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THE HOUSING MARKET: A CONCEPTUALIZATION

MODELS OF THE URBAN HOUSING MARKET can be divided into two broad classes: microeconomic models of the behavior of households and firms in demanding and supplying units of housing, and closed, general equilibrium models of urban spatial structure. The latter are considerably more ambitious. Based on simplifying assumptions about the spatial distribution of jobs, the demand for land, the transport system, and how decisions regarding housing demand and supply are made, the spatial variation in population densities, rent gradients, and land utilization are derived. The following review of these approaches is intended as a point of departure for the econometric models to be developed at length in this book.

1. MICROECONOMIC THEORIES OF HOUSING DEMAND AND CAPITAL STOCK DECISIONS

Conventional microeconomic models of household behavior have been used to describe both the demand and supply sides of the housing market. Demand models address the questions: How much land or housing do households wish to consume? And at what location? Wingo[1] and

1. In Wingo's model, a household chooses the residential location which minimizes the sum of transport costs plus land costs associated with the amount of land being consumed. A household's expenditure on land and transport was required to be consistent with a particular demand function assumed to be independent of the length of the commuting trip. Lowden Wingo, "An Economic Model of the Utilization of Urban Land for Residential Purposes," *Papers and Proceedings of the Regional Science Association* (1961), pp. 191-205.

Alonso[2] first outlined the theory as one in which households' choice of a location and an amount of land depended on the tradeoff between cheaper rents and a longer work trip, with all employment assumed to be fixed at the center. Alonso formulated the model rigorously as one of utility maximization subject to a budget constraint, with land, all other goods, and distance to the city center included in the utility

