in the 1980's and 1990's. Also, the model correctly predicts that public school households have, on average, more school-age children than private school ones.

5 Counterfactual Exercise

In this section I use the model developed so far to provide an answer to the following question: "what would have been the level of education spending per student in California in 1980–2000 if U.S. immigration had been restricted to its 1970 level?" The model can be used

to compute counterfactual enrollment rates in private school and education spending relative to income. To perform such exercise one has to take a stand about the effect of restricted immigration on the income of native households residing in California. Ignoring this general equilibrium effect might lead one to either under- or over- state the negative impact of immigrants on relative spending per student in California. The effect of immigration on the labor income of natives and previous cohorts of immigrants is the subject of some controversy in the literature (see e.g., Borjas, 2003 and Card, 2001). Recent research by Ottaviano and Peri (2008) points to a possible positive effect of immigrants on the average wages of natives, but their finding has been challenged by Borjas, Grogger, and Hanson (2008). In light of the uncertainty about the effect of immigration on the wages of natives, I take as a benchmark the case in which the income of natives and pre-1970 immigrants is unaffected by restrictions to immigration. Section 7 of the paper discusses the consequences of relaxing this assumption.[23]

Given these assumptions, I use the model to compute the counterfactual level of spending per child and other indicators of interest in 1980, 1990, and 2000 excluding immigrant households whose head immigrated to the U.S. in or after 1970, according to the U.S. Census. Formally, the following density:

$$f(y, n, x, m, \lambda | m = 1) = \frac{f(y, n, x, 1, \lambda)}{\sum_{n,x} h(n, x, 1)} \tag{11}$$

is used in the counterfactual exercise, instead of the one in equation (8). Table 4 contains the results of this exercise. In the economy with post-1970 immigration restrictions public education spending per student in California is 4, 15, and 24 percent higher than in reality in 1980, 1990, and 2000 respectively. In the year 2000, in the economy with immigration restrictions spending per student would have been $1,459 higher than in the benchmark

[23] In Section 7 I focus on wage income because it represents the largest component of household income and as such has attracted most attention in the immigration literature. It should be noted however that immigration might also have a positive effect on natives' capital income (Borjas, 1999 and Saiz, 2003) and a negative effect on natives' disposable incomes because of higher taxes associated with public services other than education. I also abstract from potential internal migration of households from other parts of the U.S. to California in response to immigration restrictions, as the evidence on this point is mixed (see Card, 2001 and Borjas, 2006).

economy. Most of these gains are due to the large drop in the number of public school students per household from about 0.52 in the benchmark economy (and in the data) to about 0.42 in the economy with restricted immigration. In the year 2000, the economy with restricted immigration is also characterized by an average income that is about \$3,000 larger than in the data. Given that each additional dollar of average income entails an increase in spending per student of about 10 cents, the increase in the average level of income accounts for about 20 percent of the computed increase of \$1,459 in spending per student in the counterfactual exercise.[24]

The switch from private to public education that occurs in response to restrictions to immigration has in principle an ambiguous effect on education spending. On the one hand, as households move into the public system they support higher levels of spending per student. One the other hand, as households move into the public system, their children use some of its resources. In order to assess the contribution of this mechanism to the results of Table 4, I recomputed the majority voting equilibrium in the counterfactual economy keeping native households' choice of private vs public schooling constant at what it was in the benchmark model. The results of this exercise are reported in Table 4 under the header "No Immigration - Constant School Choice". They show how quantitatively the second effect is larger than the first one, so that education spending per student is higher if households' school choice is kept constant in the counterfactual exercise. The net effect is, however, quantitatively small.[25]

The magnitude of the counterfactual results in Table 4 is consistent with Poterba (1997) and Fernandez and Rogerson (2001). Using panel data for U.S. states these authors estimate that the elasticity of a state's public education spending per student with respect to the average number of students per household is equal to -1. This elasticity can be used to

[24] The actual sensitivity of spending per student to average income is $s^*/\overline{n}_p^*$. With a tax rate of about 5 percent and an average number of students per household of about 0.5, one obtains the figure of 10 cents on the dollar.

[25] The presence of heterogeneity in λ across households has no effect on the results of the counterfactual experiment. Recomputing the benchmark and counterfactual equilibrium of the model under the assumption $\sigma_\lambda = 0$ gives rise to nearly identical percent declines in education spending attributable to immigration.

compute a counterfactual amount of education spending per student in the economy with restricted immigration without using the model developed in Section 3. The average number of students per household in California in 2000 is 0.52 (Table 1), while in the economy with restricted immigration and constant school choice by native households it is about 0.40 (Table 4), or 23 percent less. An elasticity of -1 implies a counterfactual amount of education spending per student equal to $7,800 in the year 2000, which is close to my finding in Table 4. Several authors have estimated (Fernandez and Rogerson, 1999 and Silva and Sonstelie, 1995) that education finance reform reduced education spending per student in California by 10–15 percent. According to my model, in 1990 immigration generates declines (relative to a non-immigration benchmark) in public education spending by 13 percent, a figure comparable to those often attributed to education finance reform. By the year 2000, the impact of immigration is instead larger than the impact of education finance reform, with a predicted decline in education spending of 19 percent.

