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Chapter Seven

Analyzing Housing Policies with the Urban Institute Housing Model

Frank de Leeuw and
Raymond J. Struyk

INTRODUCTION

An urban housing market is a network of interrelated parts. The decision to tear down a block of houses in one neighborhood forces the occupants to seek housing elsewhere and sets in motion a chain of moves that can affect communities throughout an area. The decision to restrict growth in a suburban area has similar far-flung effects, stimulating new construction in other suburbs and perhaps stimulating redevelopment of older housing as well. A decision to pay housing allowances to the low-income households of an urban area may decrease the demand for the lowest-quality stock, increase the demand for somewhat better housing, and could eventually produce changes in the entire structure of housing prices and locational patterns of the area.

The housing market is, of course, not unique in being composed of many interrelated parts. It is true of housing, however, that many policy controversies have centered to an unusual extent on exactly how this network of interrelations works—on the relocation effects of urban renewal, on the price effects of housing allowances, on the population redistribution caused by local no-growth policies. A model capable of analyzing these issues must deal in some detail with

Note: Sue Marshall, Larry Ozanne, and Ann Schnare worked with us on the model and share full credit for the results reported here. Dennis Eisen and Andrew Struik also made important contributions to the model. The entire project was sponsored by the Office of Policy Development and Research, U.S. Department of Housing and Urban Development. We, however, bear full responsibility for statements made and views expressed.

submarkets for different levels of housing quality and different geographic locations.

Besides dealing with submarkets and their interrelations, a realistic housing model must reflect two special characteristics accounting for much of the distinctive behavior of housing markets: "durability" and "neighborhood effects." Durability of housing refers not only to the long time period over which the housing stock yields its services but also to the unalterable nature of many of the characteristics of a dwelling once it is built. Whether a dwelling is a detached house or an apartment in a twenty-story building, whether it is downtown or in a suburb, whether it is on a large or a small lot—these are among the many characteristics largely fixed at the time of construction. The second feature of housing markets—neighborhood effects—refers not just to the dependence of the value of one dwelling upon the physical appearance of neighboring dwellings but, even more important, to the strong influence of neighborhood racial composition and socioeconomic status on the choice of where to live.

The Urban Institute housing model is an attempt to quantify the interrelationships among the parts of an urban housing market while emphasizing the two special characteristics of durability and neighborhood effects. It represents an urban housing market composed of thirty to forty "model" dwellings and households, a new-construction industry, and numerous possibilities for government intervention. Households choose which dwelling to occupy on the basis of the utility function, while owners of existing dwellings choose levels of housing services they will provide on the basis of expected profit maximization. Durability enters the model through the distinction between new housing, which is assumed to be perfectly elastic in supply, and existing dwellings, whose specific characteristics are among the initial conditions of the model and whose supply elasticity is one of the principle objects of empirical investigation. Neighborhood effects are captured by having each household's decision to occupy or not to occupy a particular dwelling depend not only on the characteristics and price of that dwelling but also on characteristics of other dwellings and occupants in the geographic zone in which that dwelling is located.

Development of the model has been under the sponsorship of the Department of Housing and Urban Development. HUD's particular interest in sponsoring the model has been the analysis of the possible effects of housing allowances, but the model has been designed so that a variety of housing policies and other economic or demographic developments can be analyzed within the same framework. Work on the model began in the fall of 1971, with the first year being devoted primarily to developing the theoretical model and a procedure for its computer simulation. The second year of work emphasized empirical applications to U.S. metropolitan areas during 1960-1970. Initial empirical work led to some changes in the structure of the model and in the computer algorithm simulation procedure. The most recent period has been taken up with these changes plus additional empirical work and the beginnings of policy analysis.

The remainder of this study is in three parts. We describe the model, beginning with a nontechnical account of the general structure, then proceed to a mathematical description of the key relationships, and summarize the empirical results of applications to six metropolitan areas. We deal with model results, first introducing the useful analytical device of a price-structure curve and then describing results of simulating a rise in new-construction costs, a slowdown of population growth, and two housing policies. In the final section, we appraise some of the strong and weak points of the model.

MODEL DESCRIPTION

The Theoretical Model in Brief

The Urban Institute housing model deals with ten-year changes in housing quality and household location within a metropolitan area. The four key phrases of this capsule description are "ten-year changes," "housing quality," "household location," and "within a metropolitan area." Each of them serves to distinguish the model from other models or studies, for example, from short-run explanations of housing market dynamics, from location-free theories of the filtering process, or from macroeconomic analyses with a national focus.

As mentioned earlier, a metropolitan housing market is represented in the model by a few dozen "model" households, a few dozen "model" dwellings, a building industry, and possibilities for a variety of government restrictions or programs. The four "actors" in the model are, therefore, households seeking a place to live, owners of existing dwellings offering housing services at various prices, a building industry meeting demands at an acceptable rate of return, and governments able to regulate the housing-location process at many different points. The model searches for a "solution"—a situation in which no one can improve his position according to the rules of behavior and constraints he obeys—through a matching of households with new or existing dwellings. In the nontechnical description of the model in this section, we take up each of the four actors in turn and describe the nature of the solution process. We then introduce a price-quantity diagram illustrating the interaction of households, owners, and builders.

"Model" Households. Each "model" household represents several hundred or thousand actual households, the exact number depending on the size of the metropolitan area to which the model is being applied. A household belongs to one of several household types and is characterized by two measures of its income. The household types with which we have worked in applying the model to specific metropolitan areas include white, nonelderly families; white, elderly, single-person households; black, nonelderly families; and black, elderly, single-person households; in the case of Austin, the types also include Chicano, nonelderly families, and Chicano, elderly, single-person households. Some of the parameters of the model, as we shall indicate in the next section, differ by household type.

The two income measures for each model household are an actual income figure—the estimated mean actual income of the households represented by the model—and a "model" income figure—a weighted average of actual income and median income for the household type to which it belongs. Although we initially experimented with one "permanent" income figure for each model household, we finally decided that two income figures were necessary. An actual income figure was necessary because certain of the programs the model is intended to analyze—for example, housing allowances—operate on actual income rather than any transformed version of income. The assumption of unitary income elasticity embedded in the utility function of the model, however, is inappropriate to measured single-year incomes; a second, smoothed version of income was required.[1] The model thus uses actual income as the variable directly affected by certain housing, tax, or transfer programs, and model income in actually determining the choice of location and quality which each household makes. A change in actual income—owing to a housing allowance, for example—is of course translated into a change in model income, but the latter change is smaller than the former.

Household behavior in the model consists of deciding which of all possible dwellings to occupy, including a new dwelling with any desired level of services (subject to any government-imposed minimum standards for new construction) or any of the existing dwellings in the model. The household makes its decision on the basis of the quantity of housing services offered by each dwelling, the price per unit of the housing service offered, the household's model income, and three characteristics of the zone in which each dwelling is located.

The three zonal characteristics are average travel time to and from work, average net rent per dwelling, and the proportion of residents in the zone who belong to the same racial group as the household making the choice. Travel time is simply introduced into the model as a piece of exogenous information about each zone. Average net rent and racial composition are determined by the model itself, with the result that there is a two-way interaction between household choice and the zonal characteristics. This interaction, incidentally, is the source of considerable complexity in the solution process for the model, since it introduces the possibility of multiple solutions meeting the criterion of utility maximization by each household.

All the variables influencing household choices are combined into a utility function which the household is attempting to maximize. The function has four parameters whose values decisively influence what the model predicts about the effects of housing policies. One of the principal goals of the application of the model to specific metropolitan areas is to obtain estimates of these parameters.

"Model" Dwellings. Each model dwelling, like each model household, represents several hundred or thousand actual cases; in fact, the number of actual cases per model unit is (apart from minor statistical adjustments) the same for dwellings as it is for households. Each model dwelling belongs to one of several zones (five or six so far) differing in accessibility, initial wealth, or initial racial composition. Each model dwelling is also characterized by the quantity of housing services supplied—a flow of output per month—at the beginning of the ten-year interval to which the model applies. The quantity of housing services of a dwelling, one of the basic concepts of the model, refers to an index of all the things of value which a physical structure provides—space, shelter, privacy, pleasing design, and a host of others. It does not refer to the neighborhood characteristics associated with each dwelling; these are measured by the various attributes of the zone in which a dwelling is located.

The behavior of the owners of existing dwellings consists of making price-quantity offers with the goal of maximizing expected profits. Each price-quantity offer consists of a quantity of housing services to be provided at the end of the decade to which the model refers and a price at which that quantity will be provided. The offers thus resemble rental advertisements specifying services provided and monthly cost. The price-quantity offers for each dwelling must lie along a supply curve whose position depends on the initial quantity of housing services offered by the dwelling and two parameters of the model, one related to a depreciation rate and the other to an elasticity of supply with respect to price. It is these two parameters which determine the supply elasticity of the existing housing stock.

The owner of each existing dwelling seeks to locate as high up along his supply curve as he can, for his expected profits are an increasing function of his position along the supply curve. Competition among the owners of actual dwellings making up each "model" dwelling is assumed sufficient to keep landlords from making offers above their supply curves.

