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INCOME DISTRIBUTION, COMMUNITIES, AND THE QUALITY OF PUBLIC EDUCATION*

RAQUEL FERNANDEZ AND RICHARD ROGERSON

This paper develops a multicommunity model and analyzes policies that affect spending on public education and its distribution across communities. We find that policies that on net increase the fraction of the (relatively) wealthiest residents in the poorest community are welfare enhancing; policies that decrease this fraction can make all worse off. Appropriately financed policies to (i) redistribute income toward the poorest, (ii) increase spending on education in the poorest community, and (iii) make the poorest community more attractive to relatively wealthier individuals, produce chain reactions in which the quality of education increases and tax rates fall in all communities.

I. INTRODUCTION

A striking feature of the primary and secondary public education system in the United States is the large disparity in spending per student across districts.[1] As Table I 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 expenditures on public education is financed at the local level (approximately 45 percent), the differences in expenditures per student reflect, in large part, the realities of the U. S. 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 the same initial abilities, poorer schools will turn out far fewer future scientists, violinists, etc., due to inadequate re-

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1. For a moving, if unsystematic, portrayal of this fact, see Kozol [1991].

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TABLE I
TOTAL SPENDING ($) PER STUDENT FOR THE 1986–1987 ACADEMIC YEAR
(PRIMARY AND SECONDARY SCHOOLING)

New Jersey Area		Detroit Area		New York Area	
MontClair	6,442	Bloomfield Hills	6,976	Great Neck	12,868
Parsippany-Troy Hills	6,229	Birmingham	6,668	White Plains	11,045
Cherry Hill	5,695	Grosse Pointe	5,705	Syosset	9,125
Jersey City	5,656	Royal Oak	5,172	New Rochelle	7,970
East Orange	5,005	Pontiac	4,553	Hampstead	7,462
Camden	4,871	Detroit	3,854	Baldwin	7,251
Paterson	4,708	East Detroit	3,740	Levittown	7,210
Gloucester	3,814	Highland Park	3,105	New York City	6,433
Pemberton	3,668	Dearborn	2,684	Mount Vernon	6,328

Source: 1987 Census of Governments.

sources. (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 marketplace. (iii) Education is a fundamental right, equal access to which is thus mandated by the Fourteenth Amendment of the U. S. 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 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 into matters of local control.[4] Nonetheless, since 1970 almost half of the major judicial cases decided have resulted in an overturn of the 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

2. For a review of some of these arguments, see Berne [1988] and Wise and Gendler [1989].

3. For a history of U. S. school finance policy, see Guthrie [1983] and Berne [1988].

4. The 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.

5. Since 1970 New Jersey, Kansas, Wisconsin, California, Connecticut, Washington, West Virginia, Wyoming, and Arkansas have had their school finance system overturned in court rulings.

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 the myriad of 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.[7]

The aim of this paper is to provide a characterization of some of the features that a desirable policy should possess within a framework simple enough to be analytically tractable yet which possesses sufficient richness to identify basic forces at work that are likely to be present in more complicated models. We take the stand that an examination of the interactions among communities, income distribution, individual preferences, and institutions is critical to understanding how different reforms will impact total expenditures on education, its distribution across communities, and the welfare of various groups. To this end, we employ a multicommunity model in which individuals differ in their initial income and in which education is publicly provided at the community level.

In our model there are several communities, each (endogenously) characterized by a proportional income tax rate and by a quality of public education. Individuals are free to decide in which community they wish to reside. Education is financed entirely by the local income tax. 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.

In all the stable equilibria of our model, individuals stratify themselves into communities according to income. These equilib-

6. A notable exception is Inman [1978].

7. There, the combination of the Serrano decision and Proposition 13 left 91.1 percent of students within a $100 expenditure band in 1985–1986. Between 1970 and 1989, however, California dropped from a rank of 23 to one of 46 among all states in terms of its expenditures on public elementary and secondary education as a percentage of personal income. See Benson and O'Halloran [1987] for an account of this.

ria are characterized by the coexistence of higher tax-higher quality of education communities peopled by individuals with higher incomes, and lower tax-lower quality of education communities 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 across communities and on individual welfare. The general insight that emerges from our analysis is that policies whose net effect is to increase the number of residents in the poorest community will tend to be Pareto improving. As will be seen in detail further on, these policies, through various mechanisms, make the poorest community more attractive to the wealthiest residents of that community. By encouraging a greater fraction of these wealthier individuals to take up residence in the poorest community, community mean income is increased both there and in the next-to-poorest community. The effect of these changes in mean incomes is to increase the quality of education in the affected communities and to decrease tax rates. In what we consider to be the most compelling equilibrium, a chain reaction is unleashed, with the resulting reallocation of individuals leading to a higher quality of education in all communities (and lower tax rates everywhere), thereby strictly increasing welfare for all.

Our analysis indicates that the effects of some reforms can be sensitive to the number of communities and the residence pattern of individuals, whereas other reforms are robust to these specifications. In a sense that will be made more rigorous, policies that impact directly and positively on individuals who reside in the poorest community are robust and tend to produce welfare improvements. So, for example, income redistribution toward the poorest members of society and legislative requirements to increase the quality of education in the poorest community produce robust welfare improvements (provided that they are appropriately financed). On the other hand, policies that impact directly on individuals in other communities have effects that tend to depend on the entire specification of the economy since they set in motion opposing effects on communities' mean incomes.

Our model is in the tradition of multicommunity models with heterogeneous agents as pioneered by Westhoff [1977, 1979]. This general type of model has been used by Epple and Romer [1991]; Epple, Filimon, and Romer [1984]; and Durlauf [1996], among

others, to study various issues relating to mobility. However, our model is the first to our knowledge to permit an analytic evaluation of different policies.[8]

Our paper is related to a growing literature that studies human capital accumulation in models with heterogeneous agents. Banerjee and Newman [1993] and Galor and Zeira [1993] are recent examples. As in the seminal paper by Loury [1981], location plays no role in these models, and the focus is mainly on the macroeconomic implications of heterogeneity in income or wealth in the absence of perfect capital markets. Another related strand of the literature focuses on the political economy of the financing of human capital accumulation. The central concern here is the tension between redistribution and efficiency. Glomm and Ravikumar [1992] and Saint-Paul and Verdier [1993] examine this trade-off in the context of a government that provides a uniform level of education for all, whereas Perotti [1993] and Fernandez and Rogerson [1995] allow the proportion of education expenditures that is subsidized to be endogenously determined.

The concerns of this paper are most closely paralleled in a recent literature that examines how locational choice affects efficiency in models in which some aspect of education is local. Benabou [1993] and de Bartolome [1990] are two recent examples.[9] In both models there is assumed to be an externality from education either from local returns to scale in learning [Benabou] or from local peer effects [de Bartolome] which causes the composition of the community to play a critical role. In our model, on the other hand, technology is constant returns to scale. Nonetheless, community composition matters, albeit indirectly, through its effect on community mean income and consequently on spending on education.[10]

A final related paper is Inman [1978]. He uses a large multicommunity model to numerically simulate the effects of various alternative education finance schemes and contrasts their welfare implications under different social welfare criteria. Our

8. Epple and Romer perform numerical computations, and Durlauf gives sufficient conditions for poverty traps to arise.

9. See Stiglitz [1977] for an early and illuminating discussion of some of these issues.

10. This channel is missing in Benabou since education is a private good and individuals are ex ante identical and also in de Bartolome since head taxes are used to fund education.

analysis complements his since we analytically identify policies that are Pareto improving.

