Abstract

I study the implications for human capital accumulation and welfare of alternative systems of financing K-12 public education. An important, but neglected, feature of U.S. education spending data is that at least half of the cross-sectional variation in education expenditures per student is accounted for by differences between - instead of within - states. I introduce a tractable model of human capital accumulation with heterogeneous agents and endogenous education policy that generates within and between-state spending variation. The model allows for different levels of education financing: local, state, Federal, and their combinations. I use the model to compare the current U.S. system based on a mix of local and state financing with several alternatives.

Keywords: Human Capital, Geographic Mobility, Housing Prices, Federal, State and Local Governments.

JEL codes: E24, H7, I2, J6

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1 Introduction

This paper studies the implications for welfare and other outcomes of alternatives arrangements for the financing of public education in a federation, such as the U.S. In the U.S. all three levels of government - local, state and federal - contribute in different degrees to the financing of education.\(^1\) The analysis is carried out using a dynamic general equilibrium overlapping generations model with heterogeneous agents, heterogeneous locations, and voting over education expenditures. The key departure of the paper relative to existing literature (e.g. Fernandez and Rogerson, 1998) is to consider simultaneously within and between-states differences in the distribution of education resources. The existing literature has focused on within-state differences only. However, currently, between one half and three quarters of the differences in primary and secondary education spending per student across school districts in the U.S. are due to differences in average expenditures across U.S. states, as opposed to school districts within a state (Corcoran et al. (2003) and Section 2). The importance of differences in expenditures across states in accounting for differences in expenditures across students has not received much attention in the literature. The latter has mostly focused on the effects of state-level school-finance litigation, starting with the Serrano lawsuits in California during the 1970s.\(^2\)

Murray et al. (1998) show that court-ordered education finance reform reduces inequality in expenditures across school districts, but they conclude their important paper with the following caveat:

“Finally, we have shown roughly two-thirds of nationwide inequality in spending is between states and only one-third is within states, and thus school-reform litigation is able to attack only a small part of inequality. We would conclude that while education-finance reform litigation has reduced within-state inequality, it seems unlikely that further litigation will yield large reductions in national inequality in the future.”\(^3\)

\(^{1}\) While I have in mind the financing of primary and secondary education, the ideas developed here are in principle applicable to tertiary education as well.

\(^{2}\) See Silva and Sonstelie (1995), Evans et al. (1997), Murray et al. (1998), Fernandez and Rogerson (1999), Hoxby (2001) for analysis of the effects of court-ordered education finance reform. Interestingly, Coons et al (1970) in the seminal book that provided the theoretical foundation for state-level school finance litigation, draw the reader’s attention to the “state-nation analogy to the district-state picture” (Appendix A, p.465). While they focus on education financing at the state level, they observe that “the variation among states themselves mirrors the pattern of district variation within the states. One of the implications of this is that large-scale federal aid to education is needed if we are to achieve full national equalization.”

\(^{3}\) The main reason why school-finance litigation is unlikely to reduce expenditures inequality in the future is that the financing of education is primarily a responsibility of the states and their legal creations, school districts (Fischel, 2001). In its 1973 San Antonio vs Rodriguez decision, the five to four majority of U.S.
The paper has both a positive and a normative goal. The positive goal is to study the determinants of observed differences in expenditures per student within and, especially, across states. While the existing literature on sorting across jurisdictions (Epple and Sieg, 1999) tends to emphasize differences across agents in willingness to pay for better schools, as either driven by income or preference heterogeneity, it is less clear that one can rationalize the observed variation in expenditures across states through similar mechanisms. There is less geographic mobility across states than across school districts in the data and most adult individuals in the U.S. choose to reside in their state of birth. The normative goal is to address the question “at what level of government should the financing of K-12 education take place?” This is a classic question in the literature on fiscal federalism (Oates, 1972) and education finance (Coons et al. 1970). It is also motivated by the recent debate in the U.S. about the role of the Federal government in the provision of pre-school as well as primary and secondary education.4

This paper explicitly analyzes some of the trade-offs involved in the financing of education by local, state, and the Federal government. The existing literature has not distinguished between state and Federal financing. At a basic level the observed existence of differences in education spending across U.S. states and the correlation between the latter and measures of income per capita, suggests that redistribution of education expenditures toward poorer states might increase aggregate human capital. This argument is simply the counterpart of the one made in the literature to justify redistribution of expenditures towards poorer households within a state. As in that case, redistribution is likely to generate a number of equilibrium effects on housing prices, the location decisions of workers, labor supply, and ultimately the tax base from which expenditures are financed. In light of this consideration and the fact that, as a matter of practice, the Federal government has historically provided only a small share (below 10 percent) of total education spending, the paper uses a general equilibrium model to study these questions.

The model economy features a continuum of locations (states) and agents who accumulate human capital as children, choose locations to live and work, consume and save as young, and sell their assets as old. Locations are ex-ante different in terms of their level of productivity. Each location is characterized by a labor market, a housing market, and an education policy. Following Bénabou (2002), education policy is formalized as a scheme that redistributes

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4 See, for example, the discussion in the “Choice and Federalism” 2012 report by the Koret Task Force on K-12 Education.
education expenditures across agents based on their income level. In the model redistribution of education expenditures has the potential to increase average human capital because it benefits the poor more than it hurts the rich. However, redistribution also leads to lower labor supply. The equilibrium degree of redistribution is determined by majority voting. In the benchmark model, the education finance system is mixed with a local and a state component. The structure of the model allows for closed-forms for most of the endogenous variables of interests such as the equilibrium distribution of human capital within and across states, the distribution of population, housing prices, etc.

The benchmark model generates both within and between state dispersion in education expenditures, as observed in the data. The within dispersion is due to heterogeneity in the distribution of human capital within each state. The between dispersion reflects differences in productivity across states. Locations with relatively higher productivity spend more on education despite free mobility of labor across states because higher housing prices act as a compensating differential for higher productivity (Roback, 1982).

The benchmark model is used to perform two counterfactual experiments. In the first one, the mixed local-state system is replaced by a purely local one. This experiment is analogous to the ones in Fernandez and Rogerson (1997, 1998, 1999). The mixed system generates less inequality in expenditures than a purely local one, while its effect on average human capital is in principle ambiguous and depends on parameter values. A calibrated version of the model shows that the mixed local-state system generates higher average human capital than a purely local one.

In the second experiment the local-state mix is replaced by a local-Federal financing mix. In the latter redistribution occurs at the Federal, rather than the state, level and therefore entails both redistribution from rich to poor households within a state as well as from rich to poor states. I show analytically, how in a local-Federal system the elasticity of education expenditures to an agent’s income is lower than in a local-state system. In other words, a Federal system reduces expenditures inequality across agents relative to a state one. The two systems give rise to different distributions of housing prices, population, human capital and income in the economy. To evaluate the full extent of the differences between them and present welfare comparisons I consider calibrated versions of the model.