The model includes a minimum price per unit of service, defined as that price which is just sufficient to cover the cost of operating a dwelling. If the owner of a dwelling is unable to find an occupant at any price at or above the minimum, then he withdraws his dwelling from the stock of housing. Withdrawal can take the form of long-term vacancy, demolition, conversion to nonresidential use, or abandonment. The model does not distinguish among these different kinds of withdrawal.

Builders. The third actor in the model, the building industry, plays a more passive role than model households and model dwellings. The industry is characterized by a horizontal supply curve, that is, it is prepared to offer new dwellings at a monthly total cost which is proportional to the level of services the dwelling provides. The price per unit of service at which new dwellings are available is taken as exogenous for each housing market. Empirically, it is measured on the basis of FHA data on the cost and square footage of new dwellings; it tends to set a ceiling for the price structure of all the existing stock, although existing dwellings with especially favorable zonal characteristics can command prices above the new-construction price. In the present model, newly constructed dwellings are assumed to be concentrated in a single "zone of new construction."[2]

For a time span much shorter than ten years the assumption of a perfectly elastic supply of new housing would be inappropriate. The mortgage market and building supply industries are subject to capacity limitations which sometimes strongly influence the course of new construction in the shortrun. Even over a ten-year span, the supply of land is limited and the effect is to make the supply of new housing less than perfectly elastic. Muth (1968) has argued convincingly, however, that the increase in land prices due to the bidding away of land from other users by residential users has only a neglible effect on the long-run supply elasticity of new housing.

Governments. The final factor of the model, "government," can influence the housing-location process at so many different points that it is impossible to describe its behavior succinctly. Tax charges, subsidy payments, transfer payments with or without earmarking for housing, minimum new-construction requirements, and the specification of minimum quantities of housing services in a particular zone are among the ways through which governments can affect housing markets in the model.

An income tax can be represented by replacing a household's actual income by income less the tax (and making a smaller reduction in its model income) before it enters the housing market. Tax rates and other parameters of tax formulas—for example, exemption levels—can be set separately for each household type, or even for each model household. Transfer payments are represented by using the same procedure as for taxes. A transfer earmarked for housing—a housing allowance—can be represented by requiring an eligible household to consume at least some minimum level of housing services or spend some minimum amount on housing in order to receive the transfer; the household then determines its utility-maximizing choice without the allowance, its choice with the allowance (including the minimum requirements), and the larger of these two maxima. A restrictive zoning ordinance can be represented by setting a minimum quantity of housing services for all of the dwellings in a zone. The model is exceptionally rich in the variety of government policies it can analyze.

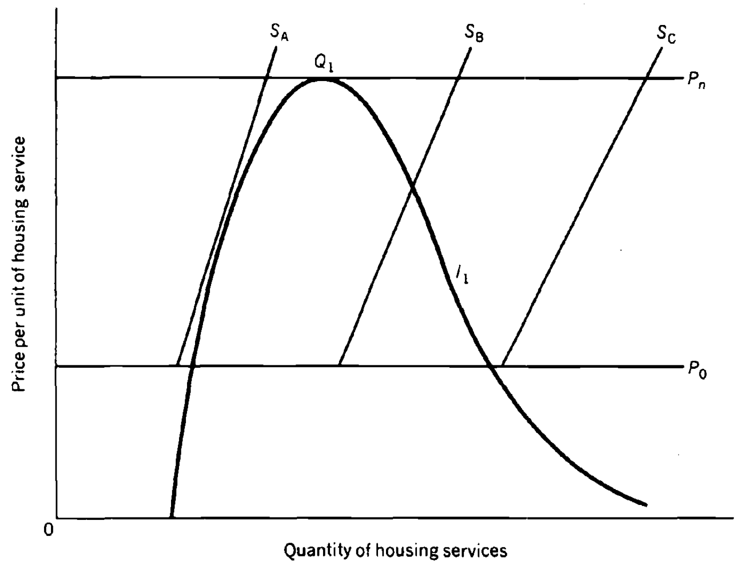
The Solution Process. The solution of the model, as mentioned earlier, is a situation in which none of the four actors has any incentive to change its position. Each household is the unique occupant of one dwelling, the one which maximizes its satisfaction given all the price-quantity offers facing it. The owner of each existing dwelling is as high up along his supply curve as he can be without finding his dwelling vacant. (If a dwelling is vacant even at the lowest point on its supply curve, it is withdrawn from the stock.) The building industry is supplying the number of new dwellings households are willing to purchase. Government regulations are strictly enforced.

The computer program to solve the model searches for a solution with these properties through a process of trial and error. Departures from solution conditions in one trial govern the way in which the solution is modified for the next trial. The steps in the search process have no theoretical or empirical significance; it is only the final solution of a problem which is of interest. Although the solution algorithm is a time-consuming and complex computer program with a number of still unresolved difficulties, it works well for the great majority of problems we have been interested in solving.

A Price-Quantity Diagram. The model deals with both the quality (or level of housing services) of dwellings and with location. Figure 7-1 illustrates the treatment of quality but not the locational aspects of the model.

The horizontal axis in Figure 7-1 measures the quantity of housing services (a weighted index of all the separate services) provided per month by an individual dwelling. The vertical axis measures price *per unit of service*, that is, the monthly gross cost of occupancy of a dwelling divided by its index of housing services. The total cost of a dwelling on a monthly basis is its price times its quantity.

The diagram represents supply conditions in an urban housing market during a ten-year interval. In a very short period—say, a month or a year—the supply of housing services is virtually determined by the stock inherited from the previous period, and the supply provided by an individual dwelling could be represented on the diagram by a vertical line. In a very long period—say, half a century—the influence of the inherited stock is quite small, and



Note: For identification of variables, see accompanying text.

Figure 7-1. Housing Supply over a Ten-Year Span.

supply possibilities could be represented by a single, close-to-horizontal curve representing the price per unit of newly constructed dwellings, along which builders can supply any desired number of new dwellings. In an intermediate period, the representation of supply must reflect both the inelastic character of the existing stock and the elastic conditions of new supply.

Line P_n in Figure 7-1 depicts the price per unit at which new dwellings are available. It is the sum of capital costs per month (including land costs), operating costs per month, and developers' normal profits, all per unit of service. Any number of new dwellings can be built along the line, each one represented by a dot corresponding to its quantity of services.

Lines S_A, S_B, and S_C depict the relation between quantity and price for three existing dwellings, a "luxury" dwelling (C) providing a high level of services, a "slum" dwelling (A) providing a low level of services, and a dwelling (B) providing a level of services between the other two. The slope and position of the three supply curves depend on the time span to which they refer—ten years in Figure 7-1. Each dwelling produced along the new supply line acquires its own supply curve for the decade following initial construction. When the model is run for two or more decades, then the position of each dwelling's supply curve shifts from decade to decade as its start-of-decade level of services changes.

Line P_0 depicts the minimum price per unit of service at which it pays the owner of a dwelling to keep it in operation. P_0 corresponds to the concept of average variable costs in the theory of the firm. In the model, if an occupant cannot be found for a dwelling at a price at or above P_0, the dwelling is dropped from the housing stock.

Finally, I_1 represents an indifference curve for one household. The point of tangency (Q_1) between I_1 and the new-construction price (P_n) represents the level of housing services that maximizes that household's utility at price P_n. If that household, in other words, is forced to occupy a new dwelling, but at any level of services it wishes, it will choose one with a level equal to Q_1. Curve I_1 depicts all other price-quantity combinations that are just as attractive to the household as the one at point Q_1. The precise shape of I_1 will not be derived here; it is sufficient to note that in order to persuade household 1 to depart in *either* direction from its optimum choice (Q_1), it is necessary to offer it a price reduction below P_n. Faced with any offer involving a price at or above P_n, the household would prefer Q_1 at P_n.

The area inside I_1 represents price-quantity combinations preferred over a new dwelling; the area outside I_1 represents outcomes less satisfying than a new dwelling at Q_1. Among the three existing dwellings depicted in Figure 7-1, only B has any chance of being preferred to a new dwelling by household 1. Dwelling B will be preferred to a new dwelling at Q_1 if it makes a price-quantity offer inside I_1. Dwellings A and C would not be preferred to a new dwelling at any price above the minimum P_0. If a housing market consisted solely of household 1, dwellings A, B, and C, and a building industry, then the market outcome would be, according to the model, occupancy of dwelling B at a price just below the intersection of S_B and I_1, withdrawal of dwellings A and C from the market, and no new construction.

As we add households and dwellings to Figure 7-1, households have an increasing number of closely substitutable existing dwellings from which to choose, and dwellings have a wider range of potential occupants. Instead of one or two isolated price-quantity points at which housing services are sold, a relatively smooth set of points forming a price-structure curve tends to emerge. These price-structure curves are a useful device for understanding the operation of the model and will be described at the beginning of the section on simulation results.

