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PUBLIC EDUCATION AND INCOME DISTRIBUTION: A QUANTITATIVE EVALUATION OF EDUCATION FINANCE REFORM

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ABSTRACT

Many states have or are considering implementing school finance reforms aimed at lessening inequality in the provision of public education across communities. These reforms will tend to have complicated aggregate effects on income distribution, intergenerational income mobility, and welfare. In order to analyze the potential effects of such reforms, this paper constructs a dynamic general equilibrium model of public education provision, calibrates it using US data, and examines the quantitative effects of a major school finance reform. The policy reform examined is a change from a system of pure local finance to one in which all funding is done at the federal level and expenditures per student are equal across communities. We find that this policy increases average income and total spending on education as a fraction of income. Moreover, there are large welfare gains associated with this policy; steady-state welfare increases by 3.2% of steady-state income.

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1. Introduction

A distinguishing feature of public education in the US is the significant role played by local property taxes and the resulting large disparity in expenditures per student observed across school districts. A series of State Supreme Court rulings and public concern over public education have led many states to consider and/or to enact reforms with the aim of reducing inequality of access to quality public education.

The effects of various reforms to the system of financing public education are difficult to predict, both qualitatively and quantitatively. Total resources devoted to education, property values, residence patterns and aggregate welfare may all be affected. Moreover, given education's critical role in determining individual income, reforms which alter total spending on education and/or its pattern across communities should have aggregate effects on income distribution, growth and intergenerational income mobility. This paper takes a first step assessing the potential effects of education finance reform. We construct a dynamic general equilibrium model of public education provision in a multi-community setting, calibrate it using US data, and use the calibrated model to evaluate the quantitative effects of a major reform.[1]

We extend to a dynamic setting the model of Fernandez and Rogerson (1992). This is a multi-community model in the tradition of those pioneered by Westhoff (1977) and Epple, Romer and Filimon (1984, 1988). Although our model is highly stylized, it incorporates four features which are central to

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[1]A notable early attempt to analyze the quantitative effects of some education reforms is Inman (1978). He estimates a multi-community model using data from the New York metropolitan area and examines the welfare effects of several reforms. One difference between his work and ours is that we model the income distribution dynamics resulting from changes in the quality of education received by children. A second difference is that whereas his model contains more features than does ours, our analysis is explicitly general equilibrium.

an analysis of public education finance in the US. First, there is substantial heterogeneity of income across households. Second, individuals are mobile across communities. Third, public education is provided at the community level and fourth, funding for public education is largely determined at the local level.

The population structure is that of a two-period-lived overlapping generations model in which there is a large number of households every period, each consisting of one old and one young member. Households choose in which community to reside. Each community has a local housing market and determines a tax rate on local housing expenditures by majority vote. The proceeds are used to provide public education for its residents. An old individual's income is determined by the quality of education received when young and an idiosyncratic shock.

The equilibrium inter-community population distribution and the tax rates that result in a given period determine the quality of education obtained by each child which, in conjunction with the realization of idiosyncratic income shocks, then determines the equilibrium income distribution over households for the following period. This process repeats itself. The equilibrium for this model has the property that in each period individuals stratify themselves into communities by income. Higher income communities have higher per student expenditures on education and higher gross-of-tax housing prices. As a result, children born into higher income households have higher expected incomes than do children born into lower income households.

We calibrate the model described above to US data. The calibration uses information on the (cross-sectional) elasticity of educational expenditures per student with respect to community mean income, the elasticity of (subsequent) earnings with respect to quality of education when young, price elasticities of housing demand and supply, mean and median income, and expenditure shares for housing and education.

In the model described above, public education is entirely funded at the local level. The major policy reform we analyze is one in which local financing of education is replaced with national (or state) financing and the revenue is distributed equally per student across communities. Several states have taken significant steps towards this kind of system.[2]

Our analysis highlights the tradeoffs that exist between a local and a national finance system. The former permits individuals, given their income, greater scope for sorting themselves into communities that more closely offer their preferred bundles than does a national system which imposes uniform spending. The latter system, on the other hand, by reducing heterogeneity in education expenditures, can modify the income distribution in such a way to attain higher average income. While the net welfare effect of the above tradeoff ex ante is not signable in our framework, our calibration yields the following results: relative to the case of pure local financing, we find that a policy of national financing leads to higher average income in the steady state, higher average spending on education, and higher welfare. The magnitude of the welfare improvement measured in terms of steady-state income

[2]US state public education finance systems vary widely in the extent to which state aid provisions attempt to lessen the inequality in spending across districts with some state systems lying close to the extremes of either local or national financing. Thus, a comparison of these two extreme possiblities is a natural starting point in an attempt to gauge the potential significance of education finance reforms that aim to lessen inequalities in local spending.

is 3.2%, which is a large gain relative to that found for many policies. The welfare implications of the transition path are also examined. We find that for annual discount rates smaller than 8.2%, a social planner would choose to implement the policy change.

Our work is related to two literatures. The first is a theoretical literature that addresses various aspects of the interaction between education, income distribution and political economy. Recent contributions to this literature include papers by Fernandez and Rogerson (1991), Glomm and Ravikumar (1992), Boldrin (1992), Saint-Paul and Verdier (1994), and Perotti (1993). These papers all consider education as being provided centrally. Papers which model the local provision of education include Durlauf (1992), Benabou (1992), Cooper (1992), Fernandez and Rogerson (1993) and Epple and Romano (1993). A distinguishing feature of our current paper is its emphasis on quantitative analysis.

The second related literature is a large empirical literature on the determinants and consequences of expenditures on public education. One aim of this literature is to examine the pattern of expenditures across communities in relation to the cross-community variation of variables. Inman (1979) and Bergstrom et al. (1982) survey this literature and Rothstein (1992) is a recent contribution. There is also a literature on the relation between spending on education and outcomes which is too extensive to survey here. Coleman (1966) is an early contribution, Hanushek (1986) surveys the literature, and Card and Krueger (1992) provide new evidence on the issue.

The outline of the paper follows. Section 2 describes the benchmark model. Section 3 discusses the calibration of this model. Section 4 reports the results of the calibration and of the policy reform carried out in the calibrated model. Section 5 performs a sensitivity analysis and Section 6 concludes.

