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INCOME AND URBAN RESIDENCE:  
AN ANALYSIS OF CONSUMER DEMAND  
FOR LOCATION

William C. Wheaton

Number 137

August 1974

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## I

It is by now well documented that in American cities, greater personal income leads consumers to locate further from the urban center in separate, suburban communities [6,10]. The pattern is not a recent or temporary one, for it has existed continuously since the "street car suburbs" of the 1850's [14]. While this configuration seems well entrenched in American culture, just the opposite arrangement frequently exists in European or Latin American cities. In these regions, the poor usually inhabit the urban periphery while persons of more means occupy central areas in the city [4,5,9]. At one time or another, urban economists have offered two different explanations for why there exist such income patterns by location. These theories are by no means mutually exclusive.

The first explanation is based on the existence of friction between social groups in American Society. This theory holds that wealthier residents fled the city to escape an influx of newly arriving low-income households. During the nineteenth century this latter group was mostly European immigrants, while during the twentieth century they were American blacks. In both cases the premise of the theory is that people of means do not enjoy living amongst those without wealth or status. There exists a host of explanations for these feelings. Psychologists tell us people simply prefer to associate with those similar to themselves [11]. Sociologists say competition between groups fosters hostile feelings [8]. Lastly and perhaps most importantly, one's neighbor becomes a partner in the collective consumption of urban services. A long literature in economics suggests people prefer public consumption with those of similar means

and tastes [13].

While this theory provides important insights into residential clustering, it can only be a partial explanation for absolute location patterns. Why for example, did Americans of wealth not remain in the city - letting the recent immigrants construct new housing on the urban periphery? The answer offered by the theory is simply that of momentum. Households of means would remain in the city only if the city could be kept "pure." A few panic sales to lower income residents would presumably so deprecate an area that the existing rich would leave and the only place to go was out. A second explanation notes that for neighborhoods to transition in this way, newly arrived low-income residents must offer greater potential rent for urban property than the present, more wealthy occupants. It provides a reason, besides social momentum, for why this might be so.

This second theory holds that as consumers move further from the urban center of employment, greater commuting costs must be counter-balanced with lower expenditure on land. To meet these rising costs, the wealthy will have to reduce their offered land price less, because they will be consuming more land. Thus, they will bid more for peripheral sites than the poor - at least relative to their offers for central locations. In the American experience, then, city landowners found it more profitable to convert their units to higher density for occupancy by the poor. It is important to realize at this point, that with a slight elaboration, this theory can be revised to explain the land use patterns in European cities as well.

If we assume that the marginal cost of commuting is not fixed, but



rises with income, it becomes possible that this greater marginal expense requires the rich to reduce their offered land prices more rapidly over distance than the poor - even though they consume greater land. In short, the net outcome of the argument really depends on how rapidly commuting outlays change with income relative to land consumption. With an income inelastic land demand, and noticeably greater commuting costs for the wealthy, greater income leads to more central locations. With land demand income elastic and relatively fixed commuting expenses, the American case results.

While this theory has been discussed by Muth [12], Alonso [1], and others [3], no attempt to date has been made to empirically determine which case holds in the United States. With empirical estimates of land demand and commuting expenses by income, it would be possible to determine whether this theory, by itself, could explain American location patterns. Such knowledge is useful not only in understanding the different forces that have created American land use patterns, but also because it provides an important tool for evaluating present and past Federal housing policies.

During the post war period, the American government has engaged in at least two separate efforts to alter the existing income-location pattern. During the late 1950's and 1960's, Title I urban redevelopment attempted to attract residents of middle and upper income back into higher density urban living. The effort by in large failed as the private market did not continue this direction once government subsidies were over. Now in the 1970's, we are witnessing another attempt, in this case to develop low income housing in the suburbs.

If the pattern of land and travel demand by income is such that wealthy people definitely outbid the poor for suburban locations, then both of these federal policies were or are doomed to failure - even in the presence of external effects and community service considerations. Even if city services were made comparable to suburban, those of means would still choose peripheral sites on the basis of the land demand argument. Alternatively, if the influence of income on land consumption and travel costs generates more central locations for the rich, then the failure of urban renewal can only be explained by its inability to generate good municipal services and sufficiently strong external effects.