Mathematical Specification

Two kinds of behavior drive the model: utility maximization by households and profit maximization by owners of existing dwellings. The household utility function and the landlord-owner supply functions used in the empirical work are specified below.[3]

Household Utility Functions. Each household evaluates each dwelling by means of a utility function. The utility of dwelling j to household i, U_{ij}, can be represented as

$$U_{ij} = HXZ_1 Z_2 Z_3 \tag{7-1}$$

H represents the utility of housing services and is defined by:

$$H = [Q_j - \alpha_i \gamma_i (Y_i^m / P_n)]^{\alpha_i} \tag{7-2}$$

where Q_j is the quantity of housing services offered by dwelling j, α_i is a parameter expressing the strength of housing preferences (versus preference for other goods) for households of type i, γ_1 is a parameter expressing the degree to which households will alter their housing choice in response to a price discount, Y_i^m is household i's model income after adjustment for taxes and transfers, and P_n is the price per unit of service of newly constructed dwellings.

The term in the utility function described by Equation (7-2) is an elaboration of the idea underlying the so-called linear expenditure system, namely, that observed demand behavior is best approximated by making utility depend on the excess of quantities consumed over some minimum acceptable levels. Unlike the linear expenditure system, however, Equation (7-2) makes the minimum acceptable level itself a function of income. The importance of the minimum depends on the parameter γ_1, which is determined empirically. For γ_1 equal to zero, Equation (7-2) reduces to a simple Cobb-Douglas expression for the utility of housing services.

X represents the utility of nonhousing goods and is specified in a manner analogous to H. The budget constraint facing the consumer is used to define nonhousing goods as $(Y_i^m - P_j Q_j)$, where Y_i^m is the household's model income and P_j and Q_j are the price and quantity of services of dwelling j.[4] X is defined as

$$X = [(Y_i - P_j Q_j) - (1 - \alpha_i)\gamma_1 Y_i^m]^{1-\alpha_i} \qquad (7\text{-}3)$$

Three zonal characteristics are represented by the Z's: accessibility (Z_1), wealth (Z_2), and racial composition (Z_3) and are defined in Equations (7-4), (7-5), and (7-6).

$$Z_1 = (200 - T_j)^{0.5 + \alpha_i - \alpha_1} \qquad (7\text{-}4)$$

where T_j is average travel time (in hours per month) in the zone in which dwelling j is located, α_i is a parameter expressing the strength of housing preferences of households of the type of household i, and α_1 is the value of α_i for white, nonelderly families.

The term in parentheses, $200 - T_j$, is an approximation to monthly hours of leisure time available to an average worker in the zone in which dwelling j is located. The exponent of this term is based on the value households place on travel time and on analysis of how we might expect this value to vary with strength of housing demand.

$$Z_2 = [(\overline{P}_j - P_0)\overline{Q}_i/(P_j' - P_0)Q_j']^{0.01\gamma_2} \qquad (7\text{-}5)$$

where P_j represents price per unit of housing services; P_0, minimum operating costs per unit of housing services; Q_i, quantity of housing services; and γ_2 is a parameter expressing the strength of preferences for a wealthy zone. $\overline{P}$ and $\overline{Q}$ refer to zonal averages (the zone in which dwelling j is located); and P' and Q', to SMSA averages. Hence, the expression represents the average net rent (gross rent less operating costs) of dwellings in a zone relative to the average net rent in an SMSA, and serves as an indicator of zonal wealth.

Finally,

$$Z_3 = R_{ij} + [1{,}000/(100\gamma_3 + 1)] \tag{7-6}$$

where R_{ij} is the proportion of households located in the same zone as dwelling j and belonging to the same racial group as household i, and γ_3 is a parameter expressing the strength of household preferences for racial homogeneity. The larger γ_3, the more sensitive is Z_3 (and hence U_{ij}) to variations in R_{ij}. With γ_3 equal to zero, Z_3 can vary only between 1,000 and 1,001, a range of 0.1 percent. With γ_3 equal to 1.0, Z_3 can vary between approximately 10 and 11, a range of 10 percent.

Supply Functions for Existing Dwellings. The supply curve for existing dwelling j is specified as follows:

$$Q_j = \left[\beta_1 + \beta_2 \left(\frac{2}{3}\right) \left(\frac{P_j - P_0}{P_c}\right)\right] Q_0 \tag{7-7}$$

where Q_j is the level of housing services currently provided by dwelling j; Q_0, the level of housing services provided by dwelling j ten years ago; P_j, the price per unit of service offered by dwelling j; P_0, operating costs per unit of service; and P_c, capital costs per unit of service for a new dwelling. β_1 and β_2 are empirically determined parameters. Prices are all on a flow basis, that is, they are costs per unit of service per month, not costs per unit of capital stock.

Equation (7-7) is derived from the maximization of an expression for expected profits, subject to a production function for housing services. The production function is given by:

$$Q = \left\{\beta_1 + \left[2\beta_2 \left(\frac{C}{Q_0}\right)\right]^{0.5}\right\} Q_0 \tag{7-8}$$

where C is the quantity of capital invested in a dwelling during a decade. The properties of this function and the derivation of the supply curve are discussed in de Leeuw and Struyk (1976).

Empirical Results

The model has been applied to six metropolitan areas for the decade of 1960-1970. The areas are Austin, Chicago, Durham, Pittsburgh, Portland (Oregon), and Washington, D.C. They represent a wide range of sizes, growth rates, racial compositions, incomes, and housing costs. Each application involved several man-months of data gathering and estimation. Space permits only the briefest summary of results.

The first major step in applying the model to an area was to specify zonal boundaries and to construct model dwellings and households. Each area was divided into four or five zones on the basis of 1960 data so as to maximize within-zone homogeneity in racial composition and rental values but subject to the constraint that boundaries of major political jurisdictions had to be retained. Thus, in most areas, there was an inner-city, low-income, high-minority zone, a "rest of the central city" zone, and two or three suburban zones separated on the basis of income.

Next, a hedonic index technique was used to construct a value and rent deflator for each zone. Each deflator was applied to the distribution of housing values and rents in order to obtain a distribution of housing services for each zone. This distribution of services was then subdivided into model dwellings. In an area with 1,200 actual dwellings per model dwelling, the 1,200 dwellings providing the lowest level of services in Zone 1 were averaged to obtain one model dwelling for Zone 2, the 1,200 with the next highest level of services were averaged to obtain a second model dwelling of Zone 1, and so forth. Model households were obtained in an analogous way from separate income distributions for each of the household types of the model (white, nonelderly families, black, nonelderly families, and so forth).

Econometric analysis of rent-income and value-income ratios was used to obtain one set of key parameters of the model, the alphas expressing the strength of preference for housing versus other goods for each of the household types of the model. Analysis of the household utility function shows that the alphas are closely related, although not identical to, the proportion of income which households of a given type devote to housing.

To estimate the other behavioral parameters, the model was simulated under a variety of assumptions about these parameters, and values were selected that gave the best fit to actual zonal distributions of incomes, racial composition, rent, and withdrawals from the initial stock of housing. This estimation by simulation proceeded in two steps. First, 1960 households were matched with 1960 dwellings under the assumption of a perfectly inelastic 1960 supply in order to obtain the best-fitting gammas of the utility function. Then, using those gammas, the model was simulated for 1960-1970, to obtain the best-fitting betas of the supply function.

The results of this lengthy and complex estimating procedure are summarized in Table 7-1. For most of the parameters there are clear central tendencies in the estimates. For example, the values of alpha for white, nonelderly families cluster around 0.8, while those for elderly, white families cluster around 0.25. For the parameters of the supply function (the β's), however, the distribution appears to be bimodal. For three of the cities, β_2 is estimated at 0.9, and β_1 ranges from 0.4 to 0.6; for two others, β_2 is estimated at only 0.4, and β_1, at 0.7. A number of empirical and sensitivity tests we have conducted lead us to conclude that (a) we cannot at present reduce this range of uncertainty about the supply function parameters and (b) some of the policy simulation results depend on which end of the range of estimates we use. Consequently, we have used two different pairs of beta estimates, an "elastic" set and an "inelastic" one, in most of our policy analyses. Even the elastic set, however, implies a price elasticity of supply in the neighborhood of 1.0, or far below the supply elasticity of new dwellings.

SIMULATION RESULTS

In this section we analyze the effects on the housing stock and household location of four economic or demographic changes: an increase in the cost of new construction, an especially topical subject in light of the experience of the past few years; a decrease in the rate of growth of urban areas, another subject suggested by recent U.S. trends; a housing allowance program with a payment formula that makes 22 percent of the population eligible; and a subsidy payment for the construction of new units, a housing strategy pursued to some extent in this country and especially interesting in comparison with housing allowances. Before reporting the results of these analyses, we introduce the concept of a "price-structure curve," which offers a way of obtaining an intuitive grasp of the effects of housing policies and other developments on various sectors of the housing market.

