Income Distribution, Communities and the Quality of Public Education:
A Policy Analysis

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1. Introduction

One of the most striking features of the primary and secondary public education system in the US is the large disparity exhibited across districts in spending per student.\(^1\) As Table 1 illustrates for jurisdictions in several states, spending per pupil can vary by as much as a factor of two even across nearby communities. It is not really surprising that this is so. Given that a substantial proportion of the expenditures on public education is financed at the local level (approximately 45%), the differences in expenditures per student reflect, in large part, the realities of the US income distribution and its allocation across states and neighborhoods.

These unequal levels of educational expenditures per student have been condemned by many on grounds of efficiency, morality and legality. Advocates of reform have argued along the following lines: (i) Large differences in financing are inefficient since, given same initial abilities, poorer schools will turn out far fewer future scientists, violinists, etc., due to inadequate resources. (ii) A system that allows the accidents of geography and birth to determine the quality of education received by an individual is inimical to the idea of equal opportunity in the market place. And, (iii) that education is a fundamental right, equal access to which is thus mandated by the 14th Amendment of the US Constitution or by similar clauses in state constitutions.\(^2\)

In the last few decades the question of whether inequality in educational expenditures constitutes a denial of equal opportunity and of constitutional

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\(^1\)For an eloquent, if unsystematic, portrayal of this fact see Kozol (1991).

\(^2\)For a review of some of these arguments see Berne (1988) and Wise and Gendler (1989).
guarantees has been the subject of many court battles.³ Arguments marshalled in defense of the status quo have contested the relationship between educational expenditure and educational quality (and hence equal opportunity) and the intrusion by the state on matters of local control.⁴ Nonetheless, since 1970 almost half of the major judicial cases decided have resulted in an overturn of a state's school finance system and many other states have independently initiated reforms in response to these cases.⁵ The judicial systems, however, have left it to the different states' legislatures to devise alternative systems of financing public education.

Although economic issues figure prominently in policy discussions concerning educational finance and its reforms, formal economic analysis seems to play little, if any, role in informing these debates.⁶ In view of the importance of these issues, this is rather troubling. The interactions among all the variables involved in educational reforms are far from simple to comprehend and, as the experience of California eloquently attests, well-intentioned programs may have rather unfortunate and unintended consequences. There, the combination of the Serrano decision and Proposition 13 left 91.1% of students within a $100 expenditure band in 1985-1986. Between 1970 and 1989, however, California dropped from a rank of 23 to 46 among all states in

⁴The association between school quality and other variables has been a topic of controversy since the Coleman report (Coleman et al. (1966)). In a recent study, Card and Krueger (1992) find a significant positive effect of school quality on mean earnings. See references therein for a discussion of the related literature.
⁵Since 1970 New Jersey, Kansas, Wisconsin, California, Connecticut, Washington, West Virginia, Wyoming and Arkansas have had their school finance system overturned in court rulings.
⁶A notable exception is Inman (1978). He simulates the effect of diverse educational reforms on agents' welfare within a complex multi-community model.
terms of its expenditures on public elementary and secondary education as a percentage of personal income.\textsuperscript{7}

This paper takes the stand that an examination of the interactions among communities, income distribution, individual preferences, and institutions is critical to understanding the effects of reforms of the public education finance system. Although any model that attempted to fully incorporate all aspects of these variables would be far too complex, our aim here is to provide a theoretical analysis of the effects of different reforms within a framework that is able to capture some features of the major forces likely to be at work, yet which retains sufficient tractability to illuminate their interactions. To this end we consider a multi-community model in which individuals differ in their initial income and in which education is publicly provided at the community level. Education is financed by a local income tax and individuals are free to decide in which community they wish to reside. The amount that is spent per student in a community determines the community's quality of education and consequently the future earnings of individuals in that community. The tax rate is determined by majority vote within the community.

The model outlined above is meant to capture three important features of the US economy and its system of public education: (i) heterogeneity of income across individuals and communities, (ii) mobility of individuals across communities, and (iii) community control of education. We further simplify the model by restricting most of our analysis to the case of two communities and three income groups—the minimum necessary to obtain an interesting

\textsuperscript{7}See Benson, C. and O'Halloran, K. (1987). Serrano v Priest is the 1971 State Supreme Court case which ruled unconstitutional California's system of financing public education. Proposition 13 placed a limit on local tax rates. Data is from various issues of the US Statistical Abstract.
analysis. We subsequently discuss how the analysis is modified by the introduction a continuous income distribution.

In all the stable equilibria of our model, individuals stratify themselves into communities according to income. These equilibria are characterized by the coexistence of a high tax–high quality of education community peopled by those individuals with higher incomes and a low tax–low quality of education community where individuals with lower incomes reside.

We use the model described to assess the impact of several types of reforms (directly and indirectly related to education finance) on the quality of education in both communities and on individual welfare. We focus our analysis on three major types of policies: those that attempt to legislate quality directly, those that target primarily the composition of a particular community, and those that redistribute income through taxes.

Our model generates several interesting results. We find that reforms that attempt to directly affect the quality differential between the wealthy and the poor community by capping the quality level in the wealthy neighborhood lowers the welfare of all individuals. Depending on the identity of the median voter in the poor community, this may also be the consequence of a policy that mandates a higher quality of education in the poor community. Moreover, the difference in the quality levels between communities may even increase.

Policies that influence educational quality through attempts to change the composition of a community (by offering, for example, subsidies to individuals who choose to locate in a particular community) also have some rather surprising consequences. We find that a subsidy that promotes the location of middle-income individuals in the poor community is Pareto improving under certain circumstances and can raise the quality of education
in both communities. A policy that subsidizes the residence of middle income individuals in the wealthy community, on the other hand, makes all individuals worse off (including those receiving the subsidy!) and decreases the quality of education in both communities. If the subsidy policy is used solely to assist the poorest individuals to locate in the wealthy community, however, this policy is then potentially Pareto improving.

We also consider redistributive tax policies. In one variant only the wealthiest individuals are taxed and the proceeds are distributed to the poorest individuals. We find that this policy may be Pareto improving and can increase the quality of education in both communities. In a different policy variation, taxes are levied on all individuals in the wealthiest community and redistributed to all residents of the poor community. This policy tends to make all individuals better off, to increase the quality of education in both communities, but also to increase the inequality in educational quality across communities. Some of the theoretical results we obtain in this section are ambiguous. A numerical example illustrates some possible outcomes of these tax policies.