The paper is organized as follows. Section II develops the model and the equilibrium concept that will be employed. Subsection III.1 examines efficiency, and subsection III.2 analyzes several policy reforms within a simplified version of the framework. Subsection III.3 considers the robustness both of our general conclusion and particular policy effects, and Section IV concludes.

II. The Model

We wish to analyze a model that will help shed light on how policies may interact with the quality of education across communities, residence choices, and individual welfare when individuals are heterogeneous in income. The essential features that such a model should possess are (i) communities, (ii) individuals who differ with respect to income and who are able to exercise some element of choice with respect to where they wish to reside, (iii) technologies that transform expenditures on education into a quality of education and quality of education into future income, and (iv) a mechanism that translates individual preferences into a collective choice.

To incorporate all of the above characteristics in a model in a tractable fashion is difficult. We choose to focus on an essentially static model in which there are J communities, I 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 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 multicommunity model.[11]

11. 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. For a discussion of the difficulties inherent in working with multicommunity models, see, for example, Rose-Ackerman [1979]; Rubinfeld [1987]; Stiglitz [1977]; and Epple, Filimon, and Romer [1984].

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

$$u(c_1) + \beta u(c_2), \tag{1}$$

where c_1 is period 1 consumption and c_2 is consumption in period 2. We assume that u is strictly concave and twice continuously differentiable. Individuals differ in their initial (period 1) income y_i which takes on one of I values indexed by $i = 1, 2, \ldots, I$ with $y_1 > y_2 > \ldots y_I$. The fraction of individuals with initial income y_i is given by λ_i. We assume that $\lambda_i > 0 \; \forall \; i$ and normalize the mass of individuals to equal one.

There are J communities indexed by $j = 1, 2, \ldots, J$. Since we are interested in examining the consequences of policies in a context in which individuals cannot perfectly separate themselves into communities, we henceforth assume that $I > J$. Each community j is characterized by a proportional tax rate on period 1 income, t_j, and by the quality of public education that it provides, q_j.[12] We assume that all residents of a given community receive the same quality of public education and, furthermore, that they cannot choose to supplement this education privately. The tax rate is chosen by majority vote within the community.[13] All tax revenue is assumed to be spent on education, and the quality of public education is determined solely by the amount of public spending per resident.[14] Education, therefore, is a locally publicly provided private good.

An individual's period 1 consumption is equal to her after-tax income. Period 2 consumption is given by period 2 income, which is determined by the quality of education. In particular, we assume that period 2 income is an increasing, concave, and differentiable function (f) of the quality (q) of education received

12. Although in reality most communities use property taxes rather than income taxes to determine the level of spending on local public goods, we prefer 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]. However, see Henderson [1985] for a critique of the literature's way of incorporating these markets.

13. $t' \in [0,1]$ is the majority vote tax rate in a community if there is no other tax rate $t \in [0,1]$ which is preferred to t' by more than 50 percent of the community's residents.

14. Thus, unlike, for example, Benabou [1993] and de Bartolome [1990], we assume that there are no peer group effects.

in period 1. Note that we rule out the existence both of capital markets that allow individuals to borrow against future earnings and of a technology (other than education) that allows individuals to transfer period 1 income into the future.[15]

Having described preferences and technology, we now turn to a description of the sequencing of decisions for individuals in this economy. We assume that these can be described by the following two-stage game. In the first stage all individuals simultaneously choose a community in which to reside. Individuals are unable to move subsequently. In the second stage communities choose tax rates by majority vote and individuals consume their after-tax income and obtain education.[16] We examine the subgame-perfect equilibria of this game.[17]

Some additional notation will prove useful. Define ρ_{ij} as the fraction of those individuals with income y_i who reside in community j and V_i^j as the indirect utility of an individual with income y_i who resides in community j; i.e.,

$$V_i^j = u((1 - t_j)\, y_i) + \beta u(f(q_j)). \tag{2}$$

Note that q_j is given by

$$q_j = t_j \mu_j, \tag{3}$$

where μ_j is mean income in community j and thus equal to

$$\mu_j = \Big(\sum_i \rho_{ij} \lambda_i y_i\Big) \Big/ \sum_i \rho_{ij} \lambda_i. \tag{4}$$

Note that if $x = (\bar{\rho}, \bar{t})$ is an equilibrium, where $\bar{\rho} = (\rho_{11}, \rho_{12}, \ldots \rho_{1J}, \rho_{21}, \rho_{22}, \ldots \rho_{2J}, \ldots \rho_{I1}, \rho_{I2}, \ldots \rho_{IJ})$ and $\bar{t} = (t_1, t_2, \ldots, t_J$, and with q_j determined by equation (3) for each j, then each individual resides in the community in which her utility is greatest taking as given x.

15. The extreme form of this assumption could easily be relaxed. Alternatively, an equivalent formulation of our model is to commence with preferences given by $u(c) + w(q)$, where $c = y(1 - t)$. This dispenses with dynamics and hence with all assumptions about savings technologies.

16. As in all voting models with infinitesimal agents, there are always equilibria generated by the fact that an agent's payoff is invariant to its own voting action. We ignore these equilibria by assuming that agents vote sincerely, or alternatively that they play weakly dominant strategies.

17. With the notable exception of Epple and Romer [1991], a similar version of this extensive form is implicitly employed by the multicommunity 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) that allow for more strategic interactions between communities.

Last, the preferred tax rate $\tilde{t}(y,\mu)$ of an individual with income y in a community with mean income μ is implicitly defined by[18]

$$u'(y(1-\tilde{t})) = \beta f'(\tilde{t}\mu)u'(f(\tilde{t}\mu))\mu/y. \tag{5}$$

At this level of generality, there is a problem with characterizing any equilibrium (other than the "trivial" equilibrium discussed later). In order to facilitate the characterization of other equilibria in this model, therefore, we impose the following restriction on preferences.[19]

ASSUMPTION 1.

$$-u''(c)c/u'(c) > 1 \quad \forall\, c. \tag{6}$$

This assumption ensures that the increase in the 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 1 income, for all quality-tax pairs.[20]

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

ASSUMPTION 2.

$$\frac{\partial^2 u(f(t\mu))}{\partial t \partial \mu} \leq 0 \quad \forall\, (t,\mu). \tag{7}$$

This condition implies that, when faced with an increase in μ, the preferred tax rate of an individual with a given income yields higher consumption in both periods.[21] The importance of Assumptions 1 and 2 will be made clear in the following propositions.

Essential to our analysis is the effect of changes in a commu-

18. We are assuming an interior solution. $u'(0) = \infty$ and $f(0) = 0$ are sufficient conditions for this. Note that strict concavity of u implies that each individual has a unique preferred tax rate.