6 The Fiscal Impact of Immigrants

Most studies of the fiscal impact of immigration assume that governments hold constant the level of services provided to their residents when faced with an inflow of new immigrants (e.g. National Research Council, 1997). According to the standard approach, the fiscal cost of immigration can be computed as the additional taxes paid by native households residing in California in the status-quo relative to an economy in which immigration is restricted to 1970 levels, while keeping education spending per student at the same level in the two economies. In addition, in the standard approach public school attendance by native households is assumed not to adjust to the new tax rate in the economy with restricted immigration. The fiscal cost of immigration computed in this way is equal to 0.2, 0.9, 1.4 percent of native households' income in 1980, 1990, and 2000 respectively.

An alternative way of computing the cost of immigration that is consistent with the ap-

proach of this paper is to let majority voting determine spending per student and households choose whether to attend public or private school in the economy with restricted immigration. Formally, let a household's indirect utility function be denoted by:

$$v\left(y\left(1-s\right),n,e,\lambda\right)\equiv\max\left\{U\left(y\left(1-s\right),n,e,\lambda\right),V\left(y\left(1-s\right),n,e,\lambda\right)\right\}. \tag{12}$$

Then, the equivalent variation $\tau\left(y,n,\lambda\right)$ for a native household characterized by the triple (y,n,λ) is such that the following indifference condition holds:

$$u(y(1-s^{*})+\tau\left(y,n,\lambda\right)-nz^{*},e^{*},z^{*},n,\lambda)=v\left(\left(1-s^{c}\right)y,n,e^{c},\lambda\right), \tag{13}$$

where the super-script "c" denotes the majority-voting equilibrium in the counterfactual economy, and the super-script "*" represents the equilibrium in the status-quo. In words, the equivalent variation represents the increase in a household's consumption such that the household is indifferent between living in the status-quo economy and living in the counterfactual economy with restricted immigration.[26]

Table 5 reports the fiscal cost of immigration computed under the standard method in which spending per student is kept constant in response to immigration and the equivalent variation measure described above. The table distinguishes between the mean cost (column "mean") which is the average for all native households in California and the cost conditional on having no school-age children and some school-age children. The mean utility-based cost computed according to the model is always more than 60 percent larger than the cost computed according to the standard approach. Intuitively, the higher number associated with the utility-based approach has to do with the convexity of preferences. Restricting immigration allows natives to save the resources associated with the schooling of children from immigrant households. These savings can either be used to lower tax rates on native

[26] Notice that in defining the equivalent variation, I do not allow households in the benchmark economy to modify their choice of school in response to the transfer τ.

households (the standard approach) or can be used to achieve a bundle that includes both lower tax rates and higher education spending on children of native households (the equivalent variation approach). Convexity of preferences imply that the latter bundle would be preferred to the former by a household who could freely choose how to spend the economy's savings associated with restricted immigration.

Note, however, that native households disagree on how to spend these savings because they are heterogeneous in terms of the vector of characteristics (y, n, λ). This heterogeneity implies that the cost of immigration computed according to the equivalent variation measure is not necessarily larger than the standard cost for all households. In fact, Table 5 shows that for households without school-age children the equivalent variation measure is slightly smaller than the standard measure. Instead, for households with school-age children the equivalent variation measure is significantly larger than the standard measure, reflecting the fact that in a voting equilibrium these households prefer to spend more on education than is actually spent.[27]

7 Sensitivity Analysis and Extensions

In this section I discuss some of the assumptions of the basic model presented in Sections 3–5, and evaluate the impact of relaxing them on the main results.

7.1 Effect of Immigrants on Natives' Incomes

The analysis has, thus far, assumed that immigration has no effect on the income of native households. As I discussed in Section 5, some authors (e.g., Ottaviano and Peri,

[27] I conclude this section with the caveat that the measures of the fiscal cost of immigration computed here refer exclusively to education spending and are static in nature. Therefore, no conclusion can be drawn about the overall welfare consequences of immigration. In order to evaluate the fiscal consequences of immigration one would need to compute the taxes paid and the set of transfers received by immigrants over the course of their entire lifetime rather than at a point in time only (National Research Council, 1997). The purpose of this section is mainly methodological, as it illustrates the impact of letting fiscal variables adjust in response to immigration.