The paper is organized as follows: Section 2 develops the model and the equilibrium concept that will be employed. Section 3 analyzes several policy reforms within the framework developed. Section 4 extends the analysis to a continuous income distribution and section 5 concludes.

2. The Model

We wish to analyze a model that will help shed light on how different policies may affect both the quality of education across communities and welfare among income groups. The essential features that such a model should possess are (i) communities, (ii) individuals that differ with respect to
income and that are able to exercise some element of choice with respect to where they wish to reside, (iii) a mechanism that translates individual preferences into a collective choice, and (iv) a technology that transforms expenditures on education into a quality of education.

To incorporate all the above characteristics into a model in a tractable fashion is difficult. We choose to focus on a model in which there are only two periods, two communities, three income groups, public education is the only option available to individuals, the quality of education is solely a function of the level of expenditure per capita within a community, and spending on education is determined by majority vote. While it is possible to argue with each one of these assumptions and simplifications, they nonetheless seem to possess enough richness to highlight many issues of concern in the debate about education finance, while at the same time preserving sufficient simplicity to permit an analysis within a multi-community model. Models of this genre can easily become intractable and most of the related literature either restricts their analysis to characterization of equilibria and conditions for existence or resorts immediately to simulations.8

There is a continuum of two-period lived individuals with identical preferences given by

\[ u(c_1) + \beta u(c_2) \] (1)

where \( c_1 \) is period-one consumption and \( c_2 \) is consumption in period two. We assume that \( u \) is strictly concave and differentiable. Individuals differ in

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8For a discussion of the difficulties inherent in working with multi-community models of local public goods see, for example, Rose-Ackerman (1979), Rubinfeld (1987), Stiglitz (1977) and Epple, Filimon, and Romer (1984). These types of models have been used by, among others, Epple and Romer (1991) to study redistribution, by Durlauf (1992) to study the dynamics of income distribution, and by de Bartolome (1991) to examine efficiency properties when peer effects exist.
their initial (period one) income $y_i$ which takes on one of three values indexed by $i=1,2,3$ with $y_1 > y_2 > y_3$. The fraction of individuals with initial income $y_i$ is given by $\lambda_i$. We assume $\lambda_i > 0 \ \forall i$.

There are two communities. Each community is characterized by a proportional tax rate on first-period income and by the quality of public education that it provides.\footnote{Although in reality property taxes determine the level of spending on local public goods in a community, we preferred not to introduce another market (housing) and an additional source of distortionary taxation and to keep the analysis more transparent instead. For multi-community models that explicitly incorporate a land/housing market see, for example, Rose-Ackerman (1979), Epple and Zelenitz (1981), Inman (1978), Epple, Filimon, and Romer (1984), and Epple and Romer (1991). See, however, Henderson (1985) for a critique of the literature's way of incorporating these markets.} We assume that all residents of a given community receive the same quality of public education and that, furthermore, they cannot choose to supplement this education privately. All tax revenue is assumed to be spent on education and the quality of public education is determined by the amount of public spending per resident. Education, therefore, is a local publicly provided private good.

An individual's period-one consumption is equal to her after-tax income. Second-period consumption is given by second-period income, which is determined by the quality of education. In particular, we assume that second-period income is an increasing, concave and differentiable function ($f$) of the quality ($q$) of education received in the first period. Note that we rule out both the existence of capital markets that allow individuals to borrow against future earnings and of a technology (other than education) that allows individuals to transfer period-one income into the future.\footnote{The extreme form of this assumption could easily be relaxed.}

For a given profile of tax rates and educational quality across communities, each individual is assumed to choose a community in which to live...
taking as given the choices of all other individuals. Given each individual's choice of residence, a community's tax rate \( t \) (and hence the quality of its education) must correspond to that which would be chosen by its residents through majority vote. That is, for \( t' \in [0,1] \) to be the tax rate in a community, there must be no tax rate \( t \in [0,1] \) which is preferred to \( t' \) by more than 50\% of the community's residents.\(^{11}\)

An important issue in defining equilibrium is the nature of the assumptions made by the voters upon choosing a tax rate. Here we assume that communities are not "too strategic". That is, each individual's preferred tax rate is chosen under the assumption that the composition of the community's residents will not change as a result of the tax rate voted in, and taking as given the other community's tax rate and quality of education. This is a subgame-perfect equilibrium for a two-stage extensive form version of this game in which all individuals simultaneously choose a community in the first stage, and the tax rate is decided upon by majority vote in each community in the second stage.\(^{12}\) We now turn to a formal description of equilibrium.

Define \( \rho_1 \) as the fraction of those individuals with income \( y_1 \) that reside in community 1 and \( V^j_1 \) as the indirect utility of an individual with income \( y_1 \) that resides in community \( j \), i.e.,

\[
V^j_1 = u((1-t^j)y_1) + \beta u(f(q^j)) \tag{2}
\]

where \( t^j \) and \( q^j \) are, respectively, the tax rate and quality level in community \( j \). Note that \( q^j \) is given by:

\(^{11}\)We are assuming throughout that all individuals vote sincerely.

\(^{12}\)With the exception of Epple and Romer (1991), a similar version of this extensive form is implicitly employed by the multi-community literature. It would be of interest, but beyond the scope of this paper, to also examine other extensive forms (i.e., alternative definitions of equilibrium) which allow for more strategic interactions between communities.
where $\mu_j$ is the mean income in community $j$, and thus equal to

\[
\mu_1 = \frac{\sum \rho_i \lambda_i y_i}{\sum \rho_i \lambda_i}
\]

\[
\mu_2 = \frac{\sum (1-\rho_i) \lambda_i y_i}{\sum (1-\rho_i) \lambda_i}
\]

The preferred tax rate $\tilde{t}$ of an individual with income $y$ in a community with mean income $\mu$ is implicitly defined by:

\[
u'(y(1-\tilde{t})) = \beta f'(\tilde{\mu})u'(f(\tilde{\mu}))\mu/y .
\]

If either $\rho_i=0 \forall i$ or $\rho_i=1 \forall i$, then we define the tax rate in the empty community to be that given by (5) for $y=\mu=\gamma_1$ (i.e. the preferred tax rate for a $\gamma_1$ individual in a community with mean income equal to $\gamma_1$).

