Relation of Highway Accessibility to Urban Real Estate Values

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This paper covers portions of the empirical results from a study on the nature and value of highway accessibility. The data are drawn from the Washington, D. C., metropolitan area. The major source of accessibility information is the 1955 Washington Metropolitan Area Transportation Study. House prices are drawn from a list of sales provided by the Federal Housing Administration. Empirical relationships have been developed between: (1) job accessibility and distance to the CBD; (2) driving time to CBD and distance to CBD; (3) proportion of job trips to CBD and driving time to CBD; and (4) house prices and job accessibility, driving time, and distance to CBD. Most of the statistical results of the study are reported but the research possibilities of relating O-D data to data on the urban housing market are emphasized.

•RECENT STUDIES stimulated by the Bureau of Public Roads have generated considerable interest in the relation between highway improvements and land values[1]. Although conducted with care and statistical competence, these studies have not gone as far as economists would like in using land value information to solve some of the vexing problems of highway evaluation. Highway improvements have value because they increase the accessibility of the land they serve, with accessibility being defined as the reciprocal of the costs of moving people and goods between points in space. Because land buyers are willing to pay for savings in vehicle-operating costs, time, and the other components of accessibility, the value of these expected future benefits is capitalized into land prices. Thus, changes in land values over time or differences in land values at a point in time can be expected to reflect differences in accessibility, and it may be possible to use this information in estimating the value of highway improvements.

The study reported in this paper attempted to estimate the value that residents of the Washington, D. C., metropolitan area place on highway accessibility to job opportunities and to the central business district (CBD). The approach was to analyze through multiple regression a cross-section of sales prices of residential properties.[2] Variations in sales price are associated with differences in accessibility characteristics. To avoid some of the conceptual and empirical difficulties inherent in a time series approach, exclusive reliance is placed on cross-sectional variation. It is thus possible to hold constant the interest rate, other construction costs, population, and the level of prices and personal incomes. The value differences that emerge depict the structure of values rather than changes through time.

THE DATA

Particularly good data on both house prices and accessibility are available for the Washington area. The value data are a sample of house sales assembled by the District

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[1] A good summary of the bulk of this work—studies prepared for the report called for by Section 210 of the Highway Revenue Act of 1956 (70 Stat. 387)—can be found elsewhere (1).

[2] Both the theoretical and empirical approaches of this study are very similar to those used in a recent study by Mohring (2).

of Columbia Insuring Office, Federal Housing Administration, to assist FHA appraisers in their work. The sales took place during the first nine months of 1961. For each sale the following information is available: street address; sales price; style of house; square feet of house area; square feet of lot; percentage of house having basement; number of stories, rooms, bedrooms, and baths; exterior construction material; garage or carport; year built; type of water and sewer service; and such special features as recreation rooms, fireplaces, fences, and porches.

The sample has wide geographic dispersion, although most of the properties are in suburban areas where the real estate market is most active. The price, size and quality ranges are determined in part by the legal requirements for FHA financing, as all sales were made with the support of FHA loan insurance. The price range is from \$8,000 to \$30,000. Though high-priced properties are excluded, the disadvantage of incomplete coverage is more than offset by the close comparability of the data resulting from the uniform way in which they were assembled and the numerous constants introduced by the FHA requirements.

Three types of accessibility data are available: airline distance to the CBD, driving time to the CBD, and indexes of accessibility. The major source of data has been unpublished information from the 1955 Washington Metropolitan Area Transportation Study. Estimates of driving times were developed for each pair of the 400 origin and destination zones into which the study area was divided. These are offpeak driving times estimated from studies of vehicle speeds along key streets and highways in the metropolitan area. The set used is driving times between zone 35 (12th and F Streets) and the other 399 zones. A second set of times linking the CBD with zones outside the CBD was developed as a by-product of the 1959 Government Employee Parking Survey. Morning peak-hour driving times were calculated from answers given by government employees to questions on their trips to work. The survey was conducted on July 21, 1959. Some 55,000 auto drivers and passengers employed in the CBD filled out the questionnaires. Only uninterrupted trips were included in the data used in this study. Details on processing and analysis of the data are presented by Mueller (3).