2008) have argued that immigration increases the average wages of native workers because the latter are complements rather than substitutes for foreign workers with the same observable skill mix. Ignoring this channel would lead one to estimate an excessive negative effect of immigration on education spending. In order to evaluate the robustness of my results, while keeping tractability, I perform the counterfactual exercise assuming that the distribution of (y, λ) conditional on (n, x, m) and $m = 1$ is lognormal with parameters $\left(\log \delta + \mu_y (n, x, 1), \sigma_y (n, x, 1), \sigma_\lambda, \mu_\lambda, \rho\right)$. The parameter δ is positive and less than one if the inflow of immigrants contributes to increase the wages of natives.[28] Since preferences are homothetic, if all households' income is scaled down by the same factor δ, the majority-voting equilibrium yields the same counterfactual tax rate and spending per student is simply equal to:[29]

$$e_\delta^c = \delta e^c,$$

where e^c is the level of spending per student in the version of the counterfactual economy in which natives' income is unchanged when immigration is restricted (Section 5). Thus, the equilibrium level of public education spending per student in the counterfactual economy in which the restriction on immigration reduces the incomes of natives by $1 - \delta$ percent would be a fraction δ of the counterfactual level of spending reported in Table 4.

I compute the value of δ, denoted by $\widehat{\delta}$, that would set the spending level in the counterfactual economy (e_δ^c) equal to the actual level of spending predicted by the benchmark version of the economy (e^*). Based on the values of e^* and e^c in Tables 4 and 5 for the 2000 Census, $\widehat{\delta} = e^*/e^c$ is equal to about 0.81. In words, a ban on post-1970 immigration to the U.S. would have to reduce California natives' incomes by 19 percent in the year 2000 to offset the negative impact of immigration of spending on public education. To put this

[28] Notice that both the mean and the variance of the marginal distribution of income increase with δ. Measures of income inequality, such as the coefficient of variation or the standard deviation of the log, are not affected by δ. Thus, I am ignoring distributional effects of immigration and the associated effects on the voting equilibrium, and instead focus on the average effect of immigration on natives' incomes.

[29] Notice that the income cut-off for attending private school goes down by a factor of δ. However, since all incomes go down by the same factor, the proportion of households with income below the cut-off remains the same.

figure in perspective it is instructive to consider the estimates of the impact of immigrants on the average wages of natives that are found in the immigration literature. The magnitude of this estimate depends crucially on the size of the elasticity of substitution in production between natives and immigrants with the same education and experience. Traditionally, the literature (Borjas, 2003) has assumed an infinite elasticity of substitution, but Ottaviano and Peri (2008, Table 3) estimate a value of about 20. With this elasticity they find that the 1990–2006 immigration wave to the U.S. will contribute in the long-run to increase average wages for U.S. natives by 0.6 percent. This is a relatively small number compared by $1 - \widehat{\delta}$. It might be argued that since California attracts immigrants disproportionately, U.S. wide averages are not representative of what happens to average wages in California. Using the same theoretical and empirical approach developed in Ottaviano and Peri (2008), Peri (2007, Table 9) estimates that immigrant inflows to California in the period between 1990–2004 have increased average wages by 2.2 percent. Peri obtains this result assuming an elasticity of substitution between immigrants and natives of about 10, which is much smaller than the value estimated by Ottaviano and Peri (2008). Thus, the 2.2 percent figure is likely to be an upper bound for the effect of 1990–2004 immigration on average native wages in California. Thus, the available evidence does not suggest that the effect of immigration on native incomes, even if on average positive, is large enough to change significantly the magnitude of the impact of immigration on public education spending per student reported in Section 5.

7.2 Immigrants' Vote

Are the results of the counterfactual experiment of Section 5 due to the fact that in the model non-citizen immigrants cannot vote? In principle, letting immigrants vote in the model has an ambiguous effect on public education spending because immigrant households tend to have relatively low income and are more likely to have school-age children relative to natives. The former effect makes them want to spend less on public education than

otherwise identical native households if $\alpha < 0$. The latter effect should instead make them want to spend more on public education than native households with the same income but without children. To evaluate the net effect, I recomputed the majority-voting equilibrium for each year allowing all households to vote, independently of their citizenship status. The results are reported in Table 6. Allowing non-citizen immigrants to vote in the model leads to higher tax rates and levels of spending per student. By the year 2000, the model predicts that spending per student would have been about \$269 higher if non-citizen immigrants were allowed to vote over education spending. This is about 18 percent of the drop in spending per student associated with immigration, according to the model (see Section 5). Therefore, the main reason for why immigration leads to a drop in education spending per student is not that immigrant household cannot vote but rather that immigration increases the tax price of education faced by all households.

7.3 More Inelastic Demand for Education

In order to evaluate the sensitivity of the results to different values of the elasticity parameter α, I re-calibrated the model assuming $\alpha = -1$, i.e., a more price-inelastic demand than in the benchmark. Table 7 reports the main predictions of the model in this case. Since restrictions to immigration effectively reduce the relative price of education spending, the model delivers smaller counterfactual education spending levels when $\alpha = -1$ than the benchmark economy. According to this version of the model, immigration reduces education spending per student by about \$590 in 1990 and \$950 in 2000, instead of \$928 and \$1,459 implied by the benchmark calibration. Note however that the counterfactual spending figure for the year 2000 is still sizeable: about 16 percent higher than in the data. The average cost of immigration among households, as measured by the equivalent variation, is instead higher when demand for education is relatively more inelastic. Last, notice that when $\alpha = -1$, the model does not perform as well as the benchmark in tracking the actual level of spending per student and the share of education spending in 1990 and 2000. Moreover, this version of the

model is less accurate in predicting private school attendance rates by native and pre-1970 immigrant households.