**Definition 1:** An equilibrium is an $x^*$ such that:

(i) Taking $x^*$ as given, each individual chooses to reside in the community in which her utility is highest, resulting at the aggregate level in $p_i-p_1$.

(ii) Taking the $p_i$ as given, each $t_j^*$ is a majority voting equilibrium for community $j$.

**Lemma 1:** In equilibrium no community is empty.

**Proof:** Suppose one community is empty. Then a $\gamma_1$ individual can always be made strictly better off by relocating in this empty community where she obtains her preferred tax rate at a higher mean income than in the other community.

There is always a trivial equilibrium in this model given by $\rho_i^*=.5$ for all $i$ and thus $t_1^*=t_2^*$ (i.e., both communities are identical). This is not, however, a particularly interesting equilibrium from the point of view of the questions that we wish to pose. Furthermore, this equilibrium is unstable.\(^{13}\)

\[^{13}\text{Instability is discussed at greater length further on in the paper.}\]
There is, however, at this level of generality, a problem with obtaining the existence of any other equilibrium. This problem is due to the tendency for individuals to wish to reside with others that possess an income greater than their own in order to obtain, for the same tax rate, a higher quality of education than that obtained by living with individuals of the same or lower income. In order to facilitate the existence and characterization of an equilibrium in this model, therefore, we impose the restriction on preferences given by Assumption 1:\textsuperscript{14}

**Assumption 1:**

\[- u''(c)c/u'(c) > 1 \quad \forall c \]  \hspace{1cm} (6)

This assumption ensures that the increase in the income tax rate that an individual is just willing to accept in return for any given increase in the quality of education is an increasing function of the level of her period-one income, for all quality–tax pairs.\textsuperscript{15}

In addition to (6), we assume the following joint condition on \( u \) and \( f \):

**Assumption 2:**

\[
\frac{\partial^2 u(f(t\mu))}{\partial t \partial \mu} \leq 0 \quad \forall (t, \mu) . \]  \hspace{1cm} (7)

This condition implies that, when faced with an increase in \( \mu \), the preferred tax rate of an individual with a given income yields higher consumption in

\textsuperscript{14}Westhoff (1977) provides the first use of this kind of condition to obtain stratified equilibria. Similar versions of this condition have been employed by Roberts (1977), Epple and Romer (1991) and Epple, Filimon and Romer (1984).

\textsuperscript{15}In other words, the assumption implies that the slope of an individual's indifference curves in \( q-t \) space increases with period-one income for all \((q, t)\).
both periods. The importance of Assumptions 1 and 2 will be made clear in Propositions 1 and 4.

Assumption 1 has strong implications for the nature of the possible equilibria independently of the mechanism chosen to translate individual preferences within a community into tax rates. In particular, it implies that all equilibria (other than the set of trivial ones discussed further on) must be characterized by the properties enumerated in Proposition 1.

Proposition 1: All equilibria in which communities have different qualities of education must satisfy:

(i) \((q_1^*, t_1^*) > (q_2^*, t_2^*)\)

(ii) The income of every individual in community one is at least as great as that of any individual in community two.

Community one has arbitrarily been defined as the community with the highest quality of education.

Proof: (i) If \(q_1 > q_2\) then necessarily \(t_1 > t_2\), otherwise all individuals prefer community one to community two and, by Lemma 1, no community can be empty. (ii) By (5), if an individual with income \(y_j\) prefers \((q_1^*, t_1^*)\) to \((q_2^*, t_2^*)\), then so does every individual with income \(y_k > y_j\).

Thus, in equilibrium, individuals are stratified into communities according to initial income. One community (henceforth called C1) will be characterized by a higher tax rate, a higher quality education, and higher income residents than the other (henceforth called C2). Note that stratification is implied simply by Assumption 1 on preferences and by individuals' ability to choose the community in which they wish to reside.

\[16\] Given (6), a sufficient condition on technology to meet the requirement specified by (7) is \(f' \geq (f/q) + (f''f/q)\). This is satisfied, for example, if \(f\) is log linear or quadratic (over the relevant region).
Proposition 2: Majority voting results in the preferred tax rate of the individual with the median income within the community.

Proof: First note that, by (6), \( \delta \bar{c}/\delta y > 0 \) (where \( \bar{c} \) is, as defined in (5), the preferred tax rate of an individual with income \( y \) in a community with mean income \( \mu \)). Next, by concavity of \( u \), given a distribution of individuals across communities each individual's preferences are single peaked with respect to the tax rate in her community. Lastly, monotonicity and single peakedness together imply that the preferences of the individual with the median income in the community will be imposed as a result of majority vote.

Although (6) and (7) do not ensure the existence of a stratified equilibrium for all initial income distributions and utility functions, we focus on those cases in which such an equilibrium exists. The following proposition restricts the set of equilibrium outcomes.

Proposition 3: Let \( x^* \) be a stratified equilibrium. Then,

(i) All \( y_1 \) individuals reside in \( C_1 \).

(ii) If \( \rho_2^* \in (0,1) \), the median voter in \( C_1 \) is a \( y_1 \) individual.

Proof:

(i) Suppose not. Then \( C_2 \) is inhabited by all three income groups and \( C_1 \) is inhabited only by \( y_1 \) individuals. The median voter in \( C_1 \), therefore, is necessarily a \( y_1 \) individual. But then the utility of a \( y_1 \) individual is higher in \( C_1 \) than in \( C_2 \) since mean income is higher in the former.

(ii) Suppose not. Then a \( y_2 \) individual must be the median voter in \( C_1 \). But then the utility of a \( y_2 \) individual is higher in \( C_1 \) than in \( C_2 \) since mean income is higher in the former and \( y_2 \) is obtaining its preferred tax rate there. Hence, no \( y_2 \) individual would choose to locate in \( C_2 \).

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17 In fact, modifying the quality technology by adding a fixed cost of producing education, it is easy to ensure the existence of equilibria for all non-degenerate income distributions and utility functions (see Westhoff (1977)).
In view of Proposition 3, the two remaining candidates for equilibrium are \(\rho_3=0\) and \(\rho_2\in[0,1]\), or \(\rho_3\in[0,1]\) and \(\rho_2=1\). The case we consider to be of greatest interest and realism is that in which no community is completely homogeneous. Furthermore, for a continuous income distribution this is naturally the only possibility. Consequently, we restrict our attention to stratified equilibria characterized by \(\rho_3=0\) and \(\rho_2\in(0,1)\).