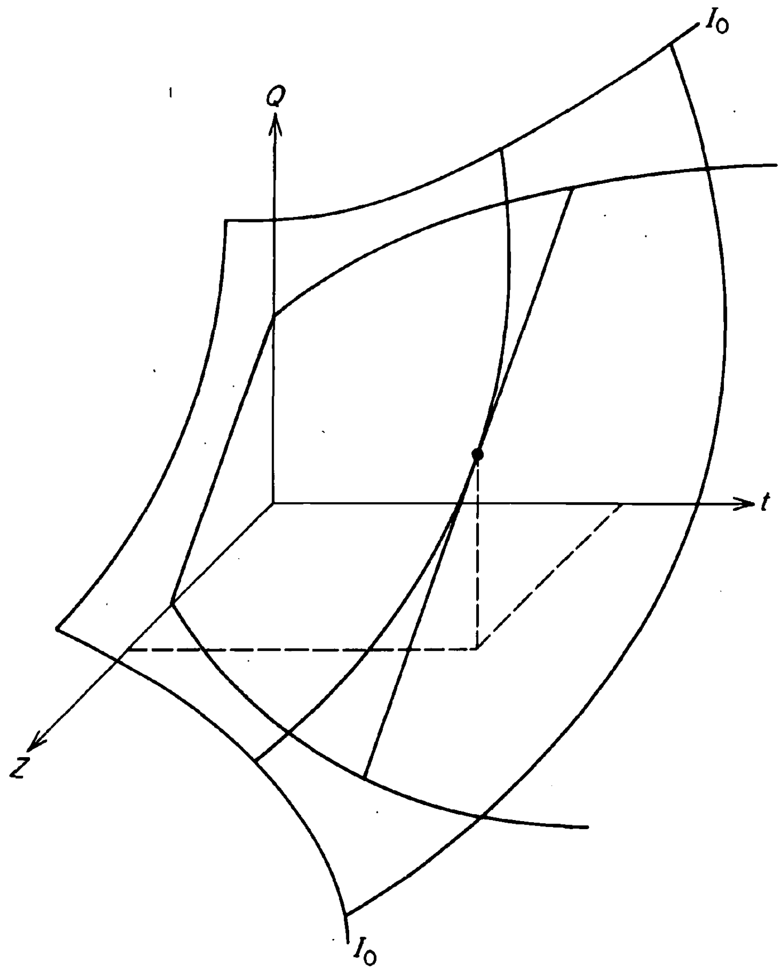

FIGURE 2.1
ALONSO MODEL OF HOUSEHOLD LOCATION

2. William Alonso, *Location and Land Use* (Cambridge: Harvard University Press, 1964).

function. The budget constraint will depend on a household's income, the price of all other goods, the land rent gradient, and the transport cost surface. This three-dimensional surface is shown in Figure 2.1. The optimal location and amounts of land and all other goods to be consumed will depend on a household's utility function and the opportunity cost surface, and is given by the tangency between the highest indifference contour and the opportunity cost surface. Formally, a household's choice of the level of housing consumption and residential location is the solution to the following utility maximization problem:

$$\text{Max: } u = U(z, q, t), \tag{1}$$

subject to a budget constraint:

$$Y = P_z \cdot z + P_q(t) \cdot q + P_t(t), \tag{2}$$

where

z = all other goods;
q = housing;
Y = income;
P_z = price of all other goods;
$P_q(t)$ = price of housing at distance t to work site;
t = distance from residence to work site;
$P_t(t)$ = price of a trip of distance t.

What distinguishes this presentation from the conventional analysis of consumer demand is the household's opportunity to choose the price at which it buys land by altering its work trip. The budget constraint is therefore nonlinear. The first-order conditions are as follows, where subscripts on U denote partial derivatives:

$$\frac{U_t}{U_z} = \frac{q \cdot \dfrac{\partial P_q(t)}{\partial t} + \dfrac{\partial P_t(t)}{\partial t}}{P_z}; \tag{1}$$

$$\frac{U_z}{U_q} = \frac{P_z}{P_q(t)}. \tag{2}$$

The first expression indicates that for the amount of land consumed, the marginal rate of substitution of all other goods for travel time equals the ratio of prices of acquiring more z or having a shorter work trip,

t. The latter includes the savings in transport costs less the increase in expenditures on land implied by moving incrementally up the rent gradient. The second expression says that at the equilibrium location chosen, the marginal rate of substitution of z and q must equal the ratio of prices.

This model implies that households will commute down the rent gradient until the additional disutility of a longer trip more than offsets the attendant savings in the price paid for land consumed. The effect of small changes in the underlying parameters on the choice variables is determined in standard fashion by totally differentiating the first-order conditions and examining the resultant equations in the differentials. For example, changes in the transport surface or rent gradient will change land consumption and the optimal location. Under the convexity assumptions above, increases in land prices or transport costs reduce the consumption of land and result in the household's locating closer to the city center. Increases in income may or may not result in the consumption of more land, depending on the nature of the utility function. While land is a superior good, so also is shortened transport time; an increase in income could conceivably lead to a move toward the center and less land consumption.

More recently, Muth has formulated the household problem as that of choosing an amount of a homogeneous product, "housing," and a distance to the city center so as to maximize utility subject to a budget constraint:

$$\text{Max } U(z,q),$$

$$\text{Subject to } Y = P_z Z + P_q(t)\, t + P_t(t).$$

In this model, q denotes housing, and distance t is left out of the utility function. In this case, the first-order conditions for a location equilibrium requires that the following equation be met:

$$q \cdot \frac{\partial P_q(t)}{\partial t} = -\frac{\partial P_t(t)}{\partial t},$$

i.e., that a change in the work trip t alters commuting costs by an amount just equal to the associated change in housing expenditures.[3] In Muth's model, the household is indifferent to the amount of land employed in producing any given amount of housing q.

3. Richard Muth, *Cities and Housing* (Chicago: University of Chicago Press, 1969), Chapter 3.

The main advantage of Muth's formulation of the housing demand side is that it complements a standard model of the theory of the firm as a description of the housing supply side. Both the demand and supply sides of the housing market are, therefore, represented by familiar neoclassical assumptions. Muth is the principal author of this synthesis, having developed the supply side of the analysis.