This paper is related to several literatures. The first one, which includes the contributions by Glomm and Ravikumar (1992), Boldrin (1992), Fernandez and Rogerson (1997, 1998, 1999, 2003), Bénabou (1996, 2002) and others, is the literature on public and private investment in human capital in economies with heterogeneous agents. Relative to this literature I emphasize the geographic dimension of the debate on education financing. Second, the paper is related to the work on effects of education finance reform in the U.S. Histori-
cally, the role of state government in the provision of public education has increased at the expense of the role of local governments (see Figure 1 below). In the last 40 years decisions by state Supreme Courts, starting from California’s in the *Serrano v. Priest* lawsuit, have contributed to increase the role of the states in the financing of education. The effects of court-ordered reform have been studied, among others, by Evans et al. (1997), Murray et al. (1998), Fernandez and Rogerson (1998) and Hoxby (2001). Last, the paper is related to models of location choice and voting over local public goods, a literature reviewed by Epple and Nechyba (2004).\(^5\)

The rest of the paper is organized as follows. Section 2 presents some empirical evidence to further motivate the analysis. Section 3 introduces the benchmark model. Section 4 discusses the qualitative properties of the model. Section 5 considers counterfactual arrangements in which redistribution occurs only at the local level or at a combination of local and Federal levels. Section 6 presents some numerical results concerning the alternative systems of redistribution of education expenditures. Section 7 concludes.

## 2 Background

This section documents some stylized facts about education spending in the U.S. that are useful to motivate the theory and the analysis developed in the rest of the paper.

### 2.1 Federal, State and Local Financing

First, an important characteristics of the U.S. system of financing education is the fact that the Federal government provides a relatively small share of schools’ revenue. Figure 1 shows the evolution of the percent contributions of Federal, state and local governments to total primary and secondary education expenditures. While the role of the Federal government has increased starting in 1965 with the passage of the Elementary and Secondary Education Act (ESEA), its share has been consistently below 10 percent. Moreover, the Federal government does not provide unrestricted general aid, but rather funds specialized programs through categorical grants to school districts.\(^6\)

For the U.S. as a whole, state and local governments provide the bulk of financing in

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\(^5\) Calabrese (2012) studies a model with two levels of government in a federation: a central government that redistributes income across households and local governments providing a public good such as education. In my paper, instead, I study the implications of shifting the same governmental function (public school provision) across different levels of government.

\(^6\) Funded programs include compensatory education for low-achieving students in low-income districts (Title I of ESEA 1965), special education for students with physical and mental disabilities (Title VI, 1966 amendment to ESEA), bilingual education (Title VII, 1967 amendment to ESEA).
Figure 1: Shares of primary and secondary education revenue in the United States by level of government. Source: National Center for Education Statistics.

almost equal amounts. Education is, on average, the most important item on state budgets (not including local governments) compared to other expenditures. For example in 2005, it accounted on average for 31 percent of general expenditures by state governments. States provide both general no-strings-attached funds to school districts through a variety of formulas (such as flat and foundation grants) as well as categorical aid for specific programs and goals (such as class-size reduction). The mix of these two types of aid varies by state.

2.2 Between and Within-State Expenditure Inequality

The second stylized fact is that the United States is characterized by an unequal distribution of expenditures per students across school districts and at least half of the variation is between-states rather than between school districts within-states. Table 1 provides information about two measures of inequality in nominal expenditures per student across school districts, the Gini coefficient and Theil index, for a selected number of years.

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7 There is also variation across states, with the poorer states receiving higher shares of Federal funds. In 2005, for example, New Jersey received 4 percent of its education funds from the Federal government, while Mississippi received 21 percent. The shares of funding provided by states and local governments also varies across states. At one extreme of the distribution is Hawaii with 90 percent of funds coming from the state and at the other extreme Nevada with 64 percent of funds raised at the local level (Digest of Education Statistics, 2008, table 172).

8 See Hanushek and Lindseth (2009) for a critical discussion of the role played by state governments in
The table shows a very slight reduction in inequality from 1972 to 2009 with variations over the sample period. Indicators of inequality achieve their lowest level in the late 1990s-early 2000s and then increase again. More importantly for the purpose of this paper is that the share of inequality attributable to between-states differences in expenditures across school districts is much larger than the within share and has been increasing over time. For example, according to the decomposition of the Theil index, in 1972 differences across states accounted for about 69 percent of inequality in nominal education spending per student while in 2009 the corresponding share is 76 percent.

Taylor (2005) has computed prices of education services across school districts and states for a selected number of years. These prices can be used to compute measures of real expenditures and expenditure inequality. The results are reported in Table 2. Adjusting for differences in the price of education across school districts and states reduces the extent of the between-state variation and increases the extent of the within variation.

Table 1: Measures of inequality in expenditures per student across school districts. Source: Murray et al. (1998), Corcoran et al. (2003), and author’s computations.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gini coefficient ((\times100))</td>
<td>16.3</td>
<td>15.0</td>
<td>13.8</td>
<td>15.8</td>
<td>15.5</td>
<td>13.0</td>
<td>12.9</td>
<td>14.6</td>
<td>15.3</td>
</tr>
<tr>
<td>Theil index ((\times1000))</td>
<td>43.7</td>
<td>37.1</td>
<td>31.0</td>
<td>40.7</td>
<td>40.5</td>
<td>30.6</td>
<td>29.3</td>
<td>39.3</td>
<td>43.2</td>
</tr>
<tr>
<td>Within states</td>
<td>13.7</td>
<td>14.4</td>
<td>14.0</td>
<td>12.6</td>
<td>13.4</td>
<td>9.9</td>
<td>8.4</td>
<td>9.9</td>
<td>10.2</td>
</tr>
<tr>
<td>Between states</td>
<td>30.0</td>
<td>22.8</td>
<td>17.0</td>
<td>28.2</td>
<td>27.1</td>
<td>20.7</td>
<td>20.9</td>
<td>29.4</td>
<td>33.0</td>
</tr>
</tbody>
</table>

Table 2: Measures of inequality in real expenditures per student across school districts. Source: Taylor (2005).

<table>
<thead>
<tr>
<th>Year</th>
<th>1997</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>Cost Adjusted</td>
<td>Nominal</td>
</tr>
<tr>
<td>Gini coefficient ((\times100))</td>
<td>13.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Theil index ((\times1000))</td>
<td>29.7</td>
<td>23.9</td>
</tr>
<tr>
<td>Within states</td>
<td>9.5</td>
<td>11.6</td>
</tr>
<tr>
<td>Between states</td>
<td>20.2</td>
<td>12.3</td>
</tr>
</tbody>
</table>

Table 3 illustrates the quantitative magnitude of cross-state variation in education spending per student. The latter is reduced, but not eliminated, when adjusting for differences in living costs across states (see Table 4).
Table 3: Variation in expenditures per student across U.S. states and over time ($2005). No adjustment in living costs across states.