As expected, the 1959 times are consistently higher than those from the 1955 study and differ from zone to zone somewhat less regularly. The accessibility indexes, developed from Transportation Study data, measure for each zone its accessibility to employment, retail sales, or population. The index is of the gravity type, varying directly with the number of people, jobs, or volume of sales, and inversely with the distance to them.

The employment index for any zone is calculated from

$$ {}_iA_e = \sum_{j=1}^{400} \frac{E_j}{\left(T_{i-j}\right)^{\alpha}} \tag{1} $$

in which

${}_iA_e$ = employment index for zone i;

E_j = number of jobs in zone j;

T_{i-j} = travel time, zone i to zone j (the 1955 travel times adjusted for terminal time were used in these calculations); and

α = an empirically-determined exponent indicating the willingness of people to travel to jobs.

The exponent α is computed through an iterative procedure and is that power of T_{i-j} which best predicts the observed interchange of trips between zones. For the employment index, the exponent was about 2, and for retail sales, 4.5, indicating that distance (time) discourages job trips less than shopping trips.

A description of the development and use of the Washington accessibility indexes can be found in two recent articles by Hansen (4, 5).

These previously mentioned data were used in answering three questions relevant to the valuation of accessibility. The first was the question of how closely the major measures of accessibility (distance, driving time, and the job accessibility index) were related to each other. The second concerned the relation between accessibility to the CBD and the proportion of job trips that were made to the CBD. The final question was how house sales prices varied with accessibility, other characteristics being held constant.

ACCESSIBILITY AND DISTANCE

To test how driving time and job accessibility vary with distance from the CBD and whether there are significant directional differences in these relations, the regressions summarized in Table 1 were run. Each of the three measures (job accessibility index, 1955 driving time, and 1959 driving time) was regressed on distance from the White House expressed first in natural numbers and then in common logarithms. The sample consisted of 104 O-D zones selected systematically from those for which all three measures were available. Seven dummy variables were included to measure the differences in intercept among the eight directional sectors. (The Transportation Study area was divided into 68 origin and destination districts and these in turn were subdivided into the 400 O-D zones already mentioned. The districts may be aggregated into eight wedge-shaped sectors whose boundaries radiate from the CBD. If the study area is visualized as a circle divided into octants, the sectors are numbered, beginning at due north and reading clockwise: 3, 4, 5, 6, 7, 8, 1, and 2.) The calculated constant is the intercept for sector 3; coefficients of the other sector variables indicate the adjustment of this constant term that is appropriate for each.

Several inferences can be drawn from Table 1:

1. Distance is a surprisingly good predictor of all three accessibility measures, by itself accounting for between 84 and 94 percent of the variation in travel time and job accessibility, respectively.
2. The log of distance gives the better fit for the job index, whereas both sets of driving times are more closely related to simple mileage.
3. Although several sector coefficients are statistically significant, all are small relative to the value of the dependent variable calculated from the constant term and the distance coefficient, and in the aggregate they add little to the explanatory power of the equations.

These relations imply that accessibility may be measured in minutes, index points, or miles, and that the value estimates should be roughly similar whatever measure is chosen. A broader implication, which is not pursued here, is that the short-run route choices of drivers, the longer-run location decisions of residents, and the highway building and improvement programs of public agencies operate to equalize the accessibility structure of the city in terms of both direction and distance.