In his presentation, the supply side of the housing market is described by a traditional production function. A homogeneous commodity, housing, is produced by a competitive industry, with firms altering factor proportions (land/nonland inputs) in response to factor prices. Housing prices are assumed exogenous. Under these assumptions, the spatial variation in land prices reflects competition by housing suppliers for the available land; spatial equilibrium in the land market requires that land rents vary in such a way that profits in the production of housing are everywhere zero. The spatial variation in land rents will therefore reflect the spatial variation in housing prices and the role of land in the production function—the terms under which land and nonland factors can be substituted in the production of housing. Factor proportions and the value of housing output per unit of land will also depend on the spatial variation in housing prices and the elasticity of substitution of land and nonland in the production function.

Following Muth's notation,[4] let $Q = Q(L,N)$ be a production function for housing, with L and N denoting land and nonland inputs respectively, with input prices r and n. Let output price be P. Profit maximization yields the usual first-order conditions, which must be met at every location if the industry is to be in competitive equilibrium.

$$\frac{\partial \Pi}{\partial L} = P \cdot \frac{\partial Q}{\partial L} - r = 0, \tag{1}$$

$$\frac{\partial \Pi}{\partial N} = P \cdot \frac{\partial Q}{\partial N} - n = 0, \tag{2}$$

where $\Pi = P \cdot Q(L,N) - Lr - Nn$.

Setting the total differential of the profit function equal to zero and substituting the first-order conditions gives an expression relating incremental changes in input and output prices and input proportions; production at any location consistent with profit maximization and no excess profits implies that the total differential must be everywhere zero. Assuming housing output prices and nonland input prices given,

4. Ibid., Chapter 2.

an equation for incremental changes in land prices can be derived, relating the latter to incremental variations in housing output prices and nonland input prices:

$$\frac{dr}{r} = \frac{QP}{Lr} \cdot \frac{dp}{p} - \frac{Nn}{Lr}\frac{dn}{n}. \tag{3}$$

Letting ρ_L and ρ_N equal the share of the value of housing output paid to land and nonland factors respectively, this expression becomes:

$$\frac{dr}{r} = \frac{1}{\rho_L}\frac{dp}{p} - \frac{\rho_N}{\rho_L}\frac{dn}{n}. \tag{4}$$

Where output prices are high, land rents will obviously be bid up (independent of any variations in nonland prices).

The above formulation is a straightforward application of the theory of the firm, based on competitive product and factor markets. Its application to urban housing markets requires assumptions about the spatial variation in output prices. For example, if nonland input prices do not vary spatially, the variation in land rents consistent with the above equilibrium conditions will depend solely on the spatial variation in housing output and land's share in total output, ρ_L. In the simplest case, where output prices are represented by a negative exponential from the city center, $P(k) = P_o e^{-\lambda k}$, land rents must assume the same algebraic form:

$$\frac{dr}{r} = -\frac{\lambda}{\rho_L}, \tag{5}$$

a negative exponential with slope $-\lambda/\rho_L$. Since ρ_L is close to zero, the slope of land rents will be many times steeper than that of housing output prices.

The intensity of residential land use can be derived in similar fashion. Differentiating the profit function yields the following:

$$d\left(\frac{PQ}{L}\right) = dr + nd\left(\frac{N}{L}\right) + \left(\frac{N}{L}\right)dn. \tag{6}$$

Assuming there is no variation in n, and letting σ denote the elasticity of substitution, $\sigma = [d(N/L)/(N/L)]/[d(r/n)/(r/n)]$, the expression can be rewritten:

$$\frac{d\left(\frac{PQ}{L}\right)}{\frac{PQ}{L}} = \rho_L \frac{dr}{r} + \rho_N \sigma \frac{d\left(\frac{r}{n}\right)}{\frac{r}{n}}, \tag{7}$$

$$= (\rho_L + \rho_N \sigma)\left(\frac{dr}{r}\right),$$

$$= \left(1 + \frac{\rho_N}{\rho_L}\sigma\right)\left(\frac{dp}{p}\right).$$

The intensity of land use across submarkets thus depends on the variation in output prices, the shares of output paid to land and nonland inputs, and the elasticity of substitution. Again, under the simplifying assumption that output prices can be represented by a negative exponential, this becomes:

$$\frac{d\left(\frac{PQ}{L}\right)}{\left(\frac{PQ}{L}\right)} = -\left(1 + \frac{\rho_N}{\rho_L}\right)\lambda. \tag{8}$$

This model can employ any production function with constant returns to scale, and any continuous output-price and input-price surfaces; the negative exponential housing price gradient is only one special case leading to a particularly simple solution for factor proportions and land density gradients.

