THE DEMAND FOR HOUSING SPACE AND QUALITY

C. LANCE BARNETT
CHARLES W. NOLAND

R-2650-HUD
JULY 1981

HOUSING ASSISTANCE SUPPLY EXPERIMENT

Sponsored by

The Office of Policy Development and Research
U.S. Department of Housing and Urban Development

Rand
SANTA MONICA, CA. 90406

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PREFACE

This report was prepared for the Office of Policy Development and Research, U.S. Department of Housing and Urban Development, under Contract No. H-1789. It presents estimated demand functions for housing space and quality. It also shows how those demand functions can be used by policymakers to better understand and forecast households' choices.

The authors thank the many individuals on the Housing Assistance Supply Experiment staff who contributed directly and indirectly to the collection and processing of the data used here. Special thanks are due to Michael P. Murray and Ira S. Lowry, who offered excellent suggestions about how to proceed with the analysis; and to James P. Stucker and Naihua Duan, whose careful reviews showed us how to improve the document. We also thank Jan Newman for typing the successive versions of the draft, and Penny Post, our editor, who read those drafts and gave us consistently sound advice about how to improve them.

SUMMARY

This report presents estimated renters' and owners' demand functions for two attributes of housing that together fully compose housing: space and quality. The data came from Brown County, Wisconsin, in 1974 and St. Joseph County, Indiana, in 1975. Since intercounty differences were statistically insignificant, data from both were pooled. Because the demand functions for renters and owners were statistically distinct, separate equations were fit for each.

Households' demand for space and quality is assumed to depend on their housing expenditures, household structure, tastes, and the prices of space and quality. Because prices did not vary within the counties, the price term is not included. Household structure is measured by number of members, number of children, and type of head (e.g., couple, single parent, etc.). Differences in tastes are represented by education and age.

Much of what was found is not surprising. Space is expense inelastic, so that as households increase their housing consumption a constantly shrinking proportion is devoted to space. Conversely, quality is expense elastic, so that as expenditures increase a steadily expanding share is devoted to quality. This finding is entirely consistent with space being a necessity that families buy first, whereas quality is a luxury that families buy once they have satisfied their need for space.

Households' characteristics also influence their choices in predictable ways. Larger families buy more space, while households with children tend to buy less space per person than households composed only of adults. Older households tend to live in dwellings that are larger than would be expected from the size of the household alone.

A surprising finding was that although owners and renters have statistically distinct demand functions, virtually none of the difference in their consumption is attributable to tenure. On average, owners buy both larger and better housing than renters, but that fact is almost entirely accounted for by their spending more and having larger families. The same factors (expenditures and household characteristics) explain differences not only between tenure groups but also within subgroups, such as the elderly or large families.

The equations presented here can be quite helpful to those responsible for designing neighborhood revitalization programs and housing assistance programs, because they show the factors determining the mixture of space and quality that households would freely choose. Neighborhood decline is typically characterized by deteriorating housing quality. To stop and eventually reverse the decline, it is necessary to understand what households prefer—which the demand equations tell us—and then to choose a set of incentives to encourage households to occupy housing that meets socially desirable quality levels. The demand equations indicate the size of the subsidy that would be required to provide such incentives.

The equations can also be used to identify the subsidy necessary to induce households to participate in housing assistance programs. Such programs typically require households to occupy housing meeting certain consumption norms as to space and quality. The demand equations indicate both how far such norms are from what households would freely choose and what size of subsidy would be required to overcome resistance to meeting the norms.

Finally, the demand equations can be used to forecast future demand for the attributes of housing. If current trends continue from now to the end of the century, households will want

houses about the same size as those available today. However, the level of quality demanded then will be substantially greater than what is presently available. To put it simply, at the end of the century Americans will want dwellings that are not much larger but are much better than what they live in today.

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I. INTRODUCTION

Considerable evidence accumulated during the past decade indicates that housing demand is both price and income inelastic (e.g., see Polinsky, 1977; Mulford, 1979; and Mayo, Friedman, and Weinberg, 1979). That is, as the price of housing goes up, households spend both more money and a larger proportion of their income on housing. As income goes up, households likewise spend more money on housing, but it constitutes a smaller share of the income. Such information is useful to policymakers looking to anticipate shifts in housing demand, but does not explain how demand for housing attributes (such as number of rooms per dwelling, location, quality of residence, etc.) changes as households' income, expenditures, and characteristics change.

Yet the demand for attributes should be as important a consideration as the demand for housing as a whole.[1] America's population is changing. We are growing older, our families are becoming smaller, and we are becoming richer. These facts will affect not only how much housing we will demand but also the mix of space and quality that we will want in our housing. This report estimates demand functions for two summary attributes which together compose housing: space and quality.[2] The demand for these two attributes depends on each household's size, structure, taste for space versus quality, and how much it chooses to spend on housing.

If the desired mix differs drastically from what is available, the implications for specific cities and neighborhoods could be profound. Housing is distinguished from most other durable goods by its fixity and longevity; consequently, it is expensive to alter. Thus, a change in demand from one space/quality mix to another could easily result in depressed property values, undermaintenance, and urban blight in one area and rapidly inflating values and upgrading in another. Without knowledge of families' demand for attributes, policymakers are manifestly less able to anticipate shifts and design appropriate policies.

Familiarity with the demand for attributes is also valuable in designing and evaluating housing assistance programs. Such programs typically require recipients to occupy dwellings that meet consumption norms for both space and quality (e.g., no more than two persons per bedroom and no health or safety defects). To attract their target clientele, the programs must either (1) establish norms close to what those households would freely choose, or (2) offer a subsidy (e.g., rental reductions) sufficient to overcome potential recipients' resistance to meeting the norms. The demand functions for attributes could enable policymakers to estimate norms close to recipients' preferences as well as to gauge the size of the subsidy required to offset recipients' resistance.

