Urban Meiosis

David E. Frame†

Zicklin School of Business
Baruch College

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Abstract

A simple model of a dynamic rental housing market is developed where a given population may move both within and between jurisdictions, each differentiated by the level of collectively financed local public goods and average commuting cost. In this environment, jurisdictions, run by local governments, compete with private land developers at the urban fringe for residents. Income growth, combined with a fixed distribution of land available and competing demands for space, implies an increasing demand for land development and the creation of new jurisdictions over time. Conditions under which urban decentralization, defined as the movement of an existing population from urban centers to suburban areas, are derived. In this environment, once the process of decentralization begins, further migration of residents from existing urban areas into new suburban developments is accelerated by the reduced property values and lower tax base of the existing development which lead to a lower level of services for remaining residents. The model identifies factors influencing the speed and structural density of suburban development in addition to potential tools for policy makers.

1 Introduction

The process of urban decentralization, more commonly known as suburbanization, has been well documented both in the popular press and in empirical studies of both population movements and changes in land consumption through time. The decentralization of urban areas between 1950 and 1990 within the United States well documented.[1] Goodman [?], Margo [21], Mieszkowski and Mills [24], and, Nechyba and Walsh [26], to name a few, document the declining proportions of jobs and residences in metropolitan statistical areas (MSAs) located in central cities. In 1950, Miezkowski and Mills estimated that central cities were home to 57% of residents and 70% of jobs a typical MSA. By 1990, these proportions had fallen to 37% and 45%, respectively. Using data from the 2000 Census, Goodman provides evidence that this trend is reversing for some cities. For example, between 1970 and 1980, the proportion of residents living within the central cities of the Chicago, Cleveland, Detroit, and New York MSAs declined. Between 1990 and 2000, this exodus reversed for Chicago and New York while Cleveland and Detroit continued to decentralize.

Despite the evident interest in these issues, there appears to be a situation where measurement is too far ahead of theory, as the theoretical aspects of decentralization remain largely unexplored. By constructing a model capturing the essential characteristics influencing relocation and development decisions in an urban environment, the relative importance of various influences can be analyzed and the conflicting claims from empirical can be untangled.

Mieszkowski and Mills [24] categorize the primary influences leading to decentralization into two competing sets of explanations: natural evolution theory and the social-fiscal theory. The first, the natural evolution theory, corresponds to the types of factors arising in urban spatial models of housing. These include changes in income [21], the rise of the use of cars in everyday life and declining costs of transportation [16], and federal tax policy [17]. The social-fiscal theory focuses on a variety of factors relating primarily to neighborhood attributes such as crime, school quality, and social unrest. There is an extensive empirical literature documenting the importance of social issues on residential location and relocation decisions, such as crime [8], [29], race [?], and civil unrest [7]. Furthermore, such problems can be self-reinforcing as their presence within urban areas may prompt wealthier households to relocate to relatively safe suburban areas, leaving lower housing values and a reduced tax base to help support and protect those who remain.

The model proposed and developed in this paper attempts to capture the dynamics of urban

[1] A similar move to the suburbs was underway in many other countries within the same general time frame, as well. See Mills and Tan. Although the question of who moved out and who stayed in sometimes differed according to country. See Brueckner, Zenou, Thisse.

decentralization in an environment where existing urban areas, run by local governments, compete with private developers at the urban fringe offering both newer housing and public services. The model is constructed to reflect minimal elements associated with two proposed theories leading to suburbanization. To capture the effects associated with the natural evolution theory, the model is dynamic, allowing for income growth over time. The land available to residents within existing jurisdictions is fixed, but new housing may be supplied by a developer at the physical boundaries of the city. The social-fiscal component is represented by the presence of collectively provided local public services which are financed through property taxes.

The model includes the following essential characteristics: preferences over residential locations relative to a central business district, local public goods financed through a proportional land tax, and land, and, more importantly, land use decisions, is/are durable and is an attempt to identify the underlying causes of decentralization, but also to capture the adjustment process along the way. Durable land use decisions are, in effect, an assumption of indivisibility. Once boundaries are drawn, they remain. If this assumption is not made, changes in relative income lead to outcomes where those receiving the greater increase are able to expand their property boundaries by effectively moving the boundary a few inches in the direction of those households receiving lesser increases. This seems to blur distinctions between short-run and long-run outcomes.