In the next section, the original arguments of Muth and Alonso are reviewed and updated. Section III discusses the estimation of land demand and travel costs for different income groups. Lastly in section IV, the estimates are used in a small simulation to determine the outcome of a competitive bidding between income groups - solely in the basis of land and travel. The results suggest that higher income does generate suburban locations, but the differences in land bids that lead to this pattern are often quite small. Given the rather large differences in land prices commonly generated by externalities, the land-travel demand argument would seem to be a lesser determinant of American location patterns.

## II

In Muth's original discussion of income and location, consumers derived utility from land  $q$  and all other expenditure (including housing)  $x$ . Income  $y$  is spent on  $x$ ,  $q$  times the price of land at location  $t$ ,  $R(t)$  and the cost of commuting distance  $t$  to work  $K(t,y)$ . This latter

cost varies by income to allow for differences in the value of time.

$$u = u(x, q) \quad (1)$$

$$y = R(t)q + x + K(t, y) \quad (2)$$

In the long run, housing and  $x$  are mobile so classical utility maximization yields the constraint condition (2) and the two marginal requirements (3) and (4).

$$\frac{\partial u}{\partial q} / \frac{\partial u}{\partial x} = R(t) \quad (3)$$

$$\frac{\partial R}{\partial t} = \frac{-\partial K}{\partial t} q \quad (4)$$

The effect of income on location amounts to a comparative static analysis on this system of equations. Differentiating (4) totally by  $y$  and re-arranging we get:

$$\frac{dt}{dy} \left[ \frac{\partial^2 R}{\partial t^2} + \frac{\partial^2 K}{\partial t^2} / q \right] = \frac{\partial K}{\partial t} / q^2 \frac{dq}{dy} - \frac{\partial^2 K}{\partial t \partial y} / q \quad (5)$$

One of the second order conditions for the solution of (2)-(4) to be a true maximum is (6) below.

$$\frac{\partial^2 R}{\partial t^2} - \frac{\partial K}{\partial t} / q^2 \frac{dq}{dt} + \frac{\partial^2 K}{\partial t^2} / q \geq 0 \quad (6)$$

Assuming that  $q$  is a "normal" good so that it has a positive income effect ( $\frac{dq}{dy}$  and  $\frac{dq}{dt} > 0$ ), condition (6) implies that that the Bracketted term on the left side of (5) is positive. The sign of  $\frac{dt}{dy}$  thus depends solely on the right side of (5).

If the demand for land is strong with income ( $\frac{dq}{dy}$  large) and marginal

travel costs relatively insensitive to wealth ( $\partial^2 K / \partial t \partial y$  positive but small), then  $dt/dy$  will be positive and consumers with greater income will locate at greater distances. If, on the other hand, land demand is weak ( $\frac{dq}{dy}$  small), while marginal travel costs increase sharply with  $y$ , then  $dt/dy$  is negative, and households of wealth locate more centrally.

This argument would be fine were it not for two problems. First, it would be useful to know just what elements make up the  $K$  function so as to ascertain the likely magnitude of  $\partial^2 K / \partial t \partial y$ . Secondly, and more important, the discussion is based on partial equilibrium analysis. In the long run the rent function must be tangent to the marginal cost/land consumption curve of different consumers in such a way that total land supply and demand balance. The argument in the general equilibrium case is best carried on by referring to Alonso's theory of bid prices.

Alonso's work is in some sense a dual theory to classical utility maximization. In the long run the market is viewed as an auction place where there is no land price - only offers or bid prices by consumers for land. Since landlords are inherently spatial monopolists and consumers atomistic, land parcels go to that group offering the most for them. Consumer bids are defined as the maximum surplus (rent) that can be extracted from households subject to them being at a fixed level of utility ( $u^0$ ). Alonso's improvement over Muth is to separately identify the nuisance of travel time (which depends on income) from travel costs (which do not). As a generalization of Alonso, we let utility depend on  $x$ ,  $q$ , distance  $t$  and a vector of housing attributes  $H$ .

$$u^0 = u(x, q, t, H) \quad (7)$$

Letting  $c(H)$  represent housing construction costs, the consumers budget constraint is written as (8). Money costs  $K(t)$  replace Muth's total costs  $K(t,y)$  as distance now generates separate disutility.