Since we find that the demand for space rises with expenses but is expense inelastic, it follows logically that quality must be expense elastic. The reason for the difference is obvious: Space is essentially a necessity and therefore bought first, whereas quality is a luxury, purchased to an increasing degree only after a household has acquired enough space.

Our demand equations are fit to data for renters and owners in two north central housing markets.[3] Much of what we find is not surprising. For instance, the size and structure of

[1]Others have estimated attribute demand functions. See, for example, King (1976); Wheaton (1977); and Kain and Quigley (1975).

[2]We assume that housing is composed of only these two attributes. See Sec. II for justification.

[3]The two housing markets are Brown County, Wisconsin (whose central city is Green Bay), and St. Joseph County, Indiana (whose central city is South Bend). Those markets are being studied by the Housing Assistance Supply

households significantly affect their allocation of housing expenditures: Larger households buy more space, other things being equal. Another important observation is that demand functions are the same for renters in both counties, and also for owners. These two findings do much to bolster confidence in the reliability of the estimated demand functions, especially in view of the substantial differences between the two markets.[4]

An important discovery was that although owners' and renters' demands for housing attributes are statistically distinct, tenure per se has almost no effect on demand. To be sure, owners buy more of both space and quality, but the difference is almost entirely attributable to owners being older, having larger families, and spending more for housing. Consequently, in forecasts of future demand for space and quality, tenure can be safely ignored. All that matters is household characteristics and expenditures.[5]

Below, we detail how the data base was assembled. Section II presents key assumptions that underlie the model, its specifications, and our estimation procedure; Sec. III contains the demand equations, which show how variations in households' housing expenses, size, structure, and taste affect their demand for space and quality. Section IV summarizes our findings and shows how the demand equations could be used by policymakers.

DATA BASE

Our data come from the baseline surveys conducted by the Housing Assistance Supply Experiment (HASE) in Brown County in 1974 and in St. Joseph County in 1975. The surveys were part of an extensive series administered to a panel of owners and occupants of about 3,000 residential units situated on 2,000 properties in each county.[6] Four different surveys were conducted, one each of households, residential buildings, neighborhoods, and landlords. The primary source of our data was the household survey, which was addressed to both renters and homeowners to obtain information about their income, family structure, dwelling, and costs associated with occupancy. From renters the survey obtained the contract rent paid directly to the landlord, plus their expenditures for utilities, which together constitute gross rent. From owners it obtained the value of their home, annual expenditures for maintenance, repairs and improvements, and insurance. The survey also collected detailed information on each mortgage, such as its length, interest rate, initial value, and whether it had a balloon payment.

Data from the other three surveys were not directly used to arrive at the results reported here. They were used, however, to fit hedonic indexes; that is, regressions of rent on the attributes of dwellings and their location. The coefficients from the regressions are estimates of the market's consensus as to attribute prices.[7] These indexes enabled us to measure space and validate certain assumptions about the structure of attribute prices.

Experiment (HASE) to help the U.S. Department of Housing and Urban Development assess the desirability and feasibility of using housing allowances (direct cash payments made to eligible families who occupy housing that meets well-defined standards for health, safety, and adequacy) to enable low-income households to occupy standard housing. Lowry (1980) lays out the initial charter and research design for HASE.

[4]Brown County has had a persistently tight housing market and is racially homogeneous. St. Joseph County, on the other hand, has a loose housing market (the vacancy rate exceeds 13 percent in the central part of South Bend) and a sizable minority population that is residentially segregated.

[5]For some other applications of the demand equations, however, tenure should be explicitly accounted for.

[6]Properties and dwellings were chosen by a multistage stratified random sampling procedure. The main lines of stratification were property size, number of dwellings, rent or value, tenure, and location (urban or rural). Exact sampling histories are available for each observation, from which we can infer marketwide population parameters. For more complete information see Poggio (1980); and Berry, Relles, and Seals (1981).

[7]The indexes and sample characteristics are reported in Barnett (1979) and Noland (1980).

In our analysis sample we included only those records for dwellings with field-complete records[8] for each of the four surveys. Each record had to provide valid responses to nearly 400 individual survey items, which were used to construct the attributes included in the hedonic index. Furthermore, the household survey records had to have complete information on income and household characteristics.

The analysis sample used to fit the demand functions contains 3,568 records, which divide by tenure in each county as follows:

	Renters	Owners
Brown County	1,556	698
St. Joseph County	956	358

The number of renter records is much larger than the number of owner records, because many more renters were sampled.[9] The records we used did not include those for occupants of mobile homes, rooming houses, and rented rooms. Also excluded were renters not paying full market rent because they were related to or employed by the landlord.

The strictness of those criteria resulted in substantial attrition from the number of household records that were field-complete at baseline (see Table 1). We do not think that the loss biases our coefficients, though, since the distributions of rent, income, household size and, most important, space are comparable to those for the field-complete records.

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[8]Field-complete records correspond to successfully completed interviews. They do not necessarily contain usable data in every response field.

[9]A primary research objective of HASE is to measure the effect of a full-scale housing allowance program on the price of housing. We expected such price effects to be larger in the rental sector of the housing market, so we used a larger sampling rate there.