In the stratified heterogeneous community equilibrium just described, Proposition 3 implies that the median voter in \(C_1\) necessarily is a \(y_1\) individual. The median voter in \(C_2\), on the other hand, can be either a \(y_2\) or \(y_3\) individual. Because most of our analysis is local, we will hold the identity of the median voter fixed when we determine the effects of different policies on the equilibrium. We will, however, examine the consequences for both possible identities of the median voter in \(C_2\).

The potential equilibria of the type specified above can be parametrized by the fraction \((\rho_2)\) of the middle class that resides in the rich community, \(C_1\). To simplify notation we drop the subscript and call this fraction \(\rho\). Each choice of \(\rho\) determines the residents of the two communities and hence the quality-tax pair for each community. Let \(V_{21}(\rho)\) denote the utility of a \(y_2\) individual that resides in community \(j\) given that a fraction \(\rho\) of all \(y_2\) individuals reside in \(C_1\). In equilibrium \(V_{21}(\rho)\) must equal \(V_{22}(\rho)\), i.e. an individual with income \(y_2\) must be indifferent between residing in \(C_1\) and \(C_2\) given that a fraction \(\rho\) of \(y_2\) individuals reside in \(C_1\). Thus, an equilibrium can be depicted graphically as an intersection of two curves, \(V_{21}(\rho)\) and \(V_{22}(\rho)\).

Note that for a given identity of the median voter in each community, a change in \(\rho\) affects community allocations solely through its effect on mean...
Proposition 4 characterizes the effects of a change in mean income on the tax rate and quality of education in a community.

**Proposition 4**: Let $t^*$ be the majority vote tax rate for a community with mean income $\mu$. Then, holding the identity of the median voter constant:

(i) $t^*$ is decreasing in $\mu$ and $q^* = t^* \mu$ is increasing in $\mu$.

(ii) $V_j(\rho)$ is decreasing in $\rho$ for $j=1,2$.

**Proof**: (i) Differentiation of (5) yields:

$$\frac{dt^*}{d\mu} = -\frac{\beta[u''(f(q))f''(q)\mu + u'(f(q))f''(q)\mu]}{u''(y(1-t))y^2 + \beta\mu^2[u''(f(q))f''(q)\mu + u'(f(q))f''(q)\mu]} < 0 \quad (8)$$

and

$$\frac{dq^*}{d\mu} = -\frac{\beta u'(f(q))f'(q)\mu - u''(y(1-t^*))t^*y^2}{u''(y(1-t))y^2 + \beta\mu^2[u''(f(q))f''(q)\mu + u'(f(q))f''(q)\mu]} > 0 \quad (9)$$

Note that (7) implies that the numerator in (8) is negative.

(ii) Follows directly from (8) and (9) and noting that the effect of an increase in $\rho$, keeping the median voter constant, is to decrease mean income in both communities.

There are two situations that may characterize a point of intersection, depending upon which $V_j$ curve is steeper. Figure 1 depicts both possibilities. A stability argument suggests focusing on the situation depicted by point A in Figure 1 and shown in isolation in Figure 2.

**Definition 2**: An equilibrium $x^*=(r^*, t^*_1, t^*_2)$ is locally stable if there exists an $\varepsilon > 0$ such that for all $\rho_1$ with $|\rho_1 - r^*_1| < \varepsilon$,

$$(\rho_1 - r^*_1)(V_1^2(r) - V_1^1(r)) > 0 \quad (10)$$

where $r=(\rho_1, \rho_2, \rho_3)$. If an equilibrium is not locally stable, it is defined to be unstable.
This definition states that for small perturbations of the equilibrium distribution of individuals between communities at least some individuals should wish to relocate to their original community.

**Proposition 5:** (i) The equilibrium depicted by point B Figure 1 is generically unstable.

(ii) The equilibrium depicted by point A of Figure 1 is generically locally stable.

**Proof:** (i) Consider an arbitrarily small movement of \( y_2 \) individuals from \( C_1 \) to \( C_2 \) such that the median voters are unchanged.\(^{18}\) Then \( V_2^2(\rho) > V_2^1(\rho) \) and this equilibrium is unstable. (ii) Small perturbations of \( y_1 \) or \( y_3 \) individuals (that do not change the median voter) meet the stability condition (10) since each income group strictly prefers one community over the other and \((q^*, t^*)\) are continuous in a neighborhood of \( r \). A perturbation that involves only \( y_2 \) individuals, by inspection of Figure 2, obeys (10). Hence the equilibrium depicted by point A is locally stable.\(\|\)

**Proposition 6:** All equilibria that are not stratified are unstable.

**Proof:** Note first that all non-stratified equilibria must, by Proposition 1, have \( q_1^* = q_2^* \) and \( t_1^* = t_1^* \). Thus, both communities have the same mean income and the same median voter. Take the community with the greatest fraction of \( y_1 \) individuals (if both communities have equal fractions of \( y_1 \) individuals, arbitrarily choose a community). Call this community \( C_2 \). Now perturb the equilibrium by taking a small fraction of \( y_1 \) individuals from \( C_2 \) and relocating them in \( C_1 \). Mean income in \( C_1 \) now exceeds mean income in \( C_2 \) and

\(^{18}\) Generically, the median voter will not change as a result of small perturbations.
the income of the median voter in C1 is now either the same or higher than before whereas that of the median voter's in C2 is either the same or lower than before. Since for a given distribution of individuals between communities $u$ is single peaked in $t$ and $\delta t^*/\delta y > 0$, the possible change in median voter implies $V_1^1(r) \geq V_2^2(r)$. Furthermore, by (8) and (9), the change in mean income implies $V_1^1(r) > V_2^2(r)$. Hence all unstratified equilibria are unstable.11

An equilibrium of the type depicted in Figure 2 exists if there exists a $\rho'$ and a $\rho''$ such that for $\rho'' > \rho'$ we have $V_2^1(\rho') > V_2^2(\rho')$ and $V_2^1(\rho'') < V_2^2(\rho'')$, and the identity of the median voter is unchanged in the interval $[\rho', \rho'']$.19

Most of the results obtained in the next section are local results, and hence apply to any equilibrium of the type depicted in Figure 2. The remainder of this paper is concerned with analyzing the implications of policy interventions assuming that the economy starts at this type of equilibrium.

