Schools and Location: Tiebout, Alonso, and Governmental Policy

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Abstract

An important element in considering school finance policies is that households are not passive. Instead they respond to policies with a combination of modified residential choice and political choice of tax levels. The highly stylized decision models of most existing analyses, however, lead to concerns about the policy evaluations. In our general equilibrium model of residential location and community choice, households base optimizing decisions on commuting costs, school quality, and land rents. With both centralized and decentralized employment, the resulting equilibrium has heterogeneous communities in terms of income and tastes for schools. This model is used to analyze a series of conventional policy experiments, including school district consolidation, district power utilization, and different equalization devices. The important conclusion is that welfare falls for all families with the restrictions in choice that are implied by these approaches.

1 Introduction

A unique feature of the U.S. education system is the high degree of both funding and control granted to local governments. As a result, school choice is inextricably tied to residential location decisions. This organization has been lauded for its responsiveness to individual demands and for the potential of increased school accountability. On the other hand, it also introduces potential inequities by tying funding decisions to local ability to pay. These conflicting views have made debates about school financing a regular item on both legislative and judicial agendas.

The complexities of analyzing the interaction of location and schooling are well known. When local citizens control taxing and spending decisions and when the quality of schools depends on the peer group, school quality is endogenous. With local funding of schools through a property tax, housing prices and the tax base also become endogenous and potentially strongly influenced by any governmental policies that affect funding formula. Finally, residential location, while potentially responsive to school quality, is also strongly influenced by job location and journey to work.

With a few exceptions, analyses of school finance policies have generally ignored one or more of these features of household choices of schools and homes. As a result, analysis of policy alternatives for school finance and operations is likely to be biased.

This paper integrates the essential features of schools and location. In a general equilibrium framework, heterogeneous families (in terms of income and tastes) seek out an optimal residential location based on commuting costs and on school quality. They also vote on local taxes, yielding variations in school spending that, along with peer influences, produce variations in school quality. The general equilibrium aspects are especially important, because housing prices vary with demand and with governmental policy.

This model is used to analyze the impacts of alternative school finance policies. First, consolidation of school districts, paralleling the trends of the past century, are considered from the perspectives of school outcomes and of individual welfare. Second, spending equalization and district power equalization – common legislative and judicial choices of the past three decades – are put into the general equilibrium framework where families react to the altered locational advantages.

2   Existing Literature

Urban location and local public finance have been built on two artificially separated streams of literature, namely urban residential location models and Tiebout models of community choice. In urban location theory, a households' residential location is determined by the trade-off between accessibility and space. The pioneer of this approach was Alonso (1964) with his simple but instructive model of the land market, which was later followed by a great deal of theoretical and empirical work by Muth (1969), Mills (1972), and others. (See the review in Straszheim (1987)). This set of models is mainly concerned with how to model residential choice where the driving force is commuting costs. By ignoring local public goods and services, they do not address many policy questions, but they do provide baseline predictions about locational choices. The typical model predicts that higher income people live in suburban areas, although Glaeser et al. (2000) suggest that the observed behavior has more stratification than can be supported by the models.

In Tiebout models of community choice, on the other hand, households care (only) about local public goods and vote with their feet to shop for the community which best satisfies their preferences. This literature has evolved from the central insight of Tiebout (1956) and builds upon the analytical framework developed in Ellickson (1971). The most influential studies from this approach have been conducted by Epple et al.(1983, 1984, 1993), who have also introduced politics into the model. (See the review by Ross and Yinger (1999)).This literature concludes that households should stratify into communities by their income and tastes, and predicts that the same type households would live in the same community. This is an important shortcoming of these models, given empirically that communities tend to be quite heterogeneous in terms of income (see, for example, Pack and Pack (1977,1978), Epple and Platt (1998)).

The urban location model and the Tiebout model have each attempted to abstract from reality in order to concentrate on a specific feature of interest. However, the conflicts with the gross empirical data are severe, suggesting that the models may not provide reliable indications of the comparative statics and of how policy interacts with location.

An innovative paper by de Bartolome and Ross (2003) suggests that combining the two modeling perspectives may provide a more realistic portrait of urban location. Their monocentric

city model that includes fiscal motivation of jurisdictions and majority voting can produce income mixing in a central city and suburban ring. Nechyba (2003), taking a different route, develops a general equilibrium model that is calibrated on pre-existing heterogeneity of income and housing.

This paper builds on these various strands. The objective is construction of a model with sufficient richness to capture the basic reality of urban spatial structure. We begin by developing a general equilibrium model of household location, school demand, and voting on taxes. We begin with a common monocentric city model except that it has two competing school districts. We then expand this to a model of with multiple workplace centers. These models, which produce income and taste mixing within communities, provide the benchmark for subsequent policy experiments. Specifically, we investigate the popular education finance reforms of school district consolidation, district power equalization, and expenditure equalization and assess the impact of these reform attempts in the context of household choice behavior.

3 Formal Model of Household Decisionmaking

The outline of our structure is easy to describe. Urban location and public good preferences are integrated with a calibrated general equilibrium model of community choice. Households that differ in both income and tastes commute to their workplaces, facing both pecuniary and time costs in commuting. Education is financed through property taxes determined by majority voting. The production function for education combines peer group effects with spending. Both location and school quality affect housing prices, and thus enter influence taxes and mobility.

After showing that mixing of different household types is found within a city with centralized employment, we relax the common monocentric city assumption of urban location models. Specifically, we develop a closed city model with decentralized employment locations: a CBD and two subcenters, and three school districts providing a local public good (education).

The primary innovations in our analysis are the introduction of more realistic decision problems for households and the subsequent tracing of the implications of this for policy. Specifically, individuals are motivated in their locational decisions by both schools and commuting costs, and individuals differ in both tastes for schooling and in income. They also consider housing qual-

ity, here proxied by lot size. Introducing these simple factors into the decision problem provides added realism that permits calibrating the model to the urban structures that we observe. It also forms the basis for a series of policy simulations that mirror a variety of proposals for changing the financing of schools.

3.1 Centralized Employment

The simplest version of a locational model that illustrates the interaction of commuting and political preferences is a monocentric metropolitan area that is divided into jurisdictions. We develop a basic structure here that generalizes easily to multiple employment centers and added school districts.

Our metropolitan area lies on a featureless xy plane. All employment is found in the Central Business District (CBD) located at the origin. Moreover, the area is divided into two jurisdictions, each operating its own schools. The y-axis, passing through the CBD, forms the boundary between the two jurisdictions. We will refer to the jurisdictions as the East School District and West School District throughout. Each jurisdiction offers a local public good (education) financed through taxes on residential property.

The labor market has two types of workers, skilled (S) and unskilled (U), who produce a composite commodity. The equilibrium wages in the CBD are determined exogenously. Skilled workers make w_s dollars per hour while unskilled workers make $w_u(< w_s)$ dollars per hour.

One member of each household works and makes all the economic decisions in the house. Each household has a pupil attending school.

Households place different values on the quality of education a jurisdiction provides. Some value education more (high valuation types, H), some less (low valuation types, L). Therefore, we have four different types of households in the city $i \in \{SL, SH, UL, UH\}$.