Table 1

COMPARISON OF FIELD- AND ANALYSIS-COMPLETE RECORDS

Site and Tenure	Number of Records		Loss Rate[a] (%)
	Field-Complete	Analysis-Complete	
Brown County			
Renters	2,835	1,556	45.1
Owners	886	698	21.2
St. Joseph County			
Renters	2,130	956	55.1
Owners	609	358	41.2

SOURCE: Tabulated by authors from baseline household surveys in Brown and St. Joseph counties.

NOTE: Field-complete records are those for which a completed interview was successfully fielded. Such records need not have complete information for each relevant survey item. See text for criteria defining analysis-complete records.

[a]The loss rate equals the percentage of field-complete records that were not analysis-complete.

II. THE MODEL

ASSUMPTIONS

The model used here rests on several assumptions. First, we assume that in choosing among dwellings consumers consider the specific mixture of attributes offered by each, not just the market consensus as to the overall "quantity" of housing service. Given identical rents, a two-bedroom dwelling with a modern kitchen will appeal to some consumers more than a three-bedroom dwelling with an old-fashioned kitchen; for others, preferences would be reversed.

Our second assumption is that households choose their optimal consumption bundle in two steps. They first decide how much of their income to spend on housing attributes versus all other goods, a decision that depends on their income as well as attribute prices and prices of other goods. They then choose how much of each housing attribute to consume, without regard to the price of any other nonhousing good. In short, they choose housing attributes based only on attribute prices and how much they want to spend on housing.[1]

The next assumption is that attributes are traded in perfectly competitive markets that are in equilibrium. Every consumer therefore faces the same set of attribute prices, and the price paid by an individual consumer is independent of the quantity he purchases. We have verified that assumption empirically; as mentioned above, hedonic indexes have been fit to data for the rental markets in both Brown and St. Joseph counties. Both times they supported the assumption of a single set of attribute prices, with the characteristics discussed above.[2]

Since the prices of space and quality do not vary within a market, the responsiveness of demand to price variation cannot be estimated. However, the absence of variation also allows us to exclude prices from the estimating equations without biasing inferences about how other factors affect demand.[3] Thus, for example, we can accurately estimate the effect of different expenditure levels on demand.

Another assumption we make is that dwellings consist of only two attributes, space and quality. To measure the amount of space consumed by a household, we use the attribute prices—expressed as dollars per month—prevailing in Brown County's rental housing market in 1974. Explicitly, the quantity of space, S, is measured as follows:

$$S = \$48(ln(\text{Rooms})) + \$19(\text{Bathrooms}) \tag{1}$$

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[1]The equivalent assumption is that consumers have weakly separable utility functions, in which housing attributes are kept separate from all nonhousing goods. For discussions of such functions and their implications for demand analysis see Goldman and Uzawa (1964); Gorman (1959); and Strotz (1957).

[2]We fit linear hedonic indexes that have cross-sectionally constant attribute prices. To test the assumption of constant attribute prices, we divided the appropriate data into groups corresponding to possible submarkets that might be supporting distinct sets of attribute prices. In Brown County, the submarkets were defined by dwelling type; in St. Joseph County, they were defined by geographical location. In neither market did attribute prices vary meaningfully across the submarkets tested.

[3]It is possible to fit hedonic indexes that yield cross-sectionally varying prices. For example, hedonic indexes using the log of rent as their dependent variable yield such prices. However, those attribute prices cannot be used to estimate price responsiveness, since they and the quantity purchased are simultaneously determined. Moreover, it is not possible to use standard econometric procedures (e.g., two-stage least squares) to remove the bias that attends simultaneity, since everything that determines the quantity demanded also affects the price paid.

Space consumption is thus measured by expenditures. We assume that quantity equals expenditures, which is justified by price being constant.

Table 2 shows how space varies with the number of rooms and bathrooms in a dwelling. For example, a dwelling consisting of one and one-half rooms[4] and a full bath provides 38 units of space. Doubling the number of rooms in that dwelling would about double the amount of space (38 to 72 units).

Table 2

SPACE CONSUMPTION ACCORDING TO DWELLING SIZE

Number of Rooms	Number of Bathrooms				
	.5	1.0	1.5	2.0	2.5
1.5	29	38	48	57	67
2	43	52	62	71	81
3	62	72	81	91	100
4	76	86	95	105	114
5	87	96	106	115	125
6	96	105	115	124	134
7	103	112	122	131	141

SOURCE: Tabulated by authors from hedonic prices for 1974 Brown County rental housing.

NOTE: Entries in table were obtained by evaluating $S = \$48(ln(\text{Rooms})) + \$19(\text{Bathrooms})$ at the indicated values for rooms and bathrooms.

We use a single measure of space consumption to obtain comparability across counties and tenure. An alternative choice would have been to fit hedonic indexes (regressions of rents or values on the attributes of dwellings and their location) with data from the rental and owner markets in each site and then use the resulting prices to construct four expenditure measures. Attribute prices would presumably vary across counties and tenure, so that the prices of space and quality would have to be in the demand functions. However, any specification error in one of those indexes would induce a positive, albeit spurious, correlation between prices and expenditures. The estimated elasticities would be biased. Moreover, if the specification errors are correlated with household characteristics, estimates of their effects would also be biased.[5]

[4]By definition the only type of dwelling with a half room is an efficiency with complete kitchen facilities. For all larger dwellings the kitchen is counted as a whole room.

[5]The specification for space actually used has been checked for such correlations. None of operational significance was found (Barnett, 1979, pp. 32-37).

We measure quality (the only other attribute supplied by dwellings) as

$$Q = E - S \tag{2}$$

where Q = quality, and
E = monthly gross rent for rental dwellings and imputed monthly housing expense for owner-occupied dwellings.