$$R = \frac{y - K(t) - x - c(H)}{q} \quad (8)$$

Taking  $t$  as a parameter, a consumers bid price for land at this location is the maximum value of (8) subject to (7). As we are concerned with the long run,  $x$ ,  $q$  and  $H$  are all variable. Letting  $\lambda$  be the lagangian associate with the constraint (7), bid price maximization yields the constraint (7) and the 3 marginal conditions (9) below

$$\lambda \frac{\partial u}{\partial q} = R/q \quad (9)$$

$$\lambda \frac{\partial u}{\partial x} = 1/q$$

$$\lambda \frac{\partial u}{\partial H} = \frac{\partial c}{\partial H}/q$$

From the envelope theorem and the conditions above, the influence of distance on bid rents can be determined as:

$$\frac{dR}{dt} = \frac{\partial R}{\partial t} = \frac{-dk}{dt}/q + \lambda \frac{\partial u}{\partial t} = 1/q \left[ \frac{\partial u}{\partial t} / \frac{\partial u}{\partial x} - \frac{dk}{dt} \right] < 0 \quad (10)$$

If land in the long run is allocated to those bidding the highest price for it, households with relatively flat bid price gradients must ultimately wind up locating at greater distances than households with bid price gradients that steeply decline over distance. This is not only an equilibrium, but an efficient arrangement as well, for a steeper bid price gradient means an individual places a higher marginal value on location.

To Alonso, then, the influence of income on location reduces to a question of how  $y$  alters the slope of the bid price gradient (10). As one might expect, this depends on the same tradeoff discussed by Muth. On the one hand greater income increases land consumption  $q$  which, from (10) is seen to make the bid price gradient flatter over distance. At the same time it will usually increase the marginal expenditure or income value of travel  $(\frac{\partial u}{\partial t} / \frac{\partial u}{\partial x})$  and this makes the offered price gradient steeper. If income has a strong effect on land demand but a weak one on the value of travel time, flatter bids by the rich suggest an equilibrium location that is further from the center. If the value of travel increases more rapidly with income than land consumption, then the wealthy will locate centrally.

Alonso also overcame Muth's problem of a partial analysis. He realized that the comparison of bid price gradients was only valid in a general equilibrium solution. Such a solution requires finding an appropriate utility level ( $u^\circ$  in (7)) for each consumer or group of consumers. Again from the envelope theorem and condition (9), we have

$$dR/du^\circ = -\lambda < 0 \quad (11)$$

As the utility level of one group of households is lowered, its bid price gradient is raised. This allows that group to capture or bid away an increasing amount of land from other groups. As lower utility levels raise bid prices, they also reduce chosen land consumption levels  $q$ . The equilibrium problem is thus to find a  $u^\circ$ , so that the area over which a household group has the highest bid exactly equals the area that group desires to consume as expressed by aggregating  $q$ 's over its members.

In both Alonso's model, and our own empirical study the urban plain is

featureless, all employment centrally located and transportation continuous. Land development is thus circular and each household group (i) will locate its  $N_i$  members in one or more radial rings. Let  $R_i(u_i, t)$  and  $q_i(u_i, t)$  stand respectively for the bid price and land consumption gradients that are solutions to (8)-(9). Equilibrium requires determining a set of utility levels so that the areas commanded by each group, defined as  $\epsilon_i$  in (12), just meet the land demands in (13).

$$\epsilon_i = [t: R_i(u_i, t) > R_j(u_j, t) \quad j \neq i] \quad (12)$$

$$2 \pi \int_{\epsilon_i} t/q_i(u_i, t) dt = N_i \quad (13)$$

over all groups i.

The final resolution of the Muth-Alonso argument thus rests on being able to estimate utility functions for different economic groups and then using these in a small simulation of competitive bidding. This will determine the locational order by distance that obtains in a general equilibrium, and then allow us to analyse the relative steepness of different bid price gradients.

### III

A methodology for estimating consumer utility parameters with the bid price approach has been discussed at some length in a recent paper by Wheaton [15]. In this section we briefly review this procedure and summarize some of the results obtained from data in the San Francisco region.

