Household Life Cycle Location Choices and the Dynamics of Metropolitan Communities

Dennis Epple

Carnegie Mellon University

Richard Romano

University of Florida

Holger Sieg

Carnegie Mellon University

May 4, 2007

The Tiebout Hypothesis and Capitalization

- A fundamental premise in modeling local jurisdictions is that households make their location decisions taking account of the public good bundles available in alternative jurisdictions.
- This hypothesis, first proposed by Tiebout (1956), has been the subject of extensive formal modeling and empirical analysis.
- Early empirical work, pioneered by Oates (1969), investigated the extent to which differentials in housing prices across jurisdictions reflect differentials in quality of local public goods and property tax rates.
- Black (1999) and Bayer, Ferreira, and McMillan (2007) are some recent applications that are in the spirit of this line of work.

Sorting and Stratification

- Much recent empirical work has focused directly on the extent to which households stratify based on differences in the quality of local public goods.

- See Epple and Sieg (1999), Epple, Romer, and Sieg (2001), Bajari and Kahn (2004), Sieg, Smith, Banzhaf and Walsh (2004), Bayer, McMillan, and Reuben (2005), Ferreyra (2007), and Ferreira (2007).

- Both research on capitalization and research on stratification of households across jurisdictions supports the hypothesis that households do in fact take account of differences in local public good bundles in making location choices.

Theoretical Models

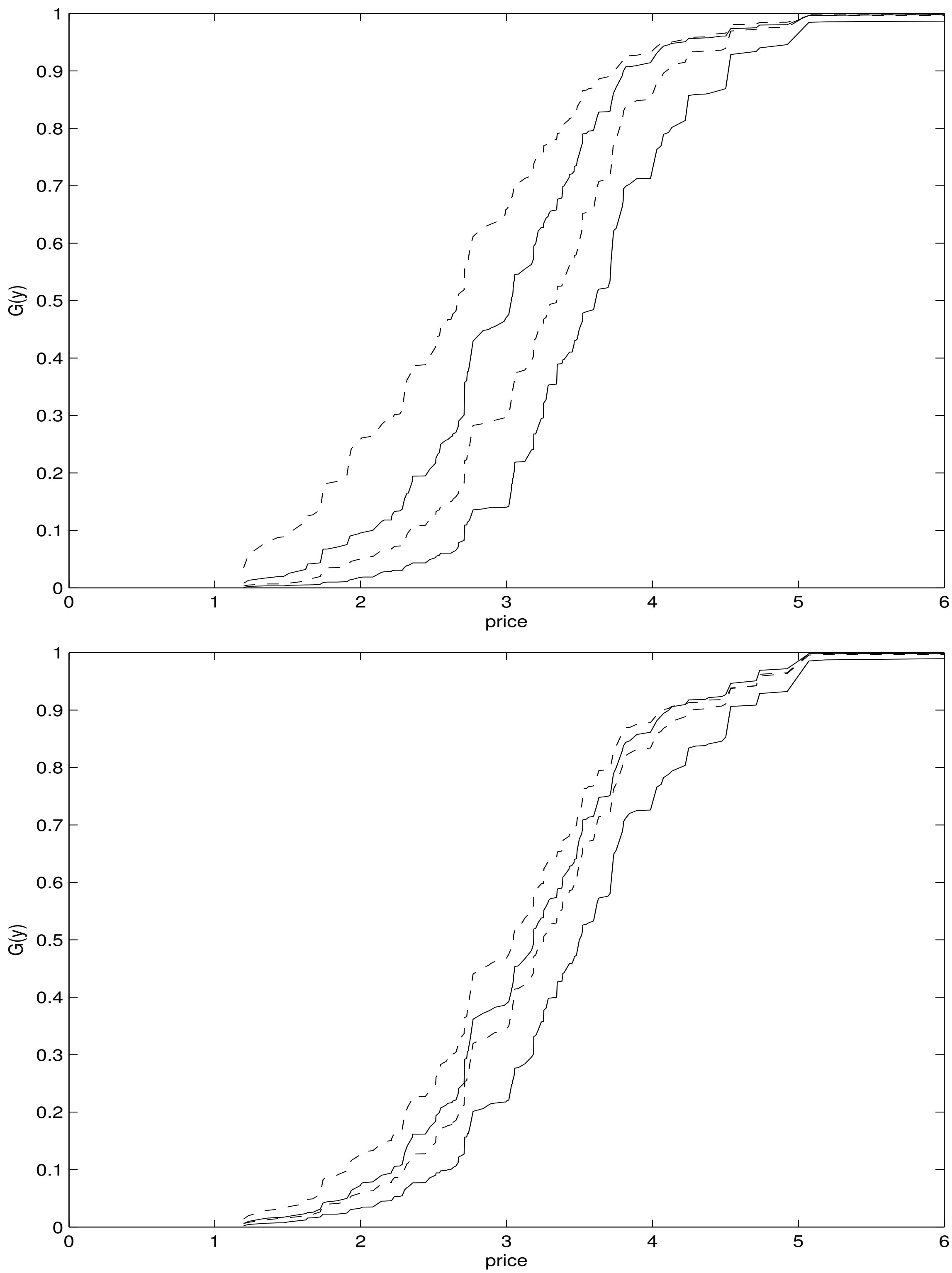
- Theoretical research has largely focused on static models.
- Examples of this type of theoretical work are Ellickson (1973), Westhoff (1977), Epple, Filimon, and Romer (1984), Goodspeed (1989), deBartolome (1990), Epple and Romer (1991), Nechyba (1997), Fernandez and Rogerson (1996), Henderson and Thisse (2001), and Rothstein (2004).
- Exceptions are Benabou (1996), Durlauf (1996), Fernandez and Rogerson (1998), Glomm and Lagunoff (1999), and Ortalo-Magne and Rady (2005).

