

School Choice: Traditional Mechanisms and Extending the Poor's
Ability to Choose*

Eric Hanushek

Stanford University

Sinan Sarpça

Koç University

Kuzey Yilmaz

Koç University

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Abstract

We develop a multi-community urban land use framework to investigate the implications of increasing school choice opportunities on educational and residential choices of a city's residents. When deciding on the location and the size of land, the households care about the distance to the business district, and a local public good: education. There is a private education alternative that breaks the link between choosing a residence area and choosing a school. The households differ in their incomes and preferences for education. In five models that differ in various aspects of choice and financing, we study the housing and education choices of the city residents, and the endogenously determined education provision levels in equilibrium. The results of the article support reformist arguments: We first show that the presence of a private alternative benefits every household, whereas school district consolidation hurts everyone. We then examine two policies that aim to increase choice. An untargeted local government support (financed by property taxes) that can be used at the private school can improve things for talented poor. A policy that supports the talented poor (using city income taxes) with funds that can be used for public as well as private schools can also improve welfare of all talented students, rich or poor.

Keywords: Tiebout Model, Urban Location Model, School Choice.

JEL Classification: H4, H7, I2

1 Introduction

School choice is nothing new in United States. Long before the first vouchers were distributed or the first charter school has opened, many American parents have been exercising choice either by choosing where to live among different school districts, or by choosing a private alternative for their offspring's education. Clearly, under such a system households with higher incomes are likely to have access to a larger opportunity set when making decisions -whether it is to relocate, or to attend private school- and the poor and disadvantaged are usually stuck with the local public school, with others like themselves. The discontent with the quality of public education, especially in urban areas inhabited mostly by the latter group, lies at the heart of school choice discussions. The reform proposals such as vouchers or charters aim to improve on the traditional mechanisms by expanding the set of alternatives for a bigger part of the population. The resulting choice and competition is hoped to create incentives for the inefficient public schools, raising the quality of education for the poor and minorities also. The opponents point attention to possible undesirable effects such as flight of talented students from public schools, deteriorating the peer quality -and efficiency- even further.

In this paper we contribute to this ongoing debate by developing a multi-community land use framework in which education is provided privately as well as a local (community) public good, and when choosing a residential location households care about accessibility also. We consider five models that differ in various aspects of choice and financing, and our results support reformist arguments. We show that having a private alternative and autonomy in school district spending -both of which we usually take for granted- have desirable consequences overall. We follow by discussing the effects of two mechanisms that aim to increase the society's ability to choose. These mechanisms share some key characteristics with vouchers and charters, so our analysis may have important implications to the related discussions.

In many states, decentralized financing of public education by property taxes gives school districts fiscal and administrative autonomy. Application of Tiebout's hypothesis predicts a competi-

tion between communities for residents, and a resulting sorting of households into school districts with other households that have similar incomes and preferences for education.¹ The sorting observed in practice may be incomplete in reality for several reasons. First, the quality of public education is not the only neighborhood characteristic that households care about. For example, accessibility -one of the main determinants of residential choices in land use theory-² is usually ignored in Tiebout models (Two exceptions that incorporate commuting to Tiebout models are de Bartolome and Ross (2003) and Hanushek and Yilmaz (2007)). Employment opportunities are typically concentrated at certain locations in the city, and commuting to and from the workplace is costly for the households. Then rents are expected to decrease as one moves away from employment locations. If land is a normal good, this will attract higher income households further away from the city, whereas the opportunity cost of commuting time -increasing in income- will have the opposite effect. Such issues have interesting implications on the relation between location choices and land demands of households, which in turn relates to local property values, tax revenues, and school district budgets.

A second reason for the partial sorting is the availability of private alternatives for education. Private schools break the link between residential decisions and school quality, therefore are likely to cause diversion from residential patterns implied by Tiebout's hypothesis. For our purposes, this is particularly important because some popular reform proposals, e.g., vouchers and charter schools, share this characteristic. In this paper, our first goal is to understand how private schools and their interaction with Tiebout sorting affect residential and educational choices of households. Our second goal is to use this understanding to predict the consequences of extending the ability to choose. Researchers have studied the provision of education and implications of reforms³ in multi-

¹This 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. (1984, 1993, 1998), who have also introduced politics into the model. Epple and Platt (1998) show that when households preferences differ, the Tiebout sorting is partial and communities are heterogeneous in income.

²In the stream of literature referred to as modern urban location theory, households' residential location is determined by the trade-off between accessibility and space. The pioneer of this approach was Alonso with his model of the land market (1964), which was later followed by a great deal of theoretical and empirical work including those of Muth (1969) and Mills (1972).

³See Hoxby (2003a) for a survey.

district models without private schooling (de Bartolome (1990), Fernandez and Rogerson (1996)), in single district models with private schooling (Manski (1992), Epple and Romano (1998)), and in multiple district economies with both public and private schooling (Nechyba(1999, 2000, 2003)). Charles A.M. de Bartolome and Stephen L. Ross (2003), and Eric Hanushek and Kuzey Yilmaz (2007) incorporate accessibility to multi-district models in which education is provided publicly. In the first paper each household consumes the same fixed lot size. In the second paper education is provided only publicly. Below we develop a framework that incorporates the following: 1. Tiebout competition among two communities for residents over a local public good , education, 2. Private alternative for education, 3. Accessibility and costly commuting, 4. Endogenous land consumption, 5. Peer effects in education. The households differ in incomes and preferences for education, and can move freely between communities that offer different property tax-education spending packages. Lot size is a continuous choice variable. In each community, the property tax rate is determined by majority voting. The quality of education depends on the spending in the district as well as some non-income characteristics of peers. We study the equilibrium with particular attention to quality of education in public and private schools, compositions of neighborhoods, and welfare levels of different household types. We usually do not see stratification across communities, we observe a sorting according to the commuting distance within each community instead. The rents that decrease in distance to the city center attracts higher income households away. A stronger preference for housing has the same effect.

In our benchmark model, the private school selects students from the pool of households that are willing to pay the full tuition. First, to assess the value of having a private school, we shut down the private school and compare the equilibrium to that of the benchmark model. Next, to understand the benefit of Tiebout sorting in the presence of a private school, we consider another model with restricted choice, under an expenditure equalization policy. Realizing its benefits, we consider two policies that aim to increase ability to choose via transfers to households. The first one is an untargeted policy. The administrators in each district offer to pay up to the local per-

student expenditure to any local resident enrolling their kids in the private school. The second policy targets the talented low income kids without any residency restrictions, and is financed by city income taxes. The households can use the transfer for the private school tuition, but can also add the transfer to the budget of a public school if they choose to attend one.

The organization of the rest of this paper is as follows: Section 2 develops the theoretical framework. Section 3 discusses the calibration of the computable model. Sections 4.1 through 4.5 present and discuss the equilibria for five different models. Section 5 concludes.