This way of measuring quality clearly oversimplifies reality, since quality as defined above includes the effects of differing location attributes. (A dwelling's rent includes some payment for its location.) Assuming that the demand for quality differs from that for location, then lumping them together could distort inferences, especially in a major city where location attributes vary greatly. However, in Brown and St. Joseph counties location attributes vary only slightly, mainly because residential parts of the counties are relatively small; the edge of the residential area is only about 30 minutes from the central business district. Moreover, hedonic indexes fit with data describing the rental markets in both counties indicate that differences in the location attributes contribute very little to the variation in rent (see Barnett, 1979; and Noland, 1980). Therefore, we think that using the measure of quality defined above yields valid inferences.

SPECIFICATION

Households' demand for space and quality depends on how much they spend for housing, the prices of space and quality, and taste. In symbols,

$$S = f(E/P_q, P_s, T) \tag{3}$$

$$Q = g(E/P_q, P_s, T) \tag{4}$$

where S = the quantity of space demanded,
E/P_q = housing expense normalized by the price of quality,[6]
P_s = the price of space,
T = taste,
Q = the amount of quality demanded.

Estimating the parameters of the demand equation requires a functional form. The one used here is

$$S = \beta_0 \cdot \prod_{i=1}^{5} x_i^{\beta_i} \cdot exp \sum_{j=1}^{4} d_j \delta_j \tag{5}$$

[6]In order for any demand function to satisfy the axioms of consumer theory, the amount of money available must be normalized by the price of one good. Here, we have chosen the price of quality.

where S = the quantity of space demanded,
β_0 = the constant term,
x_1 = housing expense (E in Eqs. (3) and (4)),
x_2 = number of persons in household,
x_3 = number of minors,
x_4 = age of head of household,
x_5 = education of head of household,
β_i's = elasticities,[7]
d_1 = indicator variable for households containing a husband and wife,
d_2 = indicator variable for households headed by a single parent,
d_3 = indicator variable for nonwhite households,
d_4 = indicator variable for households living in St. Joseph County,
δ_j = percent change in space consumption associated with being in the indicated group.

Equation (5) does not include any prices because they are constant, at least within each of the four markets (i.e., renters and owners in each site). To the extent price does vary between counties, the variable indicating whether a household lives in St. Joseph County will control for the difference.

Household characteristics are included in Eq. (5) to account for differences in the need for space due to household size and composition as well as for differences in household tastes. The latter are represented by age and education.

It is not necessary to fit an equation like Eq. (5) for the demand for quality. By definition, expenditures for space and quality exhaust housing expense. Consequently, if one knows how the demand for space varies, one also knows how the demand for quality varies. For example, the demand for space is expense inelastic so that as housing expense rises the percentage increase in space is less than that for expenses. The percentage increase in quality demanded must therefore exceed the percentage change in expenses. Similarly, if for a given expenditure one type of household consumes less space than others, it must consume more quality.

ESTIMATION

Equation (5) can be estimated using ordinary least squares (OLS), since taking the natural logarithm of both sides yields an equation that is linear in the parameters. However, the OLS estimator for the expense elasticity of demand for space would be biased, because individual households are out of equilibrium. (Such disequilibrium arises because households do not continuously tailor their housing consumption to their current circumstances.) If, as seems likely, households who spend more (or less) than their desired amount also consume more (or less) space, then the OLS estimator of the expenditure elasticity would be biased upwards.[8]

To remove that bias we used a two-stage estimation procedure. The first stage regressed housing expense on the logarithm of households' current income[9] and all the independent

[7]Elasticities are unit-free measures of responsiveness. Here they indicate the percentage change in space that results from a given percentage change in, for example, housing expense.

[8]The bias could affect more than the expenditure elasticity; the correlation between overspending and overconsumption of space could bias all the coefficients.

[9]As measured by the previous year's income.

variables in Eq. (5) except housing expense. Separate regressions were fit for owners and renters in each site.[10]

The first-stage regressions are presented in Appendix Tables A.1 and A.2. Their estimated coefficients and their overall goodness of fit are generally similar to those found by Mulford (1979), who has estimated the income elasticity of housing demand with HASE data. However, our income elasticities lie well below 1.0:

	Brown County	St. Joseph County
Renters	.100	.117
Owners	.171	.166

and are quite small relative to what others, including Mulford, found (e.g., see Polinski, 1977).

The difference is largely due to our use of current rather than permanent income, and in fact is not important here; the regressions also include the traditional determinants of permanent income, which will compensate for the small income elasticities. Since our primary purpose is to remove bias in the estimated parameters of the demand for space, we are more concerned with overall predictive ability than with individual coefficients. The second stage substitutes predicted housing expense from the first stage for actual housing expense and then estimates Eq. (4) with ordinary least squares.[11] The results of the second-stage estimator are presented in Sec. III.

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[10]For renters, housing expense is monthly gross rent, as defined earlier. Homeowners' housing expense was predicted from owners' estimates of property value using these regressions:

$$\text{in Brown County, } E' = 605 + .103V$$

$$\text{in St. Joseph County, } E' = 931 + .097V$$

where E' = annual cost of homeownership, including the opportunity cost of holding wealth as equity,

V = estimated property value.

The regressions were developed by Helbers (1980). We use these estimates rather than actual expenses to remove the large random component in actual expenses due to the highly stochastic nature of annual repair expenditures.

[11]Essentially, Eq. (5) was estimated with a two-stage least squares estimator because expense is endogenous.