8 Discussion and Conclusions

In this paper I quantify the impact of immigration on per student spending in public education in California in the period 1970–2000. The counterfactual exercises suggest that education spending per student would have been between 16 and 24 percent higher, according to the assumed magnitude of the tax price elasticity parameter, than it was in 2000 if U.S. immigration had been restricted to its 1970 level. Between 1970 and 2000 spending on primary and secondary education in California declined by about 22 percent relative to the rest of the U.S. Previous literature (e.g. Fernandez and Rogerson, 1999) has established that education finance reform is responsible for a decline of 10–15 percentage points. My results imply that immigration contributed an additional decline of about 14–19 percentage points, concentrated in the post-1980 period. Taken together these two mechanisms explain more than the observed decline in education spending. This happens for two reasons. First, during the 1970's, California experienced a favorable demographic trend relative to the rest of the U.S. Table 1 and Figure 2 show how the relative number of households per public school student in California increased during this period, despite immigration. Second, according to the Census data (see again Figure 2), income per household in California grew faster between 1970 and 2000 than in the rest of the country.

While the paper focuses on the State of California, the main insight of the model about the link between demographics and spending on public education is consistent with the evidence in Poterba (1997) and Fernandez and Rogerson (2001) who show that higher school enrollment is associated with lower education spending per capita in state-level panel regressions. Moreover, the model can shed light on the experience of other immigrant-receiving states, such as Florida. When U.S. states are ranked in terms of the 1970–2000 change in

the share of school-age children from immigrant-headed households California is first while Florida is fourth. In addition, Florida's education finance system shares some important features with California's, with the state accounting for about two-thirds of the combined state and local funding sources (Wood et al., undated). According to Census and NCES data, in the period 1970–2000 Florida has experienced a drop in education spending per student of about 4 percent relative to the rest of the U.S. Interestingly, this decline has occurred despite an increase in the number of households per student, due to the internal migration of retirees to Florida. Differently from California, the drop in education spending per student has been driven by a sharp decline in the share of education spending relative to income from 4.81 percent in 1970 to 4.10 percent in 2000. Florida's experience can in principle be explained using the model developed in this paper. In the language of the model, the inflow of retirees to Florida has shifted the identity of the median voter in the direction of smaller tax rates as households without school-age children care relatively less about public education spending.

What are the broader policy implications of this paper's findings? By quantifying some of the welfare costs of immigration in California, the major immigrant-receiving state in the U.S., the paper points to a tension between *federal* immigration policy and the *regional* fiscal impact of immigration.[30] While the State of California pays a large share of immigrants' education cost, the U.S. federal government collects federal taxes on the incomes of immigrants. The National Research Council (1997, Table 6.5) estimates that the net annual fiscal impact imposed by immigrant-headed households on native residents in California in 1994 is small and *positive* as far as federal revenues and expenditures are concerned, and significantly negative at the state and local level. Given this tension, it would be interesting to explicitly consider the welfare and distributional implications of compensatory transfers from the federal government to the states linked to immigration flows.

[30] This tension has become manifest in 1994 when California and other states unsuccessfully filed a lawsuit against the U.S. federal government to recover the costs of public education for illegal immigrants. In November of the same year Proposition 187 was approved by California voters. This proposition, later declared unconstitutional, would have excluded illegal immigrants from public education and other social services in the state.

This paper might be fruitfully expanded in at least three other directions. The first is to investigate whether immigration would have an effect on public spending even if immigrants had the same level of income and number of children per household as natives. Discussing California's experience with the provision of education and other public goods, Schrag (1998, page 9) asks whether "...is the problem caused by some combination of hostility and indifference on the part of a body of voters that isn't sure it wants to carry this kind of load for *those kinds* of people?" Alesina et al. (1999) find some evidence in favor of this view. The second is to investigate the implications of peer effects in education from which this model for simplicity abstracts. The existence of peer effects would generate incentives for residential sorting by households, even if education expenditures were perfectly equalized across school districts (see e.g., Calabrese et al., 2006). California's equalization of schooling expenditures provides a useful background to analyze this issue, as difference in education expenditures across school districts is often viewed as a primary driver of residential segregation. Last, it would also be interesting to analyze the interaction between the nature of education finance and the consequences of demographic shifts like the one that occurred in California. More specifically, one could redo the exercise carried out in this paper in the context of a foundation system, like the one that prevailed in California before the *Serrano* ruling. This system would generate a more unequal distribution of education spending across school districts and an inflow of immigrants would probably lead to a significant increase in inequality in spending over time. From this perspective, the education finance reform that occurred in California in the early 1970's had the unintentional effect of increasing the extent of redistribution from native to immigrant households. I leave the further investigation of these topics to future research.

References

Alesina A., Baqir R., and Easterly W. (1999): "Public Goods and Ethnic Divisions," *Quarterly Journal of Economics*, 1243-1284.