19. 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] among others.

20. In other words, the assumption implies that the slope of an individual's indifference curves in q-t space increases with period 1 income for all (q, t) and thus that indifference curves of individuals with different incomes through any given allocation intersect only once.

21. 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). Note that for the alternative formulation of preferences given in footnote 15, Assumption 2 is $-w''(q)q/w'(q) > 1$, i.e., symmetric to Assumption 1.

nity's mean income on an individual's preferred tax rate, $\tilde{t}$, and the implied quality of education, $\tilde{q}$. Proposition 1 establishes these comparative statics results.

PROPOSITION 1. (i) $\tilde{t}(y, \mu)$ is increasing in y and decreasing in μ.
(ii) $\tilde{q}(y, \mu)$ is increasing in y and μ.

Proof of Proposition 1. Differentiation of (5) yields

$$\frac{\partial \tilde{t}}{\partial y} = \frac{u''(y(1-\tilde{t}))y(1-\tilde{t}) + u'(y(1-\tilde{t}))}{D} > 0 \tag{8}$$

$$\frac{\partial \tilde{t}}{\partial \mu} = \frac{\beta[u''(f(\tilde{q}))f'^2\tilde{q} + u'(f(\tilde{q}))f''\tilde{q} + u'(f(\tilde{q}))f']}{D} < 0 \tag{9}$$

$$\frac{\partial \tilde{q}}{\partial \mu} = -\frac{\beta u'(f(\tilde{q}))f'\mu - u''(y(1-\tilde{t}))\tilde{t}y^2}{D} > 0, \tag{10}$$

where $D = u''(y(1-\tilde{t}))y^2 + \beta\mu^2[u''(f(\tilde{q}))f'^2 + u'(f(\tilde{q}))f''] < 0$. Note that Assumption 2 implies that the numerator in (9) is negative and that $\tilde{q}$ increasing in y follows from $\tilde{t}$ increasing in y.

QED

Propositions 2 and 3 are common to the multicommunity literature and demonstrate the strong implications of Assumption 1 for the nature of the possible equilibria.

PROPOSITION 2. Majority vote results in the preferred tax rate of the individual with the median income within the community.

Proof of Proposition 2. By concavity of u, taking as given the distribution of individuals across communities, each individual's preferences are single peaked with respect to the community tax rate and, by Proposition 1, $\tilde{t}$ is increasing in y. This yields the median voter result.[22]

QED

LEMMA 1. In equilibrium no community is empty.

Proof of Lemma 1. Suppose that some community is empty. Take a community with an individual whose income is strictly greater than the mean income of that community. Note that since $I > J$ such a community and individual must exist. Then that individual can be made strictly better off by relocating in the

22. Alternatively, Assumption 1 can be used to establish this result without explicit use of single peakedness (see Epple and Romer [1991]). Since Assumption 1 implies strict concavity of u, however, there is no associated gain in generality.

empty community where she obtains her preferred tax rate at a higher mean income than in the other community.

QED

PROPOSITION 3. All equilibria in which some communities have different qualities of education must satisfy

(i) $(q_1^*, t_1^*) >> (q_2^*, t_2^*) >> (q_J^*, t_J^*)$

(ii) $\min y \in C_j \geq \max y \in C_{j+1}$,

where community 1 (C_1) has been defined arbitrarily as the community with the highest quality of education, community 2 (C_2) that with the second highest q, and so on.[23]

Proof of Proposition 3. (i) If $q_j^* > q_k^*$, then necessarily $t_j^* > t_k^*$. Otherwise all individuals prefer C_j to C_k, and by Lemma 1, no community can be empty.

(ii) This states that if $q_j^* > q_k^*$, then the resident with the smallest income in C_j must have income at least as large as any resident in C_k. Note that by (6), given $q_j^* > q_k^*$, if an individual with income y_s prefers (q_j^*, t_j^*) to (q_k^*, t_k^*), then so does every individual with $y > y_s$.

QED

By Proposition 3, therefore, any equilibrium in which all communities do not have the same quality of education will have individuals stratified by income into communities. That is, ranking communities by their q, from highest to lowest, also generates a corresponding partitioning of the income distribution, with the uppermost partition residing in the highest q, highest t community, and the next uppermost partition in the next highest q, next highest t community, and so forth. Any equilibrium with these properties is henceforth referred to as a *stratified equilibrium.* 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. Henceforth we refer to the community with the highest q as C_1, with the next highest q as C_2, and so on.

There is always a trivial equilibrium in this model given by $\rho_{ij}^* = 1/J$ for all i, j, and thus $t_1^* = t_2^* = \ldots t_J^*$ (i.e., all communities are identical). This is not, however, a particularly interesting equilibrium from the point of view of the questions that we wish

23. Note that it is not assumed here that all communities need differ in q. If two or more communities have the same q, then for the above ordering purposes they share the same rank.

to pose. Furthermore, this equilibrium is unstable, as we show next.

DEFINITION. An equilibrium $x^* = (\bar{\rho}^*, \bar{t}^*)$ is locally stable if for each $\rho_{ij}^* > 0$, and for each $k \neq j$ there exists an $\epsilon > 0$ such that for all ρ_{ij}' that satisfy $0 < \rho_{ij}^* - \rho_{ij}' < \epsilon$,

$$V_i^j(t_j(\bar{\rho}'), q_j(\bar{\rho}')) - V_i^k(t_k(\bar{\rho}'), q_k(\bar{\rho}')) \geq 0, \tag{11}$$

where $\bar{\rho}'$ is identical to $\bar{\rho}^*$ except for the components ρ_{ij} and ρ_{ik} which equal ρ_{ij} and $\rho_{ik}^* + \rho_{ij}^* - \rho_{ij}'$, respectively, and where $t_h(\bar{\rho}')$ and $q_h(\bar{\rho}')$ are tax and quality resulting from majority voting in $C_h, h = j,k$, when individuals are allocated according to $\bar{\rho}'$. 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 4. Consider an equilibrium in which for some j,k $q_j^* = q_k^*$ and the residents of j and k are not members of only one and the same income group. Then this equilibrium is unstable.

Proof of Proposition 4. Note first that since $q_j^* = q_k^*$, it follows that $t_j^* = t_k^*$ and therefore that both communities have the same mean income and the same median voter. Let $\bar{y}$ be the highest income level found with positive mass residing in at least one of these communities. Let the community with the greatest positive mass of these individuals be C_j (if both communities have equal fractions of $\bar{y}$ individuals, arbitrarily choose a community). Now perturb the equilibrium by taking a small fraction of $\bar{y}$ individuals from C_j and relocating them in C_k. Call this new allocation of individuals $\bar{\rho}'$. Note that mean income in C_k now exceeds mean income in C_j and that the income of the median voter in C_k is now either the same or higher than before, whereas that of the median voter in C_j is either the same or lower than before. The possible change in median voter implies, for $y_i = \bar{y}$, that

24. Note that Proposition 4 does not imply that all stratified equilibria are locally stable. Westhoff [1979] shows in a model with fixed costs that at least one stratified equilibrium must be unstable. This need not be true in our model due to the absence of fixed costs.