Mobility over the Life-cycle

- The same logic that suggests households sort based on tastes for local public goods implies that households have incentives to change location over the life cycle.

- For example, one would expect that households with school-age children would place weight on the quality of local public schools when considering location choices, but that those same households would place little weight on quality of local public schools when their children have left school.

Figure 1: Sorting of Households by Income



The top panel shows households with children. The bottom panel shows households without children.

Demand for Public Goods and Housing over the Life-cycle

- Departure of children from the household, and the associated decrease in need for housing reinforces the incentives for relocation that accompany the decrease in need for local public services.

- These incentives for relocation over the life cycle in turn create incentives for young households to make their initial location choices and housing purchases taking account of the likelihood that they will relocate in the future.

- A dynamic equilibrium model embodying household life cycle choices offers the potential to improve understanding both of community characteristics and of housing markets.

Voting for Public Good Provision

- Static models of voting over taxation to provide education presume that the majority of households have children, so that the resulting equilibrium is characterized by positive spending on education.
- In reality, and any point in time, the majority of households do not have school-aged children.
- Nonetheless positive spending on education is observed in all local jurisdictions in the U.S. which is hard to explain within static voting models.

Voting and Mobility

- A dynamic framework offers the potential to better capture the incentives that households confront when voting.
- In particular, a dynamic framework offers the potential to capture the effect of current collective choices on future house values.
- Moreover, households with grown children who plan to move have an incentive to support high provision of education to maintain housing demand and property values.

Outline of the Remainder of the Talk

- Some Stylized Facts
- OLG Model of Household Sorting
- Qualitative Properties of the Model
- Quantitative Properties of the Model
- Conclusions

Data Sources

- Our sample consists of 119 communities in the greater Boston Metropolitan Area for the census years 1970, 1980, 1990 and 2000.
- A distinctive feature of the Boston metropolitan area is that the population was virtually the same in 1980 and 1990 as it was in 1970. Of course real incomes were growing over this period of time, and family size was declining
- This time period also includes a Massachusetts law that restricts property taxation (usually referred to as Proposition $2\frac{1}{2}$). This law, which was passed in 1981, limited property tax rates to two-and-a-half percent (after some adjustment period).

Correlations of Median Community Incomes in Boston

	1970	1980	1990	2000
1970	1.00	0.93	0.92	0.93
1980	0.93	1.00	0.97	0.96
1990	0.92	0.97	1.00	0.95
2000	0.93	0.96	0.95	1.00

We thus conclude that community level income is highly persistent across decades.

Correlations of Fraction of community populations aged 19 or younger

	1970	1980	1990	2000
1970	1.00	0.91	0.70	0.66
1980	0.91	1.00	0.88	0.79
1990	0.70	0.88	1.00	0.84
2000	0.66	0.79	0.84	1.00

The data also reveal much persistence in the population age distribution over time.

Proportions of the population in various cohorts

If individuals in a given cohort did not move, the number of individuals in a community in a given cohort would be the same as the number of individuals 10 years older in that community 10 years later.

		1970	1980	1990	2000
		20-24	30-34	40-44	50-54
1970	20-24	1.00	0.11	-0.54	-0.59
1980	30-34	**0.11**	1.00	0.47	0.14
1990	40-44	-0.54	0.47	1.00	0.74
2000	50-54	-0.59	0.14	0.74	1.00

		1970	1980	1990	2000
		25-29	35-39	45-49	55-59
1970	25-29	1.00	-0.01	-0.36	-0.38
1980	35-39	**-0.01**	1.00	0.88	0.60
1990	45-49	-0.36	**0.88**	1.00	0.70
2000	55-59	-0.38	0.60	**0.70**	1.00
		30-34	40-44	50-54	60-64
1970	30-34	1.00	0.57	0.21	-0.06
1980	40-44	0.57	1.00	0.88	0.41
1990	50-54	0.21	**0.88**	1.00	0.69
2000	60-64	-0.06	0.41	**0.69**	1.00

Intra-metropolitan Migration

- These results suggest that cross-community mobility is very high for those aged 20 to 29.
- Mobility is quite low for those aged 35 to 45.
- Mobility then begins to rise for those aged 45 to 54, but the correlations for that age group suggest that mobility for those households is substantially lower than for young households.