III. THE DEMAND EQUATIONS

The demand equations were fit separately for renters and owners because the data indicated that their demand equations were statistically distinct. The evidence consists of an F-test of the null hypothesis that renters and owners have identical demand parameters.[1] The appropriate F-statistic had 9,3556 degrees of freedom and a value of 9.58, which greatly exceeds the 99 percent confidence value of 2.41. However, despite that strong statistical signal, renters and owners do not appear to behave in fundamentally different ways. Virtually all of the difference in their consumption of space and quality can be accounted for by differences in spending and household characteristics. We will return to this point at the end of this section.

On the other hand, data from Brown and St. Joseph counties were pooled to estimate renters' and owners' demand equations. Support for this pooling came from F-tests for statistically distinct demand parameters between counties. The F-statistics have 9,2502 and 9,1046 degrees of freedom for renters and owners, respectively. The values of the F-statistics were 0.22 for renters and 2.27 for owners. Both values are less than the 99 percent confidence value of 2.41. (Tables A.3 through A.6 present demand parameters obtained from unpooled data.)

Tables 3 and 4 present the estimated demand parameters for renters and owners, respectively.[2] For both renters and owners, space is expense inelastic. By implication, then, quality must be expense elastic.

The estimated and implied elasticities[3] are:

	Renters	Owners
Space	.26	.35
Quality	2.32	1.65

The difference between elasticities of the two attributes is striking. A 10 percent increase in housing expense will increase the demand for space by only about 3 percent while the demand for quality will go up by 17 to 23 percent, depending on tenure. That differential has important implications for future demand patterns, which we discuss in Sec. IV.

Although housing expenses clearly influence the amount of space demanded, household size and structure are more important determinants, judging by their t-values. A 100 percent increase in household size will increase the demand for space by 10 to 20 percent. The effect of compositional differences among households varies by tenure: In a household of a given size, the number of children in the household affects renters' demand but not owners'. A renter household with three adults and one child consumes, on average, about 3 percent more space than an otherwise comparable household with two adults and two children. That difference seems sensible: Adults need more private space. However, a difference in the mix of adults and

[1]The test here was developed by Chow (1960). Here we allow the intercept to differ by site, which it does for owners. Below, we consider what that means. Tables A.3 through A.6 present the demand equations for the four tenure/county combinations.

[2]For means and standard deviations, see Table A.7.

[3]The implied elasticities for quality are derived by using the fact that the elasticity of space weighted by its share of housing expense and the elasticity of quality weighted by its share of expense must sum to 1. For proof of this proposition see Frisch (1959), pp. 177-196.

Table 3

RENTERS' DEMAND FOR SPACE:
REGRESSION RESULTS

Variable	Range of Values[a]	Regression Statistics	
		Coefficient	t-value
Dependent			
Space (ln)	28-150	--	--
Independent			
Housing expense (ln)	68-245	.255	4.670
Number in household (ln)	1-14	.195	11.164
Number of children (ln)	1-11	-.039	-3.203
Couples	Yes=1, No=0	-.031	3.399
Single parent	Yes=1, No=0	.014	.969
Black	Yes=1, No=0	.020	1.246
St. Joseph County	Yes=1, No=0	.002	.282
Age (ln)	17-96	.078	8.316
Education (ln)	1-25	-.021	-1.224
Constant	--	2.847	11.802

SOURCE: Fit by the authors with 1974 data from Brown County and 1975 data from St. Joseph County.

NOTE: Space and housing expense measured in 1974 dollars. R^2 = .34, F-statistic = 140.00, standard error of estimate = .16, N = 2,512.

[a]Untransformed values are given for variables measured in logarithms.

children in owner households does not affect their demand for space. Renters and owners thus appear to respond differently to changes in their household structure: Renters tailor their consumption, owners do not.

This asymmetry in responses suggests that the way household size and number of children affect the demand for space and quality is not correctly specified here. One possible change would be to include the children's ages in the demand equations. Younger children often share bedrooms, whereas older children tend to have separate bedrooms. Another possible correction would be to incorporate the sex of the children in the demand equations. Two boys or two girls can share a bedroom, but a boy and a girl usually have separate bedrooms.

However, we think that the asymmetry cannot be removed by changing the specification. It costs renters less to move than owners, since renters do not have to pay the substantial transaction costs associated with selling one home and buying another. Renters' consumption of space and quality should therefore be closer than owners' to their equilibrium demand. As a consequence, owners' measured household size may bear an errors-in-variables relationship to their consumption. Their current housing may have been chosen for a household larger or smaller than they presently need; that is, either in anticipation of a larger household size in

Table 4

OWNERS' DEMAND FOR SPACE:
REGRESSION RESULTS

Variable	Range of Values	Regression Statistics	
		Coefficient	t-value
Dependent			
Space (ln)	45-181	--	--
Independent			
Housing expense (ln)	100-400	.350	7.015
Number in household (ln)	1-12	.102	5.888
Number of children (ln)	1-9	.000	.015
Couples	Yes=1, No=0	-.085	-5.789
Single parent	Yes=1, No=0	-.082	-2.985
Black	Yes=1, No=0	.088	3.214
St. Joseph County	Yes=1, No=0	.049	3.939
Age (ln)	18-95	.060	4.340
Education (ln)	1-26	.023	1.411
Constant	--	2.415	9.482

SOURCE: Fit by authors with 1974 data from Brown County and 1975 data from St. Joseph County.

NOTE: Space and housing expense measured in 1974 dollars. R^2 = .23, F-statistic = 33.93, standard error of estimate = .12, N = 1,056.

the future (e.g., young couples) or to accommodate a larger household in the past (e.g., elderly households). Alternatively, they may not have anticipated their current size.