$V_i^j(t_j(\bar{\rho}'), q_j(\bar{\rho}')) \leq V_i^k(t_k(\bar{\rho}'), q_k(\bar{\rho}'))$. Furthermore, by (9) and (10) the change in mean income implies $V_i^j(t_j(\bar{\rho}'), q_j(\bar{\rho}')) < V_i^k(t_k(\bar{\rho}'), q_k(\bar{\rho}'))$.
QED

Proposition 4 establishes that all locally stable equilibria must be stratified and hence characterized by $q_1 \neq q_2 \neq \ldots \neq q_J$ except for the case in which for some j,k $q_j = q_k$ and only one and the same income group resides in C_j and C_k.[24] We henceforth ignore this last possibility by restricting our attention to equilibria in which all communities have more than one income group residing in them. 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.[25]

Given our restriction to locally stable equilibria in which no community is completely homogeneous, this implies that each income group resides in at most two communities and that a stratified equilibrium can therefore be completely characterized by a list of each community's *boundary income* (defined as the lowest income in the community) and the fraction of the boundary income group that resides there. (All individuals with income strictly greater than the boundary income in C_j, but not greater than the boundary income of C_{j-1}, must also reside in C_j.) Thus, instead of a list $\bar{\rho}^*$, we need only specify $(\bar{\rho}_b^{j*}, y_b^{j*})$, that is, the identity ($b \in I$) and fraction (ρ) of the boundary income group y_b^j in community j, for $j = 1,2, \ldots, J-1$. Note that $\rho_b^j > 0 \; \forall j$ since in equilibrium no community is empty.

There is a simple graphical representation of equilibrium allocations across two consecutive communities. Consider any equilibrium in which not all elements of $\bar{\rho}_b^j$ are equal to one; i.e., for some j, $\rho_b^j < 1$.[26] Generically, a small change in the equilibrium level of any such ρ_b^j (keeping constant all other values of $\bar{\rho}_b^j$) affects only the community allocations in C_j and C_{j+1} and these solely by changing the mean income faced by the median voter in these communities. Holding all other ρ_b^k ($k = 1,2, \ldots, J-1$, $k \neq j$) constant, let $W_b^h(\rho_b^j)$ be the utility from residing in community h ($h = j, j+1$) for an individual with income y_b^j given that a fraction ρ_b^j of that group resides in C_j. Since $\partial \mu_h / \partial \rho_b^j < 0$ $h = j, j+1$,

25. Westhoff [1977] develops conditions to guarantee existence of a stratified equilibrium, but not necessarily a stable one.

26. Note that for a continuous income distribution, it would necessarily be the case that all elements of $\bar{\rho}_b^j$ are strictly smaller than one.

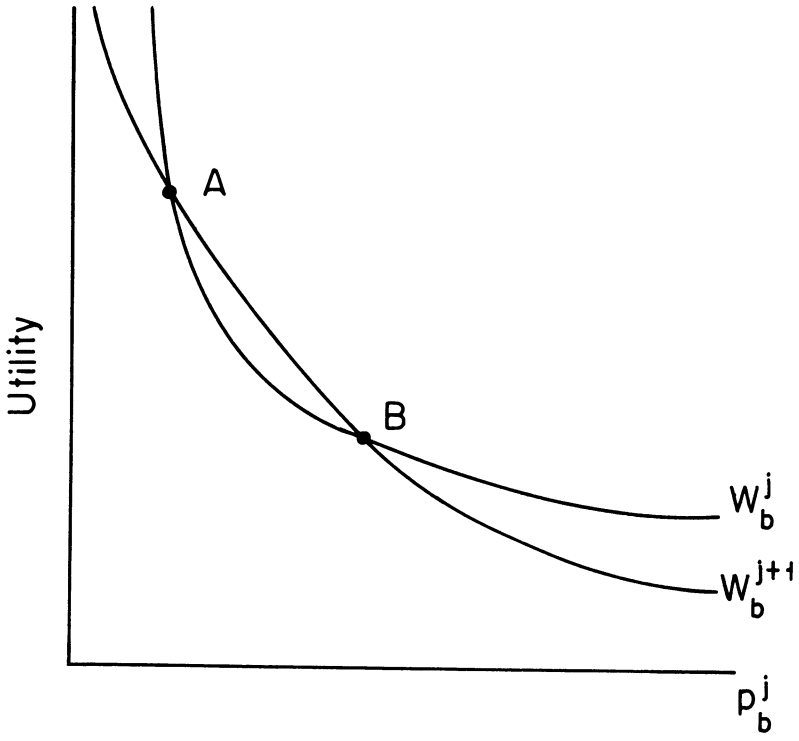

FIGURE I
Graphical Representation of Equilibrium Condition

it follows from Proposition 1 that $W_b^h(\rho_b^j)$ is decreasing in ρ_b^j for $h = j, j+1$.

Note that the equilibrium allocation in these two communities can be depicted graphically as an intersection of the two $W_b^h(\rho_b^j)$ curves since in equilibrium $W_b^j(\rho_b^{j*}) = W_b^{j+1}(\rho_b^{j*})$.[27] There are two situations that may characterize a point of intersection, depending upon which $W_b^h(\rho_b^j)$ curve is steeper at the intersection. Figure I depicts both possibilities. It is easy to show that the equilibrium depicted by point A in Figure I (and shown in isolation in Figure II) is locally stable, whereas that depicted by point B is unstable. Note that curves such as those in Figure II must characterize every pair of communities $j, j+1$ for which $\rho_b^{j*} < 1$.

27. Of course, where the W_b^h curves themselves are located depends on ρ_b^{j-1} and ρ_b^{j+1}. Thus, any given intersection itself depicts a necessary rather than sufficient condition for equilibrium and assumes that for that range of ρ_b^j the median votes are unchanged in both communities.

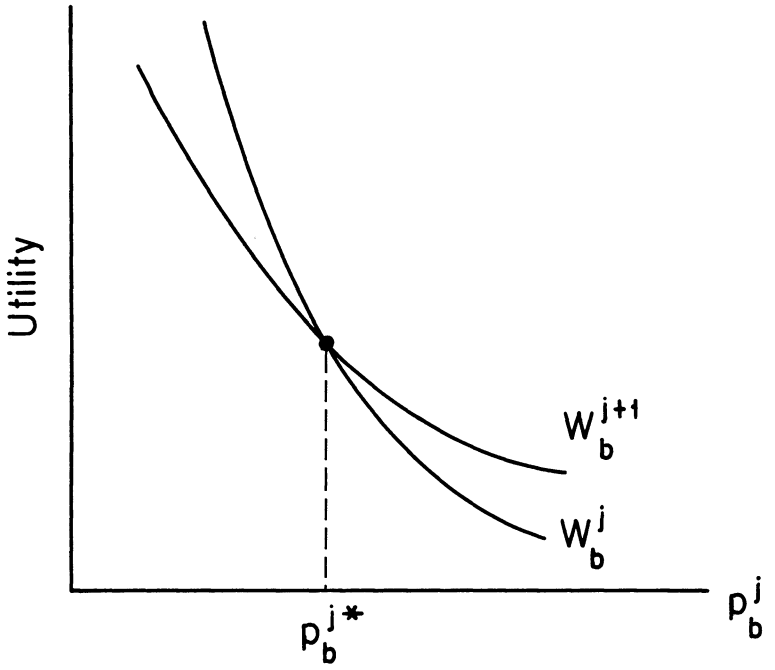

FIGURE II
Locally Stable Equilibrium

III. POLICY ANALYSIS

We next turn to the central motivation of this paper—to characterize the type of policy that can improve social welfare. To anticipate the theme that emerges from our analysis, we will argue that policies that have the net effect of increasing the number of residents in the poorest community (and thereby increasing mean income there) will have the potential to be Pareto improving, whereas policies that reduce the number of residents in this community (and thereby decrease mean income there) will tend to make everyone worse off. Prior to examining specific policies, we first turn to the question of efficiency more generally.