An OLG Model

- Consider a local economy in which activity occurs at discrete points of time $t = 1, 2, ...$
- The economy consists of J communities.
- each community provides a local public good g which is financed by property taxes, τ.
- Each community also has a fixed supply of land (housing).

Households

- There is a continuum of households that live for two adult periods.
- At each point of time households in the economy consist of two overlapping generations, denoted young (y) and old (o).
- Each household is characterized by a lifetime income level denoted by w.
- Households have a current period utility function which is defined over housing (h), a local public good, and a numeraire good (b)
- Households behave as price takers and have perfect foresight about current and future prices, tax rates, and levels of local public good provisions.

Mobility Costs

- Young households are not born with a place of residence. Thus, we assume that they can pick any community of residence in the first period without facing mobility costs.

- Old households have already established a residence when they were young. If they decide to relocate in the second period, they face mobility costs, denoted by mc.

- The distribution of lifetime income and mobility costs, $F(w, mc)$, is stationary and continuous with support $S \subseteq R^2_+$ and joint density $f(w, mc)$.

The Household Decision Problem

A young household maximizes lifetime utility:

$$\max_{d_t^y, h_t^y, b_t^y, d_{t+1}^o, h_{t+1}^o, b_{t+1}^o} \sum_{k=1}^{J} d_{kt}^y U^y(b_{kt}^y, h_{kt}^y, g_{kt}) \ + \ \beta \sum_{l=1}^{J} d_{lt+1}^o U^o(b_{lt+1}^o, h_{lt+1}^o, g_{lt+1})$$

subject to a lifetime budget constraint,

$$\sum_{k=1}^{J} d_{kt}^y (p_{kt} h_{kt}^y + b_{kt}^y) + \sum_{l=1}^{J} d_{lt+1}^o (p_{lt+1} h_{lt+1}^o + b_{kt+1}^o) = w_t - \sum_{k=1}^{J} \sum_{l \neq k} 1\{d_{kt}^y = d_{lt+1}^o = 1\} mc_t$$

and residential constraints:

$$\sum_{k=1}^{J} d_{kt}^y \ = \ 1 \qquad d_{kt} \in \{0,1\}$$

$$\sum_{l=1}^{J} d_{lt+1}^o \ = \ 1 \qquad d_{lt+1} \in \{0,1\}$$

Lifetime Indirect Utility

Given a community choice k int t and l in $t+1$, we can solve for the optimal demand for housing and other goods in both periods. Substituting these demand functions into the life time utility function yields the conditional indirect lifetime utility function which can be written:

$$V_{kl}(w_t - \delta_{kl} mc_t, g_{kt}, p_{kt}, g_{lt+1}, p_{lt+1})$$

where $\delta_{kl} = 1$ if $k \neq l$ and zero otherwise.Similarly, define

$$V^o(w^o_{nt}, g_{lt}, p_{lt}) \; = \; \max_{h_{lt}} \; U^o(w^o_{nt} - p_{lt} h_{lt}, h_{lt}, g_{lt})$$

where $w^o_{nt} = w_{t-1} - \delta_{kl} mc_{t-1} - p_{kt-1} h^y(p_{kt-1}, w_{t-1} - \delta_{kl} mc_{t-1})$

Household Sorting

Define the set of young households living in community j at time t as follows:

$$C_{jt}^{y} \;=\; \left\{(w_t, mc_t)\middle|\; d_{jt}^{y} = 1\right\}$$

The number of young households living in community j at time t is given by:

$$n_{jt}^{y} \;=\; \int\int_{C_{jt}^{y}} \; f(w_t, mc_t)\, dw_t \, dmc_t$$

Similarly define the set of old households living in community j at time t as follows:

$$C^o_{jt} \; = \; \{(w_{t-1}, mc_{t-1}) | \; d^o_{jt} = 1\}$$

The number of old households living in community j at time t is given by:

$$n^o_{jt} \; = \; \int\int_{C^o_{jt}} \; f(w_{t-1}, mc_{t-1}) \, dw_{t-1} \, dmc_{t-1}$$

Housing Demand

All households are renters. Housing demand functions $h^y_{jt}(\cdot)$ and $h^o_{jt}(\cdot)$ can be derived by solving the the decision problems characterized above. Aggregate housing demand in community j at time t is then defined as the sum of the demand of young and old households:

$$H^d_{jt} \;=\; H^y_{jt} \;+\; H^o_{jt}$$

where

$$\begin{aligned} H^y_{jt} \;&=\; \int\int_{C^y_{jt}} h^y_{jt}(w_t, mc_t)\; f(w_t, mc_t)\; dw_t\; dmc_t \\ H^o_{jt} \;&=\; \int\int_{C^o_{jt}} h^o_{jt}(w_{t-1}, mc_{t-1})\; f(w^y_{t-1}, mc_{t-1})\; dw_{t-1}\; dmc_{t-1} \end{aligned}$$

Housing Market Equilibrium

Housing is owned by absentee landlords Housing supply is stationary and exogenously given by $H^s_{jt}(p^h_{jt})$, where p^h_t is the net price of housing.