2 The Model

We consider the residential decision making and educational choice problems of a city's residents. The employment opportunities in the city are concentrated in an area called the Central Business District (CBD hereafter). Everyone that works at the CBD must choose a location to reside in the area that surrounds it. The distance to CBD is an important factor because of the pecuniary and time costs of commuting. A straight line that goes through the CBD divides the city into two jurisdictions, east (e) and west (w). The jurisdictions provide a *local public good*, education, for which there is also a *private alternative*. The (public) provision level in each locality is determined endogenously by its residents. Therefore these jurisdictions may differ in their (property) tax and expenditure policies, and are likely to compete for residents à la Tiebout (1956). The households differ in their incomes and preferences for education, and the quality of education in each school -public or private- depends on the composition of the peer group as well as the instructional expenditures.

2.1 Households

Every household must choose a community, a residence in the community (characterized by distance to CBD and land size), and also must choose between a private school and the public school of the community of choice. The household supplies labor to earn an exogeneously determined hourly

wage W . There is a dense radial transportation system. The further one lives away from CBD, the higher commuting costs he/she will face. In particular, if a household lives r miles away from CBD, the cost of daily roundtrip commute will be ar dollars (pecuniary cost, $a > 0$) and br hours (time cost, $b > 0$), which translates to bWr dollars given the opportunity cost of time. Let $l \in [0, 24]$ denote the number of non-work or leisure hours. Then the income of this household (net of transportation costs) is $Y(r) = (24 - l)W - (a + bW)r$.⁴ The households have preferences defined over: consumption of a composite consumer good z , the land consumption (the size of the residential lot) $s > 0$, leisure $l \in [0, 24]$, and quality of education q at the school the offspring attends. We assume every household has one school-age child. We normalize the price of the composite consumption good to one and denote the unit rent of land (r miles away from CBD) by $R(r)$. All land is owned by absentee landlords, and the equilibrium price $R(r)$ is determined through a competitive bidding process, details of which we discuss below. Every household pays a property tax with rate τ on value of land. Then, the budget constraint of a household can be written as:

$$z + (1 + \tau)R(r)s + Wl + p = Y(r) = 24W - (a + bW)r. \quad (1)$$

The p term represents the educational expenditures whenever applicable. In particular, for those households whose kids attend public schools, p is zero.

Households differ in their incomes (wages) and tastes for education. We name the higher income types *skilled* workers (S), and the lower income types *unskilled* workers (U). The wages for skilled and unskilled types are W_S and W_U respectively ($W_S > W_U$). Both types exhibit variation in their tastes for the local public good, education. Differentiating those as *high valuation* (H) and *low valuation* (L) types gives us four types in total: SH, SL, US , and UL . Each household needs to choose a neighborhood (east or west), a location in that neighborhood (r , distance to CBD), amount of land to reside on (s), consumption level (z), and finally a school that the offspring will attend. The jurisdictions operate their own public schools, and differ only in the *quality of*

⁴We ignore non-commute transportation costs, and travel within the CBD.

education and property tax rate (q_j, τ_j) packages. There is also a private school with quality q_{pri} in the city which breaks the link between choosing a community and choosing a school.

The preferences of a household can be represented by the utility function $U(\alpha_i, \eta_i; q, s, z, l) = q^{\alpha_i} s^{\eta_i} z^{\gamma} l^{\delta}$ where $\alpha_i + \eta_i + \gamma + \delta = 1$. The α parameter captures the taste heterogeneity for education and can take on two values $\alpha_i \in \{\alpha_H, \alpha_L\}$ such that $\alpha_H > \alpha_L$. Given the market rent curves $\{R_e(r), R_w(r)\}$ and quality-tax packages $\{(q_e, \tau_e), (q_w, \tau_w)\}$ for each jurisdiction, and quality of education and prices for private school $\{q_{pri}, p_H, p_L\}$, the household solves the problem:

$$\begin{aligned} \max_{s, z, l, j \in \{e, w\}, q \in \{q_j, q_{pri}\}} \quad & U(\alpha_i, \eta_i; q, s, z, l) = q^{\alpha_i} s^{\eta_i} z^{\gamma} l^{\delta} \\ \text{s.t.} \quad & z + (1 + \tau_j)R_j(r)s + W_i l + p = Y_i(r) \end{aligned} \tag{2}$$

where $i \in \{SH, SL, UH, UL\}$.

2.2 Schools

There are two public schools, and a private one. The public schools are neighborhood schools, enrollment is open (and free) to residents of the community only. The existence of a private alternative breaks the link between choosing a community and choosing a school.

The quality of education $q(\Pi, E)$ in a school -public or private- is determined by (per-student) instructional expenditures E and the peer quality Π . For a given group of students, an increase in the instructional expenditures increases the quality of education⁵ ($\partial q / \partial E \geq 0$). Also, different groups of students may benefit differently from a given amount of instructional expenditures. That is what the peer quality (or efficiency) component captures ($\partial q / \partial \Pi \geq 0$). Some parents value education more than others, and as a result they may spend more time helping with the kid's homework, provide a nicer study environment at home, be more involved in how schools operate, etc. That is what the *high valuation* (H) type represents in our model, and clearly having more

⁵There is a discussion on the effectiveness of monetary inputs on student's achievements, but it is hard to claim that households would not value an increase in educational expenditures.

students like this is in a peer group is desirable. We specify the peer quality to be increasing in the proportion of high valuation types:

$$\Pi = c_1 \exp\left(-c_2 \frac{N_L}{N} + c_3 \frac{N_H}{N}\right), \quad c_1, c_2, c_3 \geq 0. \quad (3)$$

We divide N_L and N_H by N -total population- for normalization.

Public schools are neighborhood schools, admission is free, but enrollment is open to residents of the community only. These schools are financed by property taxes on residential land. An equilibrium property of our model is that in each jurisdiction there is a distance r_{fj}^* called the *fringe distance* beyond which no households reside. In each community entire tax revenue is spent on education. Let $L(r)$ denote the land density r miles away from CBD. Given the equilibrium rent function $R_j(r)$, and equilibrium tax rate τ_j , we can calculate the tax base, and total tax revenues to find the per-student expenditure in the public school system:

$$E_j^{pub} = \frac{1}{N_j^{pub}} \tau_j \int_0^{r_{fj}^*} R_j(r) L(r) dr. \quad (4)$$

Note that the N_j^{pub} denotes the number of students in the public school system of community j , and not the total number of students in the community. Everything else constant, if more households send their kids to private schools, the per-student expenditure in the public schools will increase.