The Structure of Housing Prices

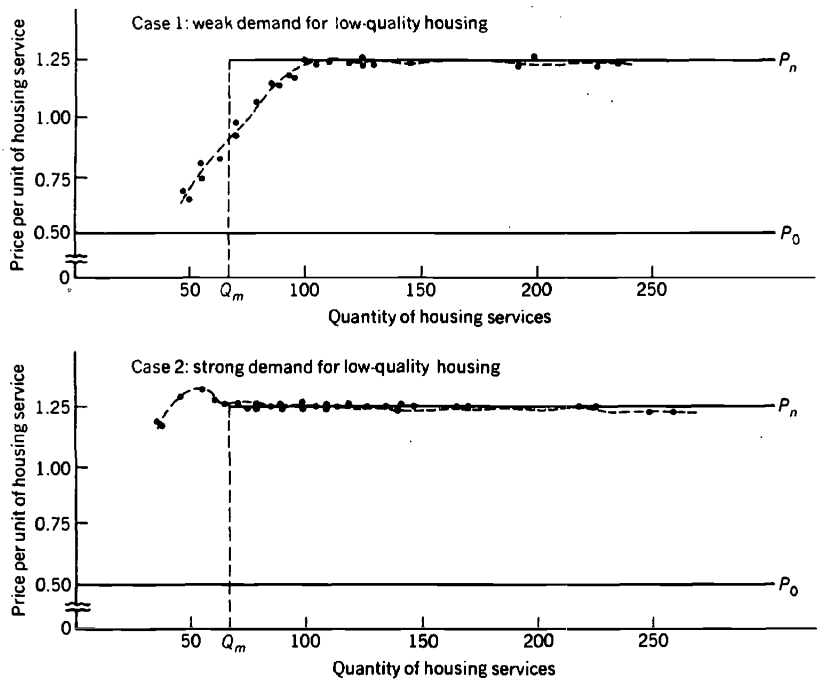
One way of thinking about the model is as a set of demand and supply functions for closely related submarkets. There is a demand for, and supply of, low-quality model dwellings in the inner city; high-quality dwellings in the inner city; and so on for many levels of housing services and many geographic locations and for new dwellings as well as existing dwellings. The prices per unit of housing services for all these model dwellings—and for the actual housing

Table 7-1. Estimated Parametric Values for Six Metropolitan Areas

Parameters	Metropolitan Areas					
	Durham	Austin	Portland	Pittsburgh	Washington	Chicago
α's: ratios of housing expense to income						
α(1): white, nonelderly families						
1960	.19	.18	.17	.16	.19	.18
1970	.17	.20	.18	.15	.19	.17
α(2): white, elderly, single households						
1960	.25	.27	.28	.22	.24	.26
1970	.26	.27	.28	.19	.25	.27
α(3): black, nonelderly families						
1960	.20	.18	.17	.19	.19	.21
1970	.19	.19	.18	.25	.20	.20
α(4): black, elderly, single households						
1960	.26	.27	–	.25	.24	.26
1970	.27	.28	–	.27	.27	.27
α(5): Chicano, nonelderly families						
1960	–	.18	–	–	–	–
1970	–	.18	–	–	–	–
α(6): Chicano, elderly, single households						
1960	–	.27	–	–	–	–
1970	–	.25	–	–	–	–
γ's: other parameters of household behavior						
γ(1): price responsiveness	.8	.8	.9	.9	.9	.7
γ(2): attitude toward zonal wealth	.4	.2	.6	.3	.3	.4
γ(3): attitude toward zonal racial mix	.7	.9	.9	.7	.6	.1
β's: supply parameters						
β(1)	.7	.4	.4	.5	.6	.7
β(2)	.4	.9	.9	.6	.9	.4

submarkets they represent—need not be the same, because one model dwelling is not a perfect substitute (in either demand or supply) for another. Prices of various model dwellings cannot differ too much, however, because substitution in demand is strong enough to cause vacancies or overoccupancy if the price of one dwelling is out of line with prices of closely related dwellings.

A price-structure curve provides a useful way to summarize housing market results in the model. Figure 7-2 illustrates two price-structure curves based on actual runs of the model; the quantity of housing services produced by each dwelling is measured along the horizontal axis; and the price per unit of housing service for each of these dwellings, along the vertical axis. The total monthly amount the occupant pays for housing services is the quantity multiplied by the price per unit of service. Each point on the curves



P_n = new-construction price.

P_o = minimum operating price of existing dwelling.

Q_m = minimum legal level of new-housing services.

Figure 7-2. The Structure of Housing Prices.

represents one model dwelling and can be thought of broadly as representing the intersection of a demand curve and a supply curve for one submarket.

Generally, prices per unit of service tend to lie between lines P_n and P_0 on the price axis. As in Figure 7-1, P_n is the price per unit at which new dwellings are available, and P_0 represents minimum costs per unit of service necessary to keep a dwelling in operation. If a unit remains vacant even after its price has been lowered to P_0, then the dwelling (according to the model) will be withdrawn from the occupied residential stock through conversion to nonresidential use, prolonged vacancy, or abandonment.

P_n tends to serve as an upper limit to housing prices because a household is very unlikely to pay more per unit of service for an existing dwelling than for a new dwelling with an identical level of services. One important exception to this ceiling role of P_n occurs because in most metropolitan areas, building codes, zoning requirements, and other regulations effectively prevent construction of new dwellings with a low level of services. For example, large parts of most metropolitan areas exclude or carefully regulate mobile homes. Below the minimum permitted level of new-housing services, represented by Q_m in Figure 7-2, there is no reason why prices per unit of service cannot exceed P_n—as in fact they do in the bottom panel of the figure.

Dynamic forces within most housing markets tend to keep prices close to the P_n ceiling for moderate- and high-service dwellings. These dynamic forces include growth in real income over time, growth in population over time, and depreciation of dwellings over time. All three forces tend to create excess demand for housing at the high-service end of the range, with the result that prices of existing dwellings in that range tend to be driven up toward the P_n ceiling and that is the range within which new construction usually takes place.

In the low-service end of the range the three forces do not act in the same direction. At that end, growth in real income and depreciation of the housing stock probably tend to create an excess supply of dwellings and, hence, lower prices. On the other hand, population growth, especially in the form of an influx of low-income households, tends to increase the demand for services. Where the excess-supply forces dominate, the result may be a situation like case 1 in Figure 7-2, in which low-service dwellings sell at a discount per unit of service. Where population growth is rapid and where there is an effective minimum Q_m near the low-service end of the scale, the result may be the curve depicted for case 2 in Figure 7-2, in which housing fairly near the low-service end of the scale sells at a premium.

Besides Q_m, the other reason prices may exceed P_n is the desirability of certain locations. Since household choices depend in part on characteristics of the zone in which a dwelling is located, a zone with especially desirable characteristics can command a premium above new-construction prices. Variations in zone characteristics account for much of the departure from smoothness in the two price-structure curves of Figure 7-2.

The device of a price-structure curve will prove useful in understanding simulations of a variety of market developments and housing policies. We shall introduce each of the four developments to be analyzed below with a discussion of how we would expect that development to change price-structure curves for different kinds of initial housing market situations. While these discussions fall far short of rigorous analyses, they provide valuable intuitive guidance to the way major housing market forces interact in the model.

Before we present actual model results, we again indicate what the policy simulations do and do not represent. The simulations trace through both the direct effects on households or dwellings of a subsidy or a higher new-dwelling price, and those indirect effects on other households or dwellings that are due to the interrelations of different sectors of the housing market. In the case of housing policies, the simulations take account of both subsidies and any taxes levied to finance them. The simulations stop short, however, of a full general equilibrium model of all interrelations in the economy; they deal only with interrelations of demands and supplies within an urban housing market. The simulations are also limited, with the exception of a few references to twenty-year runs, to ten-year changes; there are no suggestions as to the monthly or annual path that housing prices, services, or locational patterns might follow in moving from start- to end-of-decade positions. In the case of housing policies, finally, results refer to "idealized" policies in which program provisions are fully known and obeyed by each participant.

A Rise in the Cost of New Construction

In the short run, the greatest impact of a rise in new-construction costs would appear to be on those with a high probability of occupying new dwellings—generally speaking, on affluent rather than poor households, on young rather than old households, on white rather than black households. However, ten-year impacts taking full account of interrelationships among housing submarkets can be, as we shall see, quite different. A rise in new-construction costs is therefore a good example of the value of the model in improving our understanding of housing markets.

For an understanding of model simulation results, the price-structure curves just described are a useful starting point. A rise in new construction costs is equivalent to a rise in line P_n in Figure 7-2. In the middle and upper ranges of housing quality, where P_n serves as an effective upper limit to the prices of existing dwellings, we would expect the latter to rise by approximately the same amount as the rise in new-construction costs. At these higher prices, however, households will presumably choose to consume smaller amounts of housing services. This downward shift in demand can have two effects. One, which we shall not observe in the simulation and which would in general require a large price increase, is that prices of some high-quality dwellings could fall below the P_n ceiling. The second effect, very much in evidence in the simulations, is that this shift will increase the demand for low- and moderate-quality dwellings and, hence, raise their prices. Thus, even in ranges where P_n is not an effective upper limit to the price structure, an increase in P_n can cause a rise in prices.