This assumption is imposed for convenience. The alternative would be to assign property rights over the existing housing stock. Household would then obtain revenue from rental income. While these types of extensions are feasible, we do not pursue them in this paper.

The housing market in community j is in equilibrium at time t if:

$$H^d_{jt} = H^s_{jt}(p^h_{jt})$$

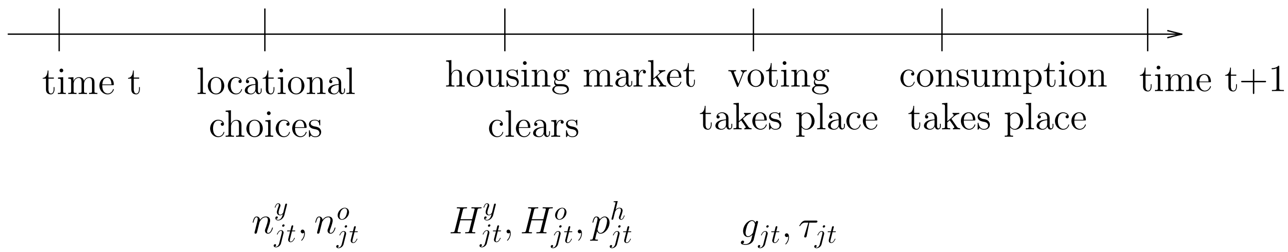
Community Budget Constraint

We assume that the public good primarily reflects education. Hence we can express the community specific budget constrained as:

$$\tau_{jt}\, p^h_{jt} \left[\frac{H^y_{jt}}{n^y_{jt}} + \frac{n^o_{jt}}{n^y_{jt}} \frac{H^o_{jt}}{n^o_{jt}} \right] = g_{jt}$$

where $c(\cdot)$ is the cost function which is associated with local public good provision per student. Note that the right hand side of the equation above reflects the revenue per young household.

Timing of Consumption and Voting Decisions



Feasible Alternatives

Consider a community j which is characterized by a pair of housing prices and public good provision denoted by (p_{jt}, g_{jt}). Combining the equation relating net and gross housing prices, $p_{jt} = p^h_{jt}(1+\tau_{jt})$, and the community budget constraint, we obtain:

$$p_{jt} = p^h_{jt} \ + \ \frac{g_{jt}}{H^y_{jt}/n^y_{jt} + (n^o_{jt}/n^y_{jt})\ (H^o_{jt}/n^o_{jt})}$$

Given our timing assumptions, all variables in this expression except (p_{jt}, g_{jt}) have been determined prior to voting. Thus the set of feasible alternatives yields a linear relationship between the choice of g_{jt} and the resulting gross-of-tax housing price p_{jt}.

Voting and Future Policies

Households in community i in period t take as given all future housing prices, tax rates, and educational spending in all communities, $(\tau_{js}, p_{js}, q_{js})$ in periods $s = t + 1, ...$

Old Voters

Substituting the community budget constraint that prevails at the time of voting into the voter's budget constraint, we obtain:

$$w_t^o = p_{jt}^h h_{jt}^o \ + g_{jt} \left(\frac{h_{jt}^o}{H_{jt}^y / n_{jt}^y + (n_{jt}^o / n_{jt}^y) \ (H_{jt}^o / n_{jt}^o)} \right) + b_{jt}^o$$

The voter's utility function is $U^o(g_{jt}, h_{jt}^o, b_{jt}^o)$. At the time of voting, all elements of the preceding budget constraint and utility function have been determined except (g_{jt}, b_{jt}^o). Quasi-concavity of the utility function and convexity of the budget constraint imply that the voter's induced preference over g_{jt} is single-peaked.

