Income Elasticity of Housing Demand
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equations) that I did not regard this to be a critical failure of the model.[2]

My subsequent adjustment of the constant term to raise the participation rate estimates for 1930 and 1940 to the census levels is not a procedure that would achieve conformity to any level whatever, nor is it circular. I was adjusting one parameter to hit two targets. The targets were Lebergott's own carefully adjusted decennial census figures, whose validity I was not questioning and did not set out to test. I could not have hit any two arbitrary targets in this way, and I could not have hit these particular targets unless my prediction errors were similar in these two years.

So much for the methodological issues. Let me turn now to the substance of my findings. Lebergott alleges that our labor force series are basically very similar — differing by less than 2 per cent in all but four years.[3] He fails to mention or comment on the

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[2] I did offer some speculations as to what structural changes might have accounted for a higher constant term in the prewar period. Lebergott is correct in noting that the shifts in the age structure and residence structure of the population which I discussed might be captured in trend-like variables in my equation — the wage rate, in particular. But neither the wage variable nor the population changes noted above followed a smooth, constant trend over the period 1922–1966. Hence, we should not expect the wage variable to account fully for these shifts in the structure of the population. Also, Lebergott ignores my discussion of changing expectations of workers regarding the "full-employment unemployment rate" as a factor that might have influenced the level of constant term.

[3] Lebergott states in the first paragraph of his comment that ". . . Professor Coen is able to reproduce my 1922–1940 labor force series with considerable fidelity ($R^2 = .90$)." The statistical comparison referred to in his statement is not very informative, however, because movement of the labor force over time is dominated by the trend in population, so that any two reasonable labor force series are bound to be highly correlated. More revealing is a comparison of his participation rate series and my participation rate series for 1922–1940. The correlation between our participation series is $-.056$, and the coefficient of determina-

fact that my estimates are consistently above his during the 1920's and consistently below his for the 1930's. The result is that my estimates of unemployment rates are substantially higher for most of the 1920's and substantially lower for most of the 1930's. The differences are striking. Did the unemployment rate for the period 1923–1929 average 3.2 per cent (Lebergott's estimate) or 5.1 per cent (my estimate)? Was the 1926 unemployment rate 1.8 per cent (his estimate) or 4.1 per cent (my estimate)? Was the unemployment rate declining in 1934 (his conclusion) or rising (my conclusion)? If Lebergott's series is to be taken at face value, and it has been widely accepted and often used, then we must conclude that the period of the 1920's was an aberration in our recent history, since we were then apparently able to achieve simultaneously very low unemployment rates and remarkably stable prices. My estimates suggest that the aberration is not so much in the experience of the twenties as in Lebergott's unemployment series which does not take account of the influence of changing labor market conditions on participation.

While I recognize that these provocative questions regarding unemployment in the 1920's and 1930's can never be answered with a high degree of certainty, I do not agree with Lebergott that we should foreclose the search for new techniques of constructing labor force and unemployment estimates for these decades. The empirical relation between inflation and unemployment is of vital interest in the formulation of economic policy, and an understanding of this relation requires thorough study of the historical record. Before shutting the books on the 1920's in particular, we ought to see what econometric methods, as opposed to linear interpolation, can tell us about unemployment in those years.

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tion is an insignificant 0.003. These more meaningful measures indicate the enormous difference in our results.

INCOME ELASTICITY OF HOUSING DEMAND

Geoffrey Carliner *

I Introduction

The earliest empirical studies of the income elasticity of housing demand supported the popular

notion that this demand was inelastic. Duesenberry and Kisten (1953) estimated it to be 0.15. Maisel and Winnick (1960) calculated a long run time series income elasticity of 0.5. However, later work which tried to use permanent income, or proxies for it, rather than measured income, found much higher elasticities. Most recently de Leeuw (1971)

adjusted cross-section estimates by Muth (1960), Reid (1962), and Winger (1968) and offered new estimates of his own. His range of estimates for all these authors is 0.8 to 1.0 for renters, and 1.25 to 1.46 for owners. Among the studies de Leeuw examined, only Lee's estimate (1963) was below 1.0.

Estimates based on time series analysis, though perhaps not comparable to cross-section estimates, have usually been somewhat lower than cross-section estimates. Muth (1965) found a stock elasticity of 0.9, while Lee (1964), using similar estimation techniques but slightly different variables, found it to be 0.34. However, Houthakker and Taylor (1970) found long run elasticities of 1.5 for renters and 2.4 for owners.