The increase in demand for low- and moderate-quality housing can cause not only an increase in prices, but an increase in housing "conservation" as well—that is, some dwellings that would otherwise be withdrawn from the stock remain occupied. In a housing market in which very few dwellings are being withdrawn from stock even without high construction costs, this conservation effect is necessarily limited. In fact, in a tight market of this kind it can even happen that higher construction costs cause some low-income households to be left literally without housing; the existing dwellings they would have occupied at a lower price structure are demanded by households that can outbid them, while the cost of a minimum-standard new dwelling ($P_n Q_m$) is higher than they can afford. In less extreme market situations, however, an increase in new-construction costs can cause a significant drop in withdrawals from the stock and result in correspondingly fewer new dwellings.

These results of higher new-construction costs are sketched in the top panel of Figure 7-3, which refers to one of the two actual cases to be analyzed below. Prices of existing dwellings in the upper quality ranges rise by almost exactly the amount of the increase in P_n, and prices of low-quality dwellings rise by somewhat more than the increase in P_n. Careful examination of the figure reveals that one additional existing model dwelling withdrawn from the stock in the low-P_n case is retained and occupied in the high-P_n case.

In Table 7-2, we summarize the numerical results for two areas,

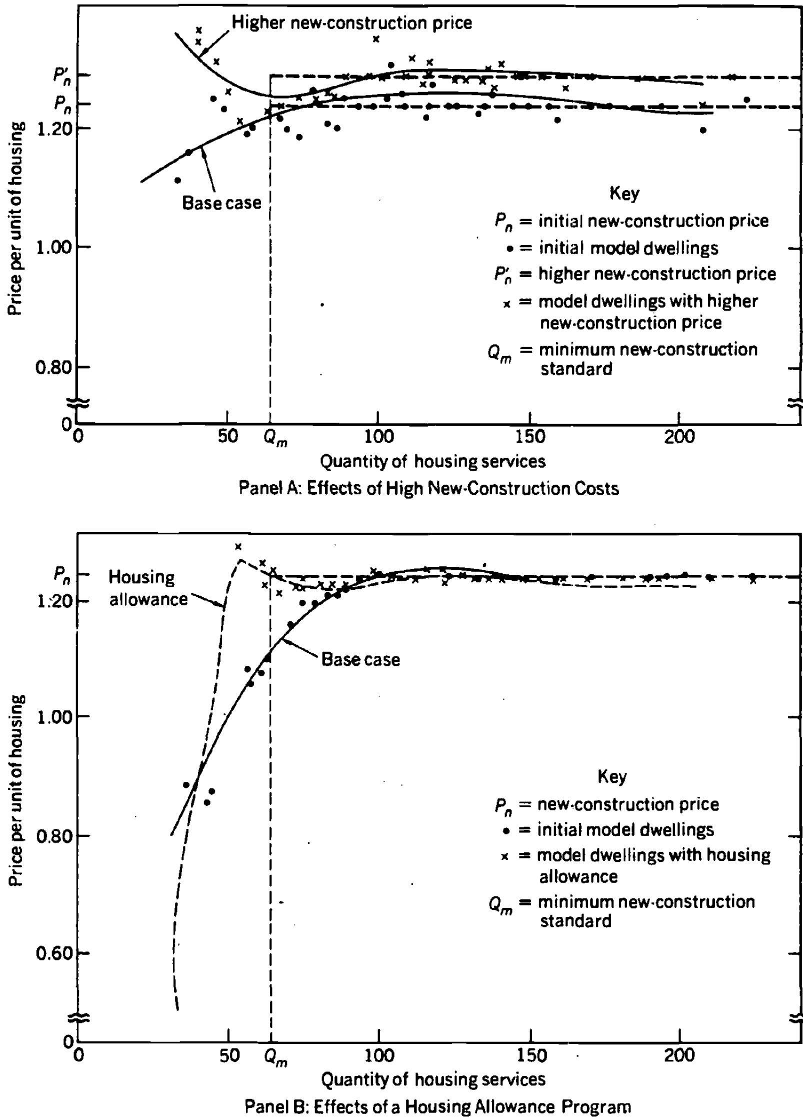


Figure 7-3. New-Construction Costs, Housing Allowances, and the Structure of Housing Prices.

each designed to be representative of a fairly large group of U.S. metropolitan areas in the 1960s. Urban Area *A* is characterized by a high rate of growth, a relatively high proportion of minority households, and a relatively elastic supply of existing dwellings. Urban Area *B* is also characterized by a high rate of growth but has a low minority proportion and an inelastic supply of existing dwellings. While these areas are just two of the eight sets of initial market conditions we used in our work, they are sufficient to give an accurate impression of our simulation results.

Results for prices and quantities generally follow the pattern suggested by the discussion of price-structure curves. Prices for high-income households (roughly, those with incomes above the median) are close to the P_n ceiling and rise by almost exactly the 5-cent increase in P_n. Prices for moderate- and low-income households for whom the P_n ceiling is not necessarily effective also rise, but by slightly less than 5 cents in some cases and slightly more in others. Quantities consumed generally fall, and the implied rise in elasticity of demand relating the fall in quantity to the rise in price is generally close to −1.0, the value which is built into the household utility functions.

The one exception to this quantity response shows up on Urban Area *A* for low-income households and for the inner-city zone. For these (heavily overlapping) categories, quantities are unchanged or higher in spite of higher prices. The clue to these exceptions lies in the next block of figures in the table, summarizing new construction and withdrawals. In Urban Area *A* there are no withdrawals from stock even in the "standard" case, and so there is no possibility of responding to higher prices by conserving dwellings which would be dropped out of the stock in the standard case. In effect, the increasing demand for moderate- and low-quality dwellings encounters a completely inelastic supply in terms of numbers of dwellings. The supply in terms of dwelling quality is not completely inelastic, however, with the result that the increase in demand permits some landlords to move up along their supply curves and offer bigger quantities at higher prices. The large price increase in the central city of Urban Area *A* reflects this movement along supply curves. In Urban Area *B*, where there are withdrawals from stock in the standard case, the supply of low-quality dwellings is not completely inelastic, and low-income households, by increasing the conservation of existing dwellings, succeed in responding to higher prices by reducing quantities consumed.

Table 7-2. Simulation Results[a] for Changes in Construction Costs and Population Growth (prices are in dollars)

	Urban Area A (rapid growth, high minority, elastic supply)			*Urban Area B (rapid growth, low minority, inelastic supply)*		
Quantities[b] and Prices	*Standard Case*	*High-P Case[n]*	*Slow-Growth Case*	*Standard Case*	*High-P Case[n]*	*Slow-Growth Case*
High-income households						
Aver. housing quantity	157.8	151.5	163.0	161.0	154.3	159.7
Aver. housing price	1.236	1.287	1.224	1.241	1.292	1.244
Moderate-income households						
Aver. housing quantity	89.2	87.7	90.9	86.3	82.1	89.2
Aver. housing price	1.242	1.275	1.205	1.218	1.263	1.194
Low-income households						
Aver. housing quantity	55.8	55.8	58.7	54.5	50.5	58.6
Aver. housing price	1.210	1.267	1.095	1.009	1.053	.858
Zonal averages (occupied dwellings)						
Inner-city zone						
Aver. housing quantity	101.6	103.2	110.9	100.9	100.1	108.0
Aver. housing price	1.219	1.296	1.206	1.184	1.220	1.119
Other zones						
Aver. housing quantity	130.4	125.0	130.3	130.8	126.9	133.0
Aver. housing price	1.232	1.278	1.186	1.184	1.247	1.167

Housing stock changes						
New construction (model dwellings)	9	9	5	15	14	10
Withdrawals (model dwellings)	0	0	3	3	2	6
Minority "model" households						
Inner-city zone	5	6	4	1	1	2
Other zones	3	2	3	1	1	0

[a]In the high P_n case, capital costs per unit of quantity are raised from $0.72 to $0.77, which raises new-construction costs per unit of quantity from $1.24 to $1.29. In the slow-growth case, the number of end-of-decade model households is reduced from 40 to 33 for Urban Area *A* and from 42 to 35 for Urban Area *B*. The number of existing dwellings (before withdrawals or new construction) is 31 in all cases.

[b]This is an index of housing quantity. The smallest new dwelling that can be built in conformity with building codes would provide 65.0 units of service per month.

The zonal average prices in the table indicate that the Urban Institute housing model—at least the version we use in this study—does not necessarily yield a price gradient in which inner-city housing prices are higher than housing prices in less accessible portions of urban areas. The relation in the model between inner-city prices and prices elsewhere depends on three sets of zonal characteristics: accessibility, average dwelling quality, and racial composition. Accessibility makes for higher inner-city prices in our model as in theoretical models or urban structures generally; but the other two attributes can work in either direction (as the discussion of Figure 7-2 illustrated in the case of dwelling quality). In the results shown in Table 7-2 the three sets of attributes result more or less in a standoff; average prices differ very little between the inner city and the rest of the urban area.[5]

The final block of figures in Table 7-2 indicates very little change in the pattern of minority household occupancy. Price-structure curves do not permit us to form any expectations about racial occupancy patterns, and it is indeed difficult to make any generalizations about simulation results based on our model. A great deal seems to depend on whether the distribution of demand by minority group households closely matches the distribution of services in a particular zone; the latter, in turn, is quite sensitive to minor variations in the initial conditions of a problem.