2. The Model

The economy is populated by a sequence of two-period-lived overlapping generations. A continuum of agents with total mass equal to one is born in every time period. Each individual belongs to a household consisting of one old person (the parent) and one young person (the child). All decisions are made by old individuals, each of whom has identical preferences given by:

$$u(c,h) + Ew(y_c), \tag{1}$$

where c is consumption of a private good, h is consumption of housing services, E is an expectations operator, and y_c is next period's income of the household's young individual. The function u is assumed to be strictly concave, increasing in each argument, twice continuously differentiable and defines preferences over c and h that are homothetic.[3] The function w is increasing and concave.

Individual income is assumed to take one of I values: y_1, y_2, $\ldots y_I$, with $y_1<y_2<\ldots y_I$. An individual's income when old is determined by q—the quality of education obtained when young—and an idiosyncratic shock.[4] The

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[3]Homothetic preferences are assumed since they simplify computation; they are in no way essential.

[4]Thus, we abstract away from any possible peer effects (i.e. the possibility that who you go to school with matters) and parental characteristics other than income. Quantitative evidence on peer effects is mixed. de Bartolome (1990) summarizes empirical findings and provides a theoretical analysis of peer effects in a multi-community model as does Benabou (1994). The importance of parental characteristics is the subject of much controversy (see Card and Krueger (1992)).

probability that an individual has income y_i when old given an education of quality q when young is equal to $\phi_i(q)$.

Define v(q) by:

$$v(q) = Ew(y_c) = \Sigma\phi_i(q)w(y_i) \tag{2}$$

Preferences can then be defined over c,h and q:

$$u(c,h) + v(q). \tag{3}$$

We assume that v is increasing, concave and twice continuously differentiable.

Old individuals must choose a community in which to reside. There are two communities. Each community j is characterized by a proportional tax t_j on housing expenditures, a quality of education q_j and a net-of-tax housing price p_j. Each community has its own housing market, with supply of housing in C_j given by $H_j^S(p_j)$. Note that this function is allowed to differ across communities, reflecting differences in land endowments and other factors. We assume that H_j^S is increasing, continuous, and equal to zero when p_j is zero. The gross-of-tax housing price in C_j is given by $\pi_j=(1+t_j)p_j$. We assume that housing services are rented and, so as not to introduce further complications, the owners of the housing services are assumed to live outside the two communities and simply consume their rental income. Proceeds from the tax are used exclusively to finance local public education. We assume that the quality of public education is equal to per pupil spending on education. All residents of a given community receive the same quality of education; education cannot be privately supplemented.[5]

[5]See Epple and Romano (1993) for a model that incorporates a private education option.

We now describe the decisions and outcomes that correspond to each time period. In each period the interaction among individuals and communities can be described as a stage game of the following form. In the first stage, all (old) individuals simultaneously choose a community (C_j, $j=1,2$) in which to reside. Thereafter, these individuals are assumed to be unable to move.[6] In the second stage, communities choose tax rates through a process of majority vote, after which individuals make their housing and consumption choices and young individuals receive education in the community in which their parent has chosen to reside. At the end of the period, uncertainty about next period's income is resolved (note that this occurs before the residence decision of the following period). Then time rolls forward and the two-stage game is repeated with the previous period's young individuals becoming this period's old individuals. We analyze the subgame-perfect equilibria of such a game.

Note that from an individual's perspective, a community is completely characterized by the pair (π,q). Thus, an individual with income y has an indirect utility function $V(\pi,q;y)$ defined by:

$$V(\pi,q;y) = \max_{c,h} u(c,h) + v(q) \qquad (4)$$

$$\text{s.t.} \quad \pi h+c\le y, \; c\ge 0, \; h\ge 0,$$

where c has been chosen as numeraire.[7] Since each individual can solve the two-stage period game by backward induction, for any equilibrium outcome

[6] This assumption implies that each individual takes the composition of the community as given when voting. This greatly simplifies the strategic interactions between communities.

[7] Note that we have implicitly assumed that education is the only technology available by which a parent can contribute to her child's income.

(π^*, q_j^*) each individual must reside in the community that yields her the greater utility.

Define $h(\pi, y)$ to be the individual housing demand resulting from the maximization problem in (4). By homotheticity h can be written as $g(\pi)y$.[8] Given a set of residents of mass N_j and a tax rate t_j in C_j, the variables q_j and p_j must satisfy:

$$N_j g(\pi_j)\mu_j = H_j^S(p_j) \tag{5.1}$$

$$t_j p_j g(\pi_j)\mu_j = q_j \tag{5.2}$$

where μ_j is mean income in C_j. The first equation requires that the housing market clear. The second states that the quality of education q_j equals the per (old) person tax revenue of the community. It is straightforward to show that for any positive value of t_j equation (5.1) has a unique solution for p_j. Furthermore, p_j is decreasing in t_j and π_j is increasing in t_j.

The following assumption on preferences greatly facilitates characterization of equilibrium in the two-stage game.[9]

<u>Assumption 1</u>: For all π, y $v'(q)/[u_c(c,h)h(\pi,y)]$ is increasing in y.

Since $v'/(u_c h)$ is the slope of an individual's indifference curve in $q-\pi$ space, Assumption 1 guarantees that this slope is increasing in initial income, i.e. that

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[8] In what follows we assume that the optimization problem in (4) results in interior solutions for c and h.

[9] This assumption is a single-crossing condition. While its algebraic expression depends on the particular model, it is used by the multi-community literature to induce separation of individuals and thus allow equilibria to be characterized (see, for example, Westhoff (1977), Fernandez and Rogerson (1992, 1993), and Benabou (1994)).

$$S - u_{cc}h(1-\pi h_y) + u_{ch}hh_y + u_c h_y < 0 \qquad (6)$$

The power of this assumption to characterize equilibrium is seen in the next two propositions which are common in the multicommunity literature.

Proposition 1: Given a set of residents, majority voting over tax rates in a community results in the preferred tax rate of the resident with the median income.

Proof: This follows immediately from the property of indifference curves discussed previously. See Fernandez and Rogerson (1993) and Epple and Romer (1991) for detailed proofs in slightly different contexts.||

Proposition 2: If in equilibrium q_1^* is not equal to q_2^* and no community is empty, then:

(i) $(\pi_1^*, q_1^*) >> (\pi_2^*, q_2^*)$

(ii) All individuals in C_1 have income at least as great as any individual in C_2

where C_1 is defined as the community with the higher value of q.

Proof: (i) If $\pi_1^* < \pi_2^*$ and $q_1^* \geq q_2^*$ then all individuals prefer to live in C_1, which contradicts the assumption that no community is empty.