This paper offers new evidence based on better data than has been available to earlier researchers. Using a four-year panel study which followed up movers, permanent income was defined and calculated in two ways. Then regressions were run on house value and rent on permanent income, price, age, race and sex of head. The results obtained are robust with respect to the definition of permanent income, and considerably lower than results from time series analysis or from cross-section studies that relied on grouped rather than individual data.

The next section of this paper sets forth the model used in the regressions and discusses the data. The third section presents the income elasticies estimated for various groups and various definitions, while the fourth section deals with the coefficients of price and demographic terms. A concluding section briefly summarizes the results.

II The Model and the Data

Using measured income instead of permanent or normal income results in underestimates of demand elasticities. De Leeuw, Muth, Reid, and Winger all attempt to reduce this bias by using city medians. They argue that the transitory components of measured income average out, leaving only the permanent components. Far preferable to grouping the data, or restricting the sample to households with unusually steady incomes as Reid also does, would be to use an actual measure of normal income. In a weighted average of several years' measured real income for individual families, the transitory or random components can be expected to cancel out, leaving only the family's normal, or permanent, income. However, the estimates of income elasticities should not depend on the weights used. Therefore two definitions of permanent income, based on data from a four-year panel study, were tried. The first of these, Y_e, is simply the four-year

average of measured real family income. Each year's income receives equal weight. The second, Y_d, has weights which decline arithmetically with time. Current year's income has a weight of 0.4, last year's income 0.3, then 0.2, and finally 0.1. Income of five years ago receives no weight.

To see whether or not estimated income elasticity was sensitive to different definitions of permanent income, regressions were run including both definitions. In addition, the current year's income, Y_m, was used to see whether demand elasticities with respect to measured income are lower than permanent income elasticities. Finally, following the suggestions of de Leeuw, permanent income including the imputed rent of the owner's occupiers, Y_r, was used. This rent was calculated as 6 per cent of the owner's equity, which was equal to the house value, minus the outstanding mortgage principle.

The data used in this paper come from "A Panel Study of Income Dynamics," conducted by the Survey Research Center (SRC) of the University of Michigan. This sample included 2,107 renting households and 2,458 owners. Unlike the SRC panel study used by Lee (1963), every effort was made to follow up movers. The sample households were interviewed four times, in the spring months of 1968 to 1971. The income term was total family income before taxes, and including earnings, property income and transfers. For the two permanent income definitions, income for the first three years was inflated to 1971 dollars by the CPI for all items, as published in the Economic Report of the President (1972). Spring 1971 values of demographic variables, contract rent, and house value were the ones used in the regressions.

The least reliable aspects of the data are the price indexes. Each household has associated with it a price for housing and a price for all goods, based on a 1967 Bureau of Labor Statistics (BLS) survey described by Brackett (1969). The BLS price indexes, constructed for three income levels, were designed to reflect cost differences among different areas. However, the SRC used only the low income index. Intercity differences are not the same for the market baskets of all income levels. The simple correlation coefficients between the low income index and the moderate and high income indexes were 0.77 and 0.75, respectively. Furthermore, the total price index assumed different percentages of car owners in different areas, and lower quality food for southerners. Finally, these indexes were constructed four years prior to the Spring 1971 survey date. During a period when national housing prices increased by 24 per cent and prices for all goods increased by 21 per cent, differences among cities could change considerably.

III Estimates of Income Elasticities

Table 1 below presents estimates of income elasticities of housing demand for different definitions of income for owners and for renters, for regressions with and without demographic variables. A typical regression, using Y_d for owners and including demographic terms, is equation (1):

$$\log \frac{H}{P} = 2.396 + \underset{(.023)}{.619} \log \frac{Y_d}{Q} - \underset{(.244)}{.800} \log \frac{P}{Q}$$

$$- \underset{(.034)}{.264} \text{ Black} + \underset{(.037)}{.162} \text{ Female}$$

$$- \underset{(.046)}{.338} \text{ Age}_{<35} - \underset{(.040)}{.185} \text{ Age}_{35-64}$$

$$R^2 = .32 \qquad (1)$$

where H is house value (contract rent for renters), P is the housing price index, Y_d is permanent income, Q is the price index of all goods, and the last four variables are dummies for heads who are black, female, under 35 and between 35 and 64, respectively. Standard errors are in parentheses.