Consider a type i household seeking a residence at a location that is r miles from the CBD in jurisdiction j. The time endowment for the household is 24 hours. The city has a dense radial transportation system. Households commute between workplaces and residences. Commuting has both pecuniary and time costs. Formally, commuting requires $a/2$ dollars per mile and $b/2$ hours per

mile. Labor is the sole source of income. Thus, the household's full income, net of transportation costs, is $Y_i(r) = 24w_i - (a + bw_i)r$.

The preferences for households are represented by a Cobb-Douglas utility function given by $U(\alpha_i, \eta_i; q, s, z, l) = q_j^{\alpha_i} s^{\eta_i} z^\gamma l^\delta$, where $\alpha_i + \eta_i + \gamma + \delta = 1$, q_j is the quality of education in community $j \in \{w, e\}$, $s > 0$ is the lot size, $z > 0$ is the numeraire composite commodity, and $l \in [0, 24]$ is leisure. $\alpha_i \in \{\alpha_H, \alpha_L\}$ is the taste parameter for education and, $\eta_i \in \{\eta_H, \eta_L\}$ is the taste parameter for lot size. The normalization of the parameters to sum to one is done to differentiate high valuation and low valuation households with the same income. To see this, consider two households, one low one high valuation, with the same income. In this formulation, a high valuation type enjoys education (lot size) more (less) than a low valuation type (i.e. $\alpha_H > \alpha_L$ and $\eta_H < \eta_L$).

The budget constraint of the household is given by

$$z(r) + (1 + \tau_j)R(r)s(r) + w_i l(r) = Y_i(r) = 24w_i - (a + bw_i)r$$

where τ_j is the property tax rate, $R_j(r)$ is the equilibrium rent per unit of land at distance r that is paid to a landlord for his land in community j. Notice that this formulation suggests that households sell all available time to employers and buy back some leisure at the prevailing market wage rate.

In a standard way, we can define the bid-rent function of the household, which shows the household's willingness to pay given a fixed utility level as:

$$\Psi(r, u_i, q_j, \tau_j) = max_{s,z,l} \left\{ \frac{Y_i(r) - z - w_i l}{(1 + \tau_j)s} | U(\alpha_i, \eta_i; q, s, z, l) = u_i \right\}$$

The bid rent function and the bid max lot size function, $s(\cdot)$, can be derived analytically by using the indirect utility function[1]:

$$\Psi(r, u_i, q_j, \tau_j) = \frac{k_i^{1/\eta_i}}{(1 + \tau_j)w_i^{\delta/\eta_i}} q_j^{\alpha_i/\eta_i} Y_i(r)^{\frac{\eta_i + \gamma + \delta}{\eta_i}} u_i^{-1/\eta_i}$$

$$s(r, u_i, q_j, \tau_j) = \frac{\eta_i}{(\eta_i + \gamma + \delta)(1 + \tau_j)} \frac{Y_i(r)}{\Psi(r, u_i, q_j, \tau_j)}$$

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[1]The approach to solving the problem comes from the duality approach (Solow 1973). The calculations exploit the fact that with this form of utility function the optimized budget shares of lot size s, composite good z, and leisure l are given by $\frac{\eta_i}{\eta_i + \gamma + \delta}$, $\frac{\gamma}{\eta_i + \gamma + \delta}$, and $\frac{\delta}{\eta_i + \gamma + \delta}$, respectively. The constant in the maximization comes from the utility function parameters: $k_i = \frac{\eta_i^{\eta_i} \gamma^\gamma \delta^\delta}{(\eta_i + \gamma + \delta)^{(\eta_i + \gamma + \delta)}}$.

We can now examine some properties of bid-rent and bid-max lot size functions. Clearly, the bid-rent function is differentiable, and decreasing in both utility level u and distance r (i.e. $\frac{\partial \Psi(r,.)}{\partial r} < 0$ and $\frac{\partial \Psi(u_i,.)}{\partial u_i} < 0$). Moreover, since $\frac{\eta_i + \gamma + \delta}{\eta_i} > 1$, the bid-rent function is convex in r. As for the bid-max lot size function, it is differentiable, and increasing in both u and r.

The relative steepness of bid-rent functions by distance determines the spatial ordering of equilibrium household locations in a jurisdiction. Following Alonso (1964), we assume a competitive land market in which households bid for land and absentee land owners offer the land to the highest bidder. For any given location, the landlord receives five implicit offers corresponding to the four different types of households and agricultural use, which has a fixed bid of r_a.

Consider two different types of households with bid-rent functions $\Psi_1(r, u_1, .)$ and $\Psi_2(r, u_2, .)$. Because the bid-rent functions are differentiable and convex in r, there is a unique intersection point for any pairs of bid-rent function, and it suffices to look at the slopes at the intersection point to determine which bid-rent function is the steepest. Let r^* stand for the intersection point (i.e. $\Psi_1(r^*, u_1, .) = \Psi_2(r^*, u_2, .)$ for some (r^*, u_1, u_2)). Given that Household 1 and Household 2 are the only bidders and Household 1 has a steeper bid-rent function (i.e. $\partial \Psi_1(r^*, u_1, .)/\partial r > \partial \Psi_2(r^*, u_2, .)/\partial r$), the bid-rent function of Household 1, $\Psi_1(r, u_1, .)$, dominates the bid-rent function of Household 2, $\Psi_2(r, u_2, .)$, as we move towards the CBD. In other words, the households are stratified by distance. The equilibrium location of Household 1 is closer to the CBD than that of Household 2 if and only if the following condition holds in our specific case:

$$\frac{\partial \Psi_1(r^*, u_1, .)/\partial r}{\partial \Psi_2(r^*, u_2, .)/\partial r} = \frac{(\eta_1 + \gamma + \delta)\eta_2}{(\eta_2 + \gamma + \delta)\eta_1} \frac{Y_2(r^*)}{Y_1(r^*)} \frac{(a + bw_1)}{(a + bw_2)} > 1$$

To understand the implications, consider two households with the same wages, bidding for a location at distance r (i.e. $w_1 = w_2$, implying $Y_1(r) = Y_2(r)$). Suppose Household 1 is a high valuation type ($\alpha = \alpha_H$) and Household 2 is a low valuation type ($\alpha = \alpha_L$). Since $\eta_1 < \eta_2$, $\partial \Psi_1(r^*, u_1, .)/\partial r > \partial \Psi_2(r^*, u_2, .)/\partial r$. In other words, high valuation type Household 1 has a steeper bid-rent curve and locates closer to the CBD. Next, consider two households with the same tastes and assume Household 1 is the higher income one (i.e. $\eta_1 = \eta_2$, $w_1 > w_2$). Whether $\partial \Psi_1(r^*, u_1, .)/\partial r > \partial \Psi_2(r^*, u_2, .)/\partial r$ is indeterminate. There are two opposing factors. First, higher

wages imply higher incomes and, since rich households want bigger houses, they want to move away from the CBD. However, because the cost of commuting is more for higher wage-earners, they want to move closer to the CBD in order to commute less.