The private school is financed by tuition revenues, and can admit students from both jurisdictions. Since a student's effect on peer quality depends on whether the student is a H or L type, it is natural for the school to condition tuition (and admission decisions) on that characteristic, if the school can price discriminate at all. Let p_H and p_L denote the tuition amounts for H and L types respectively. If N_L^{pri} and N_H^{pri} are the number of high and low valuation types enrolled in the private school, per-student expenditure is determined by:

$$E^{pri} = \frac{p_H N_H^{pri} + p_L N_L^{pri}}{N_H^{pri} + N_L^{pri}} \quad (5)$$

The private school acts as a price taker. Given different types of households' willingness to pay functions, it chooses the numbers of H -types and L -types to be admitted to maximize quality of education subject to the budget constraint (5) and a capacity constraint:

$$\begin{aligned}
& \underset{N_H^{pri}, N_L^{pri}}{max} \quad q = \Pi E & (6) \\
& s.t. \quad E = \frac{p_H N_H^{pri} + p_L N_L^{pri}}{N_H^{pri} + N_L^{pri}} \\
& \quad \quad N_H^{pri} + N_L^{pri} \leq \bar{N}
\end{aligned}$$

The equilibrium prices (p_L, p_H) are such that households' schooling decisions are consistent with the private school's admission policy.

2.3 Market Rent Curves and Allocation of Land

Land is owned by absentee landlords and auctioned off to the highest bidders. The reservation price of the landlord, R_a , is determined by an alternative use of land, such as agriculture, and is independent of the location.

For a given utility level \bar{u} we can find the maximum rent a household is willing to pay per unit of land that is r miles away from CBD by solving the following problem:

$$\Psi(r, u, q, \tau) = \underset{s, z, l}{max} \left\{ \frac{Y - z - wl - p}{(1 + \tau)s} \mid U(\alpha, \eta; q, s, z, l) = \bar{u} \right\} \quad (7)$$

For the parametrization we use, the utility maximizing budget shares are $\frac{\eta_i}{\eta_i + \gamma + \delta}$ for s , $\frac{\gamma}{\eta_i + \gamma + \delta}$ for z , and $\frac{\delta}{\eta_i + \gamma + \delta}$ for l . Substituting these in our utility function in (2) and into the above equation (7), we can write the *indirect utility function*:

$$V(\cdot) = \frac{k_i}{R(r)^{\eta_i} (1 + \tau_j)^{\eta_i} \omega^\delta} q_j^{\alpha_i} (Y_i(r) - p)^{(\eta_i + \gamma + \delta)} \quad (8)$$

and the *bid rent function*:

$$\Psi(r, u, q, \tau) = \frac{k_i^{1/\eta_i}}{(1 + \tau_j)\omega^{\delta/\eta_i}} q_j^{\alpha_i/\eta_i} (Y_i(r) - p)^{(\eta_i + \gamma + \delta)/\eta_i} u_i^{1/\eta_i} \quad (9)$$

where $k_i = \frac{\eta_i^{\eta_i} \gamma^\gamma \delta^\delta}{(\eta_i + \gamma + \delta)^{\eta_i + \gamma + \delta}}$ is a constant. We are interested in the shapes of these bid rent functions.

The negative slopes of bid rent curves:

$$\frac{\partial \Psi}{\partial r} = -\Psi(\cdot) \frac{\eta_i + \gamma + \delta}{\eta_i} \frac{a + bW_i}{Y_i(r) - p} < 0,$$

indicate that all types of households are willing to pay lower rents as they move away from CBD.

Also the bid rent curves are strictly convex for every type ($\partial^2 \Psi / \partial r^2 > 0$).

At an auction for a particular location r^* , the winner will be the type with the highest bid rent curve at that location. Given the four types in the model, and given that each type has a choice over private and public schools, in each jurisdiction we can plot eight different bid rent curves. The *equilibrium rent curve* $R_j(r)$ will be the upper envelope of the bid rent curves of different types and the agricultural rent R_a . Because all bid rent curves are convex and decreasing, the equilibrium rent curve $R_j(r)$ will be decreasing up to a distance r_{jf}^* , the *fringe distance*, and will stay constant from that point on, because the agricultural rent will exceed every household's willingness to pay for land. In our computational analysis we check and verify that two different types' bid rent curves can intersect at one point at most. This *single-crossing* property of bid rent curves proves quite useful for our analysis. Households with steeper bid rent curves will locate closer to the CBD. To understand the relation between the slope of the bid rent curve and the income and preferences of a household, suppose bid rent curves of two households intersect at r^* , i.e., $\Psi(r^*, u_1) = \Psi(r^*, u_2)$. Some algebra indicates that Ψ_1 is steeper than Ψ_2 if and only if

$$\forall r, \quad \frac{(\eta_1 + \gamma + \delta)\eta_2}{(\eta_2 + \gamma + \delta)\eta_1} \frac{a + bW_1}{a + bW_2} \frac{Y_2(r) - p}{Y_1(r) - p} > 1.$$

Consider two households with same incomes but different tastes for education. Suppose the ed-

ucation expenditure p is same for both. If both locate in the same jurisdiction, above equation implies that high valuation (α_H) types will locate closer to CBD. Since low valuation households attribute relatively more weight to land, they will locate further away from CBD where rents are cheaper. For two households with same preferences and different incomes, the answer is not that clear. Higher income increases the demand for land consumption and attracts households further away from CBD, but it also increases the opportunity cost of commuting time. To understand which effect is dominant, we will use computational models below. Attending the private school is equivalent to an income reduction by an amount p , hence the above income discussion applies.

2.4 Population

Our city is a *closed city*, population is given exogenously. Let $L(r)$ denote the land density r miles away from CBD, and let $n_j(r)$ denote the equilibrium density function of the household population in jurisdiction j . Suppose in equilibrium the residents of the land at distance r in jurisdiction j are type i households. Then $n_j(r) = \frac{L(r)}{s(r, u_i^*)}$. Let $\bar{N}_{SH}, \bar{N}_{SL}, \bar{N}_{UH}$, and \bar{N}_{UL} stand for the populations of the respective types. The population constraint for each type $i \in \{SH, SL, UH, UL\}$ can then be stated as:

$$\int_0^\infty \frac{L(r)}{s_w(r)} I[t_w^*(r) = i] dr + \int_0^\infty \frac{L(r)}{s_e(r)} I[t_e^*(r) = i] dr = \bar{N}_i \quad (10)$$

where $t_j^*(r)$ is a function showing the type of the occupant at distance r in jurisdiction j , and $I[\cdot]$ is an indicator function that takes the value 1 when the condition in brackets is satisfied, and 0 otherwise. The population constraint implicitly assumes the land market clears in each jurisdiction:

$$\forall r \leq r_{fj}^*, \quad S_j(r)n_j(r) = L(r).$$

2.5 Local Public Finance

The two jurisdictions differ only in the *quality of education* and *property tax rate* (q_j, τ_j) packages they provide. In each locality taxes are determined by majority voting. The households are myopic

in the sense that when voting, they do not consider the migration patterns and the resulting changes in composition of neighborhoods the outcomes can cause. We focus on the stationary equilibrium, which is attained when no one has an incentive to relocate in response to the voting results.