A Decline in the Rate of Population Growth

The high rates of growth that characterize the two urban areas analyzed in this study enter the model in the form of a high number of "model" households in the final year of the decade relative to the number of "model" dwellings existing in the initial year. It is easy to simulate lower rates of growth in population by reducing the number of "model" households—from 40 to 33 for Urban Area *A* and from 43 to 35 for Urban Area *B*. The same distributions of income by household type are assumed under both sets of growth rates, with the result that average income is almost the same for the rapid-growth and slow-growth cases.

In terms of price-structure curves, low population growth can be thought of as reducing demands in a wide range of submarkets. For middle- and upper-quality housing, where P_n is an effective ceiling to prices of existing dwellings, the critical question about lower growth is whether it reduces demand enough to make the ceiling no longer effective. For moderate declines in growth, such as the cases analyzed here, we would expect the model to yield simply a decline in the number of new dwellings, with very little change in prices of existing dwellings. For drastic reductions in growth, the entire structure of existing housing prices may begin to slip below P_n. For low- and moderate-quality housing, a reduction in demand cannot have very much of its impact in the form of fewer new dwellings, since there are few or no new dwellings to begin with. We would therefore expect the impact of low demand to fall on existing dwellings, pushing down their prices and quantities of services and causing some of them to be withdrawn from the stock. The possibility of withdrawal from stock means that low-income households need not reduce the quantities they consume as prices fall; rather, they can respond to price reductions by moving into higher-quality dwellings and consuming the higher quantities they prefer.

The results shown in Table 7-2 bear out these expectations. For high-income households prices hardly change, while quantities rise slightly in one area and fall in the other, a random variation due to small differences in the distribution of incomes among high-income households. For moderate- and even more for low-income households, however, average prices fall and average quantities rise. The combination of lower prices and higher quantities requires an increase in withdrawals from stock, and this takes place on a large scale in both areas. Geographically, it is especially evident in the inner city, where a significant price reduction causes dwellings to move down along their supply curves; but increased withdrawals at the low end of the quality spectrum nevertheless permit the average quantity of services per occupied dwelling to increase. As in the case of higher new-construction costs, effects on the location of minority households are small and do not provide any basis for generalization.

A Housing Allowance Program

The proposal of housing allowances for low-income households was the impetus for construction of the Urban Institute model, and the policy is currently being tested in a number of urban areas. The allowance simulations reported are in the form of a negative income tax combined with a stipulated minimum level of housing consumption as a condition of receiving an income subsidy. The minimum requirement is the means of inducing households to spend a large proportion of the subsidy on housing rather than on other goods and services.

Subsidies under these plans are equal to the difference (when positive) between 20 percent of gross income and $66.40 for elderly households and single persons and $82.70 for all other family units. The corresponding annual breakeven incomes implied by these schedules are just under $4,000 and $5,000. A tax rate of approximately 1 percent of income, after deducting exemptions, finances the subsidy. In order to receive the subsidy, elderly households and singles must consume at least 54 units of housing services, and all other eligible households must consume at least 65 units. These requirements approximately equal the levels of service which the "guarantee" subsidy levels ($66.40 and $82.70) would buy at the new-construction price per unit of service ($1.24).

In terms of price-structure curves, housing allowances reduce demand for the very poorest quality of housing, increase demand for quantities just above the minimum requirements, and slightly reduce demand (because of the tax) for high-quality housing. The effect on the poorest-quality housing ought to be a decline in price and, hence, an increase in withdrawals, with the final result that very few households may end up actually paying the lower prices.

For housing just above the minimum, results ought to depend critically on the initial price-structure curve. If there is an initial discount for this type of housing, then a housing allowance can cause a significant price increase before households will be induced to move into new dwellings. If there is no initial discount, the price effects could well be much more moderate. The bottom panel of Figure 7-3 depicts the first of these cases, in which a housing allowance causes significant price increases for quantities above the required minimum. For high-quality housing, an allowance program ought to reduce quantities consumed slightly and affect prices very little.

As Table 7-3 indicates, the results of high-income households in the two urban areas show the expected slight decline in quantities and stability in prices. Moderate-income households also experience little change in quantities and prices. For low-income households, however, there is a sharp contrast between the two areas, illustrating the two cases just discussed. In Urban Area *A*, where the supply of existing dwellings is relatively elastic and there is initially very little discount for low-quality housing, a housing allowance causes only a minor increase in prices, and most of the subsidy paid goes into higher quantities of housing services purchased by the recipients. In Urban Area *B*, on the other hand, where there is a substantial discount for low-quality housing in the standard case, an allowance causes sharp price increases for recipients in the housing allowance case. Here, about half of the increased expenditure on housing goes into higher prices, with only the remaining half going into consumption of higher quantities of services.

The figures in the table relating to moderate-income households are of greater interest than their stability might indicate, since one of the questions about housing allowances has been whether they would drive up prices facing households with income just above the eligibility limits. In the cases analyzed in the table, as well as in other cases we have analyzed, the answer is no: price effects of housing allowances are very largely confined to the income range from which eligible households are drawn.

The contrast between the two areas carried over into inner-city changes in housing stock developments. In Area *A*, with little initial price discount, allowances cause a significant shift out of the poorest-quality housing, with the result that average quantity prices for occupied dwellings in the inner city rise and withdrawals increase sharply. In Area *B*, while some existing model dwellings are upgraded, and their prices approach the new-construction price, the price of one dwelling with quantity far below the program minimum is reduced enough to tempt a low-income household to refuse the allowance and occupy an extremely low-rent dwelling. Average prices in the inner city consequently fall in Area *B*, and only one additional dwelling is withdrawn. In neither area is there any effect on racial composition.

In addition to the results shown in Table 7-3, we have analyzed a variety of other housing allowance and income transfer programs for these two cases and a number of others. Our conclusions based on this work include the following:

1. A full-scale housing allowance would, in many locations, significantly increase housing prices by participants.
2. The inflationary danger of a housing allowance varies with background circumstances. It is most severe where prices per unit of housing service initially are especially low relative to new-construction costs—where low-quality housing, in other words, is relatively cheap. The danger is least where prices initially are above new-construction costs.
3. Point 2 notwithstanding, the allowance is most cost-effective in areas with an initial price discount for lower-quality units because existing dwellings there, even after moving up their supply curves, are cheaper than dwellings providing equivalent quantities of services in no-discount areas.
4. Income redistribution without any earmarking for housing would drive up housing prices but by significantly less than allowances.
5. Most of the upward price movement due to a housing allowance affects participants directly. Households above eligibility levels suffer only minor price increases.
6. Price effects of a housing allowance are much greater over a ten-year span than over twenty years.

Table 7-3. Simulation Results[a] for a Housing Allowance and a Construction Subsidy (prices are in dollars)

	Urban Area A (rapid growth, high minority, elastic supply)			Urban Area B (rapid growth, low minority, inelastic supply)		
Quantities[b] and Prices	*Standard Case*	*Housing Allowance*	*Construction Subsidy*	*Standard Case*	*Housing Allowance*	*Construction Subsidy*
High-income households						
Aver. housing quantity	157.8	157.4	167.3	161.0	159.2	171.3
Aver. housing price	1.236	1.238	1.153	1.241	1.241	1.153
Aver. monthly tax (–) or subsidy (+)	–	–$10	–$10	–	–$10	–$10
Moderate-income households						
Aver. housing quantity	89.2	88.8	97.0	86.3	86.9	91.3
Aver. housing price	1.242	1.238	1.142	1.218	1.235	1.108
Aver. monthly tax (–) or subsidy (+)	–	–$3	–$3	–	–$3	–$3
Low-income households						
Aver. housing quantity	55.8	66.4	62.0	54.5	60.9	59.1
Aver. housing price	1.210	1.259	1.003	1.009	1.154	0.819
Aver. monthly tax (–) or subsidy (+)	–	$31	0	–	+$27	0
Participation rate	–	100%	–	–	88%	–
Zonal averages						
Inner-city zone						
Aver. housing quantity	101.6	114.0	104.9	100.9	99.1	104.5
Aver. housing price	1.219	1.246	1.149	1.184	1.123	1.067
Other zones						
Aver. housing quantity	130.4	130.1	132.1	130.8	134.1	135.2
Aver. housing price	1.232	1.240	1.135	1.184	1.240	1.087

Housing stock changes						
New construction (model dwellings)	9	12	14	15	16	17
Withdrawals (model dwellings)	0	3	5	3	4	5
Minority "model" households						
Inner-city zone	5	5	6	1	1	1
Other zones	3	3	2	1	1	1

[a]The housing allowance program pays the difference (when positive) between $82.70 (for nonelderly families) or (for other households) $66.40 and 20 percent of monthly income, subject to a minimum housing consumption requirement (see text). The new-construction subsidy lowers P_n from 1.24 to 1.15. It does not affect capital costs for improvement of existing dwellings. Both programs are financed by a tax equal to 1 percent of monthly income less $213 for nonelderly families and 1 percent of monthly income less $92 for other households.