Table 4: Variation in expenditures per student across U.S. states and over time ($2005). Adjustment in living costs across states.

The ranking of states in terms of expenditures per student is fairly stable over time. The rank correlation of state-level expenditures per student in 2005 with expenditures per students in 1975 is 0.64 (p-value 0.00).

2.3 Income, Revenue, and Expenditures Within and Between States

In the following two sections I measure the elasticity of alternative measures of education revenue and expenditure to household income.

2.3.1 Within States

I use school district level data, matched to demographic and socio-economic information from the 2000 Census to compute the extent to which expenditures and revenues per student vary with average income per student in the district. Table 5 summarizes the results.

For the U.S. as a whole the elasticity of current expenditures and revenues per student to income per student across school districts is about 0.2. Conditioning the regressions on state dummies, cuts the elasticity by more than half, indicating that differences in income between states account for a significant portion of the association between expenditures and income. Abstracting from between-state differences for now, the table illustrates the equalizing role
Table 5: Elasticity of measures of education spending and revenue per student to income per student in the year 2000 across school districts. Data source: U.S. Census and NCES. Sample size: 10,026. Legend: ** denotes statistically significant at 1 percent level.

played by states’ and the Federal government. The Federal intervention lowers the within-state elasticity income elasticity of revenues from 0.14 to 0.09, while the state intervention alone lowers that elasticity from 0.88 to 0.14.

2.3.2 Between States

At the state level, average per student income across states is positively and significantly correlated with expenditures per student. Table 6 presents the cross-sectional elasticities of expenditures to income per student for a selected number of years.

Table 6: Cross-sectional elasticity of education spending per student on personal income per student in selected years.

Table 7 presents similar information using expenditure data adjusted by differences in living costs across states. The elasticity is positive and statically significant also in this case, although smaller in magnitude.

In the time series dimension (looking within a state over time), the elasticity of expenditures to income is about two-thirds if nominal expenditures are used and 0.4 if state-level expenditures are adjusted for differences in the cost of education services (Table 8).
Table 7: Cross-sectional elasticity of education spending per student on personal income per student in selected years. The education expenditures data are adjusted for differences in the cost of living.

<table>
<thead>
<tr>
<th>Year</th>
<th>Income elasticity</th>
<th>Robust Standard Error</th>
<th>R²</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>0.55</td>
<td>0.08</td>
<td>0.41</td>
<td>51</td>
</tr>
<tr>
<td>2000</td>
<td>0.52</td>
<td>0.09</td>
<td>0.36</td>
<td>51</td>
</tr>
<tr>
<td>2005</td>
<td>0.65</td>
<td>0.14</td>
<td>0.36</td>
<td>51</td>
</tr>
</tbody>
</table>

Table 8: Panel regressions of nominal and real education expenditures per student on personal income per student (nominal expenditures: years 1970–2008; real expenditures: years 1997–2005). Real education expenditures data are adjusted for differences in living costs across states.

<table>
<thead>
<tr>
<th>Expenditures Data</th>
<th>Income elasticity</th>
<th>Robust std error</th>
<th>R²</th>
<th>Obs.</th>
<th>State and year dummies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>0.66</td>
<td>0.03</td>
<td>0.99</td>
<td>2,038</td>
<td>yes</td>
</tr>
<tr>
<td>Real</td>
<td>0.38</td>
<td>0.07</td>
<td>0.97</td>
<td>459</td>
<td>yes</td>
</tr>
</tbody>
</table>

The next section presents a model that allows to draw a distinction between within and between state differences in education expenditures.

### 3 Benchmark Model

This section introduces the model economy. A key innovation of the model relative to the existing literature is the introduction of a multiplicity of labor markets that are supposed to represent U.S. states.

#### 3.1 Description and Timing

The model represents an economy where time lasts forever and individuals’ lives last one period. Following Bénabou (2002), agents make consumption-saving and labor supply decisions. Saving takes the form of investment in the human capital of an individual’s child and in the purchase of an asset. The human capital, in turn is one factor in determining the child’s income. The timing of an agent’s life is as follows:

- an agent is born and acquires her human capital at the end of a period;
• at the beginning of the following period the agent chooses a location in which to work
and raise her own child; a location is characterized by a wage, a housing price, and an
education policy;

• the residents of a location vote over education policy;

• production, consumption, saving, investment in human capital and redistribution take
place;

• parental investment in the child’s human capital, the education policy, parental human
capital and a shock determine the human capital of the offspring. The old consume
liquidate their assets and consume.

In what follows I describe the structure of the model in more detail, focusing on stationary
equilibria in order to simplify notation.9

3.2 Preferences and Technology

The economy is comprised by a continuum of measure one of labor markets (states) $S_j$, indexed by $j \in [0,1]$ and a continuum of measure one of non-altruistic agents $i \in [0,1]$ who live for three periods, as a child, young adult and old adult. Since I focus on stationary equilibria, in what follows I omit the time index and denote next period variables by a prime.

Children do not have preferences of their own. An agent $i$ living in state $j$ cares about consumption of goods when young $c$, consumption of goods when old, $c'$, housing consumption, $x$, time spent working labor, $l$, and the expectation of his child’s human capital $h_i^\prime$.10

Parental preferences are represented by the following utility function:

$$U = \rho [\ln c + \phi \ln x + \delta \ln c'] - \frac{ln}{\eta} + (1 - \rho) E [\ln h_i^\prime]$$

where $\rho, \phi, \delta \in (0,1)$ and $\eta > 1$. The logarithmic specification for consumption and the the isoelastic one for labor are borrowed from Bénabou (2002) and are essential to generate closed-form solutions.

The human capital of the agent’s child is given by the following relationship:

$$h_i^\prime = \xi_i h_i^\alpha (\bar{e}_{ij})^\beta$$

9 The extension to the case outside of stationary equilibria is conceptually straightforward.
10 The old agent does not consume housing and does not supply labor. These assumptions can be relaxed
at the cost of some additional algebra.
where $\xi'$ is a measure of the child’s innate ability. This is assumed to follow a lognormal distribution $\ln \xi_i' \sim N(\mu_{\xi}, \sigma_{\xi}^2)$. The parameters $\alpha$ and $\beta$ are such that the accumulation technology exhibits decreasing returns to scale: $\alpha + \beta < 1$. The variable $\tilde{e}_{ij}$ represents post-redistribution education expenditures to which the child of parent $i$ is exposed in state $j$.