Households that include a couple consume 3 to 8 percent less space than households composed of the same number of single adults, doubtless because couples normally share a bedroom. Being a single parent cuts consumption only for owners, though, where the drop is about equal to that for couples. Most owners who are single parents have just become so, owing to death or separation, so their current consumption should resemble that of couples. Single parents who rent appear to adjust their living space more promptly to household composition.

Race does not affect renters' consumption, but black owners consume significantly more space (about 9 percent) than their white counterparts. By implication they consume less quality. However, since black households compose only about 2.5 percent of the owners' sample, or 26 observations (see Appendix Table A.7), their group behavior may be idiosyncratic to those households.

The indicator variable for St. Joseph County is significant only for owners. The positive sign is consistent with space being cheaper there. St. Joseph County has an exceptionally loose housing market (in 1975 the countywide vacancy rate exceeded 10 percent) and, consequently,

greatly depressed property values.[4] We think that these depressed values decrease the price of space relative to that of quality because the latter partly consists of appliances whose value should be unaffected by housing market conditions. If the relative price of space is lower in St. Joseph County, then more of it would be bought. No such effect is found for renters because rents between the two sites barely differ (Rydell, 1979).

Individual households' demand for space and quality will also depend on personal tastes. Here two variables are used to measure the effects of taste differences: age and education. Regardless of tenure, elderly households buy more space than younger households, and by implication less quality given the same expense. That preference for space over quality is consistent with the fact that elderly homeowners spend less on maintenance, thus letting their quality consumption fall (Helbers and McDowell, forthcoming). Note, however, that since elderly renters and owners both display preference for space relative to quality, elderly owners' undermaintenance cannot be solely the result of diminished physical abilities as is commonly supposed.

Education affects renters' and owners' demand in opposite ways: Renters with more education demand less space (more quality), whereas owners with more education demand more space (less quality). There are plausible explanations for both outcomes. People with more education may have a greater preference for quality, which is how renters behave. On the other hand, people with more education may have a greater preference for privacy, which is the owners' choice. Why the relationship should reverse with tenure is unclear; it may have to do with which kinds of households choose to be homeowners.

Finally, both regressions fit the data as well as most behavioral equations fit to individual data. We are able to explain a third of the variation in renters' consumption of space and slightly less than a quarter for owners. The difference in explanatory power is consistent with renters consuming closer to their equilibrium amounts than owners.

CONSUMPTION PATTERNS

Although the estimated demand equations for owners and renters differ statistically, that difference does not significantly affect consumption patterns. Owners' larger expenditures for both space and quality (see Table 5) are predominantly due to their having different household characteristics, especially their higher overall housing expenditures. For example, about two-thirds of the difference between renters' and owners' consumption of space is attributable to the differences in their housing expenditures.

The patterns in Table 5 reflect the demand elasticities described earlier. Owners spend on average about 54 percent more than renters, which results in their consuming about a fifth more space but more than twice as much quality (except for black households).

To demonstrate that tenure alone has little effect on the demand for housing attributes, we compare estimated demand for both tenure groups, predicted first with the renter equation and then with the owner equation (see Table 6). To reinforce our point we subdivide each tenure group by household type. The top half of Table 6 compares consumption of space predicted for renters, using each of the equations. The average housing expenditure and characteristics of each household type are substituted first into the renter demand equation and then into the owner equation to predict how much space each subgroup would consume. The results tell us

[4]See Rydell (1979) for the facts and a theory that links vacancy rates, rents, and property values.

Table 5

AVERAGE ACTUAL EXPENDITURES FOR SPACE AND QUALITY BY TENURE AND HOUSEHOLD TYPE

Household Type[a]	Average Expenditure ($/Mo.)			
	Space		Quality	
	Renters	Owners	Renters	Owners
Small	77.51	96.23	45.52	91.95
Large	91.77	103.85	49.96	98.10
Young head	82.56	101.16	51.70	110.07
Elderly head	78.51	97.13	28.69	83.05
Black	86.93	99.40	43.00	41.35
White	82.99	101.18	47.79	102.57
All	83.19	101.13	47.55	100.78

SOURCE: Tabulated by the authors with 1974 data from Brown County and 1975 data from St. Joseph County.

NOTE: Expenditures are measured in 1974 dollars.

[a]Large households are those with 6 or more members; small households have 1 or 2 members. Elderly heads are over 65; young heads are 35 or younger.

the amount of space renters would demand if they behaved according to the parameters of the owner demand equation: about the same as owners. We repeated the procedure for owners (see the bottom half of Table 6). Demand for quality, computed as the difference between total desired housing expenditure and predicted demand for space, is shown in Table 7.

For both tenure groups, predicted consumption is insensitive to which demand equation is used, differing by less than $4 per month for all except black households. Thus nearly all of the consumption difference noted in Table 5 results from differences in demographic characteristics and total housing expenditure. Virtually none is due to tenure per se.

Table 6

CONSUMPTION OF SPACE BY TENURE AND HOUSEHOLD TYPE

Household Type[a]	Predicted Space Expense ($/Mo.)	
	Renter Equation	Owner Equation
Renters		
Small	77.66	80.86
Large	90.42	88.02
Young head	82.62	84.02
Elderly head	79.75	80.44
Black	86.93	95.49
White	82.99	83.78
Average	83.10	84.26
Owners		
Small	92.18	95.80
Large	105.28	104.05
Young head	98.95	100.64
Elderly head	93.50	95.08
Black	92.33	99.40
White	100.62	101.18
Average	100.12	101.49

SOURCE: Tabulated by the authors with 1974 data from Brown County and 1975 data from St. Joseph County.