One issue not adequately addressed in the literature is what types of relocations define suburbanization? Here, urban decentralization is defined as the relocation of a fixed population over time. This creates the ability to distinguish between suburban development due to population growth and urban decentralization.

Within this environment, suburbanization is defined as the relocation of an existing population within a given metropolitan area, as opposed to development at the fringe that would be expected as the population of the city grows. To illustrate the process of suburbanization, the model assumes that the population residing within the area is fixed. Growing incomes are the primary causal factor. Given income growth, a fixed stock of housing available to residents and competing demands for space, there is an increasing demand for new space. Developers holding vacant land at the geographical boundaries of the city can choose to provide new housing at some time in the future. The housing in the new development is occupied by the wealthiest of households within the city. The relocation of these households reduces the tax base available to the existing local governments, limiting their ability to provide local services such as police protection, fire services, and education. This erosion of tax base provides further incentives for existing residents to relocate. As the upper end of the income distribution leaves, the poorer residents are unable to maintain the previously high level of public service provision. At some point, a new equilibrium is reached where poorer residents are compensated for the relative lack of public services by the consumption of more housing, and the relatively wealthy have moved into new suburban housing with, on average, wealthier neighbors.

This outcome is very similar the notion of dynamic instability studied by Oates, et al [27], Miyao [23], and Kanemoto [20]. These papers consider the stability of areas where residents have explicit preferences determining their willingness to live in close proximity to others. The model presented here, in contrast to this literature, does not require explicit assumptions about individual preferences for location relative to one another. In this context, the externality associated with the collective provision of local public goods through the use of property taxes leads to the instability. In this context, the wealthy don't like living with the poor because they dilute the tax base of their jurisdiction and the poor like living with the rich because the can consume greater quantities of public goods.

Similar issues are addressed in recent work by Epple, Romano, and Sieg [12], who look at cross-sectional comparisons of neighborhood composition over time. Their model considers the importance of events at different stages of life and how these might influence residential location decisions. Households with young children, for example, will place a much stronger emphasis on school quality than older residents who have just sent their children off to college. There is also fairly recent examples involving the marriage of standard urban spatial models with Tiebout competition. Examples include papers by de Bartolome and Ross [9], [10] and Hanushek and Yilmaz [18]. The models in these papers are static in nature, thereby unable to provide much insight into what is an inherently dynamic problem.

A simple analytic model is derived in the following sections. This serves to generate the basic intuition associated with the model and its environment. After which, some preliminary results and conjectures are discussed and, in the final section, extensions associated with the model are discussed.

2 A dynamic model of land and local public goods

In this section, a simple model illustrating urban decentralization in this context is presented. The model begins with a city with a fixed population but growing income where there is only one jurisdiction.

The process of decentralization can be described in the following manner. Land is allocated among residents within the city in the initial period and, once individual residential boundaries are established, they remain in place indefinitely. In effect, the only way for residents within the model to alter their housing consumption is to move to another location. If incomes grow, and residents remain at the same locations for some period of time, the services from land decrease relative to the amount of non-land consumption in their utility functions. This imbalance in marginal utilities lead to a willingness to pay to reside in a larger house potentially in a different jurisdiction.

2.1 Household behavior

The N residents of the single jurisdiction are rational agents whose consumption demands are consistent with lifetime utility maximization. The essential structure of the land market is taken from Frame [14], although in this case, residents know their future income with certainty and consumption of a local public good is included.

Residents are assumed to be identical in terms of preference, but may be heterogenous in terms of income and income growth. The distribution of incomes in period t is given by $n(y(t))$ and is defined for $y(t) \in \left[\underline{y}(t), \overline{y}(t)\right]$, where $0 < \underline{y}(t) < \overline{y}(t) < \infty$ for all t and

$$\int_{\underline{y}(t)}^{\overline{y}(t)} n(y)\, dy = N$$

Residents have preferences for housing services, numeraire consumption, and public services,

$$u(c(t), h(t), g(t)) = \frac{1}{1-\gamma}\left(c(t)^{\alpha} h(t)^{\beta} g(t)^{\delta}\right)^{1-\gamma},$$

where $\alpha + \beta = 1$ and $\delta < \beta$. The remaining parameter, γ, is the inverse of the household's intertemporal elasticity of substitution; high values of γ correspond to a reduced willingness to substitute intratemporal utility over time.