TABLE 1

COEFFICIENTS OF REGRESSIONS RELATING ACCESSIBILITY MEASURES TO DISTANCE FROM CBD

Variable	Job Accessibility Index				1955 Driving Time				1959 Driving Time			
	Regress. Coeff.	Std. Error	Regress. Coeff.	Std. Error	Regress. Coeff.	Std. Error	Regress. Coeff.	Std. Error	Regress. Coeff.	Std. Error	Regress. Coeff.	Std. Error
Constant	1,509	27	1,771	28	5.03	0.51	0.24	0.69	15.90	0.77	10.34	0.99
Miles from CBD	-119	4	-	-	2.37	0.07	-	-	2.73	0.11	-	-
Log miles from CBD	-	-	-1,349	34	-	-	26.21	0.86	-	-	30.24	1.24
Sector:												
1	12.3	37.9	-5.5	31.7	-0.76	0.71	-0.47	0.79	-2.95	1.08	-2.61	1.13
2	-10.1	27.7	3.5	23.1	1.04	0.52	0.84	0.58	-0.96	0.79	-1.20	0.83
4	-33.9	26.5	-5.5	22.2	-1.45	0.50	-1.99	0.55	-1.30	0.76	-1.92	0.79
5	-67.1	32.7	-31.6	27.3	-1.14	0.61	-1.80	0.68	-3.29	0.93	-4.06	0.98
6	-80.9	32.7	-34.3	27.2	-1.05	0.61	-1.99	0.68	-0.73	0.93	-1.81	0.97
7	- 0.1	27.8	52.3	23.2	-1.85	0.52	-2.87	0.58	-2.23	0.79	-3.40	0.83
8	-70.3	29.8	-23.4	24.9	0.04	0.56	-0.84	0.62	-0.74	0.85	-1.76	0.89
R^2	0.922		0.946		0.934		0.919		0.886		0.875	
R^2 on distance only	0.909		0.937		0.905		0.870		0.862		0.840	

ACCESSIBILITY AND CBD JOB ORIENTATION

The question of whether people choose residential locations systematically with respect to the location of their jobs is still to be satisfactorily answered. It would be expected that, as the CBD is approached, the proportion of all workers who have jobs in the CBD would increase. Two recent empirical studies document the tendency for workers' residences to be oriented to their work places. Kain (6) notes the tendency with respect to outlying employment centers in the Detroit area. Muth (7), in his work on urban density gradients, found that the concentration of manufacturing employment in the central city was highly correlated with the compactness of the associated urbanized area, implying that concentrations of residences accompany concentrations of jobs.

A different impression, however, is given by one of the tables from Silver's (8) excellent study of changing travel patterns in the Washington metropolitan area. His data suggest that distance from the CBD may have no consistent influence on the proportion of the labor force that is CBD oriented. Aggregating data by distance rings, he found that up to 2 mi from the CBD, 30.3 work trips per 100 dwelling units were made to the CBD; between 2 and 4 mi, 34.6 trips per 100 dwelling units; 4 to 6 mi, 37.4 trips; 6 to 8 mi, 29.2 trips; and 8 to 10 mi, 32.8 trips (8, Table 7). The constancy of CBD trips per dwelling unit suggests an irrational pattern of job and residence location that is at variance with the expected pattern and patterns observed elsewhere.

TABLE 2

COEFFICIENTS OF REGRESSION RELATING PERCENTAGE OF JOB TRIPS DESTINED FOR CBD TO TRAVEL TIME FROM DISTRICT OF ORIGIN TO CBD

Variable	Regress. Coeff.	Std. Error
Constant	69.70	3.23
1955 driving time	-1.27	0.15
Sector:		
1	7.01	3.22
2	11.03	2.86
4	-9.25	2.72
5	-10.27	3.22
6	-11.98	2.94
7	-19.70	2.82
8	-8.37	2.92
R^2	0.794	-