Upon choosing his residence an agent with human capital $h$ who works $l$ units of time earns income $y_{ij} = w_jh_{ij}$, where $w_j$ represent the prevailing wage in the state. The budget constraint of an agent who resides in a location $j$ is

$$\begin{align*}
y_{ij} &= c_{ij} + p_jx_{ij} + e_{ij} + \frac{e_{ij}'}{R}
\end{align*}$$

where $e_{ij}$ are (pre-redistribution) education expenditures by the agent and $p_j$ is the unit price of housing. Here, $R$ denotes the endogenous return on savings. It is assumed that agents can buy shares in a mutual fund that owns all land and whose structure is specified below.

### 3.3 State Level Education Policy

Education expenditures to which a child is exposed in state $j$ is given by:

$$\begin{align*}
\tilde{e}_{ij} &= \left( \frac{\tilde{y}_j}{y_{ij}} \right)^{\tau_j} e_{ij},
\end{align*}$$

where the state education policy is summarized by the parameter $\tau_j$ and the variable $\tilde{y}_j$ represents the level of an agent’s income at which there is no redistribution: $\tilde{e}_{ij} = e_{ij}$. The policy parameter $\tau_j$ represents the extent of redistribution of education expenditures within the state across school districts. When $\tau_j = 0$ the education finance system is entirely local, while when $\tau_j = 1$ is centralized at the state level (in the sense that all children get the same level of expenditures).\footnote{It is straightforward to show that education expenditures in the case $\tau_j = 1$ (a pure state system) is the same as would be obtained if education expenditures were financed by a proportional income tax.} Given that agents choose to spend a constant fraction of their income on education, $1 - \tau_j$ represents the elasticity of post-redistribution education expenditures to an agent’s income.\footnote{The empirical counterpart of this elasticity is reported in Table 5. Since this model abstracts from Federal financing, the number closer to $1 - \tau$ is 0.14.}

The education policy $\tau_j$ is decided after location decisions have been made but before production occurs. Following Bénabou (1996), the decisive agent in the determination of $\tau_j$ in each location $j$ is assumed to be the agent at the $p$-th percentile of the distribution of
income, with \( p \) being independent of \( j \). When \( p = 1/2 \), this reduces to the standard majority voting system in which the agent with median income is decisive.\(^{13}\) The variable \( \tilde{y}_j \) must be consistent with the fact that the government policy is purely redistributive:

\[
\int_{j \in S_j} \left( \frac{\tilde{y}_j}{y_{ij}} \right)^{\tau_j} e_{ij} di = \int_{j \in S_j} e_{ij} di,
\]

where the integrals are taken over all agents \( i \) who reside in location \( j \).

### 3.4 Production of Goods, Housing Services, and Ownership of Land

Labor markets are ex-ante different in terms of total factor productivity \( A \). Production in a state occurs through the constant returns to scale technology:\(^{14}\)

\[
Q_j = A_j L_j
\]

where \( L_j \) denotes the total supply of efficiency units of labor in a labor market. Let \( A_j \) also be lognormally distributed across labor markets with mean normalized to one: \( \ln A_j \sim N (-\sigma_A^2/2, \sigma_A^2) \).

Housing services are produced by combining land, whose supply is normalized to one in each location, and units of the homogeneous final good. Let the production function for housing services in location \( j \) be given by:

\[
X_j = Z_j^\psi
\]

with \( \psi < 1 \). The input \( Z_j \) refers to the quantity of the final good employed in location \( j \). The aggregate resource constraint for the final good is:

\[
\int Q_j dj = \int Z_j dj + \int \int (c_{ij} + e_{ij} + c'_{ij}) didj.
\]

The total mass of land in the economy is owned by a mutual fund that pays an (endogenous) return \( R \). Agents can buy shares in this fund.\(^{15}\) The fund pays a dividend \( D \), equal to

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\(^{13}\)Notice that within each state the agent with median income also has median human capital.

\(^{14}\)All results go through with decreasing returns at the cost of more complexity in the algebra. They are available from the author upon request.

\(^{15}\)This arrangement decouples the decision to purchase housing services from that of owning a house.
the sum of land rents collected in each state, and formally defined as:

\[ D = \int \left( p_j Z_j^\psi - Z_j \right) dj. \]

### 3.5 Geographic Mobility

An agent is born in the state of residence of his parent and can freely choose where to locate as a young adult. Mobility is costless. The agent can also move as an old adult but this is irrelevant for the equilibrium.

### 3.6 Stationary Equilibrium

A stationary equilibrium is represented by a wage, housing price, and redistribution policy for each state, migration choices, consumption, education expenditures and labor supply for each agent, such that: i) firms producing output and housing services optimize; ii) policies are determined via majority voting taking as given the geographic distribution of population; iii) agents choose consumption when young and old, labor, and education spending to maximize their utility subject to the budget constraint in their state of residence; iv) migration choices are individually optimal; v) the market for the mutual fund’s shares clears; vi) the distribution of human capital is constant over time.

### 4 Characterization of the Stationary Equilibrium

In this section I characterize the stationary equilibrium of this economy. Specifically, in order to keep the model analytically tractable, I focus on a stationary equilibrium in which the distribution of human capital within each location is lognormally distributed. Given that the timing of the model is such that migration choices are followed by voting and then by production and consumption, in what follows I begin with the production stage and work backwards.

#### 4.1 Production, Consumption Choices and Housing Prices

I start from the decision problem of a young adult agent who has chosen his location of residence and is facing a known policy \( \tau_j \). The optimal consumption, leisure and education
expenditure choices are given by:

\[
\begin{align*}
    c_{ij} &= \frac{\rho}{\rho} y_{ij} \\
    c'_{ij} &= \delta R c_{ij} \\
    e_{ij} &= \frac{(1 - \rho) \beta}{\rho} c_{ij} \\
    x_{ij} &= \frac{\phi}{p_j} c_{ij} \\
    l_{ij} &= l(\tau_j) = (\hat{\rho} - (1 - \rho) \beta \tau_j)^{\frac{1}{\eta}}
\end{align*}
\]  

where \( y_{ij} \) is defined above and the parameter \( \hat{\rho} \) is defined as:

\[ \hat{\rho} \equiv \rho (1 + \delta + \phi) + (1 - \rho) \beta. \]

Notice that goods and housing consumption and education expenditures are linear in income, while labor supply only depends on the degree of redistribution of education expenditures.

From the representative firm’s profit maximization in each location, the wage \( w_j \) equals the marginal product of human capital:

\[ w_j = A_j. \]

The equilibrium return \( R \) offered by the mutual fund must be such that the demand and supply of shares equal one another. Equilibrium in this market amounts to requiring that the aggregate consumption of the old equals the mutual fund dividend \( D \) plus its value \( D/(R - 1) \):

\[ \int \int c'_{ij} d\tilde{d}j = \frac{R}{R - 1} D. \]

Replacing the definition of \( D \) and consumption into this equation yields the equilibrium gross return:

\[ R = 1 + \frac{(1 - \psi) \phi}{\delta}, \]

which is a constant.