Young Voters

The budget constraint of the young voter is:

$$\begin{aligned} w_t^y &= p_{jt}^h h_{jt}^y + g_{jt}\left(\frac{h_{jt}^y}{H_{jt}^y/n_{jt}^y + \left(n_{jt}^o/n_{jt}^y\right)\left(H_{jt}^o/n_{jt}^o\right)}\right) + b_{jt}^y \\ &+ p_{kt+1}h_{kt+1}^o + b_{kt+1}^o + 1\{d_{kt}^y \neq d_{jt+1}^o\}\, mc_t \end{aligned}$$

At the time of voting, the community tax base, $H_{jt}^y/n_{jt}^y + \left(n_{jt}^o/n_{jt}^y\right)\left(H_{jt}^o/n_{jt}^o\right)$, and the voter's housing consumption, h_{jt}^y, have been determined. The voter takes current and future prices (p_{jt}^h, p_{kt+1}) and future government provision, g_{kt+1}, as given. Quasi-concavity of the voter's utility function and convexity of the budget constraint then imply that induced preferences over g_{jt} are single-peaked.

Majority Rule Equilibrium

A majority voting equilibrium is a public good provision level g_{jt} that defeats all alternative feasible public good provision levels in pairwise majority voting. We have the following result:

Proposition 1 *Voting equilibrium exists in all communities.*

This result follows from single-peakedness of preferences of all voters.

Note that the median voter is not necessarily the household with median income. In general, the identity of the median voter will depend on the composition of the communities, i.e. whether young or old households form a majority within a community.

Definition of Equilibrium

An equilibrium for this economy is defined as an allocation which consists of a vector of prices, taxes and public goods denoted by $\{p_{1t}, \tau_{1t}, g_{1t}, ..., p_{Jt}, \tau_{Jt}, g_{Jt}\}_{t=1}^{\infty}$, consumption plans for each household type, and a distribution of households among communities, $\{C_{1t}^{y}, ..., C_{Jt}^{y}, C_{1t}^{o}, ..., C_{Jt}^{o}\}_{t=1}^{\infty}$, such that:

1. Households maximize utility and live in their preferred community.

2. Housing markets clear in every community at each point of time.

3. Community budgets are balanced at each point of time.

4. The majority rules in each community at each point of time.

Stationary Equilibrium

A stationary equilibrium is an equilibrium which satisfies the following additional conditions:

1. Constant prices, tax rates and levels of public good provision, i.e. for each community j, we have $p_{jt} = p_j$, $\tau_{jt} = \tau_j$, and $g_{jt} = g_j \; \forall t$.
2. A stationary distribution of households among communities, i.e. for each community j, we have $C_{jt}^o = C_j^o$ and $C_{jt}^y = C_j^y \; \forall t$.

Single Crossing Properties

The slope of the indifference curve in the (g_k, p_k) plane of a young household is given by:

$$M^y(w_n^y, g_k, p_k, g_l, p_l) = -\frac{\frac{\partial V(\cdot)}{\partial g_k}}{\frac{\partial V(\cdot)}{\partial p_k}}$$

The slope of an indifference curve in the (g_l, p_l) plane of an old household that occupied community k when young and is occupying community l when old is:

$$M^o(w_n^o, g_l, p_l) = -\frac{\frac{\partial V^o(\cdot)}{\partial g_l}}{\frac{\partial V^o(\cdot)}{\partial p_l}}$$

We assume that $M^y(\cdot)$ is ascending in w_n^y, and $M^o(\cdot)$ is ascending in w_n^o.

Finally, let the slope in the (g_l, p_l) plane for a young household that will stay in the same community for its entire life be:

$$M_s^y(w, g_l, p_l, g_l, p_l) = -\frac{\frac{\partial V(\cdot)}{\partial g_l}}{\frac{\partial V(\cdot)}{\partial p_l}}$$

We assume that $M_s^y(\cdot)$ is ascending in w.