2. GENERAL EQUILIBRIUM MODELS OF THE URBAN HOUSING MARKET

These microeconomic models of households' and firms' decisions have served as the beginning point for general equilibrium models of urban spatial structure. In essence, the latter models describe the urban land market, explaining rent gradients, population density gradients, and factor proportions in the provision of housing throughout the city. This step from microeconomic models to closed models of urban spatial structure is a giant one, requiring many additional simplifying assumptions, particularly in the treatment of space.

The structure of existing general equilibrium models of urban spatial structure can be easily summarized. Their basic character is not unlike the early macroeconomic models: they are closed, comparative static in nature, with no specification of the adjustment processes by which the urban area transforms itself from one state to another. Space is described in one dimension, distance to the center. In the simplest versions, all employment is assumed to be located in the center, with residential locations surrounding it. Households desire a location as close to the center as possible; competition by households for space results in rents which decline from the city center. The shape of the rent surface will be determined by the nature of the transport system (which determines the costs of accessibility to the city center) and demands by households for space. The level and shape of the land rent surface affects the amount of land consumed by households at different locations, and hence residential density (persons/area) is likely to decline as distance to the center increases. In these models, a greater concentration of jobs in the center increases the costs of commuting from any given distance to the center, and hence raises the level of central-city rents. An improved transport system reduces the slope of rent gradients and leads to a more dispersed urban form. The latter is generally regarded as an instrumental factor in explaining postwar decentralization when employing such models.

There are two principal extensions of these models, each providing a more complete specification of the competition for space. Each complicates the analytics of finding a closed form solution, but neither changes the basic character of the models. First, variations among households in the preference for space—either because incomes or tastes differ—have been introduced. The conditions for spatial equilibrium in the land market remain as before; judicious choice of frequency distributions describing incomes and tastes will lead to tractable differential equations for land rent and population density. The resultant rent and density gradients decline as distance to the center increases.[5] Beckman has derived such a result, assuming the distribution of income has a Pareto distribution;[6] and Blackburn has developed tractable equations for rent and density gradients by placing certain restrictions on the distributions of certain parameters in households' utility functions describing their taste for space and access costs to the center.[7]

5. Robert M. Solow, "Congestion, Density and the Use of Land in Transportation," *Swedish Economic Journal* (March 1972), pp. 161–73.
6. Martin Beckman, "On The Distribution of Urban Rent and Residential Density," *Journal of Economic Theory* (June 1969), pp. 60–67.
7. Anthony Blackburn, "Equilibrium in the Market for Land: Obtaining Spatial Distributions by Change of Variable," *Econometrica* (May 1971), pp. 641–44.

The second extension of the models introduces competition for land by nonresidential sectors—typically, either the transport sector or a production sector which employs the household sector. Spatial variation in the demands for output in these sectors and their production functions determine the terms under which (nonhousing) producers will bid for land. Muth's pioneering paper in 1961 specified such a model of land competition by two sectors, each responsive to different demand functions for its product in the city center and each having different production functions. Negative exponential functions were employed to describe the value (or "delivered" price) of output of each sector produced at a given distance from the city center. These assumptions imply smooth, declining bid rent surfaces for land for each sector. Under appropriate assumptions about the underlying parameters, the bid rent gradients will intersect, resulting in one sector occupying land from the city center to the distance denoted by the intersection, and the other sector occupying the remaining land. Optimal land/nonland factor proportions in each sector will be related to the shape of the land rent gradient, with the intensity of land use declining from the center as land rents decline.[8]

Mills has formulated a slightly different version of a model of spatial equilibrium where there is competition for land by more than one sector. The crucial difference in Mills' model is the assumption that the two sectors competing for land must coexist at every point in urban space. One of the two sectors in Mills' model is the transport sector, which is required either to ship workers employed in the other sector back and forth or to ship that sector's output to the city center. Competition between the two sectors for land at each point determines the shape of the land rent gradient; at the same time, land rents influence the factor proportions in production by each sector.[9] The requirement that output must be transported to the city center increases the demand for land as distance to the center decreases, and hence produces declining gradients for rent and intensity of land use.