We can identify the equilibrium location of households and equilibrium market rents in each jurisdiction, once we know the equilibrium wages in the CBD along with households' utilities. Market rent $R_j(r)$ in community j is the upper envelope of the equilibrium bid-rent curves $\Psi_i(r, u_i^*, .)$ for all household types $i \in \{SL, SH, UL, UH\}$ and the agricultural rent line. Needless to say, in equilibrium, if type i households are present in both jurisdictions, they should get the same utility wherever they are so that nobody has an incentive to switch his community of residence. Since bid-rent functions for all types are convex and decreasing in r, market rent curves, $R_j(r)$ $j \in \{w, e\}$, are necessarily decreasing up to a distance.

Our real interest is to examine the interaction of school quality and location. For most interesting analyses, we must turn to a full general equilibrium model, but there are two general outcomes that follow directly from the basic structure (and are proved in the Appendix). First, if one jurisdiction, say the East, has better schools than the other, than more high valuation types will live in the East. Second, this structure will also result in an equilibrium that has income mixing in the two jurisdictions.[2]

From a household's point of view, each jurisdiction is characterized by the quality of education and property tax rate pair (q_j, τ_j) it provides. Education in community $j \in \{w, e\}$ is financed through property taxes on residential land. Each jurisdiction's local government spends all tax revenue on education. Then, the government budget constraint in community j is

$$E_j = \tau_j \bar{R}_j = \tau_j \frac{\int_0^{r_{fj}^*} R_j(r) L(r) dr}{N_j}$$

where N_j is the population, E_j is the expenditure per pupil, and $\bar{R}_j$ is the tax base per pupil in community j.

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[2]With a somewhat different structure, de Bartolome and Ross (2003) prove that a similar income mixing possibility exists in the monocentric employment model. While it may appear that it arises here because we introduce differences in tastes along with income, we will show below in our calibrated model that income mixing also occurs even when tastes and income are perfectly correlated.

Characterizing the relationship between the quality of education and the expenditure on schools has proved difficult (Hanushek 2003). Here, we emphasize the interaction of peers and spending in determining quality. Specifically, we characterize quality as being determined by:

$$q_j = \phi_j(N_L^j, N_H^j) \, E_j$$

where N_L^j and N_H^j are the number of low educational valuation and high educational valuation households in community j, respectively. The peer group effect function, $\phi_j(\cdot)$, which has a natural interpretation of determining the efficiency of spending, is given by

$$\phi_j(N_L^j, N_H^j) = c_1 + c_2 \exp(-c_3 \frac{N_L^j}{N_H^j})$$

where c_1, $c_2, > c_3 > 0$ are constants. Notice that the efficiency of schools in jurisdiction j, ϕ_j, is increasing in high valuation households and decreasing in low valuation households. The value of peer group effect is between c_1 and 0. Two arguments can be made to justify this kind of peer group effect. The first argument is based on the classical peer-group effect: the more my neighbor knows, the more I can learn from him. The second argument is that high valuation households are more involved in how schools operate such as taking a part in the schooling process as board members or simply continuously watching over school decisions. This involvement is presumed to lead to a more efficient use of resources.

The property taxes are determined by majority voting in each jurisdiction. Following Epple et al. (1983, 1984, 1993), we assume that voters are myopic[3] in the sense that they do not consider that their decision about (q_j, τ_j) will influence land prices, populations, efficiency of the schooling system, etc. Their vote will reflect their tax preferences (τ_j) that come from maximizing indirect utility as in:

$$\max_{\tau_j} V(\cdot) = \frac{k_i}{R(r)^{\eta_i}(1+\tau_j)^{\eta_i} w_i^\delta} q_j^{\alpha_i} Y_i(r)^{\eta_i+\gamma+\delta} \quad \text{subject to} \quad q_j = \phi_j(\cdot)E_j$$
$$E_j = \tau_j \bar{R}_j$$

Solving this problem yields the preferred tax rate for type i household, $\tilde{\tau}_i = \frac{\alpha_i}{\eta_i - \alpha_i}$. The preferred tax rate is a direct function of the household's valuation type. Since there are only two valuation types for households, there are two possible preferred tax rates in the economy, and high

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[3]For a model of voters with perceptions of capitalization and capital gains, see Yinger (1982, 1985).

Parameter	Value	Parameter	Value
α_H	0.019	η_H	0.048
α_L	0.016	η_L	0.051
γ	0.187	δ	0.747
a	\$1.10	b	0.1 hrs
w_u	\$10.70	w_s	\$18.30

Table 1: Calibration Parameters for Centralized Employment Model

valuation types have a higher preferred tax rate ($\tilde{\tau}_{SH} > \tilde{\tau}_{SL}$ and $\tilde{\tau}_{UH} > \tilde{\tau}_{UL}$). Also, the more they value housing and spend on it (higher η), the lower the property tax rate they prefer.

The timing of events would be as follows: At the beginning of each period, households make community/residential choice decisions with the expectation that the last period's education and property tax packages would prevail in the current period. Once they move in, they are stuck. They vote for the property tax rate in their community of residence. The public good and tax rate package might be different from what they expected, but they have chosen the community for that period. At the beginning of the next period, they update their expectations and events start over again. In analyzing this model, we impose a requirement that all local government budget are balanced. Equilibrium occurs when, regardless of their location or communities, same type households attain the same utility level (i.e. a type i household gets u_i^* everywhere).

3.1.1 Calibration

The empirical implementation involves a calibration to an urban economy around 1997. The key parameters are given in the Table 1: These parameter relate the equilibrium choices of households to relevant aggregate statistics. Recall that the household spends $\frac{\eta_H}{\eta_H+\gamma+\delta}$, $\frac{\gamma}{\eta_H+\gamma+\delta}$, and $\frac{\delta}{\eta_H+\gamma+\delta}$ percent of his net income $Y(r)$ on land, composite commodity, and leisure, respectively.[4] U.S. average weekly hours of persons working full time are about 40 hours[5], and the average annual earnings of 18 year or over high school and college graduate workers are \$22,154 and \$38,112, respectively in 1997. These figures suggest the hourly wages in the CBD for unskilled and skilled workers should be calibrated as $w_u \approx \$10.70/hour$ and $w_s \approx \$18.30/hour$, respectively. The share

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[4]For the calculations we begin with the skilled, high valuation type (SH).

[5]The statistical facts, unless otherwise indicated, come from the Statistical Abstract of the United States, 1998.

of leisure (nonwork time) in the household's budget is $\frac{\delta}{\eta_H+\gamma+\delta} = 1 - \frac{40w_s}{24 \times 7 \times w_s} \approx 0.762$. The data on average annual expenditures of some selected MSAs suggest that a household spends about 20 percent of his income on shelter. Therefore, we set the budget share of composite commodity and land as $\frac{\gamma}{\eta_H+\gamma+\delta} = (1 - 0.762) \times 0.8 \approx 0.1904$ and $\frac{\eta_H}{\eta_H+\gamma+\delta} = (1 - 0.762) \times 0.2 \approx 0.0476$, respectively. Recall that the preferred tax rate for a type i household is given by $\tilde{\tau}_i = \frac{\alpha_i}{\eta_i - \alpha_i}$ and we had two possible preferred tax rates, one for high valuation and another for low valuation type households. The one for high (low) valuation type is set to be about 1.7 percent (1.1 percent) annually. These relationships yield enough equations to calibrate α_H, α_L, η_H, η_L, γ, δ.