(ii) Follows directly from Assumption 1 regarding the slope of indifference curves in (q,π) space as a function of y.||

Proposition 2 implies that an equilibrium with $q_1^* \neq q_2^*$ will be characterized by the coexistence of a community with high income residents, high gross-of-tax housing prices, and high quality education and another community with lower income residents, low gross-of-tax housing prices, and a lower quality of education.

Any equilibrium that displays property (ii) of Proposition 2 is said to be a stratified equilibrium and is common to multi-community models.[10] Problems of existence and uniqueness of a stratified equilibrium are endemic to multi-community models (see, for example, Westhoff (1977,1979) and Epple, Filimon and Romer (1984) for a discussion). In all of the simulations reported later in the paper, however, the specifications are such that a unique stratified equilibrium exists.

Lastly, we turn to a characterization of the tax rates generated by majority voting. Using (5.1) and (5.2) one can write $q_j(t,\mu,N)$ and $\pi_j(t,\mu,N)$ as the quality of education and tax inclusive housing price, respectively, in C_j given a tax rate t, community mean income μ and a community population of N. The preferred tax rate for an individual with income y is determined by:

$$\max_{t\geq 0} \; u(y-\pi h,h) + v(q(t,\mu,N)) \quad \text{s.t. (5.1) and (5.2)} \tag{7}$$

and where h solves (4), i.e. is the utility maximizing choice given $\pi(t,\mu,N)$ and y.

Using the envelope theorem, the first order condition for this problem implies:

$$u_c h[p+(1+t)p_t] = v' q_t \tag{8}$$

[10]There may also exist equilibria which are not stratified. For example, given identical housing supply functions there always exists an equilibrium in which the two communities are identical, i.e. half of each income group resides in each community, resulting in equal tax rates, prices, and quality of education. In the analysis that follows, however, we only consider stratified equilibria. See Westhoff (1979) and Fernandez and Rogerson (1992) for a discussion in a slightly different context of how requiring stability of equilibria can eliminate all non-stratified equilibria.

where $p(t,\mu,N)$ solves (5.1) and (5.2). Note that $p+(1+t)p_t=d\pi/dt>0$.

In a stratified equilibrium C_1 has both higher mean and higher median income than C_2. Two comparative statics exercises, therefore, are of interest; how is the tax rate that solves (8), denoted by $\tilde{t}$, affected by (i) a change in y and (ii) a change in μ? Straightforward calculation yields:

$$\partial\tilde{t}/\partial y = S/D > 0 \qquad (9)$$

and

$$\frac{\partial\tilde{t}}{\partial\mu} = \frac{[u_{cc}\pi_{\mu}(h+\pi h_{\pi})-u_{ch}h_{\pi}\pi_{\mu}]\pi_t-u_c\pi_{t\mu} + (v^{''}q_t q_{\mu} + v^{'}q_{t\mu})}{D} \gtrless 0 \qquad (10)$$

where D denotes the second derivative of the maximand in (7) with respect to t. By the second order condition, D is non-positive at a maximum.

The first expression states that higher income individuals prefer higher tax rates and necessarily, therefore, higher quality education. The second expression says that an increase in mean income has an ambiguous effect on an individual's preferred tax rate. Thus it is not possible to state whether in equilibrium C_1 must have a higher or lower tax rate than C_2. As will be seen in the next section, evidence on the relationship between community mean income and spending on education suggests that the sign of $\partial t/\partial\mu$ is negative.

Thus far we have discussed extensively the properties of equilibrium of the two-stage game for any period t without making reference to future periods. It was possible to do so since the outcome in period t is independent of the future evolution of the state variable.[11] Since our larger game simply repeats this two-stage game every period, we need only keep track of the state variable of this game—the income distribution of old agents—which we write as $\lambda=(\lambda_1,\lambda_2,\ldots\lambda_I)$ where λ_i is the fraction (or equivalently mass) of old agents with income equal to y_i.

If λ_t is the income distribution of old individuals at the beginning of period t, then an equilibrium to the two-stage game in period t generates a beginning-of-period income distribution for period t+1, λ_{t+1}. We denote by $\Lambda(\lambda)$ the set of values for λ_{t+1} that correspond to subgame-perfect equilibria of the two-stage game given $\lambda_t=\lambda$. In a later section of the paper we focus on the properties of a stationary or steady state for the system i.e. a value λ^* such that $\lambda^*\epsilon\Lambda(\lambda^*)$.

3. Calibration

The objective of this work is to quantify the effects of a major change in the system of financing education. To do so it is necessary to specify functional forms for the relationships introduced in the previous section and assign parameter values. We first turn though to a brief description of the computation of equilibrium.

3.1 Computation of Equilibrium

[11]This fact, which greatly simplifies the analysis, follows from the assumption that an old individual cares about the young individual's income rather than utility, thus severing the link between one time period and the next. This is a commonly used device to render this type of analysis tractable. See, for example, Cooper (1992), Durlauf (1992) and Glomm and Ravikumar (1992). See Krussel and Rios-Rull (1993) for an illustration of the difficulties in relaxing this assumption.

We use numerical methods to solve for the equilibrium of our model. Given a beginning-of-period income distribution, our algorithm finds all stratified equilibria to the two-stage game played in each period. The key fact used in this procedure is that all potential stratified equilibrium can be parameterized by the fraction of the population that resides in C_1. We denote this fraction as ρ. Each value of ρ determines the income distributions of the two communities since it partitions the income space into higher income individuals that reside in C_1 and lower income individuals that reside in C_2. Associated with each value of ρ is a highest income individual in C_2; call this value y_{b2}. Let y_{b1} be the lowest income of an individual in C_1.

Define $W_j(\rho)$ to be the utility of an individual with income y_{bj} residing in C_j given that ρ partitions the residents of the two communities and that each community chooses its tax rate via majority vote. An equilibrium can be depicted as a "crossing" of the two W_j curves.[12] We compute the W_j curves and therefore find all the stratified equilibria. In all our simulations the stratified equilibrium is unique.

Given an initial income distribution, repeated application of the above procedure can be used to solve for the entire equilibrium sequence. We look for stable steady-state income distributions by examining the dynamic path for λ that results from each of a large set of initial distributions. In our simulations we find a unique (stable) steady state and convergence always occurs.

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[12]Since the y_{bj} are discontinuous functions of ρ (given a discontinuous income distribution), the equilibrium need not require $W_1(\rho)=W_2(\rho)$.