3. Policy Analysis

(i) Subsidy Policies to Increase Residency in the Wealthy Community

There are various policies in place in the US which attempt to increase the exposure of lower income individuals to the higher quality public services provided by wealthier communities. This is arguably something that is accomplished by policies that subsidize housing for low-income individuals in richer communities, by the busing of school children across school districts.

19A sufficient condition for uniqueness of equilibrium (ignoring the trivial equilibria), in addition to the conditions for existence given above, is that the slope of $V_2^1(\rho)$ be greater in absolute value than the slope of $V_2^2(\rho)$ at each $\rho$ and that the identity of the median voter in both communities remain unchanged. A necessary and sufficient condition for the identity of the median voters not to change is $\lambda_1 > \lambda_2 < \lambda_3$. 
etc.. We shall show that it matters very much which individuals are targeted by these policies. In fact, we demonstrate that subsidy policies that target $y_2$ individuals make all individuals in both communities worse off, whereas those that target $y_3$ individuals are potentially Pareto improving.

(a). A Policy that Targets $y_2$ Individuals

Within the context of our model, a reasonable interpretation of the policies described above is a subsidy to $y_2$ individuals in $C_1$. We shall show that this policy not only makes those individuals left residing in $C_2$ worse off, which is not surprising in itself, but that it actually decreases the utility of all individuals. On the other hand, as we show in section 3(ii), a policy that subsidizes the residency of $y_2$ individuals in the poorer community may be Pareto improving.

Consider, therefore, a marginal subsidy to those $y_2$ individuals that reside in $C_1$, postponing for now the issue of how to finance this policy. In terms of Figure 2, this policy shifts the $V_1^1$ curve upward and leaves the $V_2^2$ curve unchanged since, for a given $\rho$, the utility of $y_2$ individuals in $C_2$ is unaffected by such a policy. Consequently, the new equilibrium is characterized by a higher $\rho$ and a lower $V_2^2$.

The effect on $V_1$ is not immediate from the induced shifts in the $V_2^2$ curves. On the one hand, the subsidy to $y_2$ individuals increases mean income in $C_1$ at the initial $\rho$ (and therefore has a positive effect on $V_1^1$). On the other, however, the increased inflow of $y_2$ individuals into $C_1$ works to decrease $\mu_1$ with the opposite effect on $V_1^1$. The net effect, nonetheless, is unambiguous—$\mu_1$ decreases. To see this, observe that had $\mu_1$ increased or remained constant, then the equilibrium $V_2^2$ would also have increased since, by Proposition 4, taxes would not have increased and quality would not have
decreased in C1. In equilibrium $V_2$ falls however, indicating that $\mu_1$ must also be lower and, therefore, that $V_1$ also decreases.

Independently of whether a $y_2$ or a $y_3$ individual is the median voter in C2, the decrease in the mean income in that community implies a higher tax rate and a lower quality education. Consequently, $V_3$ also decreases in equilibrium. Thus, the new equilibrium is Pareto inferior to the zero subsidy equilibrium and has higher tax rates and lower quality of education in both communities than the original equilibrium.

The preceding discussion ignored the issue of how the subsidy is financed. Importantly, the result—a decrease in the welfare of all individuals—is robust to the identity of the group of individuals taxed to finance the subsidy. A tax on $y_3$ individuals either leaves the original equilibrium unchanged (if a $y_2$ individual is the median voter in C2) or shifts the $V_2$ curve down (if a $y_3$ individual is the median voter) since $y_3$ now prefers a lower tax rate for the same mean income, thereby reinforcing the above effects. Similarly, a tax on $y_1$ individuals causes them to vote in a lower tax rate than before, thereby increasing $V_1^1$ and augmenting the effects outlined above. Finally, a tax on $y_2$ individuals that subsidizes those $y_2$ individuals that reside in C1 is only a transfer from $y_2$ individuals in C2 to those in C1. In terms of Figure 2, therefore, this policy shifts the $V_2^1$ curve up and the $V_2^2$ curve down, again reinforcing the initial effects. It follows that a policy that uses the proceeds of any combination of the taxes discussed above to subsidize the residency of $y_2$ individuals in C1 results in lower welfare for all.

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20 We assume the use of a proportional income tax to finance the subsidy.
(b). A Policy that Targets $y_3$ Individuals

Consider next a policy that subsidizes the residency of $y_3$ individuals in Cl. The analysis of the effects of this policy cannot be conducted in terms of the $V^1_2$ curves since that diagram assumes that all of group $y_3$ resides in C2.

Note first that the subsidy needed to induce any $y_3$ individual to reside in Cl (for any value of $\rho \in (0,1)$) is less than $y_2 - y_3$. To see this, note that in equilibrium a $y_2$ individual is indifferent between residing in both communities. Since a $y_3$ individual's alternative to receiving a subsidy by residing in Cl is to remain with income $y_3$ in C2, it follows that the subsidy needed by a $y_3$ individual to move to Cl is less than $y_2 - y_3$. At the original value of $\rho$, therefore, the effect of this policy is to decrease $\mu_1$ (and hence also $V^1_2$ and $V_1$) and to increase $\mu_2$ (and hence also $V^2_2$ and $V_3$). The induced inequality in the level of utility enjoyed by $y_2$ individuals between communities implies that $\rho$ must fall from its original level, which serves to reverse the original decrease in $\mu_1$ but further increases $\mu_2$, $V^2_2$, and $V_3$.

The outflow of $y_2$ individuals from Cl to C2, therefore, must be of a sufficiently large magnitude that $\mu_1$ in the new equilibrium exceeds that in the original equilibrium (otherwise the inequality between the utilities of $y_2$ individuals across communities would persist). In particular, the outflow of $y_2$ individuals from Cl must exceed the inflow of $y_3$ individuals. The new equilibrium, therefore, is characterized by a greater mean income in both communities and, consequently, by an increase in the level of utility of all individuals (regardless of the identity of the median voter in C2).