In the short run, consumers with the utility function described in section II, will be faced with a totally different choice situation. At

each location  $t$ , land consumption  $q$  and housing characteristics  $H$  will be fixed by location. Individuals, therefore compete for locations by offering a total rent  $R$  for the existing unit and density at  $t$ . The only additional choice variable is non-locational expenditure  $x$ , so it and the individual's bid rent are determined by the solution to the utility and budget constraints, (14) and (15).

$$u^0 = u(x, q(t), H(t), t) \quad (14)$$

$$R = y - k(t) - x \quad (15)$$

In the aforementioned study by Wheaton, the utility function used was a monotonic transformation of the so-called generalized C.E.S. form. This function was selected for several reasons. First it is not homothetic and has variable elasticities of substitution, which are different for every pair of goods. The function also requires that indifference curves asymptote finite levels of housing consumption - a property that seems quite realistic. Lastly the function not only contains a great deal of freedom, but one of its limiting forms is the Cobb-Douglas. For ease of notation, we redefine the utility arguments  $q$  and  $t$  as  $h_i$  along with the elements in the housing vector  $H$ . The function and the bid rent equation derived from it (obtained by inserting (15) and separating variables) are shown in (16).

$$u^0 = -\sum_i \beta_i h_i^{-\alpha_i} - x^{-\alpha_0} \quad (16)$$

$$R = y - k(t) - (-u^0 - \sum_i \beta_i h_i^{-\alpha_i})^{-1/\alpha_0}$$

In the short run, the immobility of housing creates a locational plain that is anything but featureless. Even with a single center of employment, households possessing similar tastes and income will be



forced to locate in different units and locations. If the market is in a state of short run equilibrium, the rent that such households pay for "packages" must compensate them to the same level of utility. Thus if we consider a group of households, who by definition have similar tastes and incomes, the housing/location packages they inhabit and rents they pay should obey the functional relationship (16). Given a stochastic specification, it is possible to estimate the  $\beta_1$  and  $\alpha_1$ ,  $u^0$ , and  $\alpha_0$ . For simplicity, and also because of significant error in the measurement of  $y$ ,  $R$  and  $k$ , the error term was specified as additive. With no a priori reason to expect the contrary, it was also assumed to be normally and independently distributed. This permitted the use of least-squares estimates, which were obtained with a non-linear programming algorithm due to Fletcher and Powell [7].

The data for the estimates came from a Home Interview survey conducted in the San Francisco Bay Area [2]. Information on housing and location included unit lot size, number of rooms, age, travel time to work and an index of proximity to shopping and service facilities. These variables formed the  $h_1$  for estimation, although during the simulations unit age and accessibility were dropped from the utility function. Separability allows us to do this without altering the preferences for other housing attributes. These variables were discarded to keep within the Alonso framework where housing is mobile and all travel is to a single center. Several variables were also constructed as proxy measures for community services and neighborhood externalities. As with unit age and accessibility these variables are used during estimation so as to obtain true preferences for land, travel and housing. Again they are eliminated

from the utility functions used in the simulation. Community average income was used to measure the benefit/cost ratio of local services to households, while the neighborhood distribution of income in 4 categories served as a proxy for residential amenities.

Although our primary concern with differences in preferences by income groups, we must remember that the estimating methodology assumes uniform tastes within a group. Certain demographic variables, well known to influence tastes, would also have to be held constant if this assumption was to be met. The survey allowed us to control by race, occupation (white, blue collar), household size and age-of-head in addition to income. Lastly, the assumption that utility is constant within one of these strata may be further violated if households work at different centers or possess even small differences in income. Thus we further eliminated all households not working in the San Francisco Business area, and made the level of utility,  $u^0$ , a function of income within the range controlled by stratification.

With such controlling, sample signs grew quite small, although seven strata could be selected for estimation. Four of these represent differences only in income - given constant demographic characteristics. The other three strata exhibit major changes in life cycle and size - given fixed income. Unfortunately sample size requirements prevented the inclusion of non-white or blue collar strata. A detailed discussion of the estimated parameters and their significance is contained in the previously mentioned paper by Wheaton. Our concern here is only with the differences in value for travel time and land demand that arose from those parameters.

The first five lines in Table 1 describe the seven strata, along

with  $R^2$  values of the estimated bid functions. Lines six and seven examine the marginal expenditure or income value of 1 hour saved in travel time. Since expenditure is in annual dollars, the figures represent the value of an hour saved each day for an entire year. In keeping with convexity, it is seen that travel time has increasing marginal disutility. Lines 8 and 9, give the annual marginal expenditure value of land, again in dollars, while line 10 shows the land each stratum would consume at a distance 4 miles (and 15 minutes time) from their place of work if that land were priced at 20 thousand dollars per acre.