3.2 Functional Forms

Three functional relationships need to be specified: preferences, housing supply and the effect of the quality of education on subsequent earnings. For preferences we assume:

$$u(c,h) = \frac{a_c c^{\alpha} + (1-a_c)h^{\alpha}}{\alpha} \qquad w(y_c) = \frac{a_q(y_c^{\gamma} - 1)}{\gamma} \qquad 0<a_c<1,\ \alpha,\gamma\le 1\ \ a_q>0 \quad (11)$$

The specification for $u(c,h)$ is a transformation of a constant elasticity of substitution utility function. Note that Assumption 1 will be satisfied if and only if α turns out to be strictly negative (given $v'(q)>0$). The choice for $w(y_c)$ displays constant relative risk aversion.

We assume identical constant elasticity housing supply functions for both communities, i.e.

$$H_j^s(p_j) = ap_j^b \qquad (12)$$

This specification yields the same price elasticity for both communities (i.e. b).

The final relationship to be specified is that linking quality of education to subsequent earnings. We assume that each individual's realized income is a draw from a discrete approximation to a log-normal distribution whose mean depends on q. In particular, consider a log normal distribution of income where log of income has mean $m(q)$ and variance σ^2 and $m(q)$ is defined by:

$$m(q) = y_0 + \frac{B(1+q)^{\delta}}{\delta} \qquad B>0 \qquad (13)$$

Given a vector $[\tilde{y}_1, \ldots, \tilde{y}_I]$ where y_i is contained in $(\tilde{y}_i, \tilde{y}_{i+1})$ for $i=1,2,\ldots I-1$, and $y_I > \tilde{y}_I$, we transform the continuous distribution in (13) to a discrete distribution over the I income types (hence obtaining the $\phi_i(q)$) by integrating the above log normal distribution over the interval containing y_i.

A few comments should be noted concerning this choice. First, B>0 implies that expected income is increasing in q. Second, we assume that σ is independent of q. Third, m(q) can be concave or convex in q, depending on whether δ is smaller or larger than one. Lastly, it should be noted that (13) is a specification meant to hold only over the relevant region of q, since otherwise some combinations of parameter values and q yield negative expected income.[13]

3.3 Parameter Values

We choose parameter values such that the steady-state equilibrium of the model matches important observations for the US economy. In particular, we require that the steady state match several aggregate expenditure shares, elasticities, and properties of the income distribution for the US economy.

There are three commodities in the model: consumption, housing, and education, and hence two independent expenditure shares. The ratio of annual aggregate housing expenditures to aggregate expenditures on consumption (which includes housing), H/TC, (averaged over 1960-1990) is 0.15, and the average annual ratio of spending on public elementary and secondary education to aggregate expenditures on consumption, E/TC, is 0.053.

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[13]The term (1+q) is used rather than q as a normalization to avoid large negative numbers.

We match four elasticities: the price elasticities for housing demand and supply ($\epsilon^{d}_{h,\pi}$ and $\epsilon^{s}_{h,p}$), the elasticity of mean earnings with respect to the quality of education ($\epsilon_{m,q}$), and the cross-sectional elasticity of community public education expenditures with respect to community mean income ($\epsilon_{q,\mu}$).

Quigley (1979) surveys the literature on urban housing markets. Based on this survey we choose to match a price elasticity of housing demand (gross of taxes) equal to -.7 and a price elasticity of housing supply equal to .5. Estimates of the demand elasticity range as high as -.95, however, and the range of estimates of the supply elasticity is large. Additionally, the mapping between the (implicit) models underlying these elasticity estimates and our model is not exact. Hence we also explore the effect of different price elasticities for our results.[14] Note that the functional form we have chosen for the utility function does not imply a constant demand price elasticity for housing. By homotheticity, however, the price elasticity of demand for housing is independent of income so that we can use the model's cross-sectional steady-state observations of housing prices and per capita housing quantities to compute the (gross) price elasticity.[15] We normalize the parameter a in the housing supply function to equal 1.

A key difference between the two communities in our model is that in equilibrium C_1 has both higher mean income and quality of education than C_2. Therefore, from the steady-state equilibrium one can compute a cross-sectional elasticity of (per-student) expenditures on education with respect to

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[14]Additional empirical studies are surveyed in Olsen (1986).

[15]A demand elasticity less than one in absolute value corresponds to a negative value of α, which is required to satisfy Assumption 1.

community mean income. Many empirical studies obtain estimates of this elasticity (see Inman (1979) and Bergstrom, Rubinfeld and Shapiro (1982) for surveys). The range of estimates obtained in these studies is 0.24-1.35, with the vast majority of the estimates lying in the narrower range of 0.4-0.8. We choose parameter values so that $\epsilon_{q,\mu}$=0.62 when evaluated at the steady-state equilibrium. Note that a value greater than zero but smaller than one is significant since it implies that, ceteris paribus, communities with higher mean incomes spend more on education but tax at a lower rate.

To choose a value for the elasticity of mean earnings with respect to education quality we rely on evidence presented by Card and Krueger (1992), Wachtel (1976), and Johnson and Stafford (1973). Card and Krueger, using several indicators of quality of schooling across states and time, estimate that a decrease in the student to teacher ratio by ten students would increase earnings by 4.2%. Over the period 1924-1964 the average annual ratio of teacher's wages to total costs for public elementary and secondary schools was 54% and the average annual student-teacher ratio over the same period was 28.0. The resulting estimate of the elasticity of earnings with respect to education expenditures (quality) is 0.1774.[16] Wachtel, in a study that examines the returns to schooling using school district expenditure levels, finds an elasticity of 0.2. Since college expenditures are included as a separate variable in his regressions, it is reasonable to view this estimate as being on the low side to the extent that higher secondary education

[16]Note that Card and Krueger's elasticity estimates combine two different effects of quality on earnings: an increase in earnings holding years of education constant, and an increase in wages due to increased years of education. While our model abstracts from the effect of quality on years of education, we believe that the combined effect is the appropriate measure.

expenditures also increase the probability of attending a higher quality college. Johnson and Stafford also find an elasticity estimate of 0.2. In our benchmark calibration we choose $\epsilon_{m,q}$=0.1911 and explore the sensitivity of our results to changes in this value in section 5. We compute the elasticity by using the cross-sectional variation in the steady-state values of q across communities and equation (13) relating q to mean earnings.