Before concluding that the above policy is Pareto improving, we must discuss how this subsidy can be financed. One tax policy that serves to reinforce the Pareto improving nature of the subsidy is a tax on $y_2$. 
individuals in C1. Such a policy increases the outflow of \( y_2 \) individuals from the wealthy community, thereby contributing to the positive effects of the subsidy policy.\(^{21}\)

(ii) A Policy to Increase Residency in the Poor Community

We now consider instead a policy that subsidizes (marginally) the residency of \( y_2 \) individuals in C2. Assume that the subsidy is financed by a tax on those \( y_2 \) individuals that choose to reside in C1.\(^{22}\) In terms of Figure 2, this policy has the effect, for a given \( \rho \), of shifting the \( V_1 \) curve down and the \( V_2 \) curve up, resulting in a decrease in the equilibrium level of \( \rho \) and an increase in \( V_2 \). This policy also benefits \( y_1 \) individuals since the fall in \( \rho \) increases mean income in C1, implying a lower equilibrium tax rate and a higher quality level there.

If a \( y_3 \) individual is the median voter in C2, the subsidy policy makes \( y_3 \) individuals better off since, by Proposition 4, the increase in C2's mean income implies, in this case, a lower equilibrium tax rate and a higher quality of education in C2 also. Consequently, under these conditions a policy that subsidizes the residency of \( y_2 \) individuals in C2 is Pareto improving.

If, however, a \( y_2 \) individual is the median voter in C2, the effect on \( V_3 \) is ambiguous. On the one hand, for any given tax rate the increase in mean income in C2 makes all individuals in that community better off. On the other hand, the \( y_2 \) median voter responds to the change in her income and in C2's mean income by voting in a different tax rate. By (5), the sign of the change

\(^{21}\)Taxes levied on other groups have ambiguous welfare effects in general.

\(^{22}\)We are assuming that the tax is levied on period one income. Other tax policies have ambiguous welfare consequences.
in the tax rate depends on the magnitudes of the changes in both $y_2$'s income and in the community's mean income. A lower tax rate increases $V_3$; a higher tax rate decreases $V_3$. In the latter case the net effect on $V_3$ is ambiguous since the increase in mean income works to increase $y_3$ welfare but the greater tax rate reduces it.

(iii) A Cap on the Quality of Education in the Wealthy Community

Some states have implemented policies that in effect place a cap on the quality of public education of their richer communities. The effects of such policies can be studied in our model by analyzing a restriction of the quality of education in Cl to some level $\bar{q}_1$ (or, equivalently, a restriction on the level of spending on education per student). This restriction is assumed to be binding at the original equilibrium level of quality in Cl.

In terms of Figure 2, a (marginally binding) cap on the quality of education in Cl shifts the $V_2^1$ curve up in the vicinity of the original equilibrium. To see why, note that at the initial level of mean income, Cl must institute a lower tax rate than previously in order to reduce the quality of education to its maximum allowed level. This decrease in the tax rate is preferred by $y_2$ individuals since, for the same mean income, they desire a lower tax rate than $y_1$ individuals. Thus, the new equilibrium is characterized by a greater $\rho$ and a decrease in $V_2$. Note that in the new equilibrium the quality cap must be binding. If it were not, the $V_2^1$ curves would be unchanged and would thus yield the original equilibrium.

The consequences of the quality cap policy are somewhat surprising. Although at the initial $\rho$ $y_2$ individuals in Cl are better off than before, the resulting outflow of $y_2$ individuals from C2 lowers $V_2^2$ and decreases mean income in Cl. The decrease in $\mu_1$ allows C1's tax rate to increase which
serves to lower the utility of $y_2$ individuals in $C_1$. Thus, the new equilibrium is characterized by a higher $\rho$, a decrease in quality in both communities ($q^*_1-q_1$), a higher tax rate in $C_2$, and a decrease in $V_1$, $V_2$ and $V_3$. Note that this conclusion holds independently of the identity of the median voter in $C_2$. Thus, this policy results in a Pareto inferior equilibrium relative to the policy of zero cap.

(iv) A Floor on the Quality of Education in the Poor Community

Next we consider a policy that mandates a (marginally) higher quality of education, $q_2$, in $C_2$. We assume that at the original equilibrium $q_2<q^*_2$ so that at the original $\rho$ this policy requires a higher tax rate in $C_2$. Note that, as in the previous policy analysis, the quality constraint must be binding in the new equilibrium.

The identity of the median voter in $C_2$ determines the direction in which the curves in Figure 1a shift in response to this policy. If $y_3$ is the median voter, the tax increase at the original $\rho$ moves the tax rate in $C_2$ closer to one preferred by a $y_2$ individual, thus increasing $V^2_2$ at the original $\rho$. If, however, $y_2$ is the median voter, the forced tax increase decreases the utility of a $y_2$ individual in $C_2$ at the original $\rho$. Hence, the $V^2_2$ curve shifts up in the former case and down in the latter. We analyze each case separately.

Given $y_3$ as the median voter in $C_2$, the new equilibrium is characterized by a decrease in $\rho$, an increase in the quality of education of both communities ($q^*_2-q_2$), a lower tax rate in $C_1$, a higher tax rate in $C_2$, and an increase in $V_2$. $V_1$ is also greater (since mean income in $C_1$ increases), but the effect on $V_3$ is ambiguous. Whereas the higher tax rate at the initial...
mean income decreases their welfare, the increase in mean income in C2 makes them better off.

If, instead, \( y_2 \) is the median voter in C2, the new equilibrium is characterized by an increase in \( p \) and a decrease in \( V_2 \). The increase in \( p \) implies that \( y_1 \) individuals are likewise worse off than before since mean income in C1 falls. As in the previous case, two factors affect \( V_3 \). Now, however, they both serve to decrease \( V_3 \) since mean income falls and the tax rate is increased. Consequently, when \( y_2 \) is the median voter in C2 a policy that mandates an increase in the quality of education in C2 makes all individuals worse off.

The above disparity in results stems entirely from the fact that the tax increase has opposite effects on \( y_2 \)'s utility in C2 (at the initial \( p \)) depending on the identity of the median voter in that community. If \( y_3 \) is the median voter, a \( y_2 \) individual prefers a higher tax rate for the same mean income than that chosen by the community. Consequently, a small tax increase raises \( V_2^y \) above \( V_2 \) and generates a \( y_2 \) inflow into C2, thereby increasing mean income in both communities with the attendant beneficial effects. In the case of a \( y_2 \) median voter, the move away from this group's preferred tax rate causes a \( y_2 \) outflow into C1, thereby decreasing mean income in both communities and all individuals' utilities.