III.1. Efficiency

As can be seen easily from Figure II, y_b^j individuals in both community j and $j + 1$ would be better off if a greater fraction of that income group was forced to relocate to the poorer community, C_{j+1} (keeping all other residence decisions fixed). This follows

from the fact that (i) mean income would increase in both communities, thereby decreasing tax rates and increasing the quality of education in both communities; and (ii) y_b^j individuals were indifferent between the two communities to begin with. Indeed, all individuals in C_j and C_{j+1} would be made better off by such a change since all income groups would likewise benefit from (i).

In fact, from Figure II and the logic above, it follows that a social planner could make all individuals in both communities better off relative to the original equilibrium by forcing all y_b^j individuals to reside in C_{j+1}. While this would obviously no longer be a marginal change—and thus it would not necessarily be valid to keep the identity of the median voter fixed—this would not be a problem if the social planner could also control tax rates, since the increase in mean income in both communities implies that there always exists a tax rate (e.g., the original one) such that all would be made better off.

It is important to note that the argument sketched above cannot be carried over to the movement of the next income group, y_{b-1}. That is, it may be tempting to argue that once all y_b^j individuals have been moved from C_j to C_{j+1}, the social planner can continue to improve welfare by moving some y_{b-1} individuals from C_j to C_{j+1}, since this would likewise increase mean income in both communities. The reason this argument fails is that condition (ii) stated above does not hold; i.e., y_{b-1} individuals are not originally indifferent between the two communities. Hence, it might be necessary to compensate those y_{b-1} individuals who have been moved and the amount needed to do so may exceed the gains to those individuals who have benefited (i.e., all other individuals in the two communities).

What is the nature of the inefficiency found here? At the margin, the movement of an individual from one community to another affects the tax base (i.e., mean income) in both communities and hence the utilities of other individuals. Specifically, an individual who leaves a community in which her income is above the community mean for one in which her income is below the community mean lowers average income in both communities making individuals there worse off. If the amount that could be extracted from individuals in the two affected communities so as to leave them indifferent between this individual moving and not exceeds the amount needed to compensate the individual for not moving, then this movement is inefficient. In order to correct for

these adverse effects, communities must either penalize or compensate that individual so that the incentive to move disappears. One way to understand the inefficiency, therefore, is that a mechanism to ensure that these moves do not take place is missing. As will be shown in the next section, there are simple policies that can help mitigate this problem.[28]

We next examine the effect of various policies on allocations and welfare. To do so, we drop the fiction of a social planner able to mandate individual residence decisions, and instead analyze the effect of specific policies on the entire equilibrium allocation. We examine policies that attempt to affect residence decisions directly, policies that attempt to change expenditures on education directly, and policies that redistribute income and tax revenue. Some of these policies are similar in spirit to those that have been undertaken or proposed to reform education.

In order to develop in the simplest and clearest fashion the argument espoused above, we first analyze in some detail the effects of various policies in a two-community, three-income group version of our model. This allows, among other things, for a simple graphical representation of the consequences of these policies. We then go on to examine how the central conclusion and particular policy effects are affected by various modifications of this benchmark. Throughout, we consider solely marginal policies, allowing us to keep the income groups of the median voters constant.

III.2. Two Communities, Three Income Groups

Given our restriction to locally stable equilibria in which no community is completely homogeneous, this implies that the high quality community C_1 has y_1 and y_2 residents, whereas C_2 has y_2 and y_3 residents (i.e., the boundary individual has income y_2). The potential equilibria, therefore, can be parameterized by the fraction of the y_2 group that resides in the rich community C_1. To simplify notation, we drop the community superscript here and call this fraction ρ_2 (i.e., $1 - \rho_2$ of group y_2 resides in C_2). Each

28. Alternatively, the inefficiency can be interpreted as arising because of a missing market or incomplete assignment of property rights. Seen in this light, what is missing is the right for one group of individuals to charge other individuals for the right to live in the same community. Of course, different assignments of this right will lead to different points on the efficiency frontier. Note that it is not the case, however, that all movements to the efficiency frontier constitute a Pareto improvement relative to the initial equilibrium.

choice of ρ_2 determines the residents of the two communities and hence the quality-tax pair for each community. Note that the median voter in C_1 is necessarily a y_1 individual, otherwise a y_2 individual would strictly prefer C_1 over C_2 since mean income is higher in the former and her preferred tax is imposed. The median voter in C_2, on the other hand, can be either a y_2 or y_3 individual. As a last piece of notation, we define V_i^* as the equilibrium level of utility of income group i.

We next turn to an analysis of the effects of various marginal policies on this stratified equilibrium. Note that the comparative statics effects can be examined entirely within the confines of Figure II (where ρ_b^j should now be interpreted as ρ_2, W_b^j as W_2^1, and W_b^{j+1} as W_2^2) since the intersection of the two W_b^h curves now depicts both a necessary and sufficient condition for equilibrium.

We consider first a policy that subsidizes (marginally) the residence of y_2 individuals in C_2 (i.e., it increases their income if they choose to reside in C_2), ignoring for the moment how this subsidy is financed. Note that this policy's intention is the opposite of what is sometimes achieved by policies that attempt to make wealthy communities more accessible to lower-income individuals but draw in primarily the relatively better-off individuals from the poorer communities.

In terms of Figure II, for any given ρ_2, this policy can be depicted by an upward shift of the W_2^2 curve, resulting in a decrease in the equilibrium level of ρ_2 (that is, an outflow of y_2 individuals from C_1 to C_2) and an increase in V_2^*. This policy also benefits y_1 individuals since the fall in ρ_2^* increases mean income in C_1, generating, by Proposition 1, a lower equilibrium tax rate and a higher quality level there. If a y_3 individual is the median voter in C_2, the subsidy policy will also make y_3 individuals better off since the increase in C_2's mean income likewise implies a lower equilibrium tax rate and a higher quality of education there also.

Before concluding that this policy is Pareto improving, we must specify how the subsidy is financed. One tax policy that serves to reinforce the Pareto-improving nature of the subsidy is a tax on y_2 individuals in C_1. Such a policy increases the outflow of y_2 individuals from the wealthy community (i.e., in terms of Figure II, it shifts the W_2^1 curve down at every level of ρ_2), thereby contributing to the positive effects of the subsidy policy and leaving those y_2 individuals that remain in C_1 better off despite the tax. Consequently, in this case a policy that subsidizes the residence of y_2 individuals in C_2 is Pareto improving.