To explore with more precision the relation between accessibility and job orientation, the regression summarized in Table 2 was run. The dependent variable was the percentage of all home-based work trips destined for the CBD. This was regressed on driving time to the CBD and seven dummy sector variables. (The problem was run for 58 O-D districts outside the CBD. District 71 was excluded, as it comprises several military installations whose workers are housed on the base. District driving times were calculated by averaging the 1955 times for constituent zones.) From these results it is clear that CBD job orientation is not independent of accessibility. The differences between these findings and those in Silver's article result from differences in the level of aggregation and in the form of the variables used. Districts in the underoriented sectors to the south, 6 and 7, are on the average closer to the CBD than those in the strongly-oriented northwest. Silver's 8- to 10-mi ring contains primarily districts in sectors 2 and 3 and has none from sectors 6 and 7. Thus, in aggregating by distance rings, Silver's procedure weights the outer rings heavily with districts of above average orientation. In addition, his use of work trips to the CBD per 100 dwelling units results in relatively low estimates for the close-in districts where the total number of jobs per dwelling unit is lower than in outlying areas. Work trips (total) per dwelling unit vary between 0.96 in the inmost ring to 1.29 in the 8- to 10-mi ring (calculated from Tables 1 and 5 in 8).

Although the sector variables contribute substantially to the success of the regression, their very success raises some disturbing questions. Though the global irrationality that seemed to exist has been disposed of, it has been done so largely by localizing it. The variance among sectors in their degree of CBD orientation is truly impressive—more than 30 percentage points separate sectors 2 and 7. Two comments are in order.

These findings lend support to the sector theory of residential growth set forth by Hoyt (9) in the late 1930's. It is perhaps no accident that he was working and living in Washington when he developed it. They also warn that the pattern of accessibility values may depend on direction as well as distance.

HOUSE PRICES AND ACCESSIBILITY

The central statistical problem of this study was to isolate the component of house sales prices that is paid for accessibility. As accessibility is a component of the price of land, and land (graded and improved with streets and utilities) has been estimated to average between 16 and 18 percent of the selling price of a house, the job was to estimate the variation in a component that averages at most less than one-tenth of the price of the property.

The approach was to hold constant through least squares multiple regression the determinants of selling price other than accessibility. Because the house accounts for over 80 percent of average value, primary attention was given to identifying the significant structural variables and quantifying them in the way that has the greatest explanatory power. In arriving at the final regression equations, four sets of decisions had to be made: (a) defining the universe, in terms of age and style of house and geographic coverage, (b) choosing a sampling technique, (c) selecting the variables to be included, and (d) finding the appropriate form for measuring the variables.

The following procedure was followed: Systematically 286 house sales were selected from the basic FHA list of about 2,000 observations. All houses chosen were built after 1944 and all were located within the Transportation Study cordon. Four house styles were included: one story, one and one-half story, two story, and two story semidetached. For each house style sampled a single observation was chosen at random from each FHA data tract containing one or more eligible properties. Thus, the selection of observations was purposive in two senses: separate samples were drawn for each house style, and an attempt was made to achieve a wide and even geographic distribution of properties.

The estimating equation was of the form

$$X_1 = b_1 + b_2X_2 + b_3X_3 + \ldots + b_nX_n + U \qquad (2)$$

Eleven variables were chosen for inclusion in the final runs. Unless otherwise indicated the source of data was the basic FHA list.

X_1 = price. Selling price, adjusted where necessary for the value of nonrealty items included in the transfer.

X_2 = square feet of house. Square footage of the basic house. Because certain economies of scale are to be expected in construction costs, the logarithmic transformation of this variable was used.

X_3 = accessibility. Although several forms of the accessibility variable were tried, the measures included in the final runs were the job accessibility index, the log of distance to the White House, and the 1959 driving time to the CBD.

X_4 = square feet of lot. The logarithm of lot area was used as the value of space can be expected to increase at a decreasing rate.

X_5 = construction material. Dummy variable equal to one if house was built wholly or partially of brick; equal to zero if nonbrick.

X_6 = basement. Dummy variable equal to one when house had basement; equal to zero otherwise.