3. THE LESSONS AND LIMITATIONS OF THIS APPROACH

The important insight of these models of spatial equilibrium is their demonstration that the shape of the rent surface and the utilization

8. Richard Muth, "Economic Change and Rural-Urban Conversions," *Econometrica* (January 1961), pp.1-23.
9. Edwin Mills, "An Aggregate Model of Resource Allocation in a Metropolitan Area," *American Economic Review* (May 1967), pp. 197-211; idem, "The Value of Urban Land," in *The Quality of the Urban Environment*, ed. Harvey Perloff (Baltimore: Johns Hopkins Press, 1969), pp. 231-57.

of urban land is determined by demand and supply conditions in *all* competing sectors, and by the possibilities for land/nonland factor substitution within each sector. Demands, factor prices, or production functions in any sector affect the land market throughout the city. It is, of course, this interdependence between sectors—arising from the fact that different locations are substitutes and all sectors compete in the land market—which creates the analytic complications in obtaining a closed form solution. Perhaps the most useful application of these models is in describing competition for land by two or more nonresidential sectors, where output and input relationships can be described by traditional neoclassical production functions.

While these models impart several important insights concerning the competition for space and its effects on land rents and land use, there are difficulties when one of the sectors competing for space is residential housing. Interpreting the "output" of the housing sector presents a problem. The neoclassical approach to formalizing the urban housing market defines housing output as a homogeneous commodity, with producers choosing combinations of inputs (land and nonland inputs) so as to supply housing output at least cost, given prevailing factor prices. The housing market involves an "unobservable theoretical entity called housing service." Each dwelling unit yields some quantity of that good during each time period, "the only thing in a dwelling unit to which consumers attach value. In long-run competitive equilibrium, only one price per unit applies to all units of housing stock and another price to all units of housing service regardless of the size of the package in which these goods come. If we observe that one dwelling unit rents for twice the amount of another dwelling unit, then we say that the more expensive dwelling unit yields twice the quantity of housing service. . . ."[10]

The simplifying assumption implying homogeneity of tastes with respect to land/nonland proportions may well be reasonably suited to describing the rental or multifamily market. Rental occupants generally receive relatively little advantage from higher land/capital ratios and hence the density of development may be assumed, as a first approximation, to be a matter of indifference. (A neoclassical-production-function approach is also reasonably well suited to describing the provision of nonresidential capital stocks.) However, the assumption may be seriously misleading in describing the owner-occupied housing markets. As will be seen below, households have strong preferences for lot size, independent of other characteristics of the stock. It is likely that age of the

10. Edgar Olsen, "A Competitive Theory of the Housing Market," *American Economic Review* (September 1969), p. 614.

stock also matters. More realistically, households regard housing services as multidimensional, with some of their attributes directly associated with particular characteristics of the capital stock. If households have distinct preferences for lot size, supply decisions cannot be represented by the traditional cost-minimization model of the firm, in which firms alter land/nonland factor proportions in response to variations in land prices to produce housing at least cost. Households' willingness to pay for different densities will also be relevant to the firm's decision.

Second, capital stocks are not easily modified. It is likely that spatial variation over time in the demand for housing and in land prices will alter the course and density of new construction and neighborhood development, but these price variations are not likely to be sufficient to make it worthwhile to tear down the existing stock. Older units are rarely demolished to make way for new ones. Density or lot size is the characteristic of the stock least likely to lend itself to modification. Other modifications may not be so expensive. It is relatively easy to downgrade the quality of housing units. Undermaintenance and partitioning large units into small apartments are easily accomplished and have become familiar processes in older central cities. However, the converse of partitioning is more expensive. Converting many small apartments into a large residence with larger rooms and a different room layout invariably introduces the high costs of moving bearing walls and supports. Thus, given the high costs of conversion, we are likely to observe a wide variation in the density (and other characteristics) of the housing stock in a given location at any point in time. The recent putty-clay distinctions in production theory would seem especially relevant in describing the capital stock. While the differences between central-city and suburban submarkets have long been evident, the intrametropolitan variation, or compartmentalization, in the housing market that arises from the existence of a relatively fixed capital stock and high conversion costs is a general phenomenon.