When choosing a community, households take the tax-expenditure packages as given. They move in and vote for the property tax rate. For a household that chooses the public school the preferred tax rate is the one that solves the problem:

$$\tau_i^* = \operatorname{argmax}_{\tau} V(.) = \frac{k_i}{(1 + \tau_j)^{\eta_i} R(r)^{\eta_i} \omega^{\delta}} q_j^{\alpha_i} (Y_i(r) - p)^{\eta_i + \gamma + \delta} \quad \text{s.t. } q_j = \Pi_j E_j \quad (11)$$

and $E_j = \tau_j \bar{R}_j$

Note that the most preferred tax rate $\tau_i^* = \frac{\alpha_i}{\eta_i - \alpha_i}$ is independent of income. Clearly, for households that choose the private school, most preferred tax rate is zero, and they will always locate in the lower tax neighborhood.

Definition (Equilibrium): An *equilibrium* is a set of utility levels for each type $\{u_{SH}^*, u_{SL}^*, u_{UH}^*, u_{UL}^*\}$, market rent curves for each jurisdiction $\{R_e(r), R_w(r)\}$, quality of education and property tax rate pairs $\{(q_e, \tau_e), (q_w, \tau_w)\}$, quality of education and prices for private school $\{q^{pri}, p_H, p_L\}$, household population distribution functions $\{n_e(r), n_w(r)\}$, and type functions $\{t_e^*(r), t_w^*(r)\}$ that show the equilibrium locations of the occupants at distance r in community j such that:

- Households' choices are determined by solving (8).
- The market rent function $R_j(r)$ in each jurisdiction is determined through a bidding process among different types of households
- Same types of households obtain the same level of utility regardless of their choices.
- The private school's admission policy solves (6).
- The tax rates in each jurisdiction are determined by majority voting by myopic voters.
- Local governments' budgets balance in each jurisdiction.
- Labor and land markets clear.

- The population constraints (10) hold.

3 Calibration

The complexity of our model induces us to proceed with computational analysis. We specify the parameters of the computational model(s) to match certain statistics from U.S. data.

In the previous section, we have identified the utility maximizing budget shares for leisure, consumption, and lot size as $\frac{\delta}{\eta_i + \gamma + \delta}$, $\frac{\gamma}{\eta_i + \gamma + \delta}$, and $\frac{\eta_i}{\eta_i + \gamma + \delta}$ respectively. In U.S. average hours of work per week in full time jobs is 40 hours, and average annual earnings of workers are \$22,154 for high school graduates and \$38,112 for college graduates. Accordingly, we set the hourly wages for unskilled and skilled types as $W_U = 15$ and $W_S = 21$. In a 168(=24*7) hour week, 40 hours of work implies a 0.762 budget share for leisure. The data on household expenditures suggest that expenditures on shelter constitute about 20% of the budget of an average household. This implies budget shares of 4.76% for housing and 19% for consumption. There are two possibilities for the most preferred tax rates according to (11). We set these most preferred tax rates equal to 2.2% (1.6%) for the high (low) valuation types. The utility function parameters consistent with all these are $\alpha_L = 0.014$, $\alpha_H = 0.016$, $\delta = 0.75$, and $\gamma = 0.2$

We calculate the commuting costs assuming the households drive to work. The pecuniary cost can be calculated based on the cost of owning and operating an automobile. In 2004 pecuniary cost per mile was \$ 0.56, and we set $a = 1.1$. Assuming the commuting speed in the city is 20 miles per hour, we set $b = 0.13$. We assume 2 million households populate the city. When computing the equilibrium, we target for a (endogenous) fringe distance (city radius) around 15 miles in each jurisdiction. The proportion of skilled households in U.S. is about 30%. We expect this proportion to be slightly higher in a city. Hence, we set the proportion of skilled households to 40%, about 30% of which are low valuation types. We want the proportion of low valuation types among the unskilled to be higher and set that equal to 70%.

Studies report the proportion of students in private schools around 10%.⁶ We assume the private school can accommodate 12% of all students. We set the parameters of the school quality function to match some empirical facts as $c_1 = 4.06$, $c_2 = 3.35$, and $c_3 = 0.26$.

4 Results

First we discuss the equilibrium of the benchmark model with one private school and two (autonomous) public schools. We follow by two models that investigate the benefits of the traditional choice mechanisms. To restrict the alternatives set, we first look at the case where there is no private school. Then we analyze the consequences of consolidating the two school districts in the presence of a private alternative. In two other models we study the effects of two different “money follows student” programs, where eligible households are offered transfers to be used at the school of their choice. In the first one, every household has the option to receive a transfer -as high as the per-student expenditure at the local public school- to be used for the tuition at the private school. This is paid out of the district’s budget (local property tax revenues). The second program provides a transfer from the central government to low-income households anywhere. This transfer can also be added to a public school’s budget, and is financed by (city) income taxes. Several key properties of equilibrium exhibit big variation from one model to another, below we discuss the common features first.

The welfare comparisons of the four models are summarized in Table 1. The unit of measurement is the percentage change in rent required to keep the relevant types of households at their equilibrium utility level in the benchmark model. A negative number means the household is worse off. A quick look at the table shows that restricting choice hurts every household in the city (columns 1 and 4), whereas programs that are designed to increase choice may help all high valuation types or unskilled high types, at the expense of rest (columns 2 and 3). We discuss all these in further detail below.

⁶See Epple and Romano (1998), School District Data Book 1990, as well as the NCES report titled “Characteristics of Private Schools in the United States: Results From the 2003-2004 Private School Universe Survey.”

Table 1: Welfare Analysis.

Type	Pubonly	PoorChoice	Incometax	Consolid.
Skilled High	-0,0887	-2,0507	0,1440	-8,8147
Skilled Low	-0,0219	-1,0309	-0,2069	-7,4035
Unskilled High	-0,0862	1,0364	1,9645	-9,1897
Unskilled Low	-0,1586	-1,6476	-0,0708	-7,4933
AEU	-0,1066	-1,1488	0,3477	-7,9737

In all models, we observe communities that are heterogeneous in income. This is consistent with empirical findings (Davidoff (2005)) as well as results of theoretical studies including Tiebout models such as Epple and Platt (1998), and Tiebout-Urban hybrid models such as Hanushek and Yilmaz (2007).