X_7 = number of bathrooms. As scale economies are to be expected in construction costs, the logarithmic form was used.

X_8 = extras. Dummy variable equal to one when house was equipped with one or more of the following: garage, carport, recreation room, central air conditioning, or more than 100 sq ft of finished area in basement or upper story.

X_9 = median income. Median family income in 1960 of the census tract in which the property was located.

X_{10} = age of house. Equal to 1960 minus the year in which the house was built.

X_{11}, X_{12}, X_{13} = style of house. Three dummy variables used to distinguish among one story, two story, one and one-half story, and semidetached houses.

The results of three regressions using this set of variables are given in Table 3. Selling price was the dependent variable in each problem and the independent variables other than accessibility were identical. The fit of the equation is good and the level of significance of the coefficients is high—11 of the 12 independent variables have t-ratios exceeding 3.0. Although the behavior of all the independent variables is of interest, primary concern is with the values attached to the accessibility measures. The coefficients may be interpreted directly as the change in the selling price of a house per unit change in its accessibility, the other characteristics held constant. One hundred points of job accessibility index are worth $2.33, one minute less of driving time adds $63.68 to the price of a house, and one unit of log distance is valued at $3,552. Translated into miles, the log distance coefficient implies a premium of $444 for houses 3 mi from the CBD over those 4 mi away and a premium of $206 for 7 over 8 mi. Although job accessibility shows the highest t-ratio and R^2, both time and log distance are clearly adequate measures.

Two other value calculations developed in the study are worth mentioning. When the dependent variable was run as the logarithm of sales price so that the value of accessibility could be expressed as a percentage of sales price, 10,000 accessibility index points added 1.1 percent to sales price, other characteristics remaining the same. (Though the computations were done in common logarithms, the percentage interpretation requires that the coefficient of accessibility be converted into natural logs. The coefficient must be multiplied by 2.303 and then by 100 in order for it to be read as a percentage.) With an accessibility range in sample of about 90,000, the variable can thus account for a difference of 10 percent in sales price of two houses located at the extremes.

The second calculation was made to test whether the degree of CBD job orientation affected the observed accessibility rent gradient. Because the O-D sectors exhibited such a wide range of percentages of all jobs located in the CBD (Table 2), the basic sample was divided into two subsamples on the basis of sectoral CBD orientation. The

TABLE 3

COEFFICIENTS OF REGRESSIONS RELATING SALES PRICE TO ACCESSIBILITY MEASURES AND OTHER INDEPENDENT VARIABLES, POOLED SAMPLES

Building Type	Variable	Job Accessibility Index		1959 Driving Time to CBD		Log of Distance to White House	
		Regress. Coeff.	Std. Error	Regress. Coeff.	Std. Error	Regress. Coeff.	Std. Error
1-story	X_2	24,465	1,549	24,682	1,568	24,520	1,553
	X_3	2.33	0.47	-63.68	15.69	3,552	748
	X_4	1,208	711	973	716	1,126	712
	X_5	1,551	234	1,541	237	1,562	235
	X_6	1,192	282	1,230	285	1,225	282
	X_7	5,082	915	5,130	928	5,038	919
	X_8	797	195	781	198	766	196
	X_9	0.337	0.065	0.335	0.066	0.326	0.065
	X_{10}	-81.11	26.44	-77.31	26.78	-84.08	26.65
2-story	X_{11}	-1,632	298	-1,601	302	1,628	299
1½-story	X_{12}	-2,345	315	-2,345	319	-2,338	316
Semidetached	X_{13}	-3,885	400	-3,932	408	-3,960	403
R^2		0.868		0.864		0.867	

"overoriented" sample comprised the 100 observations in sectors 1, 2, and 3. The "underoriented" sample included the 186 observations in sectors 4 through 8, each of which averaged below sectors 1 through 3 in the percentage of job trips made to the CBD. (The division into two samples was made on the basis of the coefficients of the dummy variables given in Table 2.) The samples were run separately to determine whether they would exhibit different accessibility coefficients. The job accessibility coefficient for the heavily-oriented northern sectors was 2.28 (1.35); for the rest of the metropolitan area it was 2.69 (0.61). Clearly the slopes are not significantly different.