The last line is the most important for our discussion here. It represents the distance derivative of each stratum's bid price gradient - evaluated 4 miles from the city center and assuming each household group is at a level of utility where their bid prices all equal \$20,000. Stratum six, composed of young people entering or not yet in family formation, clearly dominates with the steepest bid price curve. This results from their extremely low demand for land and infers they will locate most centrally. Poor and moderate income households (strata 1 and 2) have the next most steeply sloped bids and presumably will locate just outside the urban center. Wealthy households (strata 3 and 4), older families whose children have left (stratum 6) and large families (stratum 7) will all locate more peripherally. The differences in bid slopes among these latter groups are all quite small.

If we look at the first four strata, we see that with rising income the slope of the bid price gradient decreases almost monotonically. The one exception is stratum 2's bid which is just slightly steeper than that of

Table 1

Strata <sup>1</sup>	1	2	3	4	5	6	7
Income	5-10K	10-15K	15-25K	25K +	5-10K	5-10K	10-15K
Size	3-4	3-4	3-4	3-4	1-3	1-2	5-6
Age	30-55	30-55	30-55	30-55	-30	56 +	30-55
Sample	106	144	100	45	120	79	69
R <sup>2</sup>	.77	.67	.82	.52	.90	.62	.73
$\frac{\partial u}{\partial T} / \frac{\partial u}{\partial x}$ <sup>2</sup>							
T = .5	12	73	142	460	79	37	75
T = 1.5	53	102	202	659	128	74	105
$\frac{\partial u}{\partial q} / \frac{\partial u}{\partial x}$ <sup>3</sup>							
q = .05	5876	6390	10310	11810	1834	7772	50800
q = .30	915	1048	1300	1928	303	1215	1122
q chosen at:							
R = 20000	.16	.17	.23	.33	.06	.21	.23
T = .5							
$\left( \frac{\partial u}{\partial T} \frac{dT}{dt} / \frac{\partial u}{\partial x} - \frac{dk}{dt} \right) / q$ <sup>4</sup>	-227	-232	-189	-175	-666	-180	-172

1. All are white, white collar occupation.

2. T = hours of travel time each work day, x = dollars of "other" expenditure per year. evaluated by strata at: 4500, 8500, 14000, 36000, 4500, 8500.

3. q = acres of land.

4.  $\frac{dT}{dt} = .05$  (20 mph),  $\frac{dk}{dt} = \$36./\text{year}$  (\$.06/mile).

stratum one. At first glance, this overall pattern seems difficult to explain. The demand for land is certainly income inelastic as a 800% increase in  $x$  (between strata 1 and 4) generates only a 100% increase in  $q$ . At the same time, the value of time is income elastic, increasing slightly more than proportionally with  $x$ . The reason why the time effect does not dominate the land effect is that the value of time must be added to the money cost of travel before dividing by land consumption in computing the bid price slope. The marginal money cost of an extra mile of travel, each way, every day is assumed to be roughly \$36.00 per year. When the values of time in Table 1 are divided by any reasonable assumed travel speed (which is necessary since the bid price derivative is with respect to distance), we see that the disutility of a mile of travel is quite small compared with money costs of a mile.

Dividing line 7 by the assumed 300 work trips per year, reveals that while the wealthiest stratum values time at close to two dollars per hour, the other groups range from only five to sixty cents per hour. These values are less than 10 percent of one's hourly wage. Thus although the value of travel time increases significantly with income, it is totally overshadowed by the fixed, money costs of travel. This allows even an inelastic land demand to play the more important role in shaping the bid price gradient.

Of course this discussion is only speculative. The relative bid price slopes of different strata, when evaluated at an arbitrary point are only suggestive of the solution that will prevail in a general equilibrium. We must obtain that solution itself to see if the same results hold when all land demands exactly balance the supplies obtained through bidding.