Residents know their future income with certainty, their incomes are given by $\{y(0), y(1)\}$. The round trip commuting cost from location $x \in \Re^{+}$ in t is $k(t)\, x$. Define the residents net income in period t as $i(t, x) \equiv y(t) - k(t)\, x$. Households can smooth consumption by borrowing or lending at the gross riskless rate of $q \geq 1$. Given $W(0) \geq 0$, wealth in any period $t+1$ is given by the difference between time t income and expenditures times the gross return,

$$W(t+1) = q\left[i(t, x) + W(t) - (c(t) + r(t)\, h(t))\right]. \quad (1)$$

Residents have no bequest motive, nor are they allowed to borrow any positive amount in the terminal period, meaning $W(2) = 0$. For simplicity, assume $W(0) = 0$.

Consider an existing city currently characterized by a single jurisdiction, $j = a$. At the current time, all fixed costs associated with land development and/or public service provision are considered sunk.

All households are assumed to reside in jurisdiction a in the initial period. At the end of the period, their leases expire and they can relocate if the opportunity exists and is beneficial. Land developers hold the right to convert currently vacant land beyond the boundary of the current jurisdiction. Jurisdiction b exists only for certain realizations of period one income. At the end of the initial period, they may offer a bundle of land, a level of public service provision, and proportional taxes to residents of jurisdiction a. Some, or all, residents of jurisdiction a, may decide to move into the new jurisdiction.

Households are rational, choosing their consumption bundles to maximize lifetime utility given the time paths of income, wealth and public services. Formally, households determine their optimal demands by solving the following discrete choice maximization problem,

$$\begin{aligned} V_a\left(W\left(0\right),g_a\left(0\right),x\right) &= \max_{\{c(0),h(0)\}} \frac{1}{1-\gamma}\left(c\left(t\right)^{\alpha}h\left(t\right)^{\beta}g_a\left(t\right)^{\delta}\right)^{1-\gamma} && (2)\\ &\quad +\phi\max\left\{V_a\left(W\left(1\right),g_a\left(1\right),x\right),V_b\left(W\left(1\right),g_a\left(1\right),x'\right)\right\}, && (3)\end{aligned}$$

where $\phi\in(0,1]$ is their rate of time preference. The function $V_b\left(W\left(1\right),g_a\left(1\right),x'\right)$ is the utility received value function corresponding to residing at location x' within jurisdiction b. The maximization problem is subject to the evolution of wealth described in 1. Finally, let $q\phi=1$, implying the ratio of the marginal rate of intertemporal substitution is one.

For now, consider the decision making problem associated with all residents remaining in the same jurisdiction for both periods.

$$V_a\left(W\left(0\right),g_a\left(0\right),x\right)=\max_{\{c(0),h(0)\}}\frac{1}{1-\gamma}\left(c\left(t\right)^{\alpha}h\left(t\right)^{\beta}g_a\left(t\right)^{\delta}\right)^{1-\gamma}+\phi V_a\left(W\left(1\right),g_a\left(1\right),x\right). \quad (4)$$

A discussion of the more general case follows.

2.2 Land markets

The city is assumed to be linear with a constant width $\theta>0$ and the geographical attributes at all locations within its boundaries are identical in every sense other than distance from the CBD.

There are potentially three boundaries within a given jurisdiction; one political, one physical, and one related to population. The political boundary of a jurisdiction, x_j^g, defines the limits of its provision of public services. In other words, if one desires the services provided by jurisdiction j, they must resident within its political boundary. These can be thought of the areas served by a city or community police force, or as the tax boundaries associated with a given school district. The physical boundary of a jurisdiction, $x_j^H \leq X_j$, is determined by its residential foot print; the land area used by households for living space. It is assumed that political and physical boundaries do not overlap, and there is no "leakage" of public services across boundaries. Finally, there is some possibility of vacant land in equilibrium. If some subset of the population relocates out of a jurisdiction, remaining residents may choose to relocate to either increase the amount of land consumed or reduce their commute, or both. The population boundary, x_j^N, may either be an upper bound or lower bound, depending on where residents end up. If there is no vacancy in the model, then $x_j^N = x_j^H$.

Once in placed, both the political and physical boundaries are assumed to be exogenous and durable. The physical boundary is determined through competition in the land market. Land used for residential purposes has an opportunity cost reflecting its value in an alternate use. Let $r^*(1)$ denote the minimum rent necessary to convert land from its existing use to urban use. As will be demonstrated in the next section, residential land rents are declining with respect to distance from the CBD. The physical boundary is determined by an equilibrium requirement that residential rent at the boundary of a jurisdiction equal its opportunity cost, or $r(x_j, t) = r^*(t)$.