NOTE: Consumption of space is measured in 1974 dollars.

[a]Large households are those with 6 or more members; small households have 1 or 2 members. Elderly heads are over 65; young heads are 35 or younger.

Table 7

CONSUMPTION OF QUALITY BY TENURE AND HOUSEHOLD TYPE

Household Type[a]	Predicted Quality Expense ($/Mo.)	
	Renter Equation	Owner Equation
Renters		
Small	45.47	42.28
Large	50.86	53.26
Young head	51.50	50.10
Elderly head	27.30	26.61
Black	43.00	34.44
White	47.79	47.00
Average	47.22	46.06
Owners		
Small	97.19	93.56
Large	103.08	104.31
Young head	109.36	107.66
Elderly head	84.21	82.62
Black	48.41	41.35
White	103.13	102.57
Average	102.23	100.86

SOURCE: Tabulated by the authors with 1974 data from Brown County and 1975 data from St. Joseph County.

NOTE: Consumption of quality is measured in 1974 dollars.

[a]Large households are those with 6 or more members; small households have 1 or 2 members. Elderly heads are over 65; young heads are 35 or younger.

IV. CONCLUSIONS

The key findings from this report are:

- Space is a necessity that households buy first. As their housing expenses increase, a larger fraction goes to buy more quality.
- Household size and structure are important determinants of space and quality demand. For example, larger families and older families spend more of their housing dollar on space; couples spend comparatively less.
- Even though owners and renters have statistically distinct demand functions, differences in their consumption can be almost completely accounted for by the owners being older, having larger families, and spending considerably more. Almost none of the difference in consumption is attributable to the differences between owners' and renters' demand functions.

At the beginning of this report, we discussed several ways in which policymakers could use the demand equations. The tenure-specific demand equations could be used for targeting and fine-tuning neighborhood revitalization programs. Neighborhood decline is associated with deteriorating housing quality or, to put it another way, housing that offers too much space relative to its quality. To stop and eventually reverse neighborhood decline, demand must be increased. The demand equations describe consumers' preferred space/quality mix, so policymakers can tell how much of an increase in quality is necessary for a neighborhood's housing to match consumers' preferences. A comparison of that change and the cost of achieving it would indicate the size of the subsidy that would be required, if revitalization is to take place without displacing current residents.

The equations can also help in the design of housing assistance programs. The purpose of these programs is to enable low-income households to afford safe, decent, and sanitary housing. Such programs operate by subsidizing (usually through rent reductions) the housing consumption of eligible households, provided they occupy dwellings that meet certain norms, such as one bedroom for every two persons in the household. The subsidy not only lets low-income families afford acceptable housing; it also compensates them if they have to occupy housing perhaps better than what they would choose on their own, given their limited resources.

The demand equations presented above can predict what a household with a given set of characteristics would choose at each level of expenditure,[1] which makes them useful to policymakers concerned with designing housing assistance programs. Would households left to their own devices (and resources) choose the kind of housing defined by such programs as acceptable, or would it be necessary to set and enforce program norms in order to ensure that they occupy acceptable dwellings? Enforcement may not be necessary, either because households already occupy acceptable housing, or because giving them a subsidy large enough to allow them to afford acceptable housing will result in their freely choosing it. However, since the equations only predict average behavior, such findings do not guarantee that all households would choose acceptable housing. What policymakers must decide is whether enforcement costs are outweighed by the benefits of ensuring that norms are met by every household.

[1]These quantities are easy to compute: All that is required are values for the independent variables and the equations discussed above.

If policymakers decide that norms should be imposed, the demand equations can be used to estimate the size of the subsidy needed. At a minimum it would have to equal the difference between the cost of the housing that targeted households could afford and the cost of what the consumption norms require them to occupy. That was roughly the basis for the subsidy formula used by the Section 8 (Existing) Program: The subsidy there corresponds to the difference between what a household could afford and what the consumption norms compel them to choose.

Households' choices between space and quality depend on families' size, structure, and real housing expenses. Thus, the demand functions can easily be combined with forecasts of those variables to predict households' future housing choices. For example, consider what the average household will demand in the year 2000.

Even though household size and structure greatly influence households' choices at any given time, they will have little effect on future demand patterns because demographic characteristics change slowly. The average household size today is 2.7 persons. By the end of the century it should be close to 2.5 persons. The demand equations indicate that such a reduction in family size would cut space consumption by 1 percent. The aging of Americans will have even less effect on demand. The median age today is 30; at the end of the century it will only be about 32.

What will affect demand greatly is growth of real income. Suppose that real incomes increase by 2 percent per year between now and the end of the century. If housing expenses keep pace with that growth (real income and real housing expenses have grown at the same rate since 1950), the demand for space would rise 13 percent per household, while the demand for quality would nearly double.

The demand equations combined with the assumptions above produce a clear message: Regardless of what happens to the tenure mix, 20 years from now Americans will want dwellings that are not much bigger but are of a much better quality than what is available today.

Appendix

SUPPLEMENTARY TABLES

Table A.1

RENTERS' HOUSING EXPENSE: REGRESSION RESULTS FOR BROWN AND ST. JOSEPH COUNTIES

Item	Brown County	St. Joseph County
Independent Variable		
Total household income (ln)	.101[a]	.119[a]
Number in household (ln)	.165[a]	.264[a]
Number of children (ln)	-.039[b]	-.081[a]
Couples	-.012	-.043[b]
Single parent	.123[a]	.054[b]
Black	*(c)*	.007
Age (ln)	-.011	-.047[a]
Education (ln)	.168[a]	.117[a]
Constant	4.168[a]	4.438[a]
Statistic		
R^2	.218	.274
F	61.702	44.797
Standard error of estimate	.229	.247

SOURCE: Tabulated by the authors from 1974 data from Brown County and 1975 data from St. Joseph County.