The final piece of information we use in calibration is data on the income distribution of families from the 1980 Census. We choose the $\tilde{y}_i$'s to match the commonly used (in thousands) income intervals—$\tilde{y}$=(0,5,7.5,10,15,20,25, 35,50)—and set the vector of y_i's equal to (2.5,6.75,8.75,12.5,17.5,22.5,30,42.5,60). Two additional items of information that we match in the steady state of our model are the 1980 Census values of mean and median family income values, equal to 21.4 and 17.9 respectively.[17]

Lastly, in our benchmark specification we set γ=0 which implies that v(q) can be approximated by the expression:[18]

$$v(q) \simeq a_q [y_0 + \frac{B(1+q)^{\delta}}{\delta}] \tag{14}$$

Although this choice of γ is somewhat arbitrary, this value lies within the range of estimates for risk aversion obtained in the asset pricing literature when preferences are defined over consumption sequences. In Section 5 we consider alternative values for this parameter.

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[17]When we compute median income in the model we assume that individuals with income y_i are uniformly distributed over the interval $[\tilde{y}_i, \tilde{y}_{i+1}]$.

[18]The fit of this approximation depends on how closely the transformation from a continuous to a discrete distribution preserves the mean of log income.

Thus, the items of information described above (two expenditure shares, four elasticities, mean and median income) and the chosen values of γ and a can be used to determine the eight parameter values: a_c, a_q, b, δ, α, B, y_0 and σ^2.

3.4 Discussion

One issue concerning the calibration procedure should be noted. Whereas the model assumes that public education is entirely financed at the local level, in the US state aid accounts for a substantial portion of expenditures on education. It is possible, therefore, that the statistics that we match in the calibration procedure are not invariant to the structure of educational finances, and hence should not be used to calibrate a model with pure local financing. The fact that financing provisions have changed significantly over the last thirty years provides an opportunity to gauge the extent of this problem. The aggregate expenditure shares for housing and (elementary and secondary) education have been relatively constant over this period and we know of no evidence to indicate significant changes in the price elasticity of housing demand over time. Hence the concern raised by this issue for these estimates is probably minor.

On the other hand, calibrating the model to match the cross-sectional elasticity of expenditures on education per student with respect to community mean income is potentially more problematic. Much of the empirical work in this area effectively involves a regression of (log of) community education expenditures per student on a number of variables including log of community mean income and a variable designed to capture the effect of state aid on the marginal price of education expenditures faced by the tax payer. The coefficient on mean income is then interpreted as the elasticity of expenditures with respect to mean income. While the empirical work attempts to take into account the rules by which state aid is provided, the elasticity estimated need not be invariant to these rules. This is perhaps less problematic than may appear at first, however, since the estimates are derived from studies of different states and many of the estimates are quite similar. Nonetheless, in light of these concerns, Section 5 provides a sensitivity analysis that allows us to address how changes in the values of the elasticities used in the calibration affect our results.

4. Results

4.1 Properties of the Benchmark Model

In this section we report the parameter values generated by the calibration described in the previous section and present some additional properties of the steady state and of the dynamics of the system. As noted before, our computations yield a unique equilibrium for the one period game, a unique stable steady state, and convergence to the steady state.[19]

Table 1 below reports the parameter values used in the calibration and the steady-state values for several variables and Table 2 provides the steady-state values of the community variables..

[19] Typically, convergence to the steady state is quite rapid (three or four periods).

TABLE 1

Parameter Values

Preference Parameters: $a_c=.936$ $a_q=.034$ $\alpha=-.6$ $\gamma=-.0001$;

Housing Supply Parameters: $a=1$ $b=.5$

Education-Earnings Relationship: $\delta=-3.9$ $B=8$ $y_0=3.01$ $\sigma^2=.63$

Steady-State Values

$\lambda=$ (.02,.06,.10,.21,.18,.13,.15,.09,.05)

mean income=21.56 median income=17.91

$\epsilon^d_{h,\pi}=-.6957$, $\epsilon_{m,q}=.1911$, $\epsilon_{q,\mu}=.6162$

E/TC=.0545, H/TC=.1448

TABLE 2

Steady-State Equilibrium Values

	C_1	C_2
t	.287	.512
p	1.468	1.117
q	1.625	0.881
μ	37.996	14.034
E/TC	.0447	.0670
H/TC	.1557	.1308
ρ	.314	
y_b	22.5	

Note that, as required for a stratified equilibrium, both quality and the gross price of housing are higher in community one. The net-of-tax price of housing is also higher in C_1. This is essential to produce stratification since the tax rate in C_1 is lower than that in C_2 as required by $\epsilon_{q,\mu}<1$ (given $q_1>q_2$ and $p_1>p_2$).

Spending per student is nearly twice as large in C_1 as in C_2. Although there are many metropolitan areas in which this range of expenditures exists, this ratio is somewhat on the extreme side of what is observed in the US data. This is not surprising, however. Our model describes how expenditures would vary across communities if all financing were done at the local level. The fact that differences are not as large in the US data as they are in our calibrated model simply indicates that state aid does (on average) decrease differences in education expenditures across communities.

In the steady state all individuals with income greater than 22.5 live in C_1, all individuals with income less than 22.5 live in C_2, and individuals with income equal to 22.5 are split across the two communities. Since the quality of education differs across communities, the children of wealthier individuals will belong to a different income distribution when old than that of the children of poorer individuals. In the steady state computed above, these two income distributions are given by:

TABLE 3

Distribution of Income Generated by Community

Income	C_1	C_2
2.5	.02	.03
6.75	.05	.07
8.75	.08	.10
12.5	.20	.22
17.5	.18	.18
22.5	.14	.13
30.0	.17	.14
42.5	.11	.08
60.0	.07	.04
	m_1=23.33	m_2=20.76

4.2 Policy Experiment

In this section we determine the effects of switching to a public education system in which there is no local financing. Rather, per student expenditures on education are the same regardless of the community of residence and the total level of expenditure is determined at the state (or national) level.[20] Of course, the manner by which revenue is raised is also important. We maintain the property tax as the tax instrument so as to keep the local versus national question starkly focused.

[20]This is similar to the system of financing education of some European countries.

Formally, the stage game of section 2 is modified so that in the second stage voting is over a single property tax rate and expenditures per student are equal across communities.[21] It should be clear that in a subgame-perfect equilibrium of this game the price of housing must be equal across communities: since all individuals face the same tax rate and obtain the same quality of education independently of the community in which they live, no one would choose to reside in the community with the higher housing price.

We use the functional forms and parameter values from the calibration procedure described in the preceding section to determine the effects of the change in policy. This is a classic policy analysis exercise in which the fundamentals or primitives are held constant but individuals are allowed to adjust their decision rules in response to the change in policy environment.

We compute the steady-state equilibrium for this economy. It remains true that there is a unique equilibrium in each period, a unique stable steady state, and that the economy converges to the steady state. Table 4 displays some of the properties of the steady-state equilibrium.