Bergstrom T., Rubinfeld, D. and P. Shapiro (1982): "Micro-Based Estimates of Demand Functions for Local School Expenditures," *Econometrica* 50, 1183-1205.

Betts J. and R. Fairlie (2003): "Does Immigration Induce 'Native Flight' from Public Schools into Private Schools," *Journal of Public Economics*, 87, 987-1012.

Borjas G. (1994): "The Economics of Immigration," *Journal of Economic Literature* 32, 1667-1717.

Borjas G. (1999): "The Economic Analysis of Immigration," in *Handbook of Labor Economics*, Volume 3A, edited by O. Ashenfelter and D. Card, North-Holland, 1999, 1697-1760.

Borjas G. (2003): "The Labor Demand Curve *Is* Downward Sloping: Reexamining the Impact of Immigration on the Labor Market," *Quarterly Journal of Economics*, 1335-1374.

Borjas G. (2006): "Native Internal Migration and the Labor Market Impact of Immigration," *Journal of Human Resources*, 41, 221-258.

Borjas G. and L. Hilton (1996): "Immigration and the Welfare State: Immigrant Participation in Means-Tested Entitlements Programs," *Quarterly Journal of Economics*, 111, 575-604.

Borjas G., R. Freeman, and L. Katz (1997): "How Much do Immigration and Trade Affect Labor Market Outcomes?," *Brooking Papers on Economic Activity*, 1997, 1-90.

Borjas G., J. Grogger, and G. Hanson (2008): "Imperfect Substitution Between Immigrants and Natives: A Reappraisal," NBER Working Paper 13887.

Calabrese S., Epple D., Romer T., and H. Sieg (2006): "Local Public Good Provision:Voting, Peer Effects, and Mobility," *Journal of Public Economics*, 90, 959-1364.

Card D. (2001): "Immigrant Inflows, Native Outflows, and the Local Market Impact of Higher Immigration," *Journal of Labor Economics*, 19, 22-64.

Carroll S., Krop C., Arkes J, Morrison P., and A. Flanagan (2005): *California's K-12 Public*

Schools: How Are They Doing?, RAND Corporation.

Clune M. (1998): "The Fiscal Impacts of Immigrants: A California Case Study," in *The Immigration Debate*, J. Smith and B. Edmonston eds., National Academy Press.

Dottori D. and I-L. Shen (2009): "Low-skilled Immigration and the Expansion of Private Schools," Working Paper.

Downes T. and D. Schoeman (1998): "School Finance Reform and Private School Enrollment: Evidence from California," *Journal of Urban Economics*, 43, 418-443.

Epple D. and T. Nechyba (2004): "Fiscal Decentralization," in V. Henderson and J.-F. Thisse eds, Handbook of Regional and Urban Economics, Vol. 4, 2423-2471, Elsevier.

Epple D. and R. Romano (1996): "Ends Against the Middle: Determining Public Service Provision When There are Private Alternatives," *Journal of Public Economics*, 62, 297-325.

Fernandez R. and R. Rogerson (1999): "Education Finance Reform and Investment in Human Capital: Lessons from California," *Journal of Public Economics*, 74, 327-350.

Fernandez R. and R. Rogerson (2001): "The Determinants of Public Education Expenditures: Longer-Run Evidence From the States, 1950-1990," *Journal of Education Finance*, 27, 567-583.

Fernandez R. and R. Rogerson (2003): "Equity and Resources: an Analysis of Education Finance Systems," *Journal of Political Economy*, 111, 858-897.

Garvey D. and T. Espanshade (1998): "Fiscal Impacts of Immigrants and Native Households: A New Jersey Case Study," in *The Immigration Debate*, J. Smith and B. Edmonston eds., National Academy Press.

Hoxby C. (2001): "All School Finance Equalizations Are Not Created Equal," *The Quarterly Journal of Economics*, 116, 1189-1231.

Lochner L. and E. Moretti (2004): "The Effect of Education on Criminal Activity: Evidence from Prison Inmates, Arrests and Self-Reports," *American Economic Review*, 94, 155-189.

Murray S., Evans W., R. Schwab (1998): "Education-Finance Reform and the Distribution of Education Resources," *American Economic Review*, 88, 789-812.

National Research Council (1997): *The New Americans - Economic, Demographic, and Fiscal Effects of Immigration*, National Academy Press.

Ottaviano G., and G. Peri (2008): "Immigration and National Wages: Clarifying the Theory and the Empirics," Working Paper, U.C. Davis.

Peri G. (2007): "Immigrants' Complementarities and Native Wages: Evidence from California," Working Paper, U.C. Davis.

Poterba J. (1997): "Demographic Structure and the Political Economy of Public Education," *Journal of Policy Analysis and Management*, 16, 48-66.

Ruggles S., Sobek M., Alexander T., Fitch C., Goeken R., Hall P., King M., and C. Ronnander (2008): Integrated Public Use Microdata Series: Version 4.0 [Machine-readable database]. Minneapolis, MN: Minnesota Population Center.