## IV

To simulate the urban land market, we constructed a city whose circumference was two thirds circular. This was done to represent the loss of land area from water in the San Francisco region. All employment was centrally located and land around this point was divided up into small rings, each being .2 miles in width. Airline distance to the center was converted into travel time with a velocity function. Central average speeds were set at 12 mph, while in the fringe they reached 50 mph. The opportunity or rural price of land was set at \$5000.00 and the marginal cost of travel at 6 cents per mile. Lastly a linear function was used for the annualized construction cost of housing. The fixed component was set at \$1000.00, with a variable cost per room of \$200.00. Of course, all of these cost or price parameters were later varied to analyse the sensitivity of the equilibrium solution.

The total population of our city was established at slightly over 1 million households. This was partitioned into each of the seven strata by a factor proportional to that group's share in the present San Francisco Region. Given initial utility levels, bid prices (with accompanying land, and housing choices) were computed for each household stratum and ring in accordance with the marginal conditions 7) and 9). All land within each ring was allotted to that group with the highest net offered bid price. Ring land areas were converted into a population "holding capacity" by dividing with the dominant stratum's land consumption in that ring. Summing over those rings commanded by each group yielded an aggregate "holding capacity" for each stratum - given the present structure of bid prices.

A general equilibrium requires that these holding capacities

(labelled  $D_i$ ) exactly equal the specified number of households in each stratum  $i$  ( $N_i$ ). If group  $i$ 's holding capacity is less than  $N_i$ , its utility level ( $u_i$ ) must be lowered in order to raise its bid price gradient and "capture" more land. The reverse holds as well and so to obtain equilibrium utility levels, the iterative process (17) was used:

$$u_i^t = u_i^{t-1} + \alpha_i [D_i^t - N_i] \quad (17)$$

$$i = 1, 7$$

At iteration  $t-1$ , utility level  $u_i^{t-1}$  generates the holding capacity  $D_i^{t-1}$  which then is used to adjust utility to  $u_i^t$ . Experiments revealed that a fairly wide range of values for the adjustment coefficients ( $\alpha_i$ ) would lead to convergence over all seven strata. The results of the base run are shown in Table 2.

Strata by Location Order	Table 2						Farthest 4
	Closest 5	2	1	7	3	6	
Inner ring	1	12	30	43	56	69	77
price <sup>1</sup>	66.30	28.60	18.17	13.47	10.00	7.60	6.46
q <sup>2</sup>	.018	.116	.178	.227	.431	.498	.980
unit size <sup>3</sup>	2.6	8.7	4.5	7.3	8.4	4.5	11.6
Outer ring	11	29	42	55	68	76	89
price	30.35	18.61	13.8	10.23	7.80	6.60	5.00
q	.04	.170	.228	.315	.534	.567	1.25
unit size	2.5	8.6	4.4	7.3	8.4	4.5	11.6

1. In thousands of dollars per acre.
2. In acres.
3. Rooms.

In Table 2, the inner ring of each stratum represents the beginning of their locational "band", while the outer ring is the terminal edge. Multiplying ring numbers by .2 converts them into mileage. Thus the urban border is at 18 miles. The location order corresponds quite closely to our analysis of bid price slopes in section III. Young households, not yet in or just entering family formation locate most centrally. Still holding income constant at 5-10 thousand dollars, we see that older households (stratum 6) locate distinctly further than their middle age counterparts (stratum 1). When income is fixed in the 10-15 thousand range, greater size also generates a more peripheral location (stratum 7 versus 2). Of course, our primary concern is with the effect of income when these demographic factors are fixed.

Comparing strata 1 through 4, clearly reveals the strong tendency for greater income to generate locations further from the urban center. In fact the order is exactly that predicted by the examination of bid price slopes in section III. The wealthiest group (stratum 4) locates furthest while the upper middle income group locates next to furthest (stratum 3). Moderate and low income households (strata 2 and 1) both locate near the urban center and between them contain the only inversion in locational order. It is important to realize that this order remained largely intact when significant changes were made in several of the simulation parameters.

In Table 2, the density gradient appears quite reasonable although land rents seem lower than one would expect. Central city residential prices usually reach over a hundred thousand dollars in urban areas of this size. In an attempt to generate figures of this magnitude, we experimented with two parameters. Raising the marginal cost of travel from 6 to 10



cents and increasing the opportunity price of land from 5 to 9 thousand dollars each resulted in central rents near \$120,000.00. Both of these changes, created a smaller, more compact city, but in neither case did the location order change significantly. The only difference was that strata 3 and 6 interchanged places. This is quite minor and does not alter any of the qualitative conclusions drawn above.