TABLE 4

Steady State Under National Financing
$\lambda = (.02,.06,.09,.21,.18,.13,.16,.10,.06)$
$t=.386$ $p=1.327$ $q=1.180$
$E/TC=.0560$, $H/TC=.1450$
mean income = 22.28, median income = 18.54

[21]Note that no additional sources of education finance are allowed, i.e. no local supplements.

A comparison of the steady-state outcomes generated by the two systems yields several expected results. Since the median voter and mean income of the entire economy lies between those of the individual communities, it is not surprising that, for example, spending per student in the steady state of the second system lies between the corresponding values for the two communities of the first system, as do the tax rate and the price of housing. Two results (not necessarily expected) are that average income and education expenditures as a fraction of total consumption are both greater under national financing. These will turn out to be central to our welfare results.

Our analysis also allows us to trace out the transition path between the two steady-states. Properties of the transition will be important to the welfare calculation of Section 4.3. For completeness, Table 5 shows the evolution of the tax rate, housing price, the quality of education, mean income, and E/TC from period 1 (defined as the first period in which individuals vote on a national tax rate given the income distribution, but not the residence pattern, generated by the local finance steady state) to period 4 (the first period in which the national finance steady state is attained).

TABLE 5.

Transition to National Finance Steady State

period	t	p	q	μ	E/TC
1	.4000	1.2840	1.1642	21.5632	.0571
2	.3874	1.3236	1.1799	22.2184	.0561
3	.3858	1.3273	1.1801	22.2760	.0559
4	.3858	1.3274	1.1801	22.2765	.0559

As can be noted from Table 5, the transition to the steady state is monotonic in all the relevant variables as of period 1. Compared to the local steady-state equilibrium of period 0, however, the transition entails a jump in E/TC as the median voter first chooses a large tax rate to increase spending on education by a large amount and then, as the income distribution shifts to the right and total income increases, the tax rate and E/TC are chosen progressively smaller.[22] We now turn to the question of the effect of this policy change on welfare.

4.3 Welfare Effects

It is clearly desirable to have some measure of the welfare effects associated with the change in the education financing system. We construct the following welfare measure. For each economy we compute, for each period t, the expected utility (EU) for a hypothetical individual whose income is a random draw from that period's income distribution. Thus, if λ_i is the fraction of the population with income y_i and V_i is the utility of an individual with income y_i then the expected utility in period t is given by:

$$EU_t = \sum_i \lambda_{it} V_{it} \tag{15}$$

Henceforth we define EU_0 to be the value of EU in the steady state of the local finance system.

We first examine the value of EU in the local financing steady state vs. the national financing steady state. Under the local system EU=-.3197; under the national system EU=-.3117. In order to translate the difference in

[22]The income level of the median voter remains unchanged throughout the transition. This need not always be the case and would generically not be so if a continuous income distribution were used.

utility into a measure not affected by monotone transformations of the utility function, we calculate the percent, Δ, by which the vector of income $(y_1, y_2, \ldots y_9)$ would have to be reduced in the national financing system to render the hypothetical individual indifferent between the two economies. This calculation holds prices, tax rates and quality of education constant at their original equilibrium levels. The magnitude of the required decrease in income is 3.2%. This is a very large difference in welfare; welfare costs of alternative policies usually turn out to be a fraction of a percent of total income.

We next examine the welfare effects along the transition path to the new steady state. Table 6 shows the value of EU_t from period 0—the steady-state under local financing—through period 4 (at which point the economy is at its steady-state equilibrium under the national financing system).

TABLE 6

Welfare Effects Along the Transition Path

Period	EU_t	Δ_t
0	-.3197	0
1	-.3205	-.3
2	-.3124	2.9
3	-.3117	3.2
4	-.3117	3.2

Note that the third column gives, for each period t, the percentage Δ_t by which the vector of income would have to be changed in order to equate that period's EU_t to EU_0 (recall that prices, tax rate and quality of education at kept at the equilibrium level attained in period t).[23] Note that period 1 will have, ceteris paribus, a greater tendency to have a negative Δ associated with it since any change in income distribution will not be realized until the following period (i.e. the income distribution of this period is that from the steady state under local finance).[24]

In order to end up with an overall welfare evaluation which includes the transition path, we need to assign a discount rate and the associated length of a period, τ. If each period is interpreted to be the productive life of an individual, 30 years seems a reasonable benchmark. The structure of our model, however, is such that an individual spends the same length of time going to school when young as being productive when old. Thus another reasonable alternative is a time period of 15 years. We explore the implications of both possibilities. Instead of arbitrarily assigning an annual discount factor, however, we ask at what rate must the future be discounted in order for both systems (including the transition to the national financing system) to yield the same total utility. More formally, we find the β such that

$$\sum_{s=0}^{\infty} \beta^{\tau s} \Delta_{s+1} = 0 \tag{16}$$

For $\tau=30$, this yields $\beta=.924$ or an implicit annual interest rate $r=8.2\%$. For any discount factor greater than .924, therefore, under the welfare criteria used it would be beneficial to switch to a national finance system.

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[23]Note that by our previous definition, $\Delta_0=0$.

[24]See Benabou (1992) for a somewhat different tension that exists between long run and short run welfare.

Similarly, for τ=15 the implied annual interest rate required for indifference is r=17.2%.

Note that the above welfare calculation did not take into account the welfare of the owners of housing (who receive the rental income). Total producer surplus from the housing market is easily computed in the two economies: Relative to its value in the steady state under local financing, it first decreases by 1.7% in period 1, and then increases first by 2.89% in period 2, and thereafter by 3.33% in each subsequent period (recall that the comparison is always with period 0—the steady-state under local financing). The β required for indifference in this case is higher (β=.966 for τ=30) but in any case producer surplus is a small fraction of total steady-state income (roughly 10%).

What is the source of the large overall welfare gain? By definition, any difference in welfare must be induced by changes in the V_i and/or changes in the λ_i. Thus, we must examine the change in utility derived from each income level's new c,h, and q bundle as well as the overall change in the income distribution.

Comparing across steady states, for the two financing systems studied above, each of the V_i is greater under local financing. That is, for each given income level, the steady state of the local financing system is preferred to that of the national financing system. Since expected utility is higher under national financing, it must be the case, therefore, that favorable changes in the distribution of income (i.e. the λ_i's) more than offset the decrease in the V_i's. This points to a tradeoff that is central to a comparison of a local and a national financing system. On the one hand, a local system has the ability to make individuals better off by allowing them greater scope to sort themselves into communities that more closely reflect their preferences given their income than does a national system that forces individuals to consume the same quantity of the publicly provided good. On the other hand, a national system may yield a better income distribution (in that higher output is generated) than a local system which generates greater heterogeneity in education expenditures. We now turn to a more detailed examination of these points.