Third, much greater realism can be achieved if one treats space in urban housing markets in discrete irregular areas, foregoing the use of continuous functions to represent demand or supply functions. Jurisdictional boundaries affecting the level of public services and taxes, differences in zoning, and racial neighborhood boundaries are all discrete and often sharply drawn. Variation in access to employment across submarkets also exists. Each of these elements affects incomes, prices, and housing supply decisions in particular markets, in many instances creating sharp discontinuities in any geographic mapping of results.

Most of the limitations of the closed, general equilibrium models of urban spatial structure which I have mentioned are associated with the simplifying assumptions required to obtain closed form solutions.

Much analytic ease is associated with the assumptions of a single central work site and competitive markets. The analysis focuses on only one market, the land market. Huge analytic complications are posed when it is recognized that the output of the housing market cannot be adequately treated in one dimension.[11] Heterogeneity in the existing stock, other differences in neighborhood desirability, and the existence of discrimination imply that the urban housing market is, in fact, a set of compartmentalized and unique submarkets delineated by housing type and location. Consequently, a great many markets must be considered, with complex interrelationships over time and space.

The combination of considering many submarkets and treating space with discrete boundaries virtually precludes finding analytic solutions delineating how these many housing submarkets are cleared or how decisions evolve over time. However, an econometric approach can provide important insights into the nature of housing markets. By not offering an analytic solution to the problem of how all submarkets are simultaneously cleared, many of the overly restrictive and simplistic assumptions employed above can be relaxed. Nevertheless, there are limitations to the econometric approach, principally the inability to predict how market results would differ if certain underlying parameters changed.

4. AN ECONOMETRIC APPROACH

The starting point for my econometric analysis is the disaggregation of the housing market into many submarkets, delineated by characteristics of the stock and location. The urban area is divided into zones, in such a way as to create as much within-zone homogeneity in the racial composition and housing stock as possible. Different kinds of housing will be available in different submarkets. Some geographic submarkets

11. The treatment of space in one dimension is perhaps the most difficult assumption of the closed, general equilibrium models to relax. The analytic advantages in being able to integrate over some portion of the unit circle in order to collapse space into one dimension are obvious; the major analytic problem then reduces to specifying the forms of the several gradient functions so that they can be easily integrated. Relaxing this assumption introduces substantial analytic complexity. For example, multiple employment centers imply the existence of "multiple peaks" in the surfaces describing the desirability of alternative locations. Bid rent functions for land for each sector and equations for the optimal mix of land/nonland inputs would have peaks as well. Boundaries between land uses would probably assume irregular shapes. Numerical methods would be required to describe bid rent surfaces and factor proportions in each location for each sector.

may contain few or no units of a particular type; e.g., in downtown areas where land rents are quite high, there is very little single-family owner-occupied housing or units built recently on large lots. The zones need not have regular shapes. Separate estimates are made of the structure of prices and occupants' incomes within each geographic submarket.

Virtually all of the econometric research in the book addresses itself to the determination of housing prices across submarkets at a point in time, and the role of those prices in the household's choices of housing type and location. The demand analysis is based on many of the insights of Alonso's microeconomic theory of housing demand. However, the present model is modified in two respects. First, households' demand for housing is represented by Alonso's utility maximization model but is extended so as to define housing as a multidimensional bundle of services with many attributes. Many of these housing services are closely associated with a particular capital stock and, thus, are acquired by choosing a house characterized by a particular set of attributes. Examples include dwelling-unit size, structure age, lot size, and tenure. Tastes with respect to these several attributes are expected to vary depending on a household's size and position in the life cycle. Preferences are also likely to be influenced by income. As in Alonso's model, opportunities confronting any given household in choosing a location and acquiring a house with a certain bundle of services will be determined by its work site (for white households). This model assumes that a household's work site influences the choice of housing but not vice versa.