Since the most common practise of commuting in the U.S. is to drive a car, pecuniary commuting cost per round trip mile is based on the cost of owning and operating an automobile. In 1997, pecuniary cost per mile was 53.08 cents, suggesting a pecuniary commuting cost of $a = \$1.1$ per round trip mile. Assuming the commuting speed is 20 miles per hour within the city, the time cost of commuting per round trip mile is set to be $b = 0.1$ hours per mile.

In equilibrium, the endogenous urban fringe distance is set to be about 12 miles in both jurisdictions. The population of the city is set to be 1,469,748 households, which implies approximately a population density of 4,680 households per square mile[6]. Approximately, 40 percent of the total population is assumed to be skilled worker households. Moreover, about 30 percent of skilled households are assumed to be low valuation types. As for the unskilled households, 70 percent are low valuation types. The agricultural rent bid r_a is set to be $\$8,897$ per acre per year. The pairs of (q_j, τ_j) $j \in \{w, e\}$ which are consistent with the population distribution summarized in the Table 2 are found.[7]

We use discrete distances and evaluate integrals numerically. We know that, if we had only one jurisdiction in the model (i.e. both jurisdictions provide the same quality of education and have the same tax rates), we could theoretically show the existence and uniqueness of equilibrium by using the boundary rent curves approach.[8] Since we have two jurisdictions, it is difficult to show

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[6]The median population per square mile of cities with 200,000 or more population was 3,546 in 1992. Source: County and City Data Book, 1994.

[7]The parameters of the education production function are set to be $c_1 = 0.$, $c_2 = 1.02$, and $c_3 = 0.001$. These parameters, as discussed below, depend on the complete structure of the metropolitan area and the varying jurisdiction.

[8]See Fujita (1986) for the formal procedure.

Types	West	East	
Unskilled High	2.4	14.7	17.1
Unskilled Low	28.8	14.2	42.9
Skilled High	6.3	21.6	27.9
Skilled Low	11.1	1.0	12.1
	48.6	51.4	**Total**

Table 2: Equilibrium percentage distribution of households across jurisdictions

Variable	West	East
Tax rate	1.09%	1.66%
Expenditure per pupil per year	$1,735	$2,305
Quality of Education	4.84	6.44
Average monthly gross rent per acre	$2,148	$2,462

Table 3: Equilibrium characteristics of jurisdictions.

the uniqueness analytically.

### 3.1.2 Spatial Structure with Centralized Employment

The equilibrium for the basic model is summarized by Table 2 and Table 3 along with Figure 0.[9] The East School District is more efficient than the West School District by virtue of its concentration of more involved parents. It offers a better education along with a higher price tag (i.e. higher property taxes). Also, the East School District has a higher expenditure per pupil.[10] Since the East School District offers a higher quality of education more efficiently, a higher percentage of high valuation types from both skilled and unskilled worker households chooses to reside there. The East School District contains 51.4 percent of the household population. Unskilled worker households make up 30 percent of the city population in both jurisdictions. However, the East School district contains more skilled worker households, which would make us expect that the efficiency is higher in the East School District. Indeed, that is the case.

Market rents and the spatial location of households in equilibrium are shown in Figure 1. (Because of the radial symmetry around the CBD, we present a cross-sectional view of the area in equilibrium). The East School District is located on the positive x-axis, and the CBD is located at the origin. Skilled worker households choose to locate away from the CBD. The inner rings around the CBD are occupied by unskilled worker households. With the current set of parameters,

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[9]Ex ante both jurisdictions are identical. Depending on the initial point, west is sometimes the efficient district.

[10]In 1999, the average expenditure per pupil was $6,146 of which 43.2% comes from local funds. We calibrate to the local spending. Source: U.S. Department of Education, 1999.

Figure 0: Monthly Gross Market Rent (per acre)
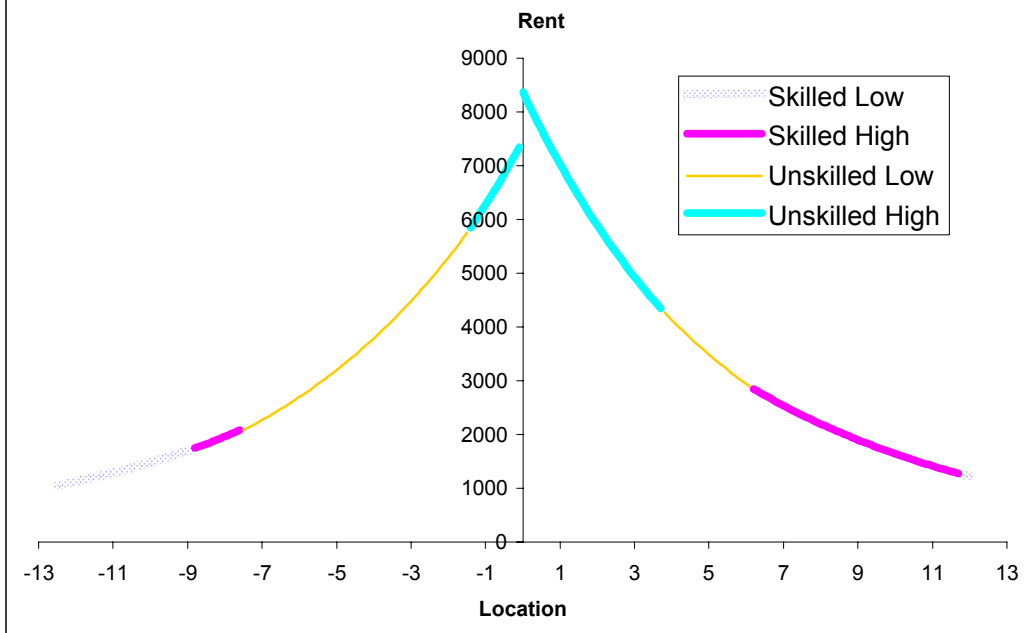
skilled worker households have a higher income and want to have bigger houses. They move away from the CBD where such houses are more abundant and cheaper. The commuting cost factors are dominated by the income effect. The low valuation type households have a higher income elasticity of lot size ($\eta_L > \eta_H$) and enjoy bigger houses by moving away from the CBD. Thus, the spatial equilibrium pattern of households (ordered from the CBD to fringe) is given as Unskilled High Valuation Households (UH), Unskilled Low Valuation Households (UL), Skilled High Valuation Households (SH), Skilled Low Valuation Households (SL).

We see market rents go down as we move away from the CBD. As expected, locations closer to the CBD have higher accessibility and we see capitalization of accessibility advantages/disadvantages. More importantly, we see a jump in the market rent as well as higher average gross market rent as we cross to the East School District from the West School District due to the capitalization of quality of education difference.

A key element of the equilibrium is the heterogeneity of both income and tastes in both communities. Necessarily, with four types of individuals, there must be mixing. But this solution shows that neither income groups nor tastes groups form homogeneous communities. Moreover, if we make income and tastes perfectly correlated (as is implicit in most theoretical investigation of locational choice), we still find heterogeneity of income across communities (not shown). The key is that the varied components of the decision making lead to trade-offs in terms of accessibility and school quality.