Note first that the steady-state income distribution under national financing stochastically dominates that under local financing; in particular, λ_1 through λ_4 are greater under local financing whereas λ_5-λ_9 are greater under national financing. The income distribution under national financing is characterized by a single parameter—the mean of the log normal distribution (recall that the variance is constant). Thus, an explanation of the higher level of mean income should provide insight into the higher welfare achieved under the national financing system.

Although equation 13 allows the mean of log income to be either concave or convex in q, our finding of δ—3.9 implies substantial concavity. It follows that holding total spending on education fixed, next period's mean income is greatest if these funds are divided equally across all students. Whereas equal division of funds is what occurs under national financing, under local financing students in C_2 receive roughly half the per student expenditures as students in C_1. To obtain an idea of how much this concavity matters, we calculate the income distribution that would result from distributing total steady-state expenditures on education in the local system equally across students. The mean of the resulting income distribution is 22.02, a gain of 2.1% over the mean of 21.56 that results from the pattern of educational expenditures found in the steady state under local financing and 63.9% of the total increase in mean income found in the steady state of the national system. Thus, there are large gains to be realized simply by spreading resources equally across all students, the remainder of the gain in mean income coming from the increased education expenditures induced by a change in financing systems.

It may be thought that a substantial portion of the welfare increase is a consequence of concavity of preferences over q since our calibration implies that v(q) is concave. Holding total spending on education constant, therefore, the average value of v(q) is maximized by a constant q across communities. A simple calculation, however, indicates that the quantitative magnitude of this effect is small. In particular, using the steady-state equilibrium values under local financing yields $v(\rho^* q_1^* + (1-\rho^*) q_2^*)$ exceeding $\rho^* v(q_1^*) + (1-\rho^*) v(q_2^*)$ by 0.0008, which is only about 10% of the difference in steady-state expected utilities for the two financing systems.

We now turn to a closer examination of the tradeoff between local and national financing systems via the use of two illustrative examples.

4.4 Two Examples

The previous discussion of welfare effects highlighted two opposing factors central to a comparison of local and national financing systems. On the one hand, local finance permits heterogeneous agents to obtain bundles closer to their preferred ones. On the other hand, the equalization of expenditures across students that occurs in a national system may result in greater mean income. In our benchmark model the second effect is dominant. Here we present two examples to show that this outcome is a result of the particular parameter values generated by our calibration procedure and is not inherent to the structure of the model. These examples may also help to illustrate the nature of the tradeoff described above.

Table 7 displays parameter values (where different from the benchmark model) and some selected statistics for the steady-state allocations under local financing for the two examples and for the benchmark. As the table indicates, both examples are not acceptable from the perspective of our calibration procedure. Most importantly, in Example 1, $\epsilon_{q,\mu}$ is too high and in Example 2, $\epsilon_{m,q}$ is too low. Our focus is on the predictions of these two examples for steady-state welfare gains associated with a change from local finance to national finance. These are reported on the last row of the table. Expressed as before in terms of output, Δ, the gains are -6.2 and +.27 percent for Examples 1 and 2 respectively.

Table 8 presents two additional pieces of information useful for interpreting the above differences in welfare predictions. First it lists preferred tax rates in the steady state under national financing by income level for the benchmark model (BM) and the two examples. This provides some indication of the extent to which individuals desire different bundles of goods.[25] Preferred tax rates exhibit the smallest range in Example 2 and the greatest range in Example 1. The second piece of information provided is the percent change in mean income (%m) that would result if the resources devoted

[25]Note that this is a rough indication since both preferences and technology differ in the three cases.

to education in the local financing steady state were spread equally across all students (as in the discussion on page 30). This figure provides some indication of the potential gains from equalizing expenditures. Note that this number is largest in the benchmark model and smallest in Example 2.

TABLE 7

Selected Features Under Local Financing

	BM	Ex. 1	Ex. 2
δ	-3.9	.5	-8
B	8	.23	35
y_0	3.0	2.0	2.9
a_q	.03	.05	.20
μ	21.56	18.16	21.79
E/TC	.0545	.0852	.0556
$\epsilon_{q,\mu}$	.616	3.12	.35
$\epsilon_{m,q}$	.19	.15	.03
Δ	3.2	-6.2	.27

TABLE 8

Preferred Tax Rates Under National Financing and %m

	BM	Ex.1	Ex.2
y_1	.22	.00	.30
y_2	.30	.08	.35
y_3	.32	.16	.36
y_4	.35	.32	.38
y_5	.39	.51	.40
y_6	.41	.68	.42
y_7	.44	.93	.44
y_8	.49	1.31	.46
y_9	.53	1.81	.48
%m	2.1	1.0	.2

An explanation of the contrasting results for welfare gains in the three cases is as follows. Example 2 is a case where spending on education is not very important (as evidenced by the small value of $\epsilon_{m,q}$). Consequently, neither of the two factors mentioned above is particularly significant and the overall welfare gain is also small. Example 1 is a case where heterogeneity is quite important. Thus, although there are sizable gains to be had simply by smoothing expenditures across students, these are outweighed by the gains associated with allowing individuals to sort themselves into different communities. Relative to Example 1, the benchmark model reverses the relative magnitudes of the two effects yielding a large overall welfare improvement.

5. Sensitivity Analysis and Alternative Comparisons

Our calibration exercise relies on several estimates obtained from empirical work. Because the empirical studies often suggest a range of estimates rather than a single value, it is of interest to check the sensitivity of our policy analysis to the use of alternative values in the calibration exercise. Furthermore, it is also of interest to see what our model implies for some statistics not used in our calibration exercise.

5.1 Sensitivity to Alternative Parameter Values

In all the exercises that follow, the model's parameters are recalibrated, i.e. parameters are chosen so that the model's steady-state matches the appropriate set of statistics. To focus the discussion, we consider only the effect of these alternatives on the steady-state welfare calculation carried out in Section 4.3.

We begin with a brief discussion of three variations that we found to have virtually no effect on the magnitude of the steady-state welfare gain: changes in the preference parameter γ and in the two housing price elasticities. Recall that γ was set to 0 in the benchmark specification. The results are very similar when γ is set to values of -1 and -5. Similarly, we found no significant effect of changing the values of the price elasticities of housing used in the calibration. For the demand elasticity we used a value of -.93 (which corresponds to the upper range of estimates), and for the supply elasticity we used values ranging from 1/3 to 3.