Indifference Loci and Sorting

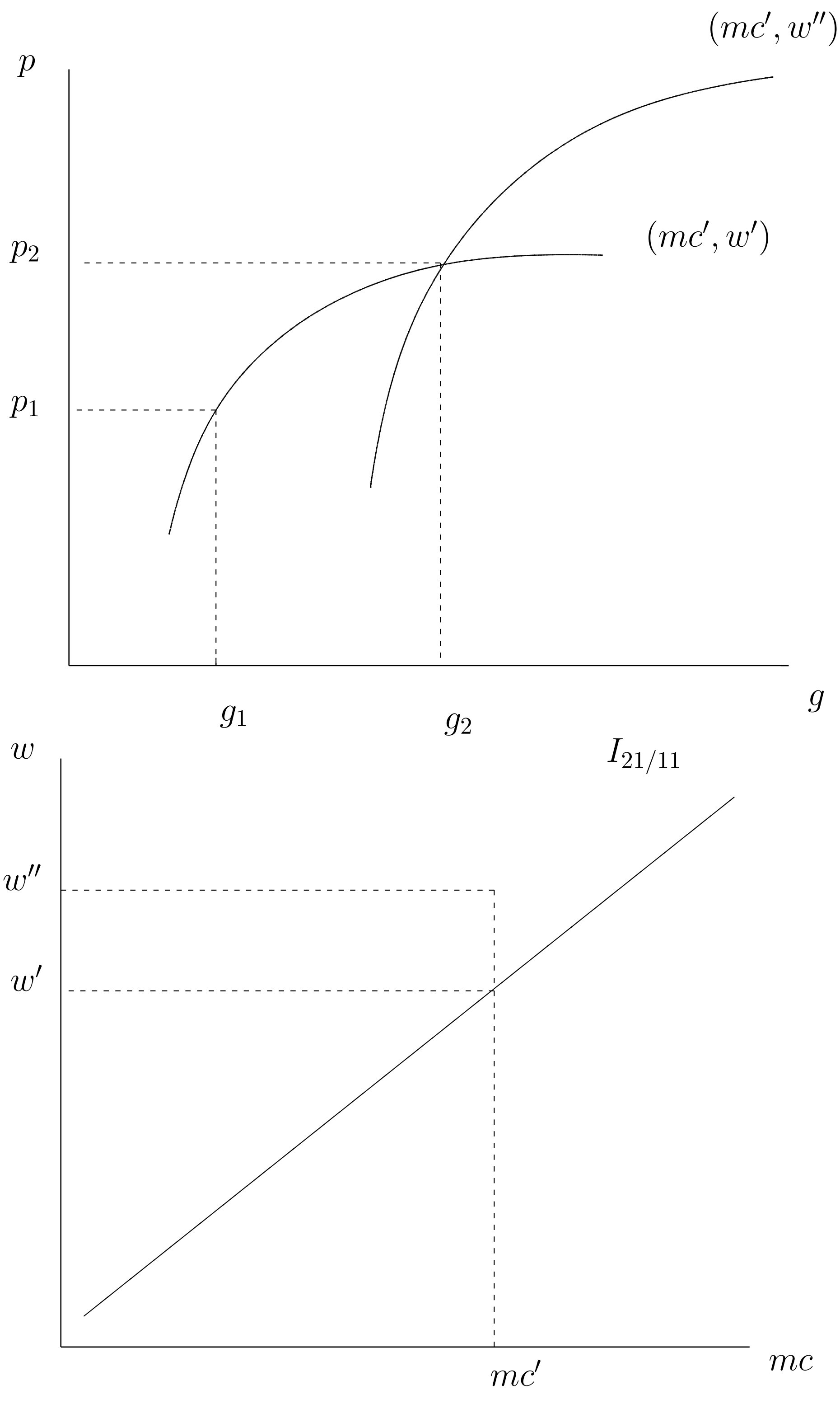
To characterize locational choices it is useful to define the following three loci in the (mc, w) plane:

1) Locus $I_{21/11}$ is defined by young households that are indifferent between (1,1) and (2,1):

$$V(w - mc, g_2, p_2, g_1, p_1) \; - \; V(w, g_1, p_1, g_1, p_1) \; = \; 0$$

Clearly, only a household with $w - mc > 0$ could potentially benefit from relocating between young and old age. If the right hand side of equation (1) is monotonically increasing in w given mc then households above $I_{21/11}$ prefer community choice (2,1) over (1,1).

Figure 2: Single Crossing



2) Locus $I_{21/22}$ is defined by young households that are indifferent between (2,2) and (2,1):

$$V(w - mc, g_2, p_2, g_1, p_1) \; - \; V(w, g_2, p_2, g_2, p_2) \; = \; 0$$

Again, only a household with $w - mc > 0$ could potentially benefit from relocating between young and old age. If the right hand side of equation (1) is monotonically increasing in w given mc, then households above $I_{21/22}$ prefer community choice (2,1) over (2,2) and vice versa.

3) Locus $I_{22/11}$ is defined by households that are indifferent between (2,2) and (1,1):

$$V(w, g_2, p_2, g_2, p_2) \; - \; V(w, g_1, p_1, g_1, p_1) \; = \; 0$$

Standard single-crossing conditions for young households that do not relocate implies that households above $I_{22/11}$ prefer community choice (2,2) over (1,1) and vice versa. $I_{22/11}$ does not depend on moving costs, and hence is horizontal in the (mc, w) plane.

Note that all three loci intersect at the same point w, mc.