3.2 Decentralized Employment

The monocentric employment model, while particularly convenient in developing closed form solutions, does not match reality.[11] Our concern here is deeper than that. The previous section showed that, even in the simplest model, commuting costs interacted with governmental service preferences. As the employment and jurisdictional option expand, these interactions may become even more important. The prior development can be expanded in a very straightforward manner (although the computational problems become considerably larger). Because the basic structure of

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[11]See, for example, the discussion of patterns of American cities in Glaeser and Kahn (2001). The incorporation of decentralized employment into urban modeling is explored in depth in White (1999).

the model we employ is identical to the prior setup, we simply identify the key differences.

We again begin with a flat featureless plane that has exogenously determined jurisdictions. As shown in Map 1, the area has two suburbaworkplaces, namely West Suburban Center and East Suburban Center, as well as a Central Business District (CBD). Firms are located at points, take up no space, and have no taxable property. Each jurisdiction also contains a school districts (named after its employment center).

— Map 1 about here $<<$ Map1.doc $>>$—

At each workplace, there are both high wage (paid to skilled workers) or low wage (paid to unskilled workers) jobs ($w_s^c > w_u^c$). Both skilled and unskilled wages across suburban centers s $\in \{w, e\}$ are not necessarily the same depending on their relative locations to the CBD, and denoted by w_s^s and w_u^s, respectively. Needless to say, $w_s^s > w_u^s$. Also, they are less than their counterparts in CBD (i.e., $w_s^c > w_s^s$ and $w_u^c > w_u^s$), because of the wage gradient induced by the lesser need to commute and the bigger and cheaper houses around these places. (For calibration, wages are exogenously set).

The worker commutes to a given workplace, but a household could have a residence differing from his/her workplace. For instance, a household commuting to his/her workplace at the CBD, could reside in West School District due to a better education, tax advantages, or less commuting distance. The city is closed in the sense that there is a set population of each of four types of households in the metropolitan area described previously; i.e., types SL, SH, UL, UH. The city has a dense radial transportation system, and the worker of every household commutes daily from his residence to his workplace, and, as before, there is both a time and distance component to the commuting cost.[12]

Since we have four types of households, three workplaces and three school districts, there are $4 \times 3 \times 3 = 36$ different household types. As before, we solve for the household equilibrium, where each household has no desire to move to a different school district.

3.2.1 Parameterization of the Decentralized Employment Model

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[12]Distance, denoted by d, is the Euclidean norm for any two points. On xy plane, the distance between (x_1, y_1) and (x_2, y_2) is $d^{21} = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$.

Map 1: City Map

Legend:
- CBD
- West School District
- East School District
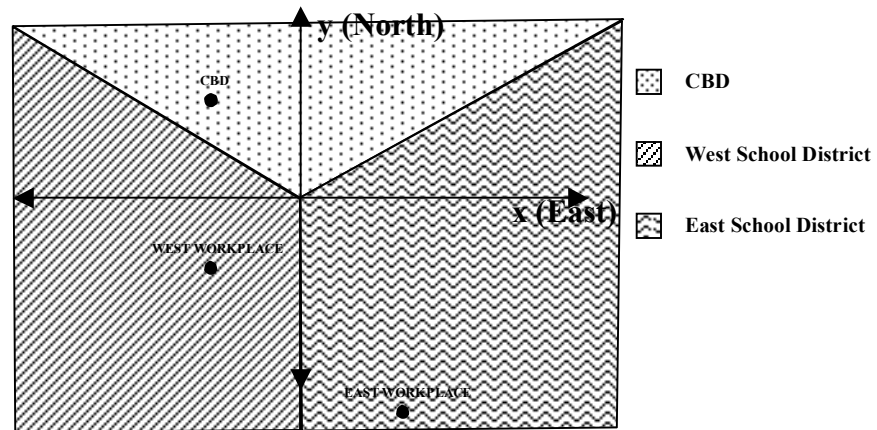
Parameter	Value	Parameter	Value
w_s^c	$18.3	w_u^c	$10.7
w_s^w	$17.6	w_u^w	$10.3
w_s^e	$17.9	w_u^e	$10.5
c_1	5.819	c_2	3.975
c_3	0.461		

Table 4: Calibration Parameters

The central parameter values for the model follow those displayed in Table 4. The population of the city is set to be 3,000,000 households. Approximately, 40 percent of the total population is assumed to be skilled worker households. Moreover, 30 percent of skilled households are assumed to be low valuation types. As for the unskilled households, 70 percent are low valuation types. A high fraction of jobs are located at the CBD (46.7%). See Table 6 for the exact decomposition of the population. Parameters of the education production function are set to be $c_1 = 5.819$, $c_2 = 3.975$, $c_3 = 0.461$, so that (q_j, τ_j) preferences of households in different jurisdictions are consistent with (q_j, τ_j) pairs that induce the underlying population distribution.[13]

We divide the metropolitan area into fine grids (i.e. apply discrete distances), and find residential location pattern over those grids. The metropolitan area is large in the sense that the grids at boundaries are left undeveloped. Therefore, we have a inelastic supply of residential property in any direction in the metropolitan area.

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[13]With these parameter values for peers, a school district of all residents with low (high) valuation has a productivity of 5.819 (9.794), a 68 percent different in productivity for the higher peer group.

Variable	CBD	West	East
Quality of Education	40.1	59.9	29.9
Tax rate	1.3%	1.66%	1.3%
Expenditure per pupil per year	$1,968	$2,273	$1,876
Efficiency	7.43	9.63	5.82
Average monthly gross rent per acre	$3,815	$4,054	$3,399

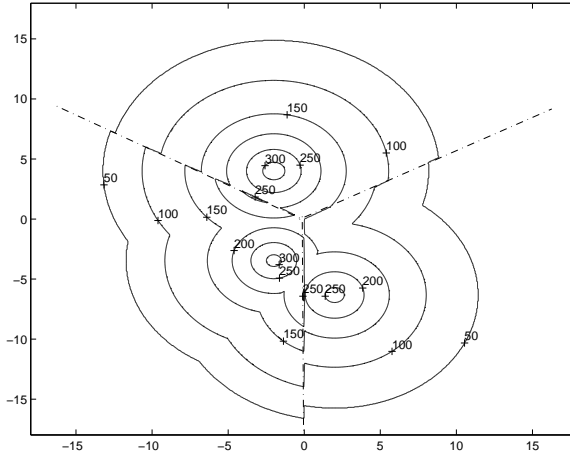Table 5: The characteristics of communities in equilibrium.

Figure 1: ISO-RENT CURVES: *Iso-rent curves have been shown. Notice the large drop/jump in iso-rent levels as we cross the district border as well as rings around the CBD extending to West and East School Districts. This is due to efficiency/quality of education difference between districts. The rent is per acre per DAY to have a descent picture.*

3.2.2 Basic Results with Decentralized Employment

The simulation results for the benchmark model are given in Tables 5 and 6 in addition to Figure 1 and 2. The West School District is the best in terms of the education it provides, while the East is the worst. West (East) School District attracts mostly high (low) valuation type households. These high valuation households put more pressure on schools and make schools more productive and efficient. The majority voting outcome of tax rates in West (East) School district are the preferred tax rates of high (low) valuation type households. To be precise, tax rates for West and East/CBD School Districts are 1.66 percent and 1.3 percent, respectively. The higher quality of education is capitalized into housing prices. Average rents attain their peak value in the West School District and their lowest value in the East. Moreover, the West School District with the highest property taxes and land prices spends more on education than the other communities in the metropolitan area.