3 Spatial equilibrium

A spatial equilibrium requires that all households with a given income level be indifferent among all possible locations within a jurisdiction. Given this condition, no household has any incentive to relocate, which is assumed to be an action without cost. Given that locations are differentiated by commuting costs and that commuting costs are increasing with distance, rents in this environment will be decreasing with distance.

An additional simplifying assumption is that all residents characterized by a given income level consume the same amount of housing within a given jurisdiction. In a spatial equilibrium, where all residents within a given jurisdiction benefit from the same level of public service provision, this results in numeraire consumptions that are also independent of x.

In the case involving one city, where the rent at the physical boundary of the city is $r^*(1)$, the rent satisfying both conditions is given by

$$r(x, 1) = r^*(1) + \frac{k(1)}{h(1)} \left(x_a^H - x\right) \tag{5}$$

at all locations $x \in \Re^+$ for a given $h(1)$.

Note that rents within a given period decrease with distance to the CBD and increase with increased commuting costs.

3.1 Household behavior

Given the finite time horizon, the household's problem can be solved by determining their optimal response in period 1 to variables determined in the initial period. The response is summarized in a value function. Given the optimal response in period 1, residents then make decisions in the initial period.

3.1.1 Optimal behavior in $t = 1$

As defined, the household's maximization problem can be solved recursively, beginning in terminal period $t = 1$ and working backwards. Let $W(1)$ be given, and, by assumption, let $W(2) = 0$. The household budget constraint at x in either jurisdiction is given by

$$i(1, x) + W(1) - (c(1) + r(x, 1)\, h(1)) \,. \tag{6}$$

Note that rents are decreasing in distance and increasing in commuting costs.

In the terminal period, $t = 1$ in this case, residents choose their preferred level of land consumption given their budget defined by ... and the given level of public services provided in the jurisdiction, $g_a(1)$.

Given the assumptions and derivations to this point, household utility in jurisdiction a in period one is determined by

$$\max_{\{c(1), h(1)\}} \frac{1}{1-\gamma} \left(c(1)^{\alpha}\, h(1)^{\beta}\, g_a(1)^{\delta} \right)^{1-\gamma} \tag{7}$$

subject to the budget constraint 6.

The corresponding demand for land use and numeraire consumption are given by

$$h(1) = \left(\frac{\beta}{r^*(1)} \right) \left(W(1) + y(1) - k(1)\, x_a^H \right), \tag{8}$$

and

$$c(1) = \alpha \left(W(1) + y(1) - k(1)\, x_a^H \right), \tag{9}$$

respectively.

Both functions are increasing in period one wealth and income. In this setting, residents with relatively greater incomes will demand greater quantities of each service producing good and, in equilibrium, receive greater utility.

The terminal period value function for a resident with income $y(1)$, wealth $W(1)$, residing at location x within jurisdiction a is given by

$$V_a\left(W(1), g_a(1), x\right) = \frac{1}{1-\gamma}\left(\alpha^{\alpha}\left(\frac{\beta}{r^*(1)}\right)^{\beta} g_a(1)^{\delta}\left(W(1) + y(1) - k(1)\, x_a^H\right)\right)^{1-\gamma}. \tag{10}$$

This describes the household's optimal behavior conditional upon remaining at the same location within a for both periods.

3.1.2 Optimal behavior in $t = 0$

The same spatial equilibrium and constant land consumption conditions hold in the initial period. In this period, renters take the influence of current actions on future outcomes through the period 1 value function. In addition to the spatial demand functions, wealth in period 1 is also determined.

The spatial rent function is given by

$$r(x,0) = r^*(0) + \frac{k(0)}{h(0)}\left(x_a^H - x\right),$$

and, substituting into the relation determining next period's wealth,

$$W(1) = q\left(i(0,x) - \left(c(0) + r(x,0)\, h(0)\right)\right).$$

By choosing $c(0)$ and $h(0)$ to maximize lifetime utility, the initial period demand functions can be expressed as functions of next period's wealth.

$$\begin{aligned} h(0) &= \left(\frac{\beta}{r^*(0)}\right)\left(-\frac{W(1)}{q} + y(0) - k(0)\, x_a^H\right), \\ c(0) &= \alpha\left(-\frac{W(1)}{q} + y(0) - k(0)\, x_a^H\right) \end{aligned}$$