The result is not surprising in view of the earlier findings. It was clear from the computations summarized in Table 1 that the accessibility-distance relation was not significantly influenced by differences in the degree of CBD job orientation. Sectoral differences in the driving time vs distance intercept were negligible in comparison with differences in sector proportions of job trips made to the CBD. The critical ratio here is not CBD job orientation, but rather the ratio of peak-hour CBD vehicle trips to highway capacity. Either the high percentages of CBD trips from the northern sectors were not associated with large absolute volumes of trips or the supply of highway facilities was sufficient to accommodate them at speeds equal to those elsewhere in the city. Under these circumstances, differences in the slope of the accessibility gradient could result only from barriers that prevented land market competition between the sectors. Political boundaries, different sets of zoning regulations, or marked differences in income, if they corresponded to sector boundaries, might bring about differences in the value gradient. There is no evidence that such barriers exist in the present case.

ACCESSIBILITY VALUES AND HIGHWAY BENEFITS

Detailed application of these results to the highway planning process is a major research undertaking in itself and is beyond the scope of this paper. It is worthwhile, however, to sketch briefly their possible role in evaluating proposed improvements.

The most straightforward application is to use the value of job accessibility. Highway improvements, by reducing travel time, will increase the indexes for properties in the area they serve. Assuming that changes in the job index reflect changes in accessibility in general, the appropriate calculation is of job accessibility "with" and "without" the project in question. Increases in the index weighted by the number of residences affected provide a physical measure of benefit to which the value findings of this study may be applied. Multiplied by the unit value reported in Table 3 ($2.33 per hundred index points), the aggregate increase in the index will measure one component of the value of the improvement.

One complication that affects the valuation of increases in job accessibility should be stressed. The formula (price times incremental quantity) for estimating the value of increases in supply is applicable only when the increment to supply is sufficiently small not to affect the unit price. When a transportation improvement is massive enough to affect the general level of accessibility values, the appropriate unit price lies between the "before" and "after" values. There is considerable support for using the arithmetic mean of the two (10, p. 41).

A second application of the findings is in estimating the value of driving time. Highway planners increasingly recognize that the value of time saved is legitimately included in highway benefits, but little evidence or consensus exists on what the unit value is. Several figures have been recommended for use in benefit calculations and several others have been suggested by recent research, most of which fall in the range of $1 to $2 per vehicle-hour (2, 11, 12, 13, 14).

The travel time coefficient developed in this study was $63.68, which may be interpreted as the present value of expected savings in time and operating costs per minute of peak-hour driving-time. To convert this capital sum into a value for current driving time, it is necessary to put it on an annual basis, divide by the number of trips per year, and adjust for the associated savings in vehicle-operating costs. This last adjustment is necessary because the capitalized value of all components of accessibility will be reflected in the coefficient of the time variable and ignoring the non-time elements leads to an overestimate of the value of driving time. Using a discount rate of

10 percent the annual value is $6.37, which when spread over an estimated 500 trips yields $0.0126 per minute per trip. Adjustment for the associated saving in operating costs requires (a) conversion of minutes to miles, (b) selection of an appropriate average speed, and (c) determination of the outlays for gas, oil, tires, etc., at that speed.