TABLE 1. — INCOME ELASTICITY OF HOUSING DEMAND

Income Definition	Regressions with Demographic Terms		Regressions Without	
	Owners	Renters	Owners	Renters
Y_e	.631 (.023)	.520 (.023)	.580 (.019)	.483 (.021)
Y_d	.619 (.023)	.521 (.023)	.564 (.019)	.480 (.020)
Y_m	.499 (.021)	.439 (.020)	.472 (.018)	.410 (.018)
Y_r	.746 (.023)	—	.676 (.019)	—

Estimates from regressions including demographic terms are higher than the other estimates, and owners' elasticities are higher than renters', but the relative sizes of the different elasticities are the same for all four columns. The lowest estimate comes from current year's measured income, Y_m, 0.472 for owners and 0.410 for renters without demographic terms. The two estimates based on the two definitions of permanent income, Y_e and Y_d, are extremely close, and somewhat larger than the measured income estimate. Finally, for owners, the estimate based on permanent income including imputed rent Y_r was the highest of all, considerably higher than the estimates based on permanent income excluding imputed rent.

The results are very encouraging. First, they support the notion that demand elasticities, especially for such durable goods as housing, are greater out of permanent income than out of current income. Second, the estimates are very robust with respect to the weighting scheme used to define permanent income. Y_e probably gives too much weight to early years' income, while Y_d may give too much weight

to the income of recent years. Fortunately, the estimates based on these two quite different definitions are extremely close. It seems unlikely that any other reasonable weighting scheme would yield results much larger or smaller.

The elasticity estimates based on Y_r were somewhat larger than de Leeuw's assumptions would imply. He argued that excluding imputed rent from the incomes of owner occupiers, biases estimates of income elasticities away from unity by a percentage of the differences between 1.0 and the estimate. His rough assumptions about the size of this bias imply that the estimate of Y_r should be about 0.58 instead of the 0.676 actually obtained.

Also tested was the hypothesis that households who have recently moved have higher elasticities than those who have not. De Leeuw expressed skepticism about Lee's findings because the panel study which he used did not include movers. It seems plausible that families who have not changed their house might have experienced changes in income, even in permanent income, and that therefore, the correlation between income and housing consumption might be lower for nonmovers than for movers.

Therefore the total SRC sample was divided into two groups, households who moved during the two years prior to the 1971 interview, and those who did not. In regressions without demographic terms, the income elasticity for moving owners was 0.612 (standard error 0.055), for nonmoving owners 0.541 (0.020). For renters the two coefficients were 0.518 (0.034) and 0.448 (0.024), respectively. Under the assumption that intercept, price elasticity, and income elasticity all vary between movers and nonmovers, an F test suggested by Chow (1960) of the hypothesis that the income coefficients differed was not confirmed.

IV Other Results

The estimates of price elasticity from these regressions varied considerably for owners and renters, and for regressions including or excluding demographic terms. For owners, there was little variation for different definitions of the income term. The lowest estimates of price elasticities were around $-.8$, significant at the 1 per cent level, for owners in regressions including demographic variables. The estimates for owners in regressions including only price and income terms were around $-.5$, also significant at the 1 per cent level. For renters, the results were more disappointing. In all cases, the standard error was at least twice the size of the estimated coefficient. These estimates ranged from $-.101$ from a regression including only price and measured income to $+.022$ from a regression in-

cluding Y_e and demographic terms in addition to price.

Table 2 presents the antilogs of the coefficients of the dummy variables from equation (1), and from a comparable regression for renters, also using Y_d for income. Because the dependent variable is the log of house value of rent, the antilogs of the dummy coefficients indicate the percentage difference in housing consumption between a member of a dummy group and a member of the excluded group similar in all other respects.

TABLE 2. — PERCENTAGE DIFFERENCES IN HOUSING DEMAND, BY COLOR, SEX, AND AGE OF HEAD

	Owners	Renters
Nonwhites (as per cent of whites)	76 [a]	91 [a]
Female Heads (as per cent of male heads)	117 [a]	125 [a]
Heads under 35 (as per cent of heads 65+)	71 [a]	110
Heads 35 to 64 (as per cent of heads 65+)	83 [a]	100

[a] Derived from regression coefficient significant at the 1 per cent level.

In both the owner and renter regressions, the coefficients for female heads are significantly positive, and the coefficients for blacks are significantly negative. Moreover, the difference between blacks and whites in the owner regression is considerably larger than in the renter regression.[1] This may reflect greater discrimination in suburban single family housing markets than in central city apartments. It may also indicate discrimination by banks in offering blacks worse mortgage terms than whites. Alternatively, it may be that blacks with the same income, age, and sex of head as whites have less wealth. All these factors would affect owners more than renters.