Figure 1 shows iso-rent curves for the metropolitan area. As sites gets close to employment centers, we observe a monotone increase in rents. We see three local maxima around workplaces. This is due to accessibility, which includes both pecuniary and time costs associated with getting to and from work. More importantly, we see capitalization of higher quality of education. The rents are higher in the West School District that provides the best education than East School District that provides the worst education. In this respect, it is quite surprising that West School District providing a much better education than CBD seems to have almost the same rents. The reason for this observation is that wages are higher at the CBD, and the households of workers with a job at the CBD can afford to pay more to outbid other bidders. It is also interesting to observe the big jumps/drops as we cross the school district borders because of the capitalization of better education. Moreover, the rings around CBD extends to both West and East School districts (i.e. the presence of in-commuters). The rents at locations the same distance to the CBD are highest in the West School District and lowest in the East. Once again, we observe the capitalization of better education. We also see the rings around the East employment center extending to the West School District, showing the presence of households with a job at East employment center residing at West School District to enjoy a better education.

In equilibrium, all poor households with steeper bid-rent curves locates closer to the workplaces than rich households with flatter bid-rent curves, while high valuation households locate closer to workplaces than low valuation households. That is, households of each type form a concentric ring, or zone, around the workplaces, and zones for all household types are ranked by the distance from the workplaces in the order of steepness of their bid rent functions. No agricultural land should be left inside the urban fringe. At the locations in between workplaces, we see the inference of concentric rings around workplaces.

Table 6 reports the distribution of households across communities in equilibrium. As opposed to the traditional Tiebout models, all communities are heterogenous, and we do not observe perfect stratification by income or tastes or distance. Although the CBD is the biggest employer and offers 46.6 percent of all jobs available, a much smaller fraction, 35.1 percent resides in CBD. A disproportionate share of high valuation households (6.3% + 3.2% = 9.5%) resides in West School

Type/Workplace	Residence				
	CBD	West	East	All	
Skilled Low:CBD	3.6		1.2	4.8	
Skilled High:CBD	10.4	6.3	0.3	17	46.6
Unskilled Low:CBD	19.6		0.5	20.1	
Unskilled High:CBD	1.5	3.2		4.7	
Skilled Low:West					
Skilled High:West		6.3		6.3	21
Unskilled Low:West		2.6	1.0	3.6	
Unskilled High:West		11.1		11.1	
Skilled Low:East			7.3	7.3	
Skilled High:East		4.4	0.2	4.6	32.4
Unskilled Low:East		0.6	17.8	18.4	
Unskilled High:East		2.1		2.1	
	35.1	36.6	28.3		100

Table 6: Equilibrium percentage distribution of households across communities.

district that provides the best education, and commutes to his workplace at the CBD. Also, there are some households (2 percent) with a job at CBD and residence at East School district. We do not see any out-commuters (i.e. residents of CBD getting to and from their workplace at any suburban employment center). Also, note the presence of some households with a workplace at East (West) and residence at West (East), either to commute less or to provide a better education to their pupils.

Iso-lot size curves are drawn in Figure 2. The pattern is quite similar to iso-rent curves, and similar arguments can be made. The lot sizes increase monotonically with distance, and has local peaks at workplaces. This is pretty consistent with empirical evidence in the U.S. The rich reside in big houses away from workplaces. Once again, we clearly see two effects: Holding distance constant to workplaces, houses around West School District are smaller than houses around the East and CBD School Districts. This is due to higher rents resulting from the capitalization of better education. Also, observe the rings around CBD extending to West and East School Districts. In the west, households with a job at CBD accept having a smaller house and/or commute more to provide their children with a better education. As for residential densities, the pattern is analogous to rents.
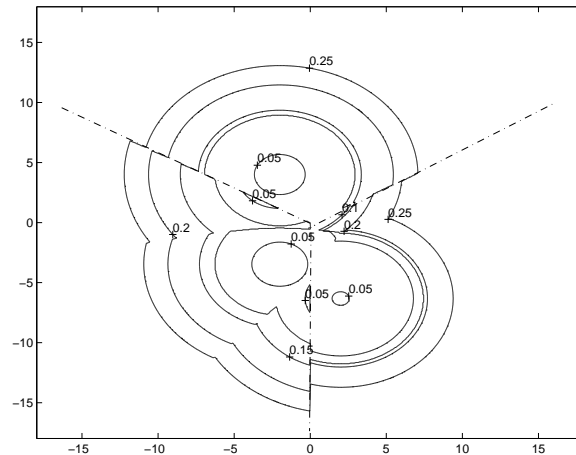
Figure 2: ISO-LOT SIZE CURVES: *Iso-lot size curves have been shown. The pattern is quite similar to that of iso-rent curves.*

4   School Finance Policy Experiments

The decentralized employment model provides a benchmark for considering alternative policies. Perhaps the most interesting are policies revolving around the financing of schools. The recent history of school finance, dating from roughly 1970, involves the interaction of courts and legislatures to move the funding of schools away from local property taxes to some alternative revenue plan (see Evans, Murray, and Schwab (1999) and Hoxby (2001)). For the most part, the discussions behind the changing finance patterns have concentrated on the outcomes displayed before. Some districts (West in our model) have a higher property tax base and spend more on their schools than others, particularly in these discussions more than the CBD. What is less often discussed is the fact that West also chooses a higher tax rate and that the disparity in spending only roughly translates into quality differences in student outcomes. What is never discussed is that, if the method of funding the schools is altered, the choices of households will also shift, leading to a different pattern of locational and schooling outcomes.

This section analyzes a series of alternative school finance policies, representing variants of policies that have been discussed or implemented in the recent period of school funding. We start with school district consolidation and then consider alternative expenditure and tax rate equalization plans along with district power equalization.

Variable	CBD	West	East
Quality of Education	51.1	31	34.7
Tax rate	1.3%	1.3%	1.3%
Expenditure per pupil per year	$1,936	$1,936	$1,936
Efficiency	9.63	5.84	6.55
Average monthly gross rent per acre	$4,046	$3,439	$3,516

Table 7: The characteristics of communities after school district consolidation.

4.1   School District Consolidation

As emphasized throughout this paper, one aspect of having a variety of school districts, as suggested by Tiebout (1956), is that households can choose schools that meet their preferences. On the other hand, the history of U.S. schooling in the 20th century was one of consolidation of districts. At the beginning of World War II, there were over 115,000 school districts. This figure fell to less than 15,000 today. While the pace of school district consolidation has slowed, the remarkable decline occurred even as the overall student population increased considerably.

School district consolidation remains relevant for policy today. In the face of various school finance equity law suits, a potential policy is full state funding – which is essentially equivalent to school district consolidation.

Although the causes of consolidation (Brasington 1999) and the potential cost savings from school district consolidation (Duncombe and Yinger 2002) are well documented, the potential welfare and efficiency consequences of consolidation have been largely ignored. Calabrese, Cassidy, and Epple (2002) analyze consolidation within the context of a political model and suggest that voters as a group are unlikely to support further consolidation, although they suggest the welfare aspects of consolidation are ambiguous.