The representative firm supplying housing services chooses \( Z \) to maximize profits:

\[ \max_Z \left\{ p_j Z^\psi - Z \right\} \]
leading to the first-order condition:

\[ \psi p_j Z_j^{\psi-1} = 1. \]

Taking into account the definition of \( X_j \) this leads to the following inverse supply function for housing services:

\[ p_j = \frac{1}{\psi} X_j^{1/\psi-1}. \] (8)

Equilibrium in the housing market requires that the supply of housing equals the demand for it. Replacing the latter into equation (8) and solving for \( p_j \) yields the following expression for the price of housing as a function of population and average labor income:

\[ p_j = \frac{1}{\psi} \left( \frac{\phi \rho}{\rho} n_j \bar{y}_j \right)^{1-\psi}. \]

Notice that the elasticity of housing prices to population and average income is positive and less than one.

4.2 Voting

Before production and consumption agents choose the level of redistribution of education expenditures. It is assumed that only young adults vote on education the policy parameter \( \tau_j \). Conditional on the saving choices they made when young, old adults are unaffected by \( \tau_j \) because there is no education spending when old.

In order to characterize her preferences over \( \tau_j \), I compute her indirect utility function at this stage. The latter is obtained by replacing equations (3)–(7) into the utility function (1) and using the assumption of lognormality to compute \( \bar{y}_j \). Specifically, the indirect utility function for an agent with human capital \( h \) residing in a state \( j \) with TFP \( A_j \), population \( n_j \) and a density of human capital among residents given by \( \ln h \sim N ( m_j, \Delta ) \), takes the following form (up to a constant):

\[ V ( \tau_j; h, n_j, m_j, \Delta, A_j ) = ( \hat{\rho} + \alpha (1 - \rho)) \ln h \\
+ \hat{\rho} \ln A_j - \rho \phi (1 - \psi) \left( \ln A_j n_j + m_j + \frac{\Delta}{2} \right) \\
+ ( \hat{\rho} - \rho \phi (1 - \psi) ) \ln l ( \tau_j ) - \frac{1}{\eta} \ln ( \tau_j ) \eta \\
+ (1 - \rho) \beta \tau_j \left[ m_j + \Delta \left( 1 - \frac{\tau_j}{2} \right) - \ln h \right]. \] (9)

The terms in the first two rows of this equation are independent of redistribution. The
term on the third row captures the effect of redistribution on labor supply and leisure, including general equilibrium effects through housing prices. The term on the fourth row represents the pure redistribution effect of the policy. A higher level of redistribution $\tau_j$ benefits agents with log human capital below the break-even level represented by the first two terms in the square brackets of the fourth row.

Notice that at the time of voting $(n_j, m_j, \Delta)$ are already set, while changes in $\tau_j$ have an effect on aggregate labor supply and therefore on the price of housing.

The preferred degree of progressivity varies according to an agent’s human capital $h$. The interior first-order condition with respect to $\tau_j$ for an agent with human capital $h$ is given by:

$$
\eta (m_j - \ln h) + 1 - \frac{\hat{p} - \rho \phi (1 - \psi)}{\rho - (1 - \rho) \beta \tau_j} + \eta (1 - \tau_j) \Delta = 0,
$$

so that the preferred tax rate of an agent declines monotonically with $h$.\(^{16}\) Notice that preferences over redistribution are single-peaked. I assume, as Bénabou (1996) that the decisive voter has human capital at the $p$-th percentile of the human capital distribution within a state. The human capital level of the pivotal voter is $h^p_j$ such that:

$$
\ln h^p_j = m_j + \sqrt{\Delta \Phi^{-1}(p)},
$$

where $\Phi$ denotes the cumulative distribution function of the normal distribution. If $p > 1/2$, the decisive agent has larger human capital than the median. It follows that the equilibrium level of redistribution $\tau_j = \tau^s$ is independent of location and solves the following quadratic equation in $\tau^s$:

$$
-\eta \sqrt{\Delta \Phi^{-1}(p)} + 1 - \frac{\hat{p} - \rho \phi (1 - \psi)}{\rho - (1 - \rho) \beta \tau^s} + (1 - \tau^s) \eta \Delta = 0.
$$

It is straightforward to show that an interior solution $\tau^s \in (0, 1)$ exists and is unique if and only if $p \in (p_{\text{min}}, p_{\text{max}})$, where these bounds are defined in the appendix.

### 4.3 Mobility

The first decision stage of an agent’s life is migration. Free mobility implies that an agent with a given human capital has to obtain the same utility independently of the location in which she chooses to settle. This means that for a worker with human capital $h$ the following

\(^{16}\) For high enough human capital an agent will prefer zero redistribution. Specifically, this occurs when log human capital is above $m_j + \Delta + \rho \phi (1 - \psi) / \hat{\rho} \phi$. 

condition must hold:
\[ V(\tau; h, n_j, m_j, \Delta, A_j) = \nabla(h) \] for all \((n_j, m_j, A_j)\),
(12)
where \(\nabla(h)\) is independent of \(j\) and takes the following form:
\[ \nabla(h) = \nabla + (\hat{\rho} + (1 - \rho)(\alpha - \beta\tau^*)\ln h. \] (13)

The constant \(\nabla\) is determined in equilibrium by the requirement that aggregate population has measure one:
\[ \int n_j dj = 1. \] (14)

Since all locations are characterized by the same redistribution policy, condition (12) implies that:
\[ \hat{\rho}\ln A_j - \rho\phi (1 - \psi)\ln (n_j A_j \exp (m_j)) + \tau^*\beta (1 - \rho) m_j = v, \] (15)
where \(v\) is an endogenous constant. The first term on the left-hand side represents the direct effect of higher wages on an agent’s utility, the second term captures the effect of higher housing prices in locations with larger population and average income. The third term captures the effect that a higher average human capital has on education expenditures. Equation (15) pins down the level of population \(n_j\) as function of the exogenous productivity of the location \(A_j\), and the (endogenous) distribution of human capital as summarized by the lognormal parameter \(m_j\). Given \(m_j\), it is straightforward to show that locations with higher TFP and wages must also have larger populations.\(^{17}\)

### 4.4 Human Capital Distribution and Population

Given equation (2) the law of motion for log human capital in state \(j\) is:
\[ \ln h_{ij}' = \ln \xi_{ij}' + \alpha \ln h_{ij} + \beta \ln \bar{e}_{ij}. \]

After some algebra, we obtain the parameters of the equilibrium distribution of human capital.