The market rents in each jurisdiction decrease as one moves away from the CBD in all models we consider below. This is an implication of costly commuting. The land allocation patterns are quite similar across different models too. Each jurisdiction is partitioned by several semi-rings that have CBD at the center. This “rings” structure dates back to von Thunen’s model of land use (1826), and is one of the building blocks of Urban Land Use Theory. In our models we have semi-rings instead of full ones because of the jurisdiction boundaries, or the local public goods problem. As a result, the widths and numbers of rings may show variation in two localities. The ordering of households around CBD however, is same in every model. We had discussed earlier that high valuation households will always locate closer to the CBD compared to the low valuation types at the same income level. Because in their utility functions, low valuation types assign relatively higher weights to land. Similarly, among households with same valuation, higher income increases the land demand and attracts households further away from CBD where the land is cheaper. High income also increases the opportunity cost of commuting time. But our results show that this effect is dominated by the former, and the ordering of households in each district in every model

is as follows: The UH types locate closest to the CBD. The UL types occupy the semi-ring that is outside that of UH types. As we move further away from CBD we see SH types first followed by SL types. Sometimes a particular type may not be present in a district. But the order between the others is still preserved. The outer end of the SL ring is the fringe distance and the land beyond that is left for agricultural use.

The distribution of SL type households across two localities remain stable in all models, but the distributions of the other three types exhibit big variations. The private school's student composition changes too, and those who attend the private school always choose to locate in the lower tax neighborhood. Since private school attending types do not receive any benefit from the tax revenues, they have no incentive to pay any.

4.1 Benchmark Model

Figure 1 and Table 2 illustrate some important equilibrium properties of the benchmark model. Without loss of generality, we will refer to the higher tax neighborhood as *east* school district throughout the rest of this paper. In the figure the equilibrium rent functions $R_j(r)$ in each jurisdiction are given by the lines, and the distribution of population within and across the communities is shown using bars. All four types of households can be observed in both localities. Only the skilled high types attend the private school, and the SH type households that choose private school are the only SH types that locate in the lower tax neighborhood. The private school does not have any students that reside in the east.

The quality of education is higher in the east, the district with higher taxes. Note that per-student expenditure in the west school district is higher. There is a group of high income residents that contribute significantly to the district's budget, but do not claim any of the revenues since their kids attend the private school. This increases the per-student expenditure for those at the public school. However, higher expenditures fail to provide a higher quality. The private school attending students are desirable (high valuation) peers, and with them being out of the peer group

the public school consists of low valuation types mostly.

Table 2: Benchmark Equilibrium

	West	East	Private
quality	10.9	14.2	23.4
expenditure	\$ 2701.4	\$ 2413.9	\$ 2040.2
tax	1.6 %	2.2 %	

In the absence of a private schooling alternative, the higher tax community provides a higher quality of education with higher per-student-expenditure (see Section 4.2 and Hanushek and Yilmaz (2006)). This could easily mislead one to overrate the role of expenditures on school quality. Also, the expenditures at the private school is lower than both public schools, but the peer quality is very high. As a result, the quality in the private school is at a maximum among all models we consider in this paper.

With this price tag, private school is not an affordable option for unskilled types. As a result, most low income-high valuation (UH) type households choose to live in the east -despite the higher rents- because of the higher quality of public education. For low income-low valuation type households, the lower-taxes in the west balances the lower quality of education, and their distribution across communities is more balanced in every model we consider here.

4.2 The Value of Having a Private Alternative

In the benchmark model we take the private alternative for granted. However, we are certainly interested in understanding who is affected -and how- from having such an option.⁷ So we analyze the equilibrium in the city without a private school, the traditional case in which school choice can be done only through community choice.⁸ Table 2 compares the quality and expenditures at schools

⁷Competition between public and private schools is analyzed in a single community framework in Epple and Romano (1998).

⁸Fernandez and Rogerson (1996) consider such a model in which public education is financed by income taxes.

in two communities. The quality in the east reaches a maximum among all models. However, the quality in the lower-tax neighborhood hits the minimum level among all models, and so does the quality difference between two neighborhoods. We see a similar effect on rents. We discuss the implications of the rent gap on households choices and welfare in detail below. Having private schooling seems to have benefits to a group larger than its students.

Table 3: Public Schools Only

	West	East
quality	6.4	18.7
expenditure	\$ 2012.3	\$ 2426.6
tax	1.6 %	2.2 %

The huge quality difference between two districts cannot be attributed to the (disproportionate) difference in per-student expenditure. The quality difference is mostly due to the differences in peer quality -or population composition- across the two districts. An inspection of Figures 8 through 11 makes this pretty clear. The high income households sort themselves into two neighborhoods according to their preferences for education: All the SH types locate in the east, and all the SL types locate in the west. We see a similar -but partial- sorting among low income households too. All the UH types locate in the east. Although we observe UL types in both jurisdictions, a larger proportion resides in the west. This model's equilibrium exhibits the strongest sorting based on preferences.

Comparing this model with the benchmark, we can summarize the benefits from having a private school as follows: A private school weakens the Tiebout sorting and allows some high income households with strong preferences for education to choose residences in the areas that have relatively lower quality public schools, and lower taxes. These parents increase the per-student expenditure in the district by paying taxes higher than the typical resident, and also by not claiming (or by redistributing) their share of local expenditures since their children attend the private school. As

a result, the other residents of these districts can have a higher quality in public schools than they could in the lack of the private school.

On average, the UH (SH) types pay taxes that are less (more) than per student expenditure. Now the east school district consists of UH and SH types only. More UH types in the neighborhood means a bigger burden on SH types. The peer quality increases with UH exchanging places with SL in the public school, and this shows in the school quality. However, the increase in rents and tax expenditures outweighs the increase in quality at the school and SH types end up worse off. In the benchmark, the contribution of private school attending SH residents was a major determinant of UH types choosing to live in west. With that out of the picture, the UH types move to east for a better education. However, the increase in quality of education fails to compensate for the higher rents and taxes for them too. The rents decrease in west school district, and so does the quality of education. The residents are (skilled and unskilled) low valuation types exclusively. However, the decline in the quality of education is so dramatic, it outweighs the gain from rents and taxes. In equilibrium every household is worse off compared to benchmark model.

4.3 A Spending Equalization Program

School district consolidation is a policy motivated by economies of scale, and it aims to increase efficiency of public schools by cutting costs. Over the last several decades, the number of school districts has decreased dramatically in United States, and the proponents demand further consolidations. In this paper our focus is on the allocation rather than the technology. Our framework allows us to study the distribution of households across districts and across schools, and the resulting education provision levels when spending is restricted to be equal everywhere.

The typical outcome in local public goods models is that households group with others that have similar preferences and income levels, or similar willingness to pay. In our framework, preferences affect the provision level not only through local residents' willingness to pay, but through peer effects too. We saw in Section 4.2 that most high valuation types stick together and pay higher

rents and taxes. Also remember that quality of education for a given expenditure level increases in the proportion of high valuation types in the peer group. As a result *both* the spending and the peer quality in their district exceeds those in the other. The benchmark model in 4.1 illustrates the distortion on this sorting caused by private school. Private school attending households chose to live in the west community where rents and taxes are lower. This increases the per-student expenditure in the district, however fails to increase quality proportionally. In this section we study households' choices when we close the willingness to pay channel, in the presence of a private school.