In contrast to the above, we found that variations in $\epsilon_{m,q}$ and $\epsilon_{q,\mu}$ have a significant impact on the magnitude of the steady-state welfare gains predicted by our model. Table 9 presents the results for several alternative values of these two elasticities. (In each case the table shows the parameter values that differ from those of the benchmark specification.) In the interest of space we do not include any of the other summary statistics for the steady-state equilibria, but note that in all cases these values are similar to those for the benchmark model.

TABLE 9
Sensitivity Analysis

$\epsilon_{q,\mu}$	δ	B	y_0	a_q	Δ
1.28	-1	.95	3.37	.030	5.67
.92	-2	2.00	3.135	.032	4.48
.74	-3	4.30	3.052	.030	4.10
.51	-5	18.5	2.985	.032	2.90
.39	-7	90.0	2.950	.035	2.23
$\epsilon_{m,q}$	δ	B	y_0	a_q	Δ
.12	-4.5	7.70	2.95	.053	1.60
.31	-3.8	12.25	3.105	.021	5.69

From the table we note that although changes in $\epsilon_{q,\mu}$ result in a sizable range of associated welfare gains, in all cases the welfare gain is substantial. Furthermore, welfare gains significantly larger than those reported in Section 4.3 are apparently plausible. As for the alternative values for $\epsilon_{m,q}$, these are not chosen in accord with any ranges based on empirical work (as indicated in Section 3, the range of estimates for this value is in fact quite tight). Nonetheless, we think it informative to indicate the sensitivity of our results to this value. For the range of values displayed in the table, the steady-state welfare gain appears to be roughly linear in this elasticity.

5.2 Some Additional Comparisons

In addition to the previous sensitivity analysis, it is also of interest to contrast the income distribution and the intergenerational mobility generated by our model with that observed in reality as well as with some alternative measures of the rate of return to education. The calibration ensures that the mean and median income in the model's steady state are approximately equal to their counterparts in the US data. The distribution of income from the 1980 US Census is given by (.07,.06,.07,.15,.15,.14,.19, .11.,.06). As is well-known, the log normal distribution does a good job of accounting for the observed income distribution except that it does not have enough mass in the tails. Not surprisingly, therefore, comparing with the λ in Table 1, the same is true of the model's steady-state income distribution.

The intergenerational mobility implied by the steady-state equilibrium of the model are summarized by the numbers in Table 10 and contrasted with averages obtained for the US by Zimmerman (1992) which are presented below in parentheses.

TABLE 10

Intergenerational Income Mobility

		Parent's Income Quartile			
		Top	Second	Third	Bottom
Child's Income Quartile	Top	.31	.25	.22	.22
		(.42)	(.26)	(.20)	(.11)
	Second	.23	.24	.25	.25
		(.34)	(.24)	(.23)	(.21)
	Third	.24	.25	.26	.26
		(.16)	(.27)	(.31)	(.33)
	Bottom	.22	.25	.27	.27
		(.09)	(.24)	(.26)	(.35)

Note that our model produces a smaller probability of a child ending up in the top quarter given that the parent is in that quarter and likewise a smaller probability of remaining in the bottom quarter given that the parent is in that quarter. This is probably in large part due to the fact that we only have two communities and use a log normal distribution to approximate the income distribution generated by the quality of education in each community. A larger number of communities would give wealthier parents access to a higher q (and thus their children a greater probability of being likewise wealthy) and the opposite would hold for poorer parents.[26,27]

An additional piece of information that can be computed using the steady-state allocations is the implicit rate of return to expenditures on education. In the steady state, C_1 spends an additional q_1-q_2 per student on education.

[26]Note that the equivalent to Table 10 under national financing would have .25 for all its entries since parental income does not affect the child's income under a national system. Hence there is greater intergenerational mobility between the bottom and the top quartiles under a national financing system.

[27]Higher values of either $\epsilon_{m,q}$ or $\epsilon_{q,\mu}$ in the calibration also make the model's predictions closer to Zimmerman's numbers.

This leads to a gain in mean income of $m_1 - m_2$. Assuming that a period lasts τ years, the implied annual rate of return r satisfies:

$$(1+r)^{\tau} = \frac{m_1 - m_2}{q_1 - q_2}$$

For a time period of thirty years, using the appropriate steady-state values yields r=.0422 whereas for τ=15, r=.086.

There is a fairly large literature that attempts to determine the rate of return to investment in human capital, in particular, the return to an additional year of schooling (see, for example, Becker (1975)). Returns of between 4 and 9 percent are at the lower half of the range found in this literature, where the typical range is 5-15%. Although our calibration procedure does not attempt to match this rate of return, it is obviously closely related to $\epsilon_{m,q}$, which is defined as $[\log(m_1)-\log(m_2)]/[\log(q_1)-\log(q_2)]$. Thus one possibility is to calibrate to a larger $\epsilon_{m,q}$ yielding higher implied annual rates of return (see Table 9).

6. Concluding Remarks

This paper develops a dynamic multi-community model and calibrates it to US data. We use the calibrated model to evaluate the consequences of reforming the public education finance system from a system of pure local finance to one in which education is financed at the national level and expenditures per student are equal across communities.

We analyze the effects of such a reform on allocations and welfare, both across steady states and along the transition path. Our findings indicate a substantial welfare gain associated with this change in policy. In our benchmark model the steady-state welfare gain associated with the national finance system is over 3% of total income.

Some simplifying features of the model should be kept in mind when interpreting the above welfare gain. First, our analysis assumes that all parents send their children to public schools. While under the current system of local finance in the US less than 10% of children attend private schools, it is possible that a move to a national finance system would increase this proportion and thereby diminish public support for public expenditure on education. Second, we assume that the quality of education is only affected by spending per student; in particular, we abstract from any peer effects and assume that parental characteristics do not influence educational outcomes other than through spending on education. Third, this welfare gain presumably overstates the potential gains from reform facing a state whose educational finance system is somewhere between the extremes of local and national financing.[28] Future work should focus on evaluating how the incorporation of these factors in the model influences the evaluation of public education finance systems.

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[28]In the US, local spending accounts for roughly 45% of all spending on public education. Potential benefits from reforms depend on both the fraction of total expenditures accounted for by state aid and on the rules which govern its allocation. A system whereby state aid simply matches local spending dollar for dollar is obviously quite different from one in which aid is primarily targeted to lower-income communities. The framework developed here can also be used to analyze systems which involve a mix of local and state financing.

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