Figure 3: Location of Young Households

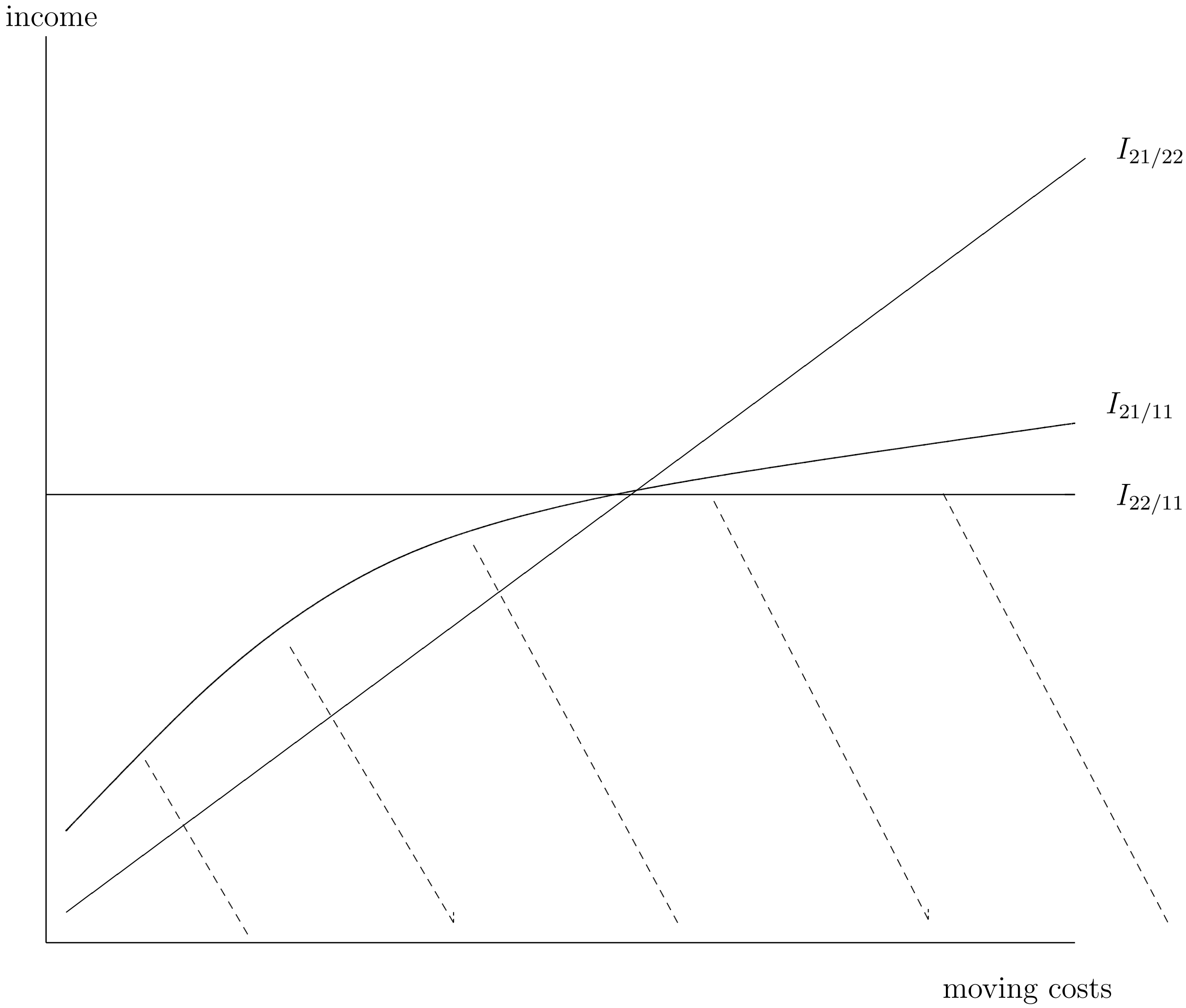
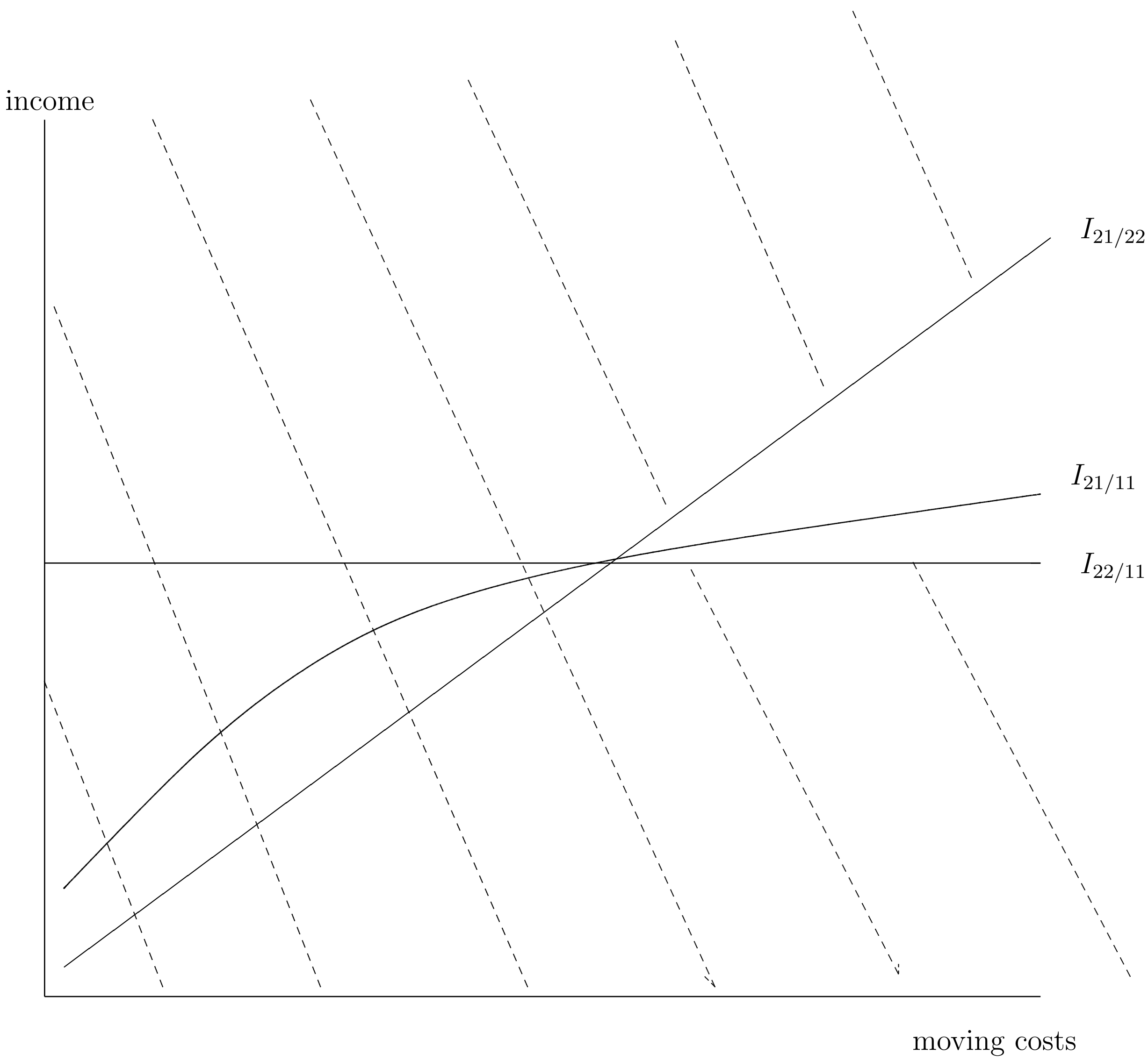