The second modification is recognition of the existence of racial discrimination in housing markets. Two important implications emerge: (1) the choices of black households must be represented by a different model, and (2) location patterns of both white and black households will be affected by racial attitudes and discrimination barriers. (Hence, race will affect neighborhood income levels and housing prices.) It is assumed that blacks are excluded from bidding in certain geographic markets, or may enter only by paying different prices than white households. (The former is an extreme assumption; presumably blacks can gain entry at some price. In many areas the absence of any blacks implies that the price of entry is extremely high.) Since there are substantial barriers between black and white submarkets, and demand and supply conditions are different in each, the structure of prices need not be the same. In addition, blacks may face both price and nonprice rationing; the latter situation arises if prices do not adjust so as to clear markets for the different types of housing. The housing choices of blacks must be made in the face of these market imperfections and entry constraints, which establish the terms under which they may obtain housing. Chapter 5 presents a model of black housing consumption which attempts to separate the effects of income, prices, and supply rationing.

Perhaps the biggest departure from traditional procedures in this book is the use of econometric relationships to describe the determination of housing prices and neighborhood incomes at a point in time. This approach recognizes the existence of discrimination, spatial discontinuities, and a heterogeneous housing stock. The model assumes housing stocks vary across submarkets and are very slow to change relative to demand conditions. Accordingly, the first task is to analyze how the existing housing stock is utilized, i.e., who lives where and pays what price. The static portion of the model explaining housing prices and incomes by submarket at a point in time assumes that household tastes and a series of variables describing each submarket are exogenous. This list includes the spatial variation in job locations and the transport system which determine access to employment; the quality of public services; the supply and characteristics of the available housing stock; and the racial composition of neighborhoods. Both prices and incomes across housing submarkets are endogenous, reflecting the outcome of a complex market-clearing process by which households arrange themselves by location and housing-stock type. In essence, the model explains why high-income households outbid low-income households at a particular location, with prices and neighborhood incomes jointly determined by demand and supply conditions in each submarket. The determination of prices involves not only the demand side of this bidding phenomenon—higher-income households bidding up the price in certain submarkets—but also the rationing effect of prevailing prices in allocating households to submarkets by income level.

Since shifts in the spatial pattern of demand are assumed to be independent of the supply of housing at a point in time, changes in prices or utilization rates must occur if the market is to clear. Substantial variation in prices and utilization rates in urban housing markets can be observed, directly traceable to this process. The assumption of a fixed stock in the short run, which is not fully adapted to current or anticipated demand at any given point in time, implies that observed prices may bear little relation to the long-run supply price for different types of housing. "Temporary" demand and supply variations may produce substantial variations in quasi rents across submarkets, producing either abnormal profits or losses for those supplying the housing stock. Intertemporal variations in the rate of return on equity to suppliers in a given area are likely to be substantial. Most discussions of housing supply changes suggest that in some instances the "short run" can be many years. Unfortunately, there are no data available on vacancies by location or stock type. In the central portions of many cities, high vacancy rates are a familiar sight in some neighborhoods, where the demand for housing has sharply declined; and building abandonment often occurs when rentals are no longer sufficient to pay operating costs and taxes.

The static portion of this model of housing markets assumes a point of departure very different from that of the closed, general equilibrium models. The latter assume prices of housing (or the desirability of sites) as given, deriving land rent and density gradients. In contrast, in the econometric model outlined here, housing stocks are assumed exogenous, and land prices are omitted; the model focuses on the determination of prices for housing stocks.