\(^{17}\)The overall effect of \(\ln A_j\) on equation (15) is positive because \(\hat{\rho} > \rho\) and both \(\phi\) and \(\psi\) are smaller than one.
capital in location $j$. The latter is a lognormal with parameters:

$$ m_j^s = \frac{\beta}{1 - \alpha - \beta} \ln \frac{l(\tau^s)(1 - \rho)}{\bar{\rho}} + \frac{\beta (1 - (1 - \tau^s)^2) \Delta^s / 2 + \mu_{\xi}}{1 - \alpha - \beta} $$.  

\hspace{1cm} + \frac{\beta}{1 - \alpha - \beta} \ln A_j $$.  

$$ \Delta^s = \frac{\sigma_{\zeta}^2}{1 - (\alpha + \beta (1 - \tau^s))^2} $$.  

Thus, locations with higher TFP are also characterized by higher average human capital, as long as $\beta > 0$. Notice also that the degree of redistribution has an ambiguous effect on average human log capital. On the one hand more redistribution leads to lower labor supply and lower accumulation of human capital. On this other, more redistribution leads to higher human capital because it increases the human capital of income-poor households with relatively high returns to investment more than it decreases the human capital of income-rich households. The latter effect prevails when inequality is relatively large. Redistribution also leads to smaller inequality, as measured by $\Delta^s$ within each state.

Notice that $\Delta^s$ and $\tau^s$ are jointly determined, since the majority-voting tax rate depends on $\Delta^s$ through equation (11) while the steady state value of $\Delta^s$ depends on $\tau^s$ through equation (17). Inequality, as measured by $\Delta^s$, is decreasing in $\tau^s$, while the equilibrium $\tau^s$ that solves equation (11) increases in $\Delta^s$. Thus, there is a unique solution for these two variables.

The full solution of the model implies that the equilibrium level of population in state $j$ is:

$$ n_j = A_j^{\theta^s} \exp \left\{ \frac{\sigma_{\alpha}^2 \theta^s (1 - \theta^s)}{2} \right\}, $$

where $\theta^s$ is the following function of the model’s parameters:

$$ \theta^s \equiv \frac{1}{\rho \phi (1 - \psi)} \left( \frac{\hat{\rho} + \tau^s \beta^2 (1 - \rho)}{1 - \alpha - \beta} - \frac{1 - \alpha}{1 - \alpha - \beta} \right). $$

Notice that the parameter $\theta^s$ can be either positive or negative. Thus, locations with higher TFP may have larger or lower populations in equilibrium. Finally, the equilibrium value of the terms $\nabla$ and $v$ in equations (13) and (15).
4.5 Education Expenditures Within and Across States

I measure inequality in expenditures per student using the Theil index $T^e$. The latter can be decomposed into a within and a between state component as follows:

$$T^e = \left( \sum_{j=1}^{n_j} \frac{E_j [\hat{c}_{ij}]}{E [\hat{c}_{ij}]} T_j d_j \right) + \left( \sum_{j=1}^{n_j} \frac{E_j [\hat{c}_{ij}]}{E [\hat{c}_{ij}]} \ln \frac{E_j [\hat{c}_{ij}]}{E [\hat{c}_{ij}]} d_j \right),$$

where $T_j$ is the within-state Theil index:

$$T_j^e = \frac{1}{n_j} \int \frac{\hat{e}_{ij}}{E_j [\hat{c}_{ij}]} \ln \frac{\hat{e}_{ij}}{E_j [\hat{c}_{ij}]} d_i,$$

and

$$E [\hat{c}_{ij}] = \int_{i \in S_j} n_j E_j [\hat{c}_{ij}] d_j$$

is the weighted average of each state expenditures with weights given by a state’s population.

After some algebra, the expression in (20) can be written as a function of the model’s parameters:

$$T^e = \frac{1}{2} (1 - \tau^s)^2 \Delta_s + \sigma_A^2 \left( \frac{1 - \alpha}{1 - \alpha - \beta} \right)^2.$$

Two observations are in order. First, the within-state Theil index is the same across locations and given by the first term on the right-hand side of equation (21).\footnote{This equals half of the variance of log education expenditures within each state.} Second, the between-state component is strictly positive as long as locations have different productivity ($\sigma_A^2 > 0$).\footnote{A similar decomposition can be performed for per capita income $y_{ij}$ and human capital. The Theil index for both variables is similar to the one in equation (21), except that the within state component is given by $\Delta/2$.}

5 Alternative Financing Schemes

In this section I consider several alternatives to the benchmark model. They differ in terms of the level of government at which redistribution of education expenditures occurs. In general one can think of two broad classes of redistribution schemes. On the one hand, there are mixed systems in which an agent’s expenditures depend on a local component (i.e., her own choices) and either a state component (i.e., a mixed local-state system as in the benchmark) or a Federal component (i.e., a mixed local-Federal system). On the other
hand, there are pure systems that are three special cases of mixed systems. One in which an
agent’s expenditures depend exclusively on her own choices (a purely local system), one in
which they are determined at the state level (a purely state system) and one in which they
are determined at the Federal level (a purely Federal system).

Historically, a purely local system captures the arrangement that prevailed in the U.S.
up to the Great Depression, whereby financing of education was for the most part a local
issue. A purely state system is currently in place in a few U.S. states such as California and
Hawaii. A purely Federal system prevails in some European countries in which education
financing is centralized at the highest level of government.

A mixed local-Federal system provides useful information about the properties of the
benchmark model. I start from this type as it facilitates the discussion of a purely Federal
system.

5.1 Mixed Local-Federal Financing

I now modify the model to allow for Federal redistribution of education expenditures. I
basically postulate that the Federal government behaves like a state, with the difference
that there is now only one redistribution policy \( \tau_f \) where education expenditures for
an agent with income \( y_{ij} \) are now given by:

\[
\hat{e}_{ij} = \left( \frac{\bar{y}_f}{y_{ij}} \right)^{\tau_f} e_{ij}.
\]

The following balanced budget conditions hold:

\[
\int \int \hat{e}_{ij} d\bar{y}_j = \int \int e_{ij} d\bar{y}_j.
\]

The Federal policy is determined before labor supply and consumption decisions are made
as in the previous sections. The decision problem of an agent for given taxes is analogous
to the ones in Section (4.1) with labor supply depending on \( \tau_f \), instead of \( \tau^*_j, l(\tau^f) \). The
first-order condition over \( \tau \) of a voter with income \( y \) is:

\[
\eta \left( \int \omega_j \ln y^m_j d\bar{y}_j - \ln y \right) + 1 - \frac{\tilde{\rho} - \rho \phi (1 - \psi)}{\tilde{\rho} - (1 - \rho) \beta \tau} + (1 - \tau) \eta \Delta = 0,
\]

where \( y^m_j \) denotes median income in state \( j \) and the weights \( \omega_j \) are given by:

\[
\omega_j = \frac{n_j \exp ((1 - \tau) (m_j + \ln A_j))}{\int n_j \exp ((1 - \tau) (m_j + \ln A_j)) d\bar{y}_j}.
\]
The integral of these weights is equal to one. Notice that the only difference between (22) and the analog condition that applies to state-level voting (equation 10) is represented by the first term on the left-hand side. Instead of the average log income within a state, redistribution now involves the weighted average of average log human capital across all states, with weights increasing in a state’s population, its average log human capital and TFP. Notice also that what matters for incentives to vote is an agent’s income and not its human capital alone because the redistribution of education expenditures happens across states as well.