Saiz A. (2003): "Room in the Kitchen for the Melting Pot: Immigration and Rental Prices," *Review of Economics and Statistics* 85, 502-521.

Schrag P. (1998): *Paradise Lost*, The New Press, New York.

Silva F. and J. Sonstelie (1995): "Did *Serrano* Cause a Decline in School Spending?" *National Tax Journal* 48, 199-215.

Sonstelie J., Brunner E., and K. Ardon (2000): *For Better or For Worse? Education Finance Reform in California*, Public Policy Institute of California.

Wood C., Chambers M., Mendonca S., K. Birkett, undated: Florida, http://nces.ed.gov/edfin.

A Data Appendix

Yearly state-level data on current nominal expenditures and fall enrollment in public elementary and secondary education for the school years 1969–1970 to 2004–2005 are from the National Center for Education Statistics. Micro data at the yearly frequency for the period 1970 to 2005 comes from the Current Population Survey. I have dropped from these samples individuals living in group quarters and with missing household income information. Micro data at the decennial frequency starting in 1970 are from the IPUMS extracts from the U.S. Census. The following samples were obtained from the IPUMS (Ruggles et al., 2008): 1970 1% Form 2 State sample, 1980, 1990, and 2000 5% State samples. For all years I drop individuals who live in group quarters. A school-age individual is defined as an individual who is between 5 and 17 years of age at the time of the Census and is enrolled in school according to the Census criteria. The Census also provides information on whether the individual is attending public or private school. In the model, the choice of public vs private school is the same for all children in the same household, while in practice this is not always the same (i.e. some households have some children in public and others in private school). For practical purposes I assume a household has all of its children in public school if at least half of its own school-age children in school are reported attending public school. In a given Census year, I define a household to be "immigrant" if its head (according to the Census) satisfies the following restrictions: (i) born outside of the 50 states of the U.S. and the District of Columbia; (ii) not born abroad of American parents; (iii) immigrated to the U.S. after the year 1970. Notice that requirement (iii) is introduced in the quantitative part of the model in order to use the year 1970 as a benchmark. A household is considered "native" if its head is not an immigrant, according to the requirements (i)–(iii) above. A household is considered "not a citizen" if its head is not a citizen according to the U.S. Census. Household income is the IPUMS variable "total household income" after 1970. Since this variable is not available in 1970, for this year I have computed household income as the sum of total personal income of all household members.

Table 1: Public Education Spending: California vs the Rest of the U.S.

Total public education spending is from the National Center for Education Statistics and refers to the academic year ending in the year mentioned in the table (e.g. 1969–1970 for 1970). Public school enrollment, household income, and the number of households are from the U.S. Census. CA stands for California, while US^- refers to the rest of the U.S. excluding California. Dollar figures are expressed in 1999 dollars using the CPI-U-RS deflator.

Year	1970		1980		1990		2000	
	CA	US^-	CA	US^-	CA	US^-	CA	US^-
Public education spending per student (1999$)	3,510	3,133	4,806	4,509	6,222	6,510	6,338	7,065
Income share of public education (%)	5.48	5.59	4.94	5.56	4.70	5.67	5.06	5.49
Public school students per 100 households	65.08	66.82	47.22	51.39	43.47	41.04	52.28	43.04
Average household income (1999$)	41,667	37,467	45,949	41,642	57,539	47,107	65,415	55,388

Table 2: Calibrated Parameter Values

The parameter α is set a-priori to -0.25 based on Fernandez and Rogerson (1999). The remaining parameters have been calibrated along the lines described in Section 4. The estimates of the densities f and h are available from the author upon request.

α	μ_λ	σ_λ	ρ	γ
-0.25	-1.8295	1.0027	-0.6891	0.1412

Table 3: Model's Predictions - California

The first five data moments in this table are constructed using the data described in the legend of Table 1. The last three moments were computed using data from the U.S. Census. Public education spending is expressed in 1999 CPI-U-RS adjusted dollars.

Year	1980		1990		2000	
	Data	Model	Data	Model	Data	Model
Public education spending per student (1999$)	4,806	4,806	6,222	6,128	6,338	6,171
Income share of public education (%)	4.94	4.94	4.70	4.70	5.06	4.94
Public school students per 100 households	47.22	47.22	43.47	44.18	52.28	52.35
Ratio average public/ private school income ($\times$100)	81.51	81.51	65.95	60.87	59.04	47.96
Coefficient of variation income public school (%)	65.45	65.45	81.43	81.65	99.85	97.09
Private school children per private school households	1.60	1.76	1.51	1.71	1.54	1.75
Public school children per public school households	1.82	1.92	1.76	1.82	1.81	1.87
% children from pre-1970 CA households in private school	9.84	10.13	10.21	9.15	11.23	11.55

Table 4: Counterfactual Experiments

Under the heading "No Immigration", I present the results from the counterfactual exercise of restricted immigration in the U.S. after 1970. The counterfactual exercise consists of using the model to predict the variables reported in the Table's rows by restricting attention to the distribution of native households and those who immigrated to the U.S. before 1970. Dollar figures are expressed in 1999 dollars using the CPI-U-RS deflator.