A variety of complex adjustment processes must be analyzed in describing how housing markets evolve over time. The lag structures involved in representing changes in work sites, transport systems, the level of public services, available housing stocks, and racial boundaries are complicated. The following remarks serve only to introduce these specification problems. To begin with, changes in employment locations and transport systems will alter the accessibility characteristics of each residential submarket. As previously noted, location decisions by households and firms together determine the geographic pattern of work trips, which is a major factor affecting the performance of the transport system. In addition, certain kinds of employment activities are related to the location of household residences. Much retailing and service employment directly serves the household sector and therefore tends to locate near residential concentrations. Most personal services fall in this category, including much of the rapidly growing local public sector. Certain wholesaling and business services will be inclined to locate near retailing employment. Where labor is an important input, a firm may be attracted to a location easily accessible for the type of work force which it employs.

Neighborhood racial composition and entry barriers to blacks will also change over time. These changes are complex and, so far, not well researched. (See Chapters 3 and 5 below.) Changes in the boundaries between black and white submarkets depend on changes in the demand for housing by both blacks and whites, whites' and blacks' attitudes about segregation, and various public actions.

The quality of public services and tax burdens are another critical dimension defining neighborhood characteristics. While there is substantial literature relating public-service expenditures to neighborhood characteristics, we know little about the process of providing public services: the definition of public-service quality, the production process, the role of expenditure differences on output levels, and so on. The adjustment of public-service quality over time depends on the preferences of each community for services, the expenditures made, and production relationships. Available evidence indicates that public-service quality rises sharply with neighborhood income, both because of the preference of richer households for more services and because of their greater ability to pay.

Adjustments in the supply of housing appear to exhibit the longest lags. Changes in housing stocks will be determined by market prices and zoning controls. Housing suppliers form expectations concerning profits from construction or conversion of the existing stock based on prices over a period of several years. A lagged adjustment process is probably relevant in describing how builders act on changes in expectations. Different production and cost relationships and diverse adjustment processes exist for different housing-supply adaptations—either new construction or conversions of the existing stock. The price of land will be the most important factor price exhibiting any significant spatial variation, thereby influencing results. Land prices will be simultaneously determined by bids of those supplying both residential and nonresidential capital stocks, decisions by landholders, and public actions. The latter includes those actions in which the public is a direct buyer or seller, and other actions which influence private land transactions, such as zoning and taxes.

The dynamic portions of this analysis are not explored in this book. Many of these processes can be usefully examined econometrically as concepts are refined and time-series data become available. Simulation models can also be useful. In highway planning, a variety of urban simulation models which attempt to deal with these types of changes in location patterns have been used. However, virtually all of the available land-use planning models employ extremely simplistic behavioral assumptions and are subject to many of the criticisms leveled against the general equilibrium models of urban spatial structure noted above,[12] while enjoying none of their conceptual advantages. The National Bureau of Economic Research (NBER) has constructed a more ambitious urban simulation model which attempts to deal with some of the important behavioral processes, particularly those concerning stock adjustments in the housing market.[13]

12. For a survey of five simulation models, see H. James Brown et al., *Empirical Models of Urban Land Use: Suggestions on Research Objectives and Organization*, Exploratory Report No. 6 (New York: NBER, 1972).
13. Gregory K. Ingram, John F. Kain, and J. Royce Ginn, *The Detroit Prototype of the NBER Urban Stimulation Model* (New York: NBER, 1972).

5. CONCLUDING OBSERVATIONS

To date, the urban land market has been the focal point in urban housing literature, beginning with the theory of location rent and, more recently, as represented in the closed, general equilibrium models already described. Alonso's concept of a bid rent surface describing the set of prices at which any one bidder is indifferent as regards alternative locations has been a theoretical cornerstone of this literature. As noted, much of it has been directed at describing how the land market clears, given a fixed supply of land and bidders with different bid rent surfaces or preferences for space. The approach outlined here suggests that classical location rent theory and associated models have missed many of the important factors which influence urban land markets. The step from a household model of housing demand stressing access-space tradeoffs to bid rent surfaces for land and the determination of how the urban land market clears is a gigantic one. Households are not typically bidding directly for land. The analysis of several important intermediate processes cannot be avoided: the choices of households for particular types of neighborhoods and housing, many of which are associated with a particular capital stock; the market-clearing process, given a relatively fixed capital stock of housing; and a variety of adjustment processes by which housing stocks and neighborhoods change in response to market prices.