However, if a y_2 individual is the median voter in C_2, the effect of the subsidy policy on V_3^* is ambiguous and must be modified to be made Pareto improving. The ambiguity stems from the following two effects. On the one hand, for any given tax rate the increase in mean income in C_2 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 C_2's mean income by voting in a different tax rate. By (8) and (9) the sign of the change in the tax rate depends positively on the increase in y_2's income and negatively on the increase in the community's mean income. Ceteris paribus, a lower tax rate increases V_3, and 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. This suggests that one way to preserve the Pareto-improving nature of the policy is by offering, instead of a subsidy, a lottery over the subsidy (with voting over tax rates after the lottery outcome is known), such that the income of the median voter is left unchanged (i.e., it remains at y_2).[29] This ensures that only the mean income effects of the subsidy are felt and therefore that V_3^* also increases.

Many states are under pressure to reduce the disparity in per student educational expenditures across districts. This can be accomplished if wealthy districts decrease their tax rates or poorer districts increase theirs. In practice, state governments may attempt to induce these actions by adjusting the formulas that determine state aid. Next we examine the consequences of directly legislating either higher or lower tax rates in specific communities. We begin by analyzing the effects of a cap on the tax rate in the wealthy community (e.g., Proposition 13), at some level $\bar{t}_1$. This restriction is assumed to be marginally binding at the original equilibrium.

In terms of Figure II a (marginally binding) cap on the tax rate in C_1 shifts the W_2^1 curve up in the vicinity of the original equilibrium. To see why, note that at the initial level of ρ_2, C_1 must institute a lower tax rate. This lower rate is preferred by y_2 individuals since, for any given level of mean income, they desire a lower rate than that preferred by y_1 individuals. Thus, the new equilibrium is characterized by a greater ρ_2 and a decrease in

29. This can be thought of as resulting from the offer of only a limited number of subsidies (i.e., fewer than desired at the equilibrium level of tax rates and mean incomes) with these being randomly allocated (i.e., a y_2 individual receives a subsidy with a probability smaller than one).

V_2^*. Note that in the new equilibrium the tax cap must be binding since, if it were not, the W_2^j curves would be unchanged and would thus yield the original equilibrium.

The consequences of the tax cap policy are somewhat surprising. Although at the initial ρ_2^* those y_2 individuals in C_1 are better off than before, the resulting outflow of y_2 individuals from C_2 decreases mean income in C_1. The decrease in μ_1 causes C_1's quality of education to further decrease, which lowers the utility of y_2 individuals in C_1. Thus, the new equilibrium is characterized by a higher ρ_2^*, a decrease in quality in both communities, a higher tax rate in C_2 and a lower one in C_1, 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.

Next we consider a policy that mandates a (marginally) higher quality of education, $\bar{q}_2$, in C_2. Thus, at the initial ρ_2 this policy requires a higher tax rate in C_2. Note that, as in the previous 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 II shift in response to this policy. If y_3 is the median voter, the tax increase at the original ρ_2 moves the tax rate in C_2 closer to one preferred by a y_2 individual, thus increasing W_2^2 at that level of ρ_2. However, if y_2 is the median voter, the forced tax increase decreases the utility of a y_2 individual in C_2 at the initial ρ_2. Hence, the W_2^2 curve in the vicinity of the ρ_2^* 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 ρ_2^*, an increase in the quality of education of both communities ($q_2^* = \bar{q}_2$), a lower tax rate in C_1, and an increase in V_2^*. V_1^* is also greater (since mean income of C_1 increases) and, by the envelope theorem, so is V_3^* since the effect of the increase in mean income on utility is positive and the negative effect of a marginally greater tax rate over y_3's preferred one has second-order effects.

If, instead, y_2 is the median voter in C_2, the new equilibrium is characterized by an increase in ρ_2^* and a decrease in v_2^*. Then, as in our previous tax cap example, all individuals are made worse off as the decrease in mean income of both communities implies that the quality of education falls and that tax rates increase.

Note that the above disparity in results stems entirely from the fact that the tax increase has opposite effects on y_2's utility in C_2 (at the initial ρ_2^*) depending on the identity of the median voter in that community. Thus, the same policy results in opposite net flows of y_2 individuals between communities with a net flow into C_2, as before, associated with a Pareto improvement, and a net outflow associated with everyone being made worse off.[30]

Next we turn to an analysis of two redistributional policies: the first operating on income, and the second on expenditures on education. Consider, therefore, a marginal increase in the income level of y_3, ignoring for the moment how this increase is engineered. Independently of the identity of the median voter in C_2, for any given level of ρ_2, y_2 individuals in C_2 are better off (since mean income in C_2 is greater and furthermore the preferences of y_3 now more closely resemble those of y_2 individuals). This leads to a fall in the equilibrium level of ρ_2^* and an increase in V_2^*.

In the new equilibrium, mean income is greater in both communities and, through the same reasoning as in the previous examples, the utility of all three groups is higher as is the quality of education in both communities. As before, one possible way to finance such a policy is through a tax on all y_2 individuals in C_1 or through an income tax on all y_2 individuals in both communities. Note that in the latter event such a tax would not cause the reverse outflow of y_2 individuals from C_2 to C_1 since the marginal utility of income is greater in C_1 (since $t_1^* > t_2^*$) implying that an additional income tax makes y_2 individuals worse off in C_1 than in C_2.

Another Pareto-improving policy is to redistribute expenditures on education away from C_1 and toward C_2. The easiest way in which to design such a scheme to be Pareto improving is, for each t chosen in C_1, to redistribute a fraction γ of tax revenue in C_1 toward educational expenditures in C_2. This implies that for any (t_1,t_2) per capita expenditures on education in C_1 are reduced from $t_1\mu_1$ to $(1 - \gamma)t_1\mu_1$ and increased in C_2 from $t_2\mu_2$ to $t_2\mu_2 + \gamma t_1\mu_1(N_1/N_2)$, where N_j is the fraction of the economy's population in C_j.

Note that the effect of this policy is, at all levels of ρ_2, to reduce the effective tax base in C_1. Consequently, at each level of ρ_2

30. While it may seem strange that the same policy can generate such different results, note that if we were to generalize to many income groups, then the likelihood of y_2 being the median voter is small, and thus this policy is more likely to be associated with a welfare improvement.

the median voter in C_1 would prefer a higher t and a lower q. Thus, W_2^1 shifts down for all ρ_2. In addition, this policy increases in a lump-sum fashion the revenue available for education in C_2. Although this is not identical to an increase in mean income in C_2, it produces the same effects as it induces the median voter in that community to prefer a lower t and a higher q for all ρ_2. Thus, this policy also shifts W_2^2 up. The net effect, therefore, is to decrease ρ_2^* and increase V_2^*. Note that the outflow of y_2 individuals from C_1 to C_2 must be of a sufficient magnitude to reverse the fall in effective mean income in C_1 caused by this policy; i.e., $\mu_1' > \mu_1/(1 - \gamma)$ (where a prime denotes the new equilibrium value of the variable). Otherwise the median voter in C_1 would impose a higher t and lower q, implying that y_2 individuals in C_1 are worse off. Thus, the net effect of this policy is to decrease tax rates and increase quality in both communities, making all better off.