Year	1980	1990	2000
No Immigration			
Public education spending per student (1999$)	4,983	7,056	7,630
Income share of public education (%)	4.92	4.55	4.65
Public school students per 100 households	46.05	38.23	41.78
% children in private school	9.21	6.19	6.81
Average household income	46,601	59,227	68,484
No Immigration - Constant School Choice			
Public education spending per student (1999$)	4,998	7,146	7,764
Income share of public education (%)	4.89	4.46	4.49
Public school students per 100 households	45.55	37.00	39.61
% children in private school	10.13	9.15	11.55

Table 5: Alternative Measures of the Cost of Immigration

"Standard approach" is the extra taxes that, on average, a household has to pay in the status-quo relative to the economy without post-1970 immigration. "Equivalent variation" refers to the case in which spending per student adjusts endogenously in response to restrictions to immigration. Figures are expressed in 1999 CPI-U-RS adjusted dollars.

Year	1980			1990			2000		
	mean	children		mean	children		mean	children	
		0	≥ 1		0	≥ 1		0	≥ 1
Standard approach	112	98	147	520	430	797	938	690	1,629
Equivalent variation	189	66	497	862	378	2,362	1,512	677	3,843

Table 6: Model's Predictions with Immigrants' Vote

"I. Vote" refers to the version of the model in which immigrants are allowed to vote. "Bench." reproduces the benchmark results of Table 3. Public education spending is expressed in 1999 CPI-U-RS adjusted dollars.

Year	1980		1990		2000	
	Model		Model		Model	
	I. Vote	Bench.	I. Vote	Bench.	I. Vote	Bench.
Public education spending per student (1999$)	4,868	4,806	6,310	6,128	6,440	6,171
Income share of public education (%)	5.02	4.94	4.88	4.70	5.21	4.94
Public school students per 100 households	47.40	47.22	44.48	44.18	52.89	52.35

Table 7: Sensitivity Analysis with Respect to the Price Elasticity Parameter α

In this table I present the results for $\alpha = -1$. The calibration procedure is described in Section 4 and it is such that the model matches certain key moments in the year 1980. The values of the other parameters of the model are: $\mu_\lambda = -2.8180$, $\sigma_\lambda = 1.2739$, $\rho = -0.9865$, $\gamma = 0.1049$. For each year, the column "Act" presents the prediction of the model for the moments of interest (i.e., the equivalent results to those in Table 3). The column "Cou" instead presents the results of the counterfactual experiment of restricted immigration (i.e., the equivalent results to those in Table 4). Dollar figures are expressed in 1999 dollars using the CPI-U-RS deflator.

Year	1980		1990		2000	
	Act.	Cou.	Act.	Cou.	Act.	Cou.
Public education spending per student (1999$)	4,806	4,922	6,055	6,645	6,089	7,039
Income share of public education (%)	4.94	4.92	4.74	4.43	4.81	4.30
Public school students per 100 households	47.22	46.57	45.09	39.52	51.64	41.85
% children from pre-1970 CA households in private school	10.35	8.18	7.22	3.03	14.27	6.65
Average equivalent variation	-	198	-	916	-	1,620