A factor for converting minutes to miles can be derived from the mileage coefficient of the 1959 driving time regression reported in Table 1. The distance coefficient (2.73) was divided by 1.20, a factor commonly used to convert airline miles to road miles (15, p. 90). It is equal to 2.28, indicating that a difference of 1 min in driving time at the margin is associated with 1/2.28 = 0.44 mi. Thus, the saving of 1 min simultaneously saves the operating costs of driving 0.44 mi. This relation also indicates that average speed at the margin is 26.4 mph. Joseph (16) has calculated average operating costs to be $0.0312 per mi at 25 mph, and Winfrey (11), in an independent calculation, arrives at an estimate of $0.0368. (Winfrey explicitly includes an allowance for depreciation attributable to mileage, which may account for the difference between the estimates.) It is clear that the estimated value of $0.0126 per min does not even cover the saving in operating costs and implies a zero or negative valuation of driving time.

These calculations indicate that Mohring's conclusions would have been very different from what they were if he had taken account of savings in operating costs. His rent gradient is remarkably close to the one presented here. If his coefficient (2, p. 427) is converted to a per-lot basis, the capitalized value of time is $71.24 per min. The driving time estimates he used are most comparable with the 1955 Transportation Study times, which yielded a coefficient 10 percent higher than the 1959 figures. Therefore, an estimate equivalent to Mohring's of just over $70 is obtained. It thus appears that adjustment for operating cost savings would also absorb all of Mohring's gradient.

The reasons for this unexpected conclusion are not obvious. One might argue that house buyers are ignorant of locational differences in commuting time or operating costs, that they in fact place no value on time, or that they act irrationally in bidding for housing. None of these hypotheses is convincing. The care, time, and effort that buyers and sellers put into real estate transactions and the almost universal distaste for congested commuting argue strongly against such facile explanations. Nor is there any reason to question the estimates of operating costs that were used. The explanation must therefore lie either in the coefficient itself or in the series of adjustments that converted it into dollars per minute.

Considering first the adjustments, two possibilities are worth noting:

1. The 10 percent discount rate may be too low. Two factors tend to restrict the time period over which buyers would expect to receive the benefits of superior accessibility. The first is uncertainty about future transportation improvements, particularly freeway building and the much discussed mass transit plan for the Washington area. Secondly, much of Washington's population is notoriously transient. Both of these factors may influence buyers to discount future accessibility advantages very heavily.
2. The estimate of 500 trips per year may be too high. Washington has probably gone farther than any other metropolitan area in the development of car-pooling arrangements. Reducing the estimate to one round trip per week substantially lowers the adjustment for operating expenses. Car-pooling does not, however, lower the time cost of commuting; by increasing the circuity of travel, it probably increases it. The calculated value of time would therefore remain low.

A more basic question is whether the accessibility coefficients measure what they are intended to measure. Because accessibility is highly correlated with distance from the CBD, the coefficients will reflect the value of whatever else is correlated with distance and not included in other variables in the equation. Such factors as the presence of contaminants in the air, noise, and crime are examples of "distance-related" factors. Because they are undesirable and generally positively correlated with accessibility, their presence would cause the coefficients to understate the value of access. In view of the industrial structure of the Washington area and the geographic coverage of the sample, it would be expected that the value effect of these particular nuisances would be relatively small.

Accessibility is also correlated with two other factors that would tend to depress values—the age and density of housing. (The simple correlation coefficient relating accessibility and age of house was 0.24; between accessibility and square feet of lot, it was -0.35.) Though both age and lot size are explicitly included in the equation, the behavior of their coefficients is not inconsistent with the hypothesis that the accessibility coefficient is picking up some of their influence on price.

CONCLUSION

This study was prompted by gaps in knowledge about the value of transportation improvements. The findings have shown that sales prices set in the urban real estate market do reflect accessibility differences and that sales data can be used for estimating accessibility values. The value of job accessibility may have direct application in highway evaluation, but a test of its usefulness requires the calculation of "with" and "without" indexes for a specific improvement. The case for using these findings in evaluating savings in driving time is weaker, a major reason being the critical series of assumptions that must be made to convert the time coefficient to a value for driving time. Until more is known about the demand for trips to the CBD and how the urban land market discounts future benefits, this approach will have limited application.

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