[b]See Table 7-2, note b.

This last point is particularly worth emphasizing.[6] The structure of the model implies that the price effects of housing policies should become less severe as time passes. The reason is basically that the longer the time span the more elastic the supply of housing. A price that causes the services from an existing dwelling to decline by 10 percent in one decade will cause services to decline by approximately 20 percent in two decades; conversely, a price causing a rise in services by 10 percent in one decade will cause a rise of about 20 percent in two decades. Furthermore, the longer the time span under consideration, the larger generally will be the share accounted for by new construction, the supply of which is assumed to be perfectly elastic. Our simulation results suggest that ten years is too short a period in which to attain the highly elastic response to housing subsidies we would eventually expect, but twenty years' time suffices.

A New-Construction Subsidy

The policy of a supply subsidy to all newly constructed dwellings corresponds to what is often called the "filtering" strategy of encouraging high levels of new-housing starts with the expectation that these will eventually benefit occupants of existing housing through a chain of moves.

The specific policy is one which lowers the price of new dwellings from $1.24 to $1.15 per unit of housing service. The subsidy is financed out of general income taxes; the tax rate is identical to the one used to finance the full-scale housing allowance just discussed. This identity of tax rates and hence of program costs facilitates comparison between the two policies.

In terms of price structure we would expect a new-construction subsidy to have effects in many respects just opposite to those of an increase in new-housing costs. In the portion of the price-structure curve where the new-construction price is the effective ceiling, prices of existing dwellings should decline by roughly the amount of the subsidy. At these lower prices the demand for relatively good quality housing should shift upward (the tax to finance the subsidy will moderate but not eliminate this shift), with a corresponding downward shift in the demand for low-quality dwellings. The downward shift should in turn cause prices of low-quality dwellings to fall and withdrawals to increase.

In our two urban areas, as Table 7-3 shows, the decline in prices facing high-income households closely matches the depth of the subsidy, while the price decrease for low-income households is nearly twice as large. Low-income households are thus major, if indirect, beneficiaries of the construction subsidy.

Like housing allowances, construction subsidies lead to increasing withdrawals from the housing stock. For those existing dwellings not withdrawn from the stock, however, construction subsidies lead to declines in prices and services provided, while housing allowances generally lead to increases in both factors. The zonal averages in Table 7-3 illustrate the contrast in prices, although they mask the contrast in quantities because of differences in withdrawals and new construction between the two policies.

The household utility function underlying the model provides a way of summarizing costs and benefits of the two programs to different groups of the population. Using the utility function, it is possible to calculate an average change in monthly income (positive or negative) equivalent to each policy for each of the three groups of households distinguished in Table 7-3, taking account not only of taxes and transfers but of market effects as well. These "cash equivalents" are in simple cases closely related to consumer surpluses. In some more complex cases, as when minimum participation requirements push households off their demand curves, the cash equivalents remain operative, whereas measures of consumer surplus do not.

There are serious conceptual problems in any such calculation of a "cash equivalent" of a given policy even for a single household, let alone a group of households. Nevertheless, the comparison among households of differing incomes seems interesting enough to warrant presenting the results shown in Table 7-4. The income definitions are the same as those used in Table 7-3; households labeled low income are those eligible for the housing allowance; moderate income, those with incomes between 100 and 150 percent of eligibility; and high income, all other households.

Two principal conclusions are suggested by the data in Table 7-4. The first, hardly a surprise, is that housing allowances are of more benefit to low-income households and of greater cost to the other two groups of households than new-construction subsidies. Thus, in the first column, a housing allowance policy is the equivalent of a $26 increase in monthly income for the average low-income household, while a new-construction subsidy is the equivalent of only $5 per month. For the average moderate-income household, the allowance is the equivalent of a $2 decrease in monthly income, while the construction subsidy is the equivalent of a $5 increase. For middle-to-high income households both policies are equivalent to decreases in average income, with a greater decrease for the allowance plan (—$10) than for the new-construction subsidy (—$3).

The second, and perhaps unexpected, conclusion is that both policies in effect redistribute income from high-income to low-

Table 7-4. Cash Equivalence of Two Housing Policies (dollars per household per month)

	Urban Area A (rapid growth, high minority, elastic supply)	*Urban Area B (rapid growth, low minority, inelastic supply)*
Low-income households (eligible for allowance)		
Full-scale allowance	+26	+16
New-construction subsidy	+5	+14
Moderate-income households (near-eligible for allowance)		
Full-scale allowance	–2	–3
New-construction subsidy	+5	+2
Middle- to high-income households		
Full-scale allowance	–10	–4
New-construction subsidy	–3	–4

Note: The "cash equivalent" figures in this table are derived from individual household utility levels before and after the introduction of each policy, which is carried out in three steps. The first step is the translation of utility changes for each household into income or cash equivalent changes. In this step prices and certain other market variables are held constant at an average of their no-policy and policy levels. The second step is the averaging of cash equivalent changes over groups of households. The third step is the correction of the group averages in step 2 so that their average over all households for any one city and policy equals zero. The correction is accomplished by adjusting each group average cash equivalent by the same fraction of group average income. Essentially, this correction is a way of distributing the increased profits on existing dwellings in the case of a housing allowance and the reduced profits on existing dwellings in the case of a new-construction subsidy. The distribution of profits in both cases is assumed to be proportional to group average income. While this assumption is plausible, it has not been tested, nor is the restriction that cash equivalents average to zero the result of any empirical or theoretical work.

income households. That a housing allowance works out that way is not of course surprising, but that a new-construction subsidy should have that effect is something of a surprise. The reason for the result is the close substitution in demand between new and existing dwellings. Although the direct price subsidy goes only to occupants of new dwellings—and their incomes are well above the average—the indirect price effects of the subsidy extend the benefits to low-income households. Taxes to finance the subsidy are paid by high-income and "near-eligible" households, and not by low-income households.

Some caveats are in order with respect to this final result. A different tax structure could of course substantially alter the progressivity of either program. Furthermore, while the calculations in the table take detailed account of market changes as they affect housing consumption, they deal only crudely, as the note to the table indicates, with the feedback of market changes to income via changes in landlord and homeowner profits. Nevertheless, the comparisons in the table are of some value in themselves and perhaps even more valuable as an indication of the potential of the model in comparing costs and benefits of a wide range of housing programs to different groups of households.

THE RELIABILITY OF RESULTS

The aim of the Urban Institute housing model has been to quantify the broad interrelations among sectors of a metropolitan housing market. Without such quantification there is invariably a great deal of uncertainty about the effects of housing and land-use policies, including housing allowances, construction subsidies, restrictive zoning, and urban renewal. But while quantification is highly desirable, a detailed tracing of all linkages, short run and long, among the many neighborhoods and structural types of a large metropolitan area would be an enormously complex and expensive undertaking. The model has therefore focused on "broad" interrelations, restricting itself to five or six geographic zones, a single quantitative index of physical housing services for each of a few dozen model dwellings, and a small number of parameters expressing the behavior of households and owners.

There are two ways of looking at the model that may be helpful in judging how well it meets our objective. The first is a brief listing of its principal strengths and weaknesses. The second is a capsule summary of its essential structural features—an attempt to answer the question, What ingredients of a model are necessary to obtain policy results like the ones in this study?

On the strengths and limitations of the model, three strong points deserve special emphasis. First, the model is grounded in a well-developed theory of housing market behavior. Because of its relatively tight theoretical framework, the model is rich in the range of empirical information that can be related to it and of exogenous developments or behavioral changes it can analyze. Further, model solutions, while obtained through a fairly complex and not always automatic algorithm, can be understood and analyzed quite easily through graphic devices such as new-housing indifference curves and price-structure curves.

The second point has to do with validation. The model has been fitted to six metropolitan areas displaying a wide variety of housing conditions and has produced a distinct clustering of most of the major estimated parameters. The results for all six areas as a group have been analyzed for the sensitivity of the errors of fit to slight changes in the parameters. Only for the parameters measuring the supply behavior of the existing stock does the range of uncertainty remain large enough to have important policy implications. For the six areas to which it has been applied, the model is a distinct improvement over a simpler model in which housing depreciates at a fixed rate and neighborhood effects are ignored. In addition, the model has performed respectably when used to predict 1970 market outcomes for one area on the basis of parametric values obtained by applying the model to other areas. On balance, the present model has received much more extensive empirical testing than other existing urban models.

The third strong point is that the model is capable of analyzing a broad range of detailed policy changes. Many of the qualitative policy implications derived from the model hold up under a range of initial conditions, but the variation is often systematic and the results suggest broad generalizations about the effects of housing policies in different markets. The model should generate many ideas about the consequences of housing policies and the design of optimal policies, especially if the range of uncertainty about supply behavior is narrowed.