Lastly, while the size of constructed homes appeared quite reasonable, the rather arbitrary nature of the housing cost function led us to alter its parameters as well. This did change the size of selected units, but had no effect on the locational order of households. When housing is flexible in the long run, its cost or price structure does not influence the choice of location.

While the "stability" of our location order is encouraging, a final test of robustness is to determine whether the pattern resulted from significant or relatively minor differences in bid gradients. To see this, we turn to Table 3, where the equilibrium price profiles of each group have been reproduced at selected locations.

Table 3

Strata by Location Order	5	2	1	7	3	6	4
Ring							
5	48.19*	34.49	31.79	27.33	28.20	26.01	29.95
20	15.46	23.33	22.79	21.02	20.46	19.57	20.12
35	5.30	16.04	16.21	15.88	15.17	14.75	14.64
50	.62	11.07	11.42	11.53	11.27	11.07	10.98
60	---**	8.62	8.99	9.00	9.18	9.10	9.06
72	---	6.36	6.69	6.34	7.11	7.16	7.15
82	---	4.90	5.19	4.20	5.69	5.81	5.86

\* thousands of dollars.

\*\* bid prices less than zero.

If stratum 5 is excluded, the variation in bids between the remaining groups ranges from a high of 20% in the city to a low of only 4% in the fiftieth ring. This seems small, especially when compared with the bid structure of younger households in group 5. Thus although there exist substantial differences among strata in the value of time and the demand for land, these compliment one another to yield bid price gradients that appear quite similar. Our results then, suggest that life-cycle, size and income may exercise a greater role in the short run, when density and housing are fixed and provide additional considerations for selecting a location. If substantial differences do exist in long run bid prices, they must be the product of additional demographic factors like race, ethnicity or family background.

Perhaps most important, these results suggest that differences in the preference for land and travel in the long run may influence location less than considerations of social externalities or public consumption. In most metropolitan areas, and at a given distance from the urban center, the cost of land varies by more than a hundred percent between the most and least affluent communities. This is a range far greater than that generated by our simulation, inferring that social preferences and momentum may in fact, be the dominant force in the market for location.

In spite of these qualifications, the outcome of the simulation does reveal a definite tendency for greater income to generate more distant locations. The formation of wealthy suburbs then, does have a cause besides social momentum. Furthermore, if redevelopment is to ever attract wealthy residents back to the city, the development of urban amenities due to externalities must exceed those presently found in the

suburbs. Our qualifications have merely said that they need not exceed them by very much.

## References

1. Alonso, William, Location and Land Use (Harvard University Press, 1964).
2. Bay Area Transportation Study Commission, Home Interview Survey (San Francisco, August 1967).
3. Beckman, M.J., "On the Distribution of Urban Rent and Density," Journal of Economic Theory, 1 (1969).
4. Caplow, Theodore, "Urban Structure in France," American Sociological Review 17 (1952).
5. Caplow, Theodore, "The Social Ecology of Guatamala City," Social Forces 28 (December, 1949).
6. Catanese, Anthony J., "Home and Workplace Separation in Four Urban Regions," Journal of American Institute of Planners (September, 1971).
7. Fletcher R. and Powell, M.S.D., "A Rapidly Converging Descent Method of Minimization," Computer Journal 6 (1963).
8. Gans, Herbert J., The Levittowners (Random House, N.Y., 1967).
9. Gist, Noel P., "The Ecology of Bangalore, India," Social Forces 35(May, 1957).
10. Hoover, Edgar M. and Vernon, R., Anatomy of a Metropolis (Harvard University Press, 1959).
11. Lauman, Edward O., Prestige and Association in an Urban Community (Bobbs-Merril Co., Indianapolis, 1966).
12. Muth, Richard, Cities and Housing (University of Chicago Press, 1969).
13. Rothenberg, Jerome, "The Impact of Local Government on Intra Metropolitan Location," Papers and Proceedings, Regional Science Association 24(1970).
14. Warner, Samuel B., Street Car Suburbs (Harvard University Press, 1962).
15. Wheaton, William C. "A Bid Rent Approach to Housing Demand" (MIT Working Paper 135, July 1974).







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