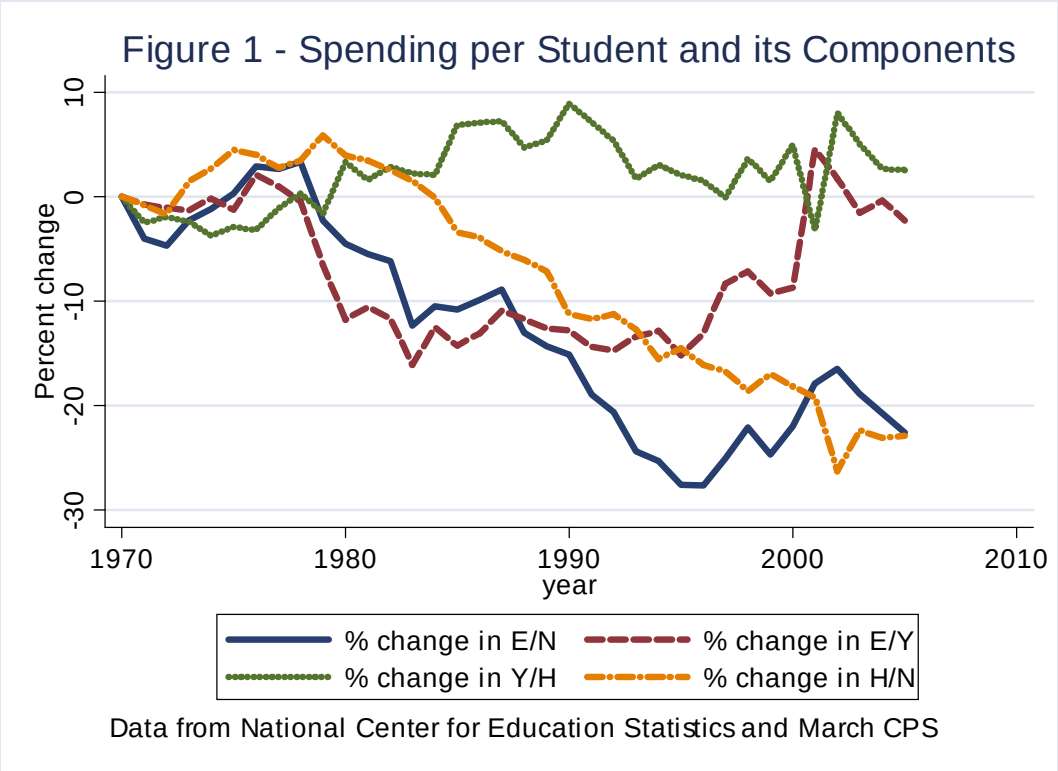

Figure 1: Decomposition of the evolution of education spending per student in California relative to the rest of the U.S. Data source: Current Population Survey (household income and number of households) and National Center for Education Statistics (school enrollment, education spending).

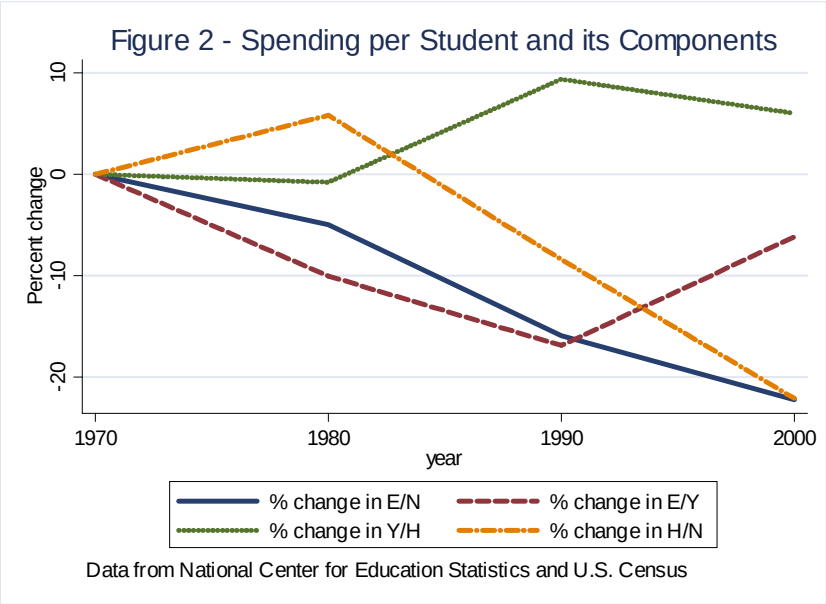

Figure 2: Decomposition of the evolution of education spending per student in California relative to the rest of the U.S. Data source: U.S. Census of Population (school enrollment, household income, number of households) and National Center for Education Statistics (education spending).

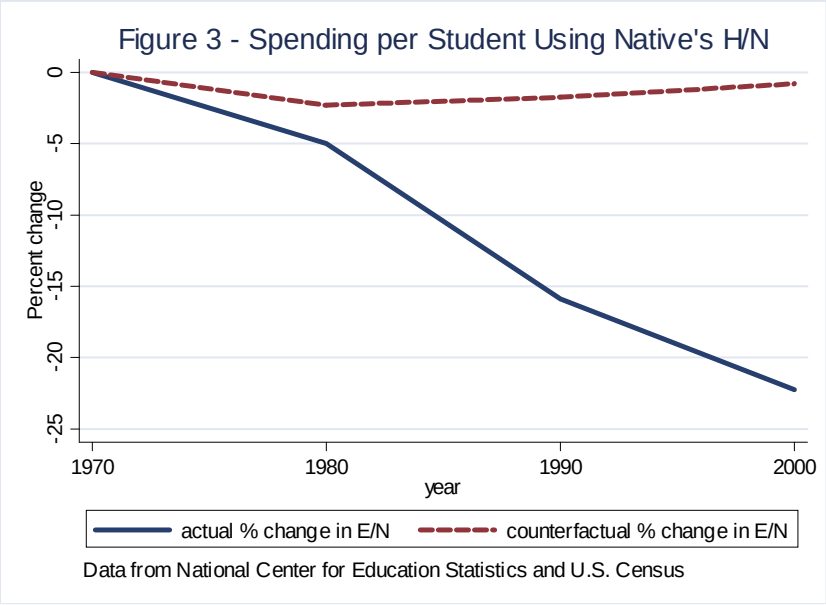

Figure 3: Counterfactual evolution of spending per student in California relative to the rest of the U.S., using natives' ratio of households per student. Data sources: U.S. Census of Population (school enrollment and number of households for native and foreign-born households) and National Center for Education Statistics (education spending).