(v) Redistributive Tax Policy

We now explore the effects of some redistributive tax policies on the equilibrium of the model. We consider two policies: one that redistributes from the wealthiest to the poorest individuals (i.e. from \( y_1 \) to \( y_3 \)), and the other that redistributes from the wealthiest to the poorest community (i.e. from C1 to C2). Both policies are in place in many states.
(a). Redistribution From the Wealthiest to the Poorest Individuals

We consider a policy that places a proportional tax \( r \) on the income of \( y_1 \) individuals and distributes the proceeds in a lump-sum fashion to \( y_3 \) individuals. The tax base in \( C_1 \) remains unchanged (i.e. \( t_1^* \) is levied on \( y_1 \), not \( y_1(1-r) \)) but the tax base in \( C_2 \) includes the transfer (i.e. \( t_2^* \) is levied on \( y_3+ry_1(\lambda_1/\lambda_3) \)). We analyze the two components of this redistributive policy separately, beginning with the transfer of income to \( y_3 \) individuals.

Consider, therefore, a situation where \( y_3 \) increases and \( y_1 \) and \( y_2 \) remain unchanged. Independently of the identity of the median voter in \( C_2 \), the \( V_2^2 \) curve shifts upward and the \( V_2^1 \) curve is left unchanged resulting, in equilibrium, in a fall in \( \rho \) and an increase in \( V_2 \). In the new equilibrium mean income has increased in both communities. Thus, by Proposition 4, the utility of all three groups is higher as is the quality of education in both communities.

Next consider a proportional tax \( r \) solely on the income of \( y_1 \) individuals, assuming for now that the resulting revenue is simply discarded. Note that since \( C_1 \)'s tax base is unchanged at the original equilibrium tax rate, \( y_1 \) individuals have the same second-period consumption but lower first-period consumption. Consequently, they prefer a lower tax rate which, at the initial level of \( \rho \), is also closer to the rate preferred by \( y_2 \) individuals in \( C_1 \). Thus, the \( V_2^1 \) curve shifts up and the \( V_2^2 \) curve is left unchanged. The new equilibrium is characterized by a higher \( \rho \) and a lower \( V_2 \). Since mean income falls in both communities, so do \( V_1^1, V_3^1 \) and the quality of education in both communities.

Combining the two components of the redistributive tax policy suggests that the net effect on utility and on the quality of education is ambiguous.
Two different effects are at work here. First, the community composition effect given by changes in $\rho$ affects all individuals' utilities in the same direction (i.e. $V_i$ increases (decreases) as $\rho$ decreases (increases)). Second, $y_1$ individuals are worse off due to $r$ and $y_3$ individuals are better off because of the transfer. Intuitively, for this tax policy to be Pareto improving $\rho$ must decrease by a sufficient amount to offset the negative effect of $r$ on $y_1$ individuals. Although one can obtain analytic expressions for changes in utilities and $\rho$, these expressions are not particularly illuminating. A numerical example serves to illustrate some of the outcomes. The specification and results are shown in Table 2.

Panel A reports percent changes in utilities, in $\rho$, in total spending on education ($E$), and in educational quality in each community. For higher values of $y_2$, this policy makes $y_1$ individuals worse off but all other individuals better off, whereas for lower values of $y_2$ all individuals are made better off. The table shows that as $y_2$ decreases, the responsiveness of $\rho$ increases, resulting in a greater outflow of $y_2$ individuals from the rich community.

Table 2 also indicates changes in spending on education. In this example when $y_1$ individuals are made worse off, total spending on education increases although quality increases in the poor community and decreases in the rich community. When the policy is Pareto improving, quality increases in both communities and the ratio of quality in the poor to rich neighborhood increases. Increases in quality for both communities need not imply that total spending on education increases (since the poor community is becoming relatively larger) and, in fact, in these examples it decreases.
(b). Redistribution From the Wealthy to the Poor Community

We now consider a policy that taxes the income of all individuals in C1 at rate $r$ and distributes the proceeds lump sum to all individuals in C2. As indicated by our previous arguments (see also (3.1b)), the effect of this policy on the equilibrium is ambiguous. Intuition suggests, however, that this policy should have a larger impact on the movement of $y_2$ individuals from C1 into C2 since the tax directly affects their relative incomes in the two communities.

Panel B presents results for the same example used in panel A. In all cases the tax is Pareto improving, lowers total spending on education, and increases the quality of education in both communities. This is in accordance with the intuition expressed above since the greater the $\rho$ response, the more likely that this policy is Pareto improving. One difference between this and the previous policy, however, is that in all cases the increase in quality in the wealthy community exceeds that in the poor community in percentage terms, implying that inequality as measured by the ratio of qualities is increased by this policy.

4. Continuous Income Distributions

While the assumption of only three income types is a useful simplification, it is important to determine whether the results of the preceding section are robust with respect to changes in this feature. This section assumes a continuous distribution of income types and argues that the conclusions of section 3 carry over to this setting.

Note that Propositions 1 and 2 do not depend on the 3-type discrete income distribution and are also valid for any continuous income distribution. A stratified equilibrium, therefore, is now characterized by an income level
\( \tilde{y} \) such that \( C_1 \) contains all individuals with \( y < \tilde{y} \), and \( C_2 \) contains all individuals with \( y > \tilde{y} \). Individuals with income \( \tilde{y} \) reside in both communities. Each choice of \( \tilde{y} \), henceforth called the boundary individual, implies tax rates and education qualities for the two communities. If \( V_j^1(\tilde{y}) \) is the utility attained by the boundary individual conditional upon residing in community \( j \), equilibrium requires \( V_j^1(\tilde{y}) = V_j^2(\tilde{y}) \).