The above analysis examined the effects of policies that, at the margin, attempt to reduce inequality in spending per student across communities. The analysis clearly indicates that the mechanism used to achieve this matters. As a somewhat separate exercise, it is also of interest to examine the consequences of a nonmarginal policy change: a move to a system of national taxation and equal quality of education across communities. Note that the simple structure of the model implies that under this policy individuals no longer have any reason to care about in which community they reside.

Assume that the median voter at the national level is from income group y_2. As a result of this policy change, this individual now faces a national mean income lower than the original μ_1, but higher than the original μ_2. Since y_2 was originally indifferent between the two communities, the fact that national mean income is higher than the old level of μ_2 implies that y_2 individuals must be made better off (irrespective of the original identity of the median voter in C_2) as a result of this policy. If the median voter in C_2 originally had been a y_2 individual, then y_3 individuals are also made better off by this policy since tax rates fall and quality increases. On the other hand, if the median voter in C_2 had been a y_3 individual, then the switch in median voter may not compensate for the increased mean income, and y_3 individuals may be worse off. In all cases, y_1 individuals are made worse off since from a situation of being the decisive voter and having high community income they suffer a fall in mean income and y_2 becomes the median voter.

This subsection has examined various policies all within a setting of two communities and three income groups. A possible concern therefore is in regard to the robustness of our conclusions with respect to alternative configurations. We next turn to this issue.

III.3 Robustness

Note that in all the examples provided above, Pareto-improving policies have the net effect of transferring individuals to the poorer community. By so doing, mean income is increased in both communities, laying the basis for the welfare improvement. This is the general conclusion that we wish to emphasize. We now turn to an examination of how robust this conclusion and the effects of specific polices are with respect to certain modifications of the benchmark model of the previous subsection.

Note first that there is nothing special about three income groups. Generalizing to $I \geq 3$ income groups (and maintaining an equilibrium characterized by $\rho_b^1 < 1$) preserves both the general conclusion and the specific policy results.

The introduction of additional communities (and simultaneously additional income groups so as to preserve the nonhomogeneous community structure of our equilibrium) likewise does not affect the main conclusion of the analysis, although, as will be seen shortly, it must be restated slightly to allow for different equilibrium configurations. The effects of some policies, however, do depend on the number of communities, whereas others are robust to this modification. We turn first to how the effects of some policies are modified since it naturally leads to a restatement of the general conclusion.

Consider for the sake of concreteness a three-community economy with an arbitrary number of income groups. To facilitate notation, let us denote by y_2 the income of the boundary individual in C_1 (where now the space between y_1 and y_2 can be filled with a discrete number of income groups) and similarly the boundary individual for C_2 is denoted by y_3. Let the lowest income group be y_4.[31] For now let ρ_b^1 and ρ_b^2 be strictly smaller than one, that is, y_2 resides in both C_1 and C_2, and similarly y_3 resides in both C_2 and C_3. To further simplify notation, we drop the community superscripts and refer to the fraction of group y_2 (y_3) that resides in C_1 (C_2) by ρ_2 (ρ_3) with $1 - \rho_2$ ($1 - \rho_3$) residing in C_2(C_3).

31. Similarly, the space between y_2 and y_3 and between y_3 and y_4 can be filled with a discrete number of income groups.

While all the statements that we make in what follows can be shown to be true algebraically or graphically, the logic is sufficiently simple to restrict our presentation to a verbal analysis.

First, we examine a policy that has the same results as before: subsidizing individuals to reside in the poorest community. In this case, that would imply subsidizing y_3 individuals to reside in C_3. The same logic as before reigns here: as a consequence of C_3 becoming relatively more attractive to y_3 individuals for all levels of ρ_3, some y_3 individuals will move from C_2 to C_3 increasing mean income in both communities. This is where the action would have ended in the two-community example. Now, however, the decrease in ρ_3 also makes C_2 more attractive to y_2 individuals, generating an outflow of these from C_1 to C_2. Thus, in the new equilibrium mean income increases in all communities, so that, by Proposition 1, quality increases, and tax rates fall in all communities, increasing welfare for all.[32] Note that this subsidy can be financed by appropriately taxing y_2 individuals in C_1 and y_3 individuals in C_2.

We next turn to a policy whose effects are different in a three-community economy. Consider the policy of capping the tax rate in C_1 as discussed in the previous subsection. As before, this has the effect of making C_1 relatively more attractive to y_2 individuals and causing an outflow of y_2 individuals from C_2 to C_1. This is where all action ended in the two-community world, leaving all individuals worse off. In this economy, however, the outflow of some y_2 individuals implies that y_3 individuals are no longer indifferent between residing in C_2 and C_3 since mean income has decreased in C_2 as a consequence. This in turn provokes an outflow of some y_3 individuals from C_2 to C_3, causing mean income to increase in C_3. Thus, in the new equilibrium μ_3 is higher, with its attendant benefits to all individuals in C_3, and in particular implying an increase in V_3^*. But, in order for V_3^* to have increased, μ_2 must also be greater relative to its original equilibrium value. Thus, all individuals in C_2 must also be better off, and in particular, V_2^* must be greater.

Summing up, the new equilibrium has greater mean income in C_2 and C_3 and lower mean income in C_1. All individuals in C_2 and C_3 are made better off, whereas in C_1 all individuals whose income is equal to or greater than the median are worse off (since

32. However, note that if y_3 is the median voter in C_3, then the same modification in the policy is needed as before, i.e., a lottery over the subsidy.

mean income has fallen) but some individuals with low enough income in this community (in particular, y_2, the lowest income in this community) are made better off despite the fall in mean income due to the decrease in the tax rate mandated by this policy.

What explains the different results obtained in the two economies? In the two-community economy the y_2 outflow from C_2 brought about a decrease in the mean incomes in both communities with its attendant negative welfare effects. In the three-community economy the y_2 outflow generated an accompanying y_3 outflow from C_2 to C_3, which increased mean income in C_3. Furthermore, the y_2 outflow from C_2 which lowered μ_2 is more than compensated for by the y_3 outflow from C_2 increasing μ_2, yielding greater mean income in C_2 as a consequence.[33] Thus, in a three-community economy a tax cap policy in the wealthiest community produces the opposite net flows from the poorest community than in the two-community economy; i.e., individuals now move to the poorest economy rather than away from it.