Regarding limitations, four points deserve some emphasis. First, the model is restricted to ten-year intervals and in fact in work so far, to the single ten-year interval 1960-1970. Much public concern over the market effects of housing policies relates to periods shorter than ten years; but the model conveys no information about the annual or monthly path from the initial position to its ten-year results. Much could be done by way of applications to urban areas outside the United States, time spans other than a decade, and historical periods other than the 1960s.

A second limitation is that the model is too aggregative to serve as a reliable predictor of the detailed consequences of policy changes or exogenous developments for particular zones or household groupings. For example, because the number of model dwellings and households means is small, only restricted confidence can be placed in the spatial shifts of minorities associated with the introduction of housing subsidy policies. Policy implications by broad groupings—high-quality versus low-quality housing, central city versus suburb, or rich versus poor households—are probably the finest level of detail for which serious attention to model results is warranted.

Less obvious than these points are the third and fourth limitations of the model, arising from its restricted range of behavior. On the household side, behavior consists of choosing between housing and other goods and among various housing submarkets. The possible effects of housing allowances and other housing policies on work incentives or family formation are ignored. Furthermore, it does not deal with noncompliance with policy regulations or with "noneconomic" influences on household responses—for example, psychological reasons that might lead a household to decline participation in an allowance program even if it stands to gain economically by enrolling.

On the business side, the model is restricted to markets for new and existing housing. There is no treatment of the basic determinants of land costs, although an extension of the basic model does contain implications about the effects of housing programs on relative land costs in different portions of a metropolitan area, given the overall average cost of land for new construction. Nor is there any treatment of markets for other inputs into housing services, such as maintenance, labor, or construction materials, or of the feedback of market changes to the distribution of household incomes.

We conclude with a list of "essential features of the model" which, taken together, imply a theory of urban housing markets with implications resembling, at least qualitatively, the simulation results presented in this paper. Of the seven features listed below, some are bases for classifying or disaggregating the housing stock, some are historical characteristics of metropolitan areas, and some are empirical values of key parameters. The seven features are these:

1. *Market segmentation*—the segmentation of a metropolitan housing market into submarkets defined by location and quantity of services.
2. *Imperfect substitution*—the empirical finding that these submarkets are close but not perfect substitutes in demand, the imperfection being due both to strong preferences regarding quality level and to strong neighborhood effects.
3. *Durability*—the separation of housing supply into new and existing supply, with the latter accounting for most of the supply even in a ten-year span.
4. *Elastic new supply*—the assumption, based on past empirical work, that the supply of new housing is extremely elastic in a period as long as ten years.
5. *Inelastic existing supply*—the empirical finding that the supply of housing services produced from existing dwellings is far from perfectly elastic over a ten-year span.

6. *Supply trends*—the empirical finding that at stable (over time) relative prices, existing dwellings change their level of services very slowly.
7. *Demand trends*—the historical fact of growth of real income per household over time in almost every metropolitan area (but great variation among areas in growth of population).

The presence of market segmentation makes it possible for prices to differ in various sectors of the market and for policies to have heavier impacts on some submarkets than on others. Differential prices, however, also require the presence of imperfect substitutability in demand and inelastic supply of at least some portion of the stock. Without these additional conditions, responses to price signals by households and suppliers would work to eliminate price variations. Thus, the next four characteristics are all also necessary conditions for differential policy impact in different segments of the market.

The last two factors are responsible for the normal excess demand for high-quality units, which is met by new construction, and the more variable outcome at the low end of the quality spectrum, with price discounts under some conditions but not under others. These determinants of price structure in turn govern the differences among submarkets and among metropolitan areas in the impact of housing policies. Judgments about the reliability of the policy results in this study (at least as to the direction and general magnitude) should depend on how well these seven features of the model are thought to constitute an accurate characterization of urban housing markets.

Our own judgment is that the estimates are the best currently available and that they are reliable enough to merit serious consideration in discussions of housing policies, at least as to direction and general magnitude. We are aware, of course, of the value of more testing and research. But we feel that further exploration of the "space" of policies, city types, and parametric estimates should be encouraged along with developmental work. Even the present model, we feel, can be exploited to suggest a great deal about the possible consequences of alternative housing subsidy forms, land-use policies, mixed policy strategies, least-cost ways of achieving policy goals, and a number of other matters that go well beyond the results in this study.

NOTES TO CHAPTER SEVEN

1. Pioneering studies of the income concept appropriate to housing demand are those of Muth (1960) and Reid (1962). The proposition that a single year is

much too short for measuring the effect of income on housing demand, strongly supported by these two studies, is by now generally accepted even though controversy about other aspects of housing demand continues.

2. Ann Schnare has developed a version of the model in which the assumption of a single zone of new construction is dropped and new dwellings are allocated geographically.

3. A detailed justification of functional forms chosen and an analysis of their mathematical properties will be found in de Leeuw and Struyk (1976).

4. In an expanded version of the model developed by Ann Schnare (but not used here) money costs of transportation as well as housing expenditures are deducted from model income.

5. The standoff, however, is apparently sensitive to our simplifying assumption that all new dwellings are located in a single, relatively inaccessible "zone of new construction." In a version of the model developed by Ann Schnare in which this assumption is dropped, there is a much more pronounced tendency toward above-average prices in the central city.

6. To simulate the model for two decades, model dwellings occupied at the end of the first decade become the existing stock for the second decade. Model households for the second decade are derived by extrapolating growth rates in population and average income.

REFERENCES

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Muth, R.F. 1960. "The Demand for Nonfarm Housing." In *The Demand for Durable Goods*, edited by A. Harberger. Chicago: University of Chicago Press.

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Comments on Chapter Seven

Edwin S. Mills

This is an important study. The Urban Institute housing model is as imaginative, elaborate, careful, and sophisticated as any extant urban model. This study reports on use of the model for some painstaking analysis of government housing policies and of changes in other exogenous variables in the model. The policy analysis is as carefully done as any I have seen with an urban model, and is much more carefully done than most policy analysis in any substantive specialty in economics.

No one interested in the housing problems of the poor can fail to be instructed by the simulations of the effects of housing allowances and construction subsidies. They shed light on those issues that have been important in the debate about government housing policy: the extent to which a subsidy for construction of new houses might improve low-income housing by the filtering down process; the extent to which housing allowances might result in more expensive rather than better housing for recipients; and the effect of housing allowances on housing costs of those not eligible for the allowances.

But suppose I ask myself how this study affects my views about government housing policies, or how it might have affected my views if the numbers had been different but still consistent with the underlying model. I want to defend the conclusion that it is unlikely that these simulations will tell us anything that will affect our views about housing policies.

The most fundamental question that can be asked about government housing programs is: Why have them? More specifically, suppose the decision has been made to redistribute income by taxing the nonpoor and using the money to benefit the poor. Why do it through housing programs rather than by a negative income tax or some other cash grant? There is nothing here that would justify use of housing programs to redistribute income. The reason for redistribution via housing programs is presumably the existence of an external economy or neighborhood effect from housing consumption. But no such externality is mentioned. That is to say, if we calculate the sum of gains and losses in consumer surplus from the housing allowance (or the construction subsidy) and the taxes to pay for them, the sum must be negative. In this model, housing subsidies either create or widen gaps between prices and costs whose equality is necessary for efficient allocation of housing resources. Whether one ought to favor housing programs or cash grants to redistribute income depends on the existence or nonexistence of market failure in housing, not on details about how elastic housing supply is to low-income people. Yet the paper concentrates entirely on the latter kind of issue and says nothing about the former.

Next, suppose that it has been decided, on grounds not discussed in the study, to redistribute income by housing programs. How might the simulations affect my views as to the choice between a housing allowance and a construction subsidy. It seems to me that simple economic common sense tells us that the housing allowance is to be preferred. A construction subsidy benefits the poor only indirectly in that new housing in the model (and in reality, except for public housing) is constructed only for the nonpoor and the poor benefit by acceleration of the filtering down process. The housing allowance, however, goes directly to the poor. Only if the housing allowance is badly designed, for example, by forcing the poor to consume much more housing than they want, could a construction subsidy benefit them more than a subsidy provided to them directly. Any model that suggested otherwise would be suspect. In fact, this one does not. Table 7-4 shows that, dollar for dollar, the poor benefit more from the housing allowance than from the construction subsidy. It is hard to imagine a simulation that would change my belief that the poor will benefit more from a dollar spent on a housing allowance than from a dollar spent subsidizing new construction.

Of course, the numbers are nevertheless interesting. Even though the poor benefit less from a construction subsidy than from an equally costly housing allowance, the nonpoor are likely to prefer the construction subsidy since they receive some benefit from the program. This is certainly important to officials who must face the electorate, but it is also a kind of information the political process is likely to bring to their attention forcefully.

In conclusion, I feel that the simulations are very interesting, but that they do not, and probably could not, change my mind on important matters.