The decisive voter is now the agent who ranks in the \( p \)-th percentile of the economy-wide income distribution, or the agent with income \( y^p \) defined by:

\[
\int n_j \Phi \left( \frac{\ln y^p - \ln l(\tau^f) - \ln A_j - m_j}{\sqrt{\Delta}} \right) dj = p.
\]

Since this equation does not have a closed-form solution for \( y^p \), I approximate the function \( \Phi(x) \) around \( x^p = \Phi^{-1}(p) \). A first-order approximation yields the following solution for \( \ln y^p \):\(^{20}\)

\[
\ln y^p \approx \int n_j \ln y^p_j dj \quad (24)
\]

or the population-weighted average of the \( p \)-percentiles of the state-level income distribution.\(^{21}\) Replacing equation (24) into equation (22) yields the equation for the equilibrium redistribution rate \( \tau^f \). While I cannot solve for the exact solution in closed-form, it is straightforward to show that \( \tau^f \) is larger than \( \tau^s \) if and only if:

\[
\int \omega_j \ln y^m_j dj > \int n_j \ln y^m_j dj.
\]

This is always the case because the \( \omega_j \) weights assign a higher weight to larger values of state-level median income than the simple population weights \( n_j \). The economic intuition for this result is that in a Federal system the decisive agent has an incentive to redistribute both within states and across states, while in a state system the only feasible redistribution is within state.

The equilibrium distribution of human capital in a system with federal financing is such

\(^{20}\)Specifically, I use the approximation \( \Phi(x) = 0.5 + \Phi'(0)x + O(x^2) \). Notice that a second-order approximation to \( \Phi \) would yield the same result because \( \Phi''(0) = 0 \).

\(^{21}\)The accuracy of this approximation increases as the variance parameter \( \sigma_A^2 \) declines. In what follows I compute the numerical solution of the model for the benchmark parameter values.
that average log human capital and its variance in state $j$ are:

$$m^f_j = \frac{\beta}{1 - \alpha - \beta} \ln l(T^f) (1 - \rho) \beta + \frac{\beta (1 - (1 - T^f)^2)}{1 - \alpha - \beta} \frac{\Delta^f/2 + \mu_f}{1 - \alpha - \beta}$$

$$+ \frac{\beta (1 - T^f)}{1 - \alpha - \beta (1 - T^f)} \ln A_j$$

$$\Delta^f = \frac{\sigma^2_\xi}{1 - (\alpha + \beta (1 - T^f))^2}.$$  

Notice that the expression for $m^f_j$ differs from the one corresponding to the state-level financing only because of the term that multiplies TFP. The constant term is the same as in equation (16), except for the difference in the policy parameter $T^f$ instead of $T^s$. The dependence of local average log human capital on local TFP is weaker than in case of state financing. This would be true even if $T^f = T^s$. The within-state variance of log human capital is also smaller in the Federal system. Thus Federal financing unambiguously leads to a smaller dispersion in human capital in the economy because of higher redistribution within and across states.

The distribution of population under Federal financing is also different. It can be shown that it is given by the same expression as in equation (18), with $\vartheta^s$ replaced by $\vartheta^f$, defined as:

$$\vartheta^f = \frac{\widehat{\rho} - \tau^f \beta (1 - \rho)}{\rho \varphi (1 - \psi)} - \frac{1 - \alpha}{1 - \alpha - \beta (1 - T^f)}.$$  

### 5.2 Pure Financing Schemes

In this section I briefly discuss the special cases of pure systems. In a purely local system there is no redistribution of education expenditures. The equilibrium is the same as in the mixed local-state system setting the redistribution variable $T^s = 0$. Relative to a mixed system, a purely local system entails higher within-state inequality, as $\Delta^s$ declines in $T^s$ and the same amount of between-state inequality. This system is another special case of the local-state mix system in which the redistribution parameter is set to $T^s = 1$. This system is a special case of the mixed local-Federal system in which the redistribution parameter is set to $T^f = 1$. Its negative effect on labor supply is similar to the state system, but the other implications are different. Specifically, notice that this system completely eliminates any connection between the state-level distribution of human capital and local productivity (equation 25).

The following comparisons can be established. The ratio of average human capital in the
The three terms in this expression reflect respectively: (i) the effect of redistribution on labor supply; (ii) on human capital accumulation within a state; (iii) on the distribution of population across states. Comparing a pure state system with a pure local one, the first effect is negative in the sense that redistribution by states reduces labor supply. The other two effects are positive instead. According to the second effect, redistribution facilitates accumulation of human capital by poorer households more than it hurts the accumulation by richer ones. This is the effect emphasized in the previous literature by Fernandez and Rogerson (1998) among others. The third effect is new and reflects the reallocation of population across states that occurs as a consequence of redistribution in a mixed local-state system. The intuition is as follows. A state with higher TFP is characterized by higher average human capital. Redistribution of expenditures makes a state more attractive to potential immigrants and increases its population size in a stationary equilibrium. Thus, relative to a local system, a mixed local-state system skewes the distribution of population towards states with higher TFP and higher average human capital. The average human capital in the economy is therefore higher than in a pure local system. The third effect is larger the larger the dispersion in TFP across locations.

Comparing the Federal and state systems one obtains:

$$\frac{\bar{h}^f (1)}{\bar{h}^s (1)} = \exp \left\{ \frac{\beta^2 \sigma_A^2}{(1 - (\alpha + \beta)^2)} \left( \frac{3}{2} \frac{1 - \alpha}{\beta} - 1 - \frac{1 - \alpha - \beta}{\beta} \frac{\hat{\rho}}{\rho \phi (1 - \psi)} \right) \right\}. \tag{26}$$

It is a-priori ambiguous whether this ratio is larger or smaller than one. Notice that a pure state and a pure Federal system have the same effect on labor supply and long-run inequality within each state. Thus, the effects (i) and (ii) are the same in these two systems. The only difference pertains to the term in $\sigma_A^2$. This reflects two types of effects. First, in a pure Federal system average state human capital is independent of local productivity. A Federal system lowers human capital in the richer states and increases it in the poorer states. As long as $\alpha$ and $\beta$ are not too large this effect raises average human capital in the economy. The second effect is the mobility effect (iii). Specifically, the ratio (26) tends to be less than one if either the share of housing consumption $\phi$ or the inverse price elasticy of housing supply are close to zero. In this case, according to equation (15), states with

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22 Recall that a pure local system is analogous to a pure state system with $\tau^s = 0$. 