Using the intertemporal condition setting the intertemporal marginal rate of substitution equal to $q\phi$ which is assumed to be one, determines wealth in period 1. Substituting in the expression for wealth provides the following land demand functions

$$\begin{aligned} h(0) &= \left(\frac{\beta}{r^*(0)}\right)\left(\frac{q}{q+\varphi}\right)\left(i\left(0, x_a^H\right) + \frac{i\left(1, x_a^H\right)}{q}\right) \\ h(1) &= \left(\frac{\beta}{r^*(1)}\right)\left(\frac{q\varphi}{q+\varphi}\right)\left(i\left(0, x_a^H\right) + \frac{i\left(1, x_a^H\right)}{q}\right), \end{aligned}$$

where

$$\varphi \equiv \left[\left(\frac{r^* (1)}{r^* (0)} \right)^{-\beta} \left(\frac{g_a (1)}{g_a (0)} \right)^{\delta} \right]^{\frac{1-\gamma}{\gamma}}$$

The rents are found by substituting in the above demand functions into the corresponding spatial rent.

4 Local public goods equilibrium

A local public goods equilibrium is defined by the clearing of the land market and, for a given land tax rate, a balanced budget.

4.1 Land market equilibrium

Equilibrium within the land market determines the outer boundary of the residential area and the level of land rents. The city is closed in the sense that there is no migration either in or out of the area, N remaining constant. If there are multiple jurisdictions within the city, or, if new or existing space becomes available, residents are free to relocate at no cost.

In equilibrium, the supply of land must equal demand in each period and competitive bidding implies that the rent at the boundary of the residential area equal its opportunity cost. This condition requires

$$r \left(x_j^H, t \right) = r^* (t) . \tag{11}$$

If the distribution of incomes within the city at time t is distributed uniformly over $\left[\underline{y} (1) , \overline{y} (1) \right]$, the aggregate demand for land within jurisdiction a is given by

$$\left(\frac{\beta}{r^* (1)} \right) \left(W (1) + \left(\frac{N}{2 \left(\overline{y} (1) - \underline{y} (1) \right)} \right) - k (1) \, x_a^H \right) .$$

Define $\lambda (t)$ as the difference between the highest and lowest bounds for income in t, $\lambda (t) \equiv \left(\overline{y} (1) - \underline{y} (1) \right)$. Equating the demand for land to its supply, clearing in the land market is characterized by

$$\left(\frac{\beta}{r^* (1)} \right) \left(W (1) + \left(\frac{N}{\lambda (t)} \right) - k (1) \, x_a^H \right) = \theta x_a^H . \tag{12}$$

4.2 Local public service provision

The public good provided by the jurisdiction are financed by a proportional land tax, z_j, which are taken as given. Jurisdictions are required to balance their budgets on an annual basis, thereby determining the level of public services provided.

For residents of jurisdiction j, the rent paid is given by $r(x,t) = (1+z_j)\,\hat{r}(x,t)$, where $\hat{r}(x,t)$ represents the net-of-tax rent which is what is received by landowners in this setting. The difference, $z_j \hat{r}(x,t)$, the tax per unit of land, is received by the local government or land management company overseeing the provision of services for the jurisdiction.

The cost of providing $g_a(t)$ is increasing and linearly related to the land area of the city, $g_a(t)\,b(t)\,\theta x_a^H$. Revenue is the total tax revenue paid by residents, which equals

$$\theta z \left(\int_0^{\bar{x}} \hat{r}(x,t)\,dx \right) \left(\int_{\underline{y}(t)}^{\overline{y}(t)} h(t)\,dy \right).$$

A balanced budget provides an annual level of public goods provision equal to

$$g_a(t) = \frac{\theta z \left(\int_0^{\bar{x}} \hat{r}(x,t)\,dx \right) \left(\int_{\underline{y}(t)}^{\overline{y}(t)} h(t)\,dy \right)}{b(t)\,\theta x_a^H}.$$

4.3 Land development and urban meiosis

At this point, there is no decentralization in any economic environment due to the assumption that residents remain in their current jurisdiction. The more general case involves the potential creation of new jurisdictions and household behavior will be characterized by the dynamic discrete choice problem defined by **??**. The resulting rents arising from that model provides a measure of willingness to pay to reside in a new jurisdiction. Land developers, holding vacant land at the fringe of the city and observing residential willingness to pay for larger land areas and less redistribution, will choose tax and provision levels to maximize profits.