This section explores the consequences of school district consolidation. The CBD, West, and East School Districts are consolidated under the name, Greater City School District. The metropolitan area moves from benchmark to new equilibrium, which is described by Tables 7, and 8, and Figure 3.

Consolidation has a common spending and tax policy across all of the districts, but it does not imply that outcomes are the same. One striking feature of the new equilibrium is that, although all jurisdictions spend the same amount of money on education, they end up with providing different
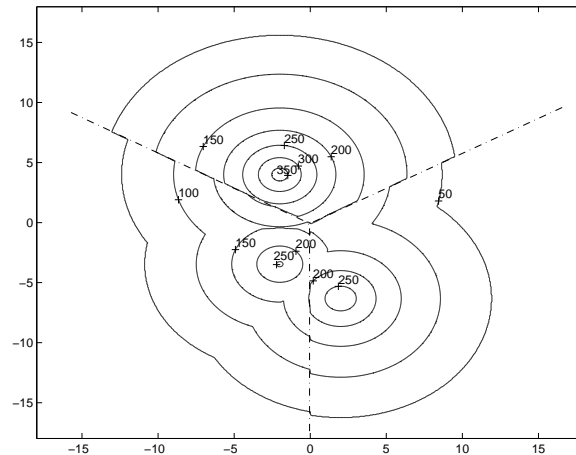
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Figure 3: ISO-RENT CURVES: *Iso-rent curves after School district consolidation have been shown.*

qualities of education. The CBD School district offers the best education, while the West School District is the worst. The driving force is the impact of peers on schooling outcomes, which in turn are capitalized into rents. The property taxes prevailing at equilibrium are, not surprisingly, the preferred tax rate of low valuation households. We also see the capitalization of better education into rents (see Figure 3). The rents around the CBD, which provides the best education, are much higher than the rents around the West School District, which provides the poorest education.

Table 8 shows the population distribution in the metropolitan area after school district consolidation. The number of CBD residents increases, since CBD now also offers the best education in addition to having jobs with higher wages than any other workplace in the metropolitan area. We do not see any significant change in worker/resident population in the East. The major worker/resident movement to CBD comes from West. Once again, we do not have perfect stratification by incomes or tastes, but most high valuation households reside in the community with best schools, the CBD.

In terms of welfare, the constrained choices of consolidation makes every household worse off. Both Skilled and Unskilled High Valuation Households are the most severely hit groups, where the policy is the equivalent of a two percent consumption loss. But even the unskilled, low valuation households are hurt, because rents are driven up from the minimums previously available. (See the summary in Table 12).

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	Residence				
Type/_workplace_	**CBD**	**West**	**East**	**All**	
Skilled Low:CBD		2.2%	0.7%	2.9%	
Skilled High:CBD	19.2%	1.2%	1.2%	21.6%	50.2%
Unskilled Low:CBD	3.3%	4.2%	0.3%	7.8%	
Unskilled High:CBD	17.9%			17.9%	
Skilled Low:West		2.8%		2.8%	
Skilled High:West		0.4%		0.4%	16.7%
Unskilled Low:West		12.5%	1%	13.5%	
Unskilled High:West					
Skilled Low:East		1.8%	4.6%	6.4%	
Skilled High:East		0.6%	5.4%	6%	33.1%
Unskilled Low:East		3.1%	17.6%	20.7%	
Unskilled High:East					
	40.4%	28.8%	30.8%		100%

Table 8: The percentage distribution of households across communities after school district consolidation.

4.2   District Power Equalization

The wealth neutrality approach, developed by Coons, Clune and Sugarman (1970), has been a perennial candidate for school finance reform. A portion of the funding in many states is based on a version of this.[14] It explicitly does not call for equal spending among districts, only that all districts are able to realize the same revenues from the same tax effort. As is well known, however, the implications for spending patterns depend centrally on the behavior of households in setting taxes and choosing locations (see, for example, Feldstein (1975)).

This section analyzes the consequences of moving to a metropolitan (state) government, rather than school districts, that raises tax revenues and redistributes them to school districts proportionally to the property tax rate that prevails in each school district. Since the capitalization of education and accessibility again yields an incomplete stratification by incomes or tastes along the lines elaborated in the previous section, we mostly concentrate on the welfare analysis (after briefly describing the new equilibrium).

As shown in Table 9, the West School District now provides a somewhat better education, compared to the benchmark, while there is a significant fall in quality in the CBD schools. The

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[14]The central idea is a variable matching grant that equalizes the yield across varying tax bases from a property tax . It is variously called guaranteed tax base, district power equalization, or wealth neutrality.

Variable	CBD	West	East
Quality of Education	32.8	63.2	30
Tax rate	1.30%	1.66%	1.30%
Expenditure per pupil per year	$1,864	$2,375	$1,864
Efficiency	6.42	9.72	5.87
Average monthly gross rent per acre	$3,714	$4,140	$3,425

Table 9: The characteristics of communities after district power equalization.

Variable	CBD	West	East
Quality of Education	53.9	32.6	35.8
Tax rate	1.33%	1.52%	1.43%
Expenditure per pupil per year	$2,039	$2,039	$2,039
Efficiency	9.65	5.84	6.4
Average monthly gross rent per acre	$4,088	$3,563	$3,582

Table 10: The characteristics of communities after expenditure equalization.

West School District is the most efficient school district, since it is home mostly to high valuation households. We also see the effect of access and wages on rents. Rents in the East remain below those in the CBD, even though the tax rates and school quality are essentially the same.

The impact of District Power Equalization on households are shown in Table 12. This table displays the change in rent needed to hold household utility constant after the introduction of the policy. (Table 13 provides an estimate of the consumption change required for constant utility). Again, all households seem to be worse off. The most severely hit group is Skilled High valuation households (who have to share part of the capitalized rents from high school quality with other groups). However, the welfare loss for each household is smaller than that of School District Consolidation.

As Feldstein (1975) previously indicated, this program does not sever the relationship between a community's expenditure per pupil and its wealth (here measured by rents). Communities with the same property tax rates, as in our simulation, might end up with different quality of schools, and tax rates also vary by wealth.

4.3 Expenditure and Tax Equalization Policies

Much of the history of school finance reform in the latter half of the 20th century had as a central concern reducing educational spending disparities. Readily apparent and large differences in spending on education from district to district became one major target of court action and

Variable	CBD	West	East
Quality of Education	57.8	31.9	38.1
Tax rate	1.48%	1.48%	1.48%
Expenditure per pupil per year	$2,190	$2,000	$2,089
Efficiency	9.64	5.82	6.65
Average monthly gross rent per acre	$4,210	$3,517	$3,632

Table 11: The characteristics of communities after tax equalization.

legislative change. District consolidation takes this to an extreme by insuring that taxes and spending are equalized everywhere, while district power equalization allows for differences based on tastes but equalizes revenue from chosen tax rates.[15]

This section looks at two "more radical" approaches, albeit ones that match some of the rhetoric around school financing policy. The first explores the consequences of equalizing expenditure per pupil across school districts by simply administratively setting spending to the average of expenditures per pupil across school districts at benchmark. (Expenditures are set at the average expenditure in the baseline model). The second, following some of the discussions that emphasize differential tax rates, administratively sets the tax rates. In both cases, we permit household locational choices to operate such that capitalization and preferences yield different school quality. In the first case, tax rates are allowed to differ across communities, while in the second case spending differs across communities.