Table 4: Consolidation

	West	East	Private
quality	8,1	11,8	12,7
expenditure	\$ 2004,6	\$ 2004,6	\$ 1104,5
tax	1.6 %	1.6 %	

Table 4 displays the equilibrium outcomes. Both the quality of education and the per-student expenditures at public schools are lower than those at the benchmark equilibrium. Moreover, the quality difference between two public schools is slightly larger compared to benchmark. This low quality of public education in both localities makes the private school much more attractive to all high valuation types. The unskilled cannot afford the tuition, but the harder competition among skilled high valuation types causes a lower equilibrium tuition/expenditure level for the private school. As a result, we see the most dramatic effect of this policy on the quality of private school. Note that it is not the peer quality that is affected, the private school still consists of SH types only. But the quality implied by the low expenditure level exceeds the quality of the east public school only slightly.

Consolidation weakens high valuation households' incentives to live in the east. The city consists of only one district now, and the low valuation types constitute the majority. Therefore the voting outcome is the lower tax rate. Combined with the decrease in rents in both commodities, this results in lower tax revenues overall which explains the low expenditures. In the benchmark model,

households determined quality of education through instructional expenditures and peer effects. But now they are left with only the latter, hence cannot be as effective on provision levels. Also in the benchmark model, the tax revenues from private school attendees that live in the west contribute to the budget of public school students in the west only. Many unskilled high valuation types choose to live there because of the resulting high per-student-expenditure. Under a consolidation policy, those revenues will be split between two districts. This will affect the incentives of UH type residents, and some will move to east. The burden on the skilled residents of the east increases, since they will subsidize more unskilled types now.

The combined effects not only decrease the rents in both jurisdictions, but also narrow the rent gap between the communities. East housing is relatively cheaper compared to the benchmark, and this attracts some new residents - particularly SL types. Despite the decrease in quality of education, every household will benefit from the decrease in rents and tax payments. To see which effect dominates, we conduct a welfare analysis in Table 1. As summarized in the last column, shows that the impact of expenditure equalization is not only negative for everyone, but also huge in magnitude compared to the welfare changes in the other models above. In our economy low valuations types are the majority so the outcome represents their preference. This hurts high valuation types and triggers a chain of events -some of which we described above- which in turn hurt also the rest in equilibrium.

4.4 An Untargeted Program Financed by Property Tax Revenues

The analysis in the previous sections suggests that having a larger opportunity set has desirable consequences not only for the households who choose the higher spending neighborhood or the private school, but for the society in general. Clearly high income households have more flexibility when making decisions -whether it is to relocate, or to attend private school- and low income households have very limited options, if any. Public administrators may be interested in increasing the access for the low income families as well. In practice this would be desirable not only in

terms of fairness and equality, but also in terms of increasing school competition and efficiency. If choice is beneficial, then the effects could be amplified as the number of people that exercise choice increases. In this section and next, we investigate the consequences of two programs that aim to enable more people to make choices.⁹

In our framework, the jurisdictions collect property taxes, and spend the revenues as educational expenditures in the public school system (see (4)). Let's say each household living in jurisdiction j is entitled to an expenditure of V_j dollars from the district's budget. Instead of spending this money in public schools on behalf of the households, suppose the administrators offer the local residents the option to use up to V_j dollars from the district's budget, to pay tuition at the private school:

$$V_j = \max\{p, E_j^{pub}\}, \quad j \in \{e, w\} \quad (12)$$

Of course this offer is conditional on being admitted at the private school. The households can add on top if the tuition p exceeds the transfer amount. The school quality implications of this policy can be seen in Table 5. The quality difference between the two public schools increases. The school in the east (west) has higher (lower) quality compared to the benchmark equilibrium. The expenditures are very close, so the quality difference can be attributed mainly to the differences in composition of population between two localities.

Table 5: Choice to the Poor

	West	East	Private
quality	8.5	16.1	9.9
expenditure	\$ 2314	\$ 2513	\$ 859
tax	1.6 %	2.2 %	

⁹One such mechanism proposed by school choice proponents to increase choice -especially for the low income households- is vouchers (For effects of vouchers see Manski (1992), Epple and Romano (1998), Rangazas (1995), Hoyt and Lee (1998), Nechyba (1999,), Nechyba (2003).) Vouchers can be unconditional, or eligibility and its amount can be conditioned on some student characteristics (income, ability) or school characteristics (tuition), and different types of vouchers would cause different distributions of students across schools. Voucher design is a very interesting problem (see Epple and Romano (2003b), Nechyba (2000), Caucutt (2002)). The mechanism we consider in this section can be thought as a flat-rate voucher, to which every household is eligible.

The quality in the private school is very low, almost as low as the public school in the west. The student composition has changed completely. Unlike benchmark model, no SH types exist in the private school, and it consists of UH types only. The peer quality did not diminish, all students are still high valuation types, so quality decline is caused by the big reduction in per-student expenditure. For efficiency purposes, the private school should needs to charge a higher tuition for low valuation types because of their negative effect on peer quality. But low valuation types are not willing to pay higher than high valuation types. So the competition for the private school seats is between UH and SH types really, and they will both bid for a residence in the west. For a UH type, a private school spending/tuition up to E_w^{pub} -the per-student expenditure in west public school- comes at no cost, whereas SH types have to pay the full amount. With this advantage, UH types outbid SH guys. Their high demand keeps the equilibrium tuition/spending at the private school at a very low level. At the same time east becomes more attractive for SH types, because of the move of a significant number of UH types who would live in east and pay relatively less. Their spending in the east is more effective now, so they spend more and the resulting quality of education is higher than the benchmark.

Our welfare analysis shows that the unskilled high valuation types do benefit from this policy, but the other three types of households end up worse off compared to the benchmark model.

4.5 A Targeted Program Financed by Income Tax Revenues

The program we have considered in the previous section is is untargeted - any household is eligible. However, earlier we had argued that lower income households are the ones that really face restrictions on alternatives and choice. And among them, the high valuation types are more likely to make use of such a transfer. Our findings in the previous section verify these. The UH types use the transfers and replace the SH types in the private school. If UH types are the clientele, then it may be desirable to design a program that targets them exclusively.

More important, in Section 4.4 each district offers a locally financed transfer to its own residents.

But we have also learned that a household that chooses the private school will live in the west school district where the tax rates (and most likely rents and expenditures too) are lower. Therefore it does not really matter whether the east offers the same program or not, because the burden of the program is on the west residents really. This is particularly unfair if the west is poorer. In the benchmark, the private school attendees are SH types exclusively. In 4.1 we have discussed the importance of their contribution to the public school expenditures. When UH types replace them in 4.4, the public school attending residents in west lose this contribution and face the burden of the private school at the same time. Finally, the program in 4.4 increases ability to choose for UH types that attend the private school, however does not provide any direct benefits for the remaining UH types.