When land is made available in a new jurisdiction, residents can choose to relocate and will do so only when they are made better off. In previous versions of this model, it was the wealthiest residents of the jurisdiction choosing to relocate first. This has two interesting effects. First, it creates a cascade-like effect in terms of who wants to relocate. As residents from the upper portion of the income distribution relocate, their contribution to the provision of public goods is gone, leaving a smaller and poorer tax base to fund public goods projects. This has the effect of decreasing the attractiveness of the jurisdiction to the households that are next in line in the income distribution, providing incentives for them to relocated, thereby putting downward pressure on services and repeating the process. This process continues until an income level is attained defining an individual's indifference between communities, both the demand for housing and the population of the existing area will decrease, meaning that there is more housing available to residents remaining in the existing area and that the rents for these properties will fall.

There is a body of empirical evidence suggesting the importance of the impacts of dramatic changes in the social fabric within urban areas, such as riots [7], changes in the crime rates within a neighborhood [8], and/or losses due to catastrophic natural events. If such exogenous events lead to some disturbance in the distribution of income within a neighborhood, relocation by wealthy residents, for example, the model suggests a mechanism by which such idiosyncratic events can lead to a persistent decline in the economic and social character of a given neighborhood.

Second, there will be a subset of vacant land available for the remaining poor households to move into. If the initial distribution of land involved incomes increasing with distance from the CBD, then poorer residents will move from their proximate, but relatively small, plots to more distant, but larger, plots. Rents will be tied to the commuting cost of the household at the greatest distance from the CBD, and increase incrementally as distances shrink. The reduced rents lead to what is commonly referred to as filtering in the housing market; relatively poor households can increase their consumption of housing services by moving into the structures previously occupied by wealthy residents (see [5] and [1]).

4.4 What doesn't cause suburbanization

Papers by Baum-Snow (?), (?) and Glaeser and Kahn [16] develop models whose results suggest that the prime causal factor leading to the observed decentralization from 1950 to 1990 is a reduction in transportation costs and scale. In addition, Glaeser and Kahn provide substantial empirical support for their argument.

The primary causal factor in this environment relates to changes in income. In particular, changes in the distribution of income. If residents were homogenous in terms of income, or if behavior is derived using a single representative age, there is no new development and no decentralization.

In the environment derived here, it is easy to show, even in this incomplete specification, it is not particularly clear that reducing commuting costs will lead to decentralization. First, if all residents experience the same reduction per unit of distance, the rent gradient within the city becomes less steep and rents at all locations, except at the boundary, decrease. While

4.5 What is the role of the collective provision of public goods?

Canonical models of housing markets in the urban economics literature have some difficulty explaining certain empirical observations. For example, Glaeser and Gyourko find that there are neighborhoods within cities such as Detroit, Buffalo, and Cleveland, where house prices are well below replacement cost. Furthermore, many of these neighborhoods are at locations that would be considered advantageous from a commuting standpoint, yet few arrive to purchase the properties at these "bargain" prices even during times when residential housing markets were appreciating.

The answer provided by this model is that the neighborhoods do not provide the level of public services necessary to attract wealthier households. One conjecture is that if there is vacant land within the political boundary of a jurisdiction, new development will take place at some location outside of the political boundary. If someone relocates within the same jurisdiction, they receive the same level of public goods provision. If there is a large degree of redistribution in the existing jurisdiction, relocating to a new community where there is more income homogeneity and, therefore, less redistribution, will be preferable. This produces land use patterns associated with leap frog development.

5 Extensions

Currently, the model is being constructed in a more general computational environment. This should allow for more flexible distributions of incomes and to allow for housing demand to vary with location, as well as voting on public goods provision. There are several issues that can be considered in this type of environment

- In demonstrating existence of a local public goods equilibrium, Nechyba [25] uses an exogenous distribution of housing quality to guarantee the satisfaction of a necessary single crossing point property. In the setting developed here, rather than assuming a small number of quality levels, a distribution of housing sizes and qualities can be produced using historical data.
- Many public programs, particularly relating to education, may be self-defeating if they involve a large degree of redistribution. By simulating the effects of various tax and/or subsidy plans, it may be possible generate estimates of the likelihood the success or failure of a particular policy to achieve its desired results, and to avoid unintended ones.
- Many cities are currently suffering significant revenue losses due to increased unemployment and declining property values. What will the effects on cities be in the event of declines in local public expenditures?

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