We again assume the economy starts at the old benchmark and moves to new equilibrium. Expenditure equalization is described in Table 10. While tax equalization is described in Table 11.

With expenditure equalization, the CBD offers the best education, while having the highest rents. Most high valuation types reside in the CBD School District, and CBD has the highest efficiency. While the CBD has the lowest property tax rate, it also has the most expensive housing. The West district ends up having the highest tax rate, the lowest quality of schools, and, consistently, the lowest rental values.

Under tax rate equalization, the ranking of the cities in terms of educational quality remains the

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[15]Note that all of our simulations begin with the current national average of state and local funding. The policy options presume that roughly half of spending comes from the state, and this will lead to equalization compared to an entirely local taxing and spending system.

Type	Consolidation	Expenditure Equal.	Tax Equal.	Power Equal.
Skilled High	-2.01	-1.40	-0.35	-1.72
Skilled Low	-1.80	-1.49	-0.58	-1.29
Unskilled High	-2.25	-1.49	-0.22	-1.42
Unskilled Low	-1.65	-1.19	-0.37	-1.53

Table 12: Winners and losers as a result of governmental involvement, measured by rent change needed to equate welfare with baseline. (Minus sign means loss while a plus is a proxy for gain).

same, but the dispersion is widened over that in the expenditure equalization case. In both cases, however, the dispersion is narrower than observed in the baseline. With expenditure equalization, the variation in school quality is the least of all of the policies except consolidation. Nonetheless, Table 12 indicates that again all households are worse off in welfare terms with the policies.

4.4   Summary of Welfare Changes

Table 12 and Table 13 summarize the welfare change of households resulting from the previous policy alternative. As noted above, we calculate welfare changes in two complementary ways. In Table 12, we present the percentage change in rents that would be needed to provide the same utility in the move from the benchmark (unconstrained) equilibrium to the various policy options. Table 13 we provide a measure of the consumption change that is equivalent to the utility change with the introduction of the policy.

Although we have ideal conditions for governmental involvement -the presence of peer group effects and the redistributive motives for the government to reduce spending disparities- the welfare implications of the policies that are shown in Table 12 and Table 13 are somewhat surprising. Due to distortions that could only be captured by a general equilibrium framework, crippling the Tiebout system by divorcing local property wealth (i.e. the price mechanism) from school spending results in welfare losses for *all* households. The worst policy, in terms of welfare loss, is school district consolidation, but district power equalization does surprisingly bad. Tax equalization has the least effect on welfare of the various policies, but there is little obvious reason for choosing this – given the households have the ability to move according to differences in taxes and housing prices.

Type	Consolidation	Expenditure Equal.	Tax Equal.	Power Equal.
Skilled High	-0.52	-0.36	-0.09	-0.44
Skilled Low	-0.48	-0.40	-0.15	-0.34
Unskilled High	-0.58	-0.38	-0.06	-0.36
Unskilled Low	-0.44	-0.32	-0.10	-0.41

Table 13: Winners and losers as a result of governmental involvement in terms of consumption equivalents. (Minus sign means loss while a plus is a proxy for gain).

5 Conclusions

This paper provides a unified treatment of two artificially separated streams of literature, namely urban location theory and Tiebout models of community choice. It also takes the model beyond the limits of a monocentric city model by introducing decentralized employment locations and produces a locational outcome that is more consistent with empirical observation. As opposed to the prediction of Tiebout models, the stratification of households by income into communities, all communities are heterogenous, and contain all household types. The model also predicts the capitalization of better education and of accessibility.

We use the model to assess the impact of several types of reforms in the pursuit of equity in school finance on the quality of education and individual welfare. A significant finding of our paper is that households seem to be uniformly worse off as a result of governmental involvement. In the baseline, communities establish different levels of education and property taxes, and households "*vote with their feet*" to choose the optimal bundle. The property tax essentially becomes a fee for education and location. When government policy divorces intervenes, households are not made better off.

Moreover, with school district consolidation and expenditure equalization programs, districts have the same expenditure per pupil, yet end up providing different levels of education. Improving the fiscal capacity of schools may be a necessary requirement to improve outcomes, but clearly it is not sufficient to achieve equity of educational opportunity. Operating on just the spending margin does not make the situation better, even when one has specific distributional objectives.

6 Appendix

In the monocentric area model, two general propositions follow directly from our basic model.

Proposition 1. *Suppose that school quality is higher in the East (i.e., $q_e \gg q_w$), and all four different types of households are bidding for land. Then, the size of the ring allocated to High (Low) valuation households is larger (smaller) in the East.*

Proof: Consider a Skilled High Valuation household in East School District. The bid-rent function for Skilled High Valuation household, $\Psi_{SH}(r, u_{SH}, .)$ dominates that for Unskilled Low Valuation household, $\Psi_{UL}(r, u_{UL}, .)$ if $r \geq r^{*e}_{ULSH}$, where r^{*e}_{ULSH} is such that $\Psi_{SH}(r^{*e}_{ULSH}, u_{SH}, .) = \Psi_{UL}(r^{*e}_{ULSH}, u_{UL}, .)$. Notice that

$$\Psi_i(., q_w, \tau_w) = \frac{(1+\tau_e)}{(1+\tau_w)} \frac{q_w^{\alpha_i/\eta_i}}{q_e^{\alpha_i/\eta_i}} \Psi_i(., q_e, \tau_e) \ \forall i \in \{SL, SH, UL, UH\}$$

And note that at r^{*e}_{ULSH} in the West School District,

$$\frac{\Psi_{SH}(r^{*e}_{ULSH}, u_{SH}, q_w, \tau_w)}{\Psi_{UL}(r^{*e}_{ULSH}, u_{UL}, q_w, \tau_w)} = \frac{q_w}{q_e}^{\alpha_H/\eta_H - \alpha_L/\eta_L} \ll 1 \quad \text{if} \quad \alpha_H/\eta_H - \alpha_L/\eta_L > 0$$

Since bid-rent functions are convex and differentiable, it follows that $r^{*e}_{ULSH} \ll r^{*w}_{ULSH}$. Similarly, one could show that $r^{*w}_{SHUH} = r^{*e}_{SHUH}$ and $r^{*w}_{SHSL} \ll r^{*e}_{SHSL}$. The proof is the same for all other types, $\forall i \in \{SL, SH, UL, UH\}$.

Now, let us introduce the fifth alternative, the agricultural use of land. Theoretically, it is not clear what exactly happens. But still, we can come up with the following proposition.

Proposition 2. *Suppose $q_e \gg q_w$ and the landlord holds an auction with 5 alternative bids. Then, it cannot be case that we got perfect stratification by income. At least, one community should be heterogenous in income, as opposed to the traditional Tiebout Models.*

Proof: Without the loss of generality, assume that the steepness of bid-rent functions from the lowest to the highest would be as Skilled Low, Skilled High, Unskilled Low, and Unskilled High valuation households. If it is the case that the flattest bid-rent function household, Skilled Low valuation type, happens to live in the West School District, then by Proposition 1, it must be also the case that Unskilled Low valuation household is present in the West School District. If some

Skilled Low valuation types were to live in the East School District, again by Proposition 1, Skilled and Unskilled High valuation households should be present in the East School District.

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