The problems we have just described motivate us to study the effects of a program that targets UH types exclusively and treats them equally, while distributing the burden throughout the city rather than the lowest tax community only. Specifically, the city collects income taxes to finance a transfer to all the unskilled high valuation type residents in any locality. We denote the (exogeneous) city income tax rate by t . The budget of a typical household is then:

$$z + (1 + \tau)R(r)s + p = (24 - l)(1 - t)W - (a + b(1 - t)W)r.$$

In addition to all the standard effects of an income tax, note that we observe a decrease in commuting costs because of the decrease in opportunity cost of time. The total income tax revenue is distributed equally among all eligible households. The households can then take this money and use it for private school tuition, contributing on top if necessary. Alternatively, the households may attend the public school of their choice, and add the transfer amount to that school's budget. If V denotes the per-household transfer amount, and N_j^{UH} denotes the number of UH types in the public school system of community j , the budget of the district (the counterpart to (4)) will look

like:

$$E_j^{pub} = \frac{1}{N_j^{pub}} \left[\tau_j \int_0^{r_{fj}^*} R_j(r) L(r) dr + N_j^{UH} * V \right] \quad (13)$$

There is no difference between SH and UH types in terms of peer quality. In the previous models SH types were more desirable neighbors than UH types because of their higher contribution to tax revenues. This program may increase UH types' contributions to the local budgets, and make them more desirable students in every community. We choose the income tax rate (0.26%) so that the private school no longer consists of a single type of students. When we increase (decrease) the tax rate, the proportion of UH (SH) types increases and reaches 1 eventually.

Table 6: Choice to the Poor 2

	West	East	Private
quality	9,7	16,8	17,0
expenditure	\$ 2647,3	\$ 2586,1	\$ 1483,2
tax	1.6 %	2.2 %	

Some key properties of equilibrium are given in Table 6. The school in the east (west) has higher (lower) quality compared to the benchmark equilibrium, and the quality of private school is lower than that in benchmark just like in the previous exercise. But the quality of education in every school is higher compared to those in the previous section.

We see both UH types and SH types in the private school, the proportion of the first group being slightly higher. High-valuation types -skilled or unskilled- either live in the east, or attend private school. West rents are significantly lower compared to the benchmark, whereas rents in east decrease only slightly. Those SH types that are replaced by UH types in the private school move west. That does not hurt the expenditures much because of a few reasons. Because of the low rents we see a migration of SL types from east to west which partially compensates decrease in SH population. Second, the burden is no more on west residents only unlike the program in 4.4. Third, the total number of public school students in west decreases, increasing per-student

expenditure. Finally, the decrease in west rents increase a typical household's lot size, causing the neighborhood and the taxable land to expand. As a result the peer quality and the expenditures in west decrease only slightly, causing a small decrease in school quality compared to the benchmark.

The UH types that do not attend the private school live in east. They contribute to district's budget not only through property taxes, but also through the program's transfers as well. The SH population in the east increases too. The program decreases the burden of UH types on SH types, and SH money is more effective now. The resulting expenditure level in east exceeds the benchmark level, and so does the peer quality. The quality of education in east is higher compared to the benchmark. The improvement on school qualities over 4.4 decreases the private school demand, and the implied tuition/expenditure level is higher in this model's equilibrium.

All high valuation types benefit from this policy, the welfare change to the unskilled being higher. As a measure of total welfare in the economy we calculate an index, a normalized sum of household utilities, and call it Aggregate Expected Utility (AEU). Among the four models we consider, this policy is the only one that is an improvement over the benchmark in terms of AEU.

5 Concluding Remarks

We have introduced a private schooling alternative in a two-community city, and illustrated under different conditions how it alters the residential and educational choices as well as opportunity sets of different types of households. The concern for accessibility enriches the Tiebout framework through its implications for the relation between location choices and land demands of households, which in turn relate to property values, tax revenues, and school district budgets. A particularly interesting finding is the severed link between expenditures on school quality (4.1 and 4.5). Another one follows from the experiments in which we restrict alternatives: Having a larger opportunity set has benefits not only for the households that select choose those alternatives, but for the remaining as well. The lack of private schooling caused a disturbingly low quality of education in the poorer neighborhood, and expenditure equalization caused fairly large welfare losses to every resident.

Concerned by the inequality of opportunities between the rich and poor when choosing schools, we have considered two very simple mechanisms to extend the ability for the latter. Our results point to the desirability of central financing as opposed to local. We can draw some lessons from these experiments about the market implications of popular reform proposals such as vouchers and charters. Our future work will study these issues in greater detail.

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Figure 1: Monthly Gross Market Rent (per acre)