An important result in the earlier analysis was given by Proposition 4: increases in \( \rho \) implied a lower tax rate and a higher quality of education in both communities. This result reflected the effect of a change in a community's mean income on allocations holding median income constant. With a continuous income distribution the effect of the induced change in the identity of the median individual within a community can no longer be ignored. Letting \( \hat{y} \) denote the median income in a community with mean income \( \mu \), differentiation of equation (5) yields:

\[
\begin{align*}
\frac{\partial V_j}{\partial y} & = \frac{\partial}{\partial y} \frac{\partial V_j}{\partial \mu} = -\frac{\partial}{\partial \mu} \frac{\partial V_j}{\partial y} - \frac{\partial}{\partial y} \frac{\partial V_j}{\partial \mu}, \\
\frac{\partial V_j}{\partial \mu} & = \frac{\partial}{\partial \mu} \left[ \frac{1}{\rho} \left( \frac{\partial V_j}{\partial y} \right) - \frac{1}{\rho} \left( \frac{\partial V_j}{\partial \mu} \right) \right],
\end{align*}
\]

where \( A = \frac{u''((1-t^*)\hat{y})(1-t^*)\hat{y} + u'((1-t^*)\hat{y})}{u((1-t^*)\hat{y})} < 0 \).

Note that both mean and median income in each community are increasing in \( \tilde{y} \). The denominator in these expressions is identical to the one in (8) and (9) and is negative. The numerators, however, now contain an additional term \( A \) which, by Assumption 1, is negative. Although expression (12) is therefore always positive, the numerator of (11) cannot be signed without additional assumptions. Previously, condition (7) implied \( \frac{\partial t}{\partial \rho} < 0 \). Now a stronger condition is required to ensure that the effect of the change in mean income
on the tax rate dominates the effect of a median voter with a greater income. We henceforth simply impose $dt^*/d\tilde{y}<0$ and show that with this assumption the results of section 3 are robust to the introduction of continuous income distributions.

Given our previous assumption, $V_D^1(\tilde{y})$ is an increasing function of $\tilde{y}$. The intersection of the $V_D^1(\tilde{y})$ curves define an equilibrium. Proposition 6, which states that all non-stratified equilibria are unstable, carries over to this setting as does the argument in Proposition 5 which characterizes as unstable equilibria produced by $V_D^1$ intersecting $V_D^2$ from above. Thus, we focus only on stable equilibria as depicted in Figure 3.

Two examples illustrate how the results of section 3 carry over to this setting. First consider a cap on quality in the wealthy community. This shifts the $V_D^1$ curve up in the vicinity of $\tilde{y}^*$ and leaves the $V_D^2$ curve unchanged. The equilibrium value of $\tilde{y}$ decreases and, by (11) and (12), tax rates increase and quality of education falls in both communities. Thus, all individuals are made worse off by this policy (as in section 3.iii).

Consider now the policy of the previous section that subsidized $y_2$ individuals to locate in Cl. A similar policy in the present context would be to subsidize those individuals in C2 with an income in a small neighborhood of $\tilde{y}^*$. Ignoring the financing of this subsidy, this policy induces a discontinuity in the $V_D^1$ curve, shifting it upward in the neighborhood of $\tilde{y}^*$. Consequently, the new equilibrium is characterized by a lower value of $\tilde{y}$, higher taxes and a lower quality of education in both communities. Obviously, all individuals that do not move as a result of this subsidy policy are worse off than before. Some individuals that move to Cl and receive the subsidy, however, may be better off. Although this last possibility indicates a slight weakening of the result obtained in section 3 (where this policy was
 Pareto dominated by a zero subsidy policy), it is at most a fraction of those individuals who move that may be made better off since one can show that the boundary individual in the new equilibrium is strictly worse off and thus, by continuity, so are individuals with incomes only slightly greater.

The other policies can be analyzed similarly; the important point is that our previous findings are fairly robust when extended to continuous income distributions.

5. Conclusion

Making use of a simple multi-community model we obtain strong predictions about the impact of several policies on community tax rates, qualities of education, the allocation of individuals across communities, and welfare. We summarize our main findings below.

Policies that subsidize the location of particular individuals in specific communities have very different effects depending both on the income group and the community targeted. Whereas subsidizing middle income people to locate in the wealthy community reduces the welfare of all individuals and lowers the quality of education in both communities, a subsidy to locate lowest income individuals in the wealthy community can make everyone better off and raise the quality of education in both communities. A policy that subsidizes the residency of middle income individuals in the poor community, on the other hand, is Pareto improving and increases the quality of education in both communities.

Many states have attempted to deal with inequality in per pupil spending across communities by requiring that rich communities spend less and/or poor communities spend more. We find that a policy that limits spending in the rich community has negative consequences: the quality of education in both
communities decreases and all individuals are made worse off. The effects of a policy that mandates greater spending on education in the poor community depends on the identity of the median voter in that community. If the median voter is a middle income individual, then all individuals are made worse off.

A significant finding of our analysis is that a large number of policies produce the same qualitative welfare effect for all individuals. This is surprising since, given heterogeneity of individuals and the redistributive nature of the policies considered, one might have expected most policies to generate both winners and losers. Community composition effects play a key role in obtaining this consensus: were it possible to simply decrease (increase) the fraction of middle income people in the wealthy community, this would by itself increase (decrease) the welfare of all individuals. Policies that affect community composition, therefore, can make all better or worse off.

The analysis was deliberately carried out in a simple framework in order to facilitate an understanding of the interactions of some of the basic forces at work. The model as is captures three important features of the context in which expenditures on primary and secondary education are determined in the US: individuals differ in income, decision-making on educational finance occurs largely at the local level, and households are mobile across communities. Of course, many other factors were left out and would be of great interest to examine in future analyses. Prominent among these are: (i) the existence of a private alternative to public education,24 (ii) the ability of communities to render themselves more impermeable to the inflow of low

income individuals (through zoning, for example),\textsuperscript{25} (iii) different strategic interactions among communities, (iv) dynamic considerations,\textsuperscript{26} and (v) the existence of a housing market.

\textsuperscript{25}See Hamilton (1974).
\textsuperscript{26}See Durlauf (1992)
References


Figure 3
Table One

Expenditures Per Pupil in Several School Districts

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Source: Kozol (1991)
Table Two  Simulation Results

A. Tax on $y_1$ individuals

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B. Tax on community one

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Notes:

Specification in all cases is $u(c)=c^\alpha/\alpha$, $f(q)=q$, with $y_1=1$, $y_3=.95y_2$, $\alpha=-10$, $\beta=.5$, $\lambda=(.20,.35,.45)$. Percent changes correspond to change from $\tau=0$ to $\tau=.001$. 