Figure 4: Location of Old Households



Proposition 2 *The equilibrium in the two community case satisfies the following properties:*

a) Only households that are fairly wealth and have low moving costs move are movers in this model. All other households are stayers.

b) The fraction of young households exceeds the fraction of old households in community 2. The fraction of old household exceeds the fraction of young households in community 1.

c) Holding moving costs fixed, young households are stratified by income and vice versa.

d) Holding moving costs fixed, old households are not stratified by income. Holding income fixed, old households are stratified by moving costs.

A Parametrization

Let the utility function be:

$$\frac{1}{\rho}(\alpha_g g_t^\rho + \alpha_h [h_t^y]^\rho + \alpha_b [b_t^y]^\rho + \beta_g g_{t+1}^\rho + \beta_h [h_{t+1}^o]^\rho + \beta_b [b_{t+1}^o]^\rho)$$

where $\rho < 0$.

We assume that the housing supply has constant elasticity τ and is given by

$$H_{jt}^s = [p_{jt}^h]^\eta$$

To finish the parametrization, we assume that the logarithm of income and moving cost are normally distributed.

A Calibration

- $\rho = -.15$
- $\alpha_h = 0.3$ $\beta_h = 0.2$ $\alpha_g = 0.08$ $\beta_g = 0.03$ $\alpha_b = 0.4$ $\beta_b = 0.5$
- $\ln(w) \sim N(11.436, .626)$: The mean of w is \$112,638 with standard deviation \$78,018.
- $mc \sim N(1500, 100)$
- The correlation of mc with $\ln(w)$ is set to be .5.
- $\eta = 3$.

	community 1	community 2
fraction of young	0.537	0.463
fraction of old	0.639	0.361
income young	62302	170905
average housing demand young	1243	2956
average housing demand old	1361	1694
net price of housing	11.54	12.55
revenue per student	5421	13275
tax rate	0.163	0.247
gross of tax housing price	13.43	15.66

Results

- Community 1 is significantly larger than community 1. It contains 53.7 percent of young households and 63.9 percent of old households.
- As a consequence 10.2 percent of households relocate from community 2 to community 1 when being old.
- Young households that live in community 1 are significantly poorer than households living in community 2. Mean income in community 1 is $62,302 compared to $170,905 in community 2.
- While the difference in average housing consumption among the two communities is large for young households, it is much smaller for old households. This is due to lack of stratification of old households, i.e.

old households living in community 2 are either fairly poor or fairly rich.

- Revenues per student in community 1 are \$5421 and \$13275 in community.
- The median voter in community 1 is a rich old household.
- The median voter in community 2 is a relatively poor young household.