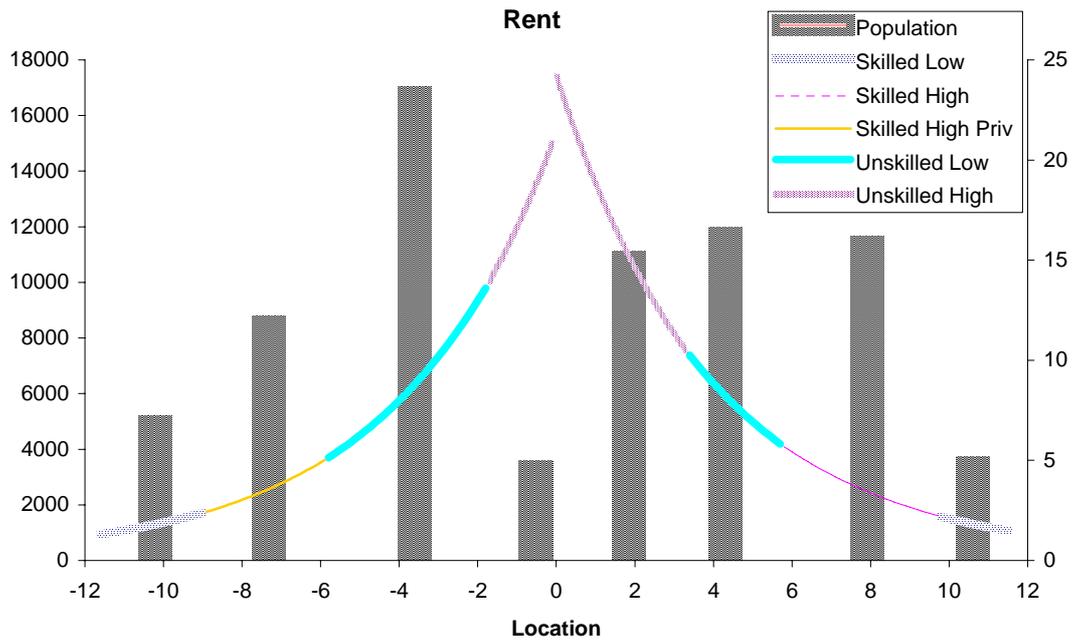


Fig 6: Expenditure per Pupil per year

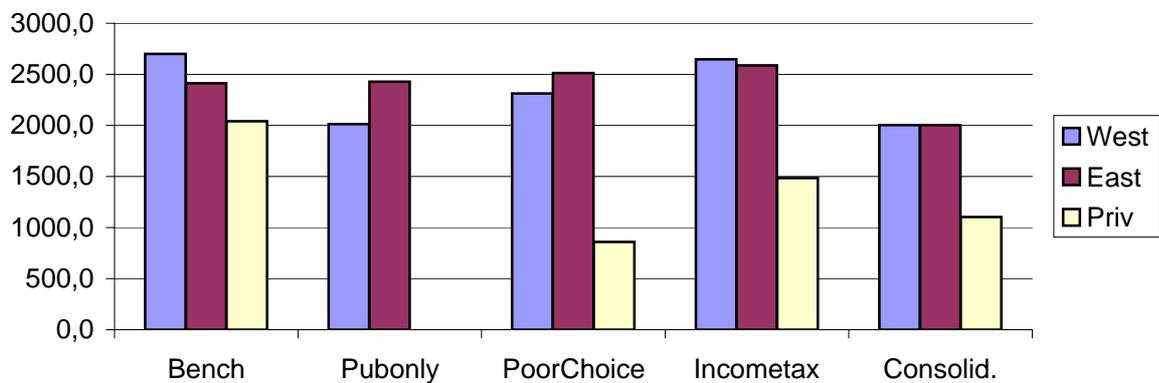


Fig 7: Quality of Education

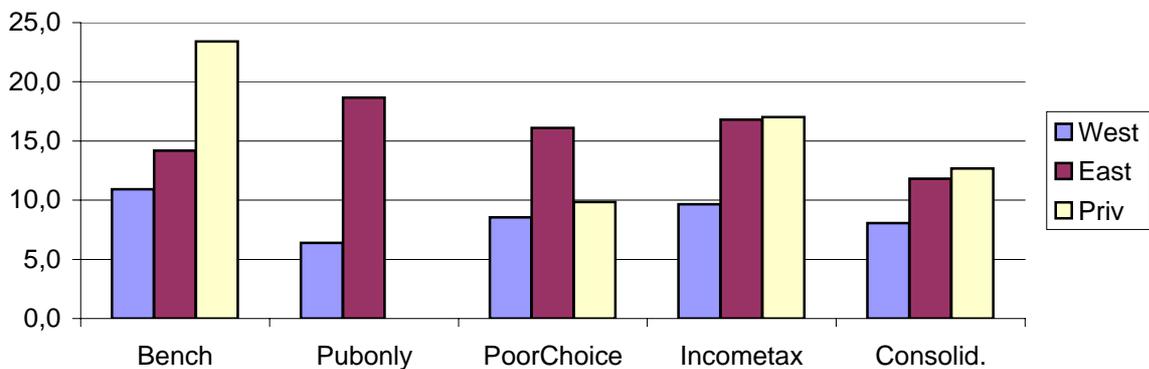


Fig 8: The Population Distribution of Skilled Low

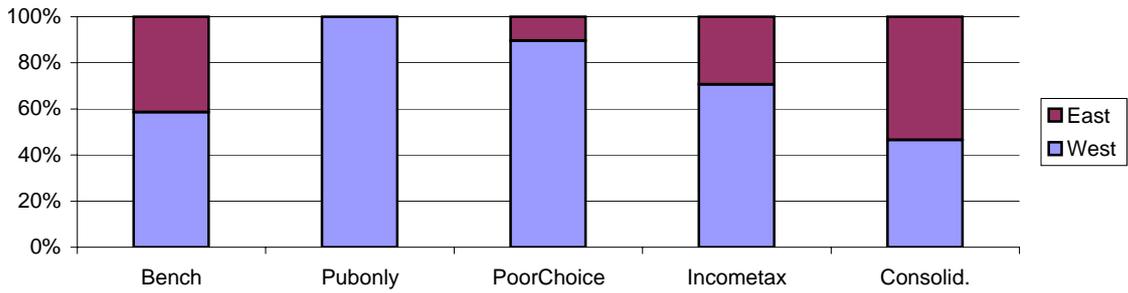


Fig 9: The Population Distribution of Unskilled Low

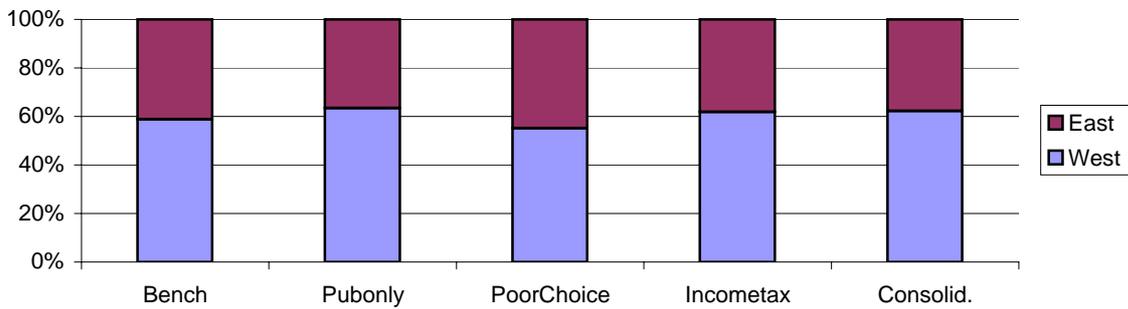


Fig 10: The Population Distribution of Skilled High

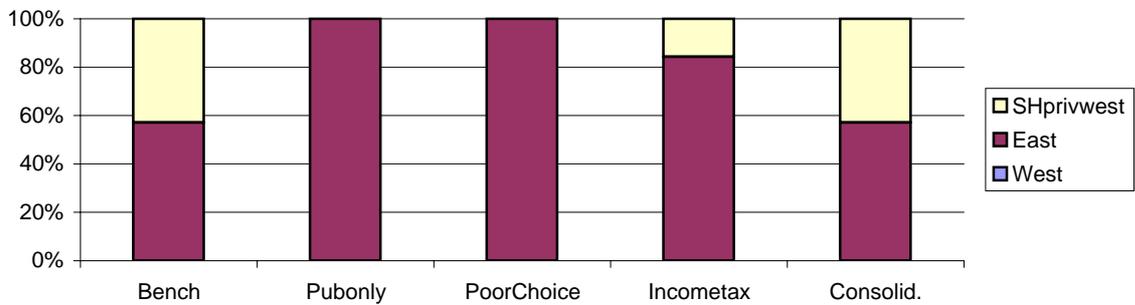


Fig 11: The Population Distribution of Unskilled High