NOTE: The dependent variable is the logarithm of total housing expense, measured in 1974 dollars.

[a] Significant at the 95 percent confidence level ($t > 1.96$).

[b] $t > 1$.

[c] Because Brown County has almost no minority population, the race variable was omitted from the Brown County regression.

Table A.2

OWNERS' HOUSING EXPENSE: REGRESSION RESULTS FOR BROWN AND ST. JOSEPH COUNTIES

Item	Brown County	St. Joseph County
Independent Variable		
Total household income (ln)	.168[a]	.171[a]
Number in household (ln)	-.072[b]	-.076[b]
Number of children (ln)	.065[b]	.051[b]
Couples	.019	.103[a]
Single parent	-.012	.035
Black	(c)[b]	-.204[a]
Age (ln)	.035[a]	.004
Education (ln)	.108[a]	.104[a]
Constant	4.606[a]	4.500[a]
Statistic		
R^2	.192	.233
F	23.343	13.257
Standard error of estimate	.224	.257

SOURCE: Tabulated by the authors from 1974 data from Brown County and 1975 data from St. Joseph County.

NOTE: Space and housing expense are measured in 1974 dollars.

[a] Significant at the 95 percent confidence level ($t > 1.96$).

[b] $t > 1$.

[c] Because Brown County has almost no minority population, the race variable was omitted from the Brown County regression.

Table A.3

DEMAND FOR SPACE: REGRESSION RESULTS FOR BROWN COUNTY RENTERS

Independent Variable	Regression Statistics	
	Coefficient	t-value
Housing expense (ln)	.200	2.641
Number in household (ln)	.202	9.725
Number of children (ln)	-.025	-1.790
Couples	-.031	-2.876
Single parent	-.004	-.203
Age (ln)	.074	6.488
Education (ln)	-.048	-1.870
Constant	3.190	9.885

SOURCE: Fit by the authors with 1974 data from Brown County.

NOTE: Space and housing expense measured in 1977 dollars. R^2 = .35, F-statistic = 120.27, standard error of estimate = .15, N = 1,556.

Table A.4

DEMAND FOR SPACE: REGRESSION RESULTS FOR BROWN COUNTY OWNERS

Independent Variable	Regression Statistics	
	Coefficient	t-value
Housing expense (ln)	.358	5.644
Number in household (ln)	.115	5.214
Number of children (ln)	-.006	-.310
Couples	-.096	-5.187
Single parent	-.088	-2.507
Age (ln)	.067	3.826
Education (ln)	.030	1.390
Constant	2.330	7.350

SOURCE: Fit by the authors with 1974 data from Brown County.

NOTE: Space and housing expense measured in 1974 dollars. R^2 = .24, F-statistic = 31.93, standard error of estimate = .12, N = 698.

Table A.5

DEMAND FOR SPACE: REGRESSION RESULTS FOR ST. JOSEPH COUNTY RENTERS

Independent Variable	Regression Statistics	
	Coefficient	t-value
Housing expense (ln)	.416	4.575
Number in household (ln)	.163	4.818
Number of children (ln)	-.055	-2.440
Couples	-.030	-1.841
Single parent	.042	1.796
Black	.025	1.399
Age (ln)	.086	5.141
Education (ln)	-.009	-.368
Constant	2.035	4.920

SOURCE: Fit by the authors with 1975 data from St. Joseph County.

NOTE: Space and housing expense measured in 1975 dollars. R^2 = .33, F-statistic = 57.28, standard error of estimate = .18, N = 956.

Table A.6

DEMAND FOR SPACE: REGRESSION RESULTS FOR ST. JOSEPH COUNTY OWNERS

Independent Variable	Regression Statistics	
	Coefficient	t-value
Housing expense (ln)	.306	3.536
Number in household (ln)	.082	2.893
Number of children (ln)	.007	.282
Couples	-.064	-2.525
Single parent	-.076	-1.703
Black	.077	2.406
Age (ln)	.047	1.990
Education (ln)	.019	.760
Constant	2.748	6.253

SOURCE: Fit by the authors with 1975 data from St. Joseph County.

NOTE: Space and housing expense measured in 1975 dollars. R^2 = .18, F-statistic = 9.26, standard error of estimate = .13, N = 358.

Table A.7

MEANS AND STANDARD DEVIATIONS OF VARIABLES USED TO FIT DEMAND FUNCTIONS FOR SPACE

Variable	Renters		Owners	
	Mean	Standard Deviation	Mean	Standard Deviation
Dependent				
Space (ln)	4.42	.20	4.62	.14
Independent				
Housing expense (ln)	4.87	.13	5.31	.16
Number in household (ln)	.74	.57	1.07	.58
Number of children (ln)	.39	.56	.62	.64
Couples	.48	.50	.80	.40
Single parent	.09	.29	.02	.15
Black	.05	.22	.02	.16
St. Joseph County	.38	.49	.34	.47
Age (ln)	3.43	.39	3.82	.35
Education (ln)	2.55	.27	2.45	.32

SOURCE: Tabulated by the authors from 1974 data from Brown County and 1975 data from St. Joseph County.

NOTE: Space and housing expense are measured in 1974 dollars.

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