24
higher average human capital also tend to have a larger population, everything else equal. In a state system local average human capital is an increasing function of local productivity, so states with higher productivity attract a larger share of the population than in a Federal system. It follows that in this case a higher fraction of the population lives in states with a higher level of average human capital, increasing the economy-wide mean. If housing prices react strongly to higher average incomes or if housing consumption is a large share of total consumption, instead, higher average human capital tends to lead to lower population and the Federal system leads to higher overall human capital.

6 Numerical Results

In this section I present some numerical results based on a calibrated version of the model. While the model can be solved analytically, the comparison across financing regimes discussed above sometimes requires comparisons of somewhat complicated expressions. To facilitate these comparisons I select a benchmark calibration of the model’s parameters and I refer to numerical results any time the sign of analytical expressions cannot be easily determined.

6.1 Parameter Values

A subset of parameters is the same as in Bénabou (2002). Specifically, the supply elasticity parameter is set to $\eta = 6$, the human capital production function parameters $\alpha = 0.35$ and $\beta = 0.25$. The discount factor $\delta$ is set to 0.46, with a time period equal to 20 years and a yearly discount factor of 0.96. The parameters $(\rho, \phi)$ are set jointly match the housing and K-12 education shares in aggregate consumption in the year 2000. They equal 17 and 5.1 percent according to the Economic Report of the President (2000). I obtain $\rho = 0.72$ and $\phi = 0.38$. The inverse housing supply elasticity is set to $1/3$ following Eppl et al. (2012), so $\psi = 3/4$. I would like the model to be consistent with the observed amount of inequality in real expenditures both within and between states. To achieve this I measure the U.S. average within-state cross-sectional standard deviation of annual log income, i.e. the counterpart of $\sqrt{\Delta}$ in the model and obtain a value of 1.03 using 2000 U.S. Census data. I then exploit the fact that the Theil index decomposition in Table 2 shows that half of the overall expenditures inequality is between states. Hence, equation (21) implies that $(1 - \tau^s)^2 \Delta^s = 0.0023$, where the right-hand side is the Theil coefficient for the overall economy (see Table 2). This together with the measured value of $\Delta^s$ is used to obtain $\tau^s = 0.8527$. Finally, I impose this number in equation (11) and obtain a value for $p = 0.56$. Hence the decisive voter has human capital above the median. The parameter $\sigma_\xi$ is set to guarantee that $\sqrt{\Delta} = 1.03$, 25
yielding a value $\sigma_\xi = 0.95$. Finally, $\sigma_A$ is set by requiring that the between state portion of expenditures inequality in the model is half of the total. This gives $\sigma_A = 0.09$.

6.2 Results

In this section I present some numerical results using the calibrated version of the model. In the mixed local-Federal system, the equilibrium redistribution parameter is equal to $\tau_f = 0.8534$. The latter is slightly larger than its state-level counterpart, as the approximation in Section 5.1 suggests.

Figure 2 presents the density of individual human capital in the economy for the two mixed financing system I considered, the local-state and the Federal-state one. Figure 3 presents the distributions produced by the three pure systems - local, state and Federal.

The mixed state and Federal systems produce very similar densities to the pure state and Federal ones. This is not shown in the figures, but it may be expected since the calibrated value of $\tau$ in each is about 0.85, which is close to one. A purely local system gives rise to a distribution of human capital that is first-order stochastically dominated by either a pure state system or a pure Federal system. Similarly, the density generated by a pure Federal system is itself stochastically dominated by a pure state system. The latter result is not due to differences in rates of redistribution as these two systems are characterized by practically identical values of $\tau$ in this numerical example.

23 Notice that none of these distributions is lognormal because each is obtained as the weighted sum of a continuum of lognormal densities with different location parameters.
Figure 3: Human capital densities in the three economies with “pure” systems.

Figures 4, 5 and 6 report states’ population, average human capital and housing prices, as a function of TFP in the three pure systems.

Using the numerical values of the parameters described in the previous section, I find that the pure state system generates about 12.6 percent more human capital than a purely local one. This net gain reflects a loss by 0.6 percent because of distortions to labor supply due to redistribution, a gain by 13 percent associated with decreasing returns in the accumulation of human capital, and a gain by 0.2 percent due to the effect of redistribution on a state’s population.\(^\text{24}\) A pure state system also features about 8.6 percent higher human capital than a purely Federal one.

7 Conclusions

[Preliminary]

This paper studies the process of human capital accumulation in an heterogeneous agents economy characterized by multiple locations (states) within a federation. Human capital accumulation can be financed in one of three ways: entirely locally, locally with redistribution of education expenditures at the state level, or locally with redistribution of expenditures at the Federal level. The previous literature has mostly focused on the implications of school finance reforms - such as those that have occurred in the U.S. in the last 40 years - involving an increase in states’ role at the expense of local funding. This paper takes this analysis

\(^{24}\)A mixed local-state system generates about 14.7 percent more human capital than a purely local one.
Figure 4: Population by productivity in the three “pure” systems.

Figure 5: Average human capital by productivity in the three “pure” systems.
further by drawing a distinction between state and Federal financing. This focus is motivated by the evidence that at least half and possibly more of the differences in education spending per student in the U.S. are between, rather than within, states. The paper has two goals. First, investigate the conditions under which heterogeneity in average expenditures across states can occur in economies where states decide autonomously on redistribution policies and individuals are free to move to arbitrage away possible differences in wages, housing prices, or public policies. Second, explore the implications of alternative systems of financing for aggregate human capital accumulation and for welfare. The model is purposefully simple and can be solved analytically. This has the advantage of facilitating the analysis of the mechanisms behind the results.

I have obtained two types of results thus far. On the positive side, in equilibrium, the model generates dispersion in average education spending across states. States with higher productivity spend more per capita, which is consistent with the data. It also generates dispersion in education expenditures within each state. On the normative side, a numerical comparison between the benchmark system characterized by a mix of local and state financing and a purely local one, reveals that the mixed system leads to a significant steady state gain in average human capital relative to the local one. A comparison between the benchmark model and one in which redistribution occurs at the Federal level shows that a Federal system reduces the sensitivity of a child’s education expenditures to his parents’ income and leads to a smaller dispersion in expenditures across states.

Figure 6: Housing price by productivity in the three “pure” systems.
References