It is important to stress, therefore, that the same general conclusion holds here as before: policies that work to increase residence in the poorest community tend to be welfare improving; policies that decrease residence in the poorest community tend to make all worse off. The effects of some policies, however, as just seen, depend on the number of communities in the economy because they set in motion contradictory effects on the mean income of a community. A tax cap in C_1, for example, tends to decrease mean income in C_2 by causing an outflow of y_2 individuals from that community but simultaneously works to increase mean income in that community by generating an outflow of y_3 individuals to C_3. The ultimate resolution of these two contradictory forces and in particular of the policy's net effect on residence in the poorest community depends on the total number of communities.[34] Other policies, whose direct incidence is on the poorest boundary income group, do not set in motion contradictory effects on community mean income and thus have consequences that are independent of the total number of communities in the economy. For example, a subsidy to y_b^{J-1} to reside in C_J or an income trans-

33. Note that the overall outflow of y_2 individuals in this economy must be sufficiently small to ensure that the fall in mean income in C_1 does not overwhelm the welfare gains to y_2 brought about by a tax rate in C_1 closer to its preferred one.

34. See Fernandez [1995] for an analysis of how whether the number of communities is odd versus even is central to the resolution of these contradictory forces.

fer to y_I both induce individuals from boundary income groups to move toward the least wealthy of the two communities in which the boundary group resides, thus increasing welfare everywhere.

In the examples discussed above we maintained the assumption that $\rho_b^j < 1$ for all communities. This is in many ways the most compelling equilibrium configuration to examine since for a continuous income distribution this would be the only possibility.[35] For discrete income distributions, however, one cannot eliminate the possibility that for some communities $\rho_b^j = 1$. It is not difficult to show, in any case, that a different configuration does not alter the conclusion above.

To see why, note that any community k for which $\rho_b^k = 1$ is effectively isolated from below; i.e., marginal policies will cause no outflows or inflows of the poorest individuals in that community. Thus, marginal policies that impact directly on individuals with incomes greater than y_b^k do not affect allocations in C_1 $j > k$, and policies that impact directly on individuals with income smaller than y_b^k do not affect allocations in C_j $j \leq k$. More specifically, define a connected sequence s of communities as one in which only the poorest community in that sequence has $\rho_b^k = 1$. Then, all policies that impact directly on individuals within an income group that resides in a community in that sequence have the same effects as described previously, and for those policies the economy can be treated as consisting of those k communities.[36] Let the poorest community in a given connected sequence s be denoted by C_{ps}. We are now ready to state our general conclusion.

While the effect of some particular policies may depend on the number of communities and whether some communities are isolated, note that the bottom line that emerges is quite clear. If the policy is such that on net individuals move to any C_{ps}, i.e., to the poorest community in a connected sequence, then this policy will tend to be Pareto improving. Movements away from the poorest community in a connected sequence will tend to make all individuals worse off. This conclusion is independent of the number of communities and of the configuration of individuals across communities.

35. A continuous income distribution, however, would introduce the additional complication that the median voter would no longer remain constant given marginal policies.

36. Note that a J-community economy can consist of many such connected sequences, each of which would then operate as independent subeconomies vis-à-vis marginal policies.

In particular, therefore, a (marginal) subsidy policy to attract individuals to any C_{ps} is Pareto improving (provided that it is financed appropriately, e.g., by taxing y_b individuals in $C_{p-1,s}$). Likewise, income redistribution in favor of the poorest individuals in any C_{ps} (or in fact toward any individual whose income is smaller than the median in the C_{ps}) is Pareto improving (provided again that it is financed appropriately). In the context of our most compelling equilibrium configuration, i.e., the nonisolated equilibrium, this implies that a subsidy to increase residence in C_J will be Pareto improving. Likewise, income redistribution toward y_I (or to any group in C_J with y smaller than the median income in that community) will also be Pareto improving. Both of these policies will have rather spectacular chain reaction effects whereby some individuals from each border income group in each community move to the poorer of the two communities that they reside in, thereby increasing mean incomes everywhere and generating an increase in quality and decrease in tax rates in each community. For an equilibrium in which some communities are isolated, these same chain reactions will occur for all communities in any connected sequence to which these policies are applied.

IV. Conclusion

We examined the consequences of various policies within the context of a model that generates a stratified equilibrium in which communities are ranked according the quality of education and individuals stratify themselves into communities by income.

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 several important features of the context in which expenditures on primary and secondary education are determined in the United States: individuals differ in income; decision-making on educational finance occurs largely at the local level; and households are mobile across communities. Of course, many 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 alterna-

37. See Stiglitz [1974] and Glomm and Ravikumar [1992] for interesting analyses although not in the context of a multicommunity model.
38. See Hamilton [1975] and Fernandez and Rogerson [1993].

tive to public education;[37] (ii) the ability of communities to render themselves more impermeable to the inflow of lower income individuals (through zoning, for example);[38] (iii) different strategic interactions among communities; (iv) dynamic considerations;[39] (v) the existence of a housing market; (vi) an endogenous determination of the number of communities; and (vii) interactions between state (or federal) and local policies. It would also be of interest to examine other forms of taxation and their implications, including progressive income taxes and property taxation.[40]

A significant finding of our analysis is that there are relatively simple policies that produce the same qualitative welfare effect for all individuals. This is surprising since, given heterogeneity of individuals and the redistributive nature of most policies considered, one might have expected these policies to generate both winners and losers. Community composition effects play a key role in obtaining this consensus. We show that the equilibrium distribution of individuals among communities is inefficient in the absence of intervention. Ranking communities by their level of educational expenditures, or equivalently by their level of mean income, we demonstrate that the inability of communities to selectively penalize or reward individual residence decisions leads to too small a fraction of those individuals who are wealthiest within a given community being located there. Alternatively, too large a fraction are located in the community that is ranked just higher. Policies that affect the equilibrium allocation of individuals in the right direction, therefore, can make all better off.

The general insight that emerges from our analysis is that policies that on net increase the number of residents in the poorest community (appropriately defined for a connected sequence) will tend to be Pareto improving. These policies unleash a chain reaction, increasing the quality of education in all communities (and decreasing tax rates everywhere) thereby strictly increasing welfare for all.

Our analysis also indicates that whereas the effects of some

39. See Fernandez and Rogerson [1994] and Benabou [1992] for dynamic models that incorporate some of these features.

40. In particular, it should be possible to substitute a progressive tax scheme and still obtain similar results. For example, if instead of a linear tax there were a tax schedule given by $\gamma_i t$, where $\gamma_i \in (0,1]$ indicates a proportion of the tax rate t paid by individuals with income y_i, and individuals voted over the value of t, our general conclusion should still remain valid although the condition that guarantees that $\partial \tilde{t}/\partial \mu$ is negative would have to be modified accordingly and it would be necessary to check that a stratified equilibrium continued to exist.

reforms can be sensitive to the number of communities and the residence pattern of individuals, other reforms are robust to these specifications. In particular, policies that impact directly and positively on individuals who reside in the poorest community are robust and tend to produce welfare improvements.[41] So, for example, income redistribution toward the poorest members of society, direct transfers toward educational expenditures in the poorest community, and legislative requirements to increase the quality of education in the poorest community, produce robust welfare improvements. The sensitivity of other policies to the exact specification of the number of communities should perhaps be interpreted as a warning against using these policies given this dependence and the existence of robust alternatives.

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41. It should be noted that although all Pareto-improving policies considered induce an increase in the absolute levels of per capita expenditures on education in the poorest communities, the gap in these expenditures across communities need not decrease as a consequence.

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