Unlike race and sex, the effect of age on housing demand is completely different for owners and for renters. Among renters, old and young families spend about the same. The coefficient for families with heads under 35 indicates that they spend 10 per cent more than families with heads over 65, but the difference is not statistically significant. For families between 35 and 64, there is no difference. However, among owners, the young demand considerably less housing. Owners under 35 own houses worth 71 per cent of houses of similar owners over 65, while owners 35 to 64 own houses worth 83 per cent of those of owners over 65.

If the level of spending differs for different age groups, then it is possible that the income elasticity

[1] While no strict hypothesis was tested, the difference between the Black coefficient in the owner regression and the Black coefficient in the renter regression was 2.7 times the sum of their standard errors.

will differ as well. To test this hypothesis, dummy variables were included in the regression to allow both the intercept and the income elasticity to vary by age group. In equation (2), Y_d is permanent income for all ages; Y_y is income if the household head is under 35, zero otherwise; Y_z is family income if the head is between 35 and 64, zero otherwise. Thus the income elasticity for heads 65 and over is the coefficient of Y_d. The elasticities for the other age groups are their coefficients added to the Y_d coefficient. These results are for owners.

$$\log \frac{H}{P} = 2.830 + \underset{(.041)}{.501} \log \frac{Y_d}{Q}$$
$$+ \underset{(.076)}{.401} \log \frac{Y_y}{Q} + \underset{(.048)}{.120} \log \frac{Y_z}{Q}$$
$$- \underset{(.244)}{.830} \log \frac{P}{Q} - \underset{(.034)}{.246} \text{ Black}$$
$$+ \underset{(.037)}{.162} \text{ Female} - \underset{(.339)}{2.091} \text{ Age}_{<35}$$
$$- \underset{(.198)}{.651} \text{ Age}_{35-64}$$
$$R^2 = .32. \qquad (2)$$

The demographic coefficients are all significantly different from zero at the 1 per cent level. In fact, the income elasticities and the dummy intercept coefficients for young and middle-aged household heads are significantly different from each other as well as from the oldest group. This pattern of coefficients indicates that at given income levels, old people demand more housing than young people. However, young people are more responsive to income changes than old people. Perhaps this occurs because old owners, other things equal, tend to be wealthier than young owners. Unfortunately, the data do not permit a direct test of this hypothesis. Alternatively, older families may be more influenced by out-of-pocket expenses than by the opportunity cost of their imputed rent, since many of them have paid off their mortgages.

When dummies for both intercept and income elasticity for age groups were included in regressions of renters, none of the coefficients was significant. I also tested the hypothesis that income elasticities were different for blacks and whites. However, when dummy variables for both intercept and income elasticity were included for blacks, neither one was significant.

V Conclusion

My results indicate that the income elasticity of housing demand is around 0.6 to 0.7 for owners and 0.5 for renters. Regardless of the income defi-

nition, the sample used, the moving characteristics, or other variables included in the regression, all the income elasticity estimates presented in this paper are significantly above zero and below one. This supports the findings of the only other estimates of income elasticity based on a panel study, and contradicts the results of studies based on grouped cross-sectional data.

Estimates of price elasticities varied from close to zero to -0.8. However, as emphasized above, the price data were not very reliable. Other results are that, other things equal, blacks demand less housing than whites, and female-headed households demand more than male-headed ones. However, the hypothesis that income elasticities differ for whites and blacks could not be confirmed. On the other hand, income elasticities for households with young owners are significantly higher than for older owners. This difference is not true for renters.

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ERRATA

In a Note entitled "A Cross-Section Model of Economic Growth Re-examined," by William D. O'Neill and Richard Kosobud published in the Review in November 1972, page 468, second paragraph, second sentence, equation should read:

Using $d\ (GNP/N)/(GNP/N) = (d/dt)\ (GNP/N)$ and (1), (2) into (3) gives
$$(d/dt)\ (GNP/N) = (c_1 a_1 + c_2 b_3)\ GNP/N + c_1 a_2\ (GNP/N)^2 + c_1 a_3\ (GNP/N)^3 + c_2 b_1\ (GNP/N)\ [1/(b_2 + GNP/n)]. \tag{4}$$

In an Article entitled "Household Demand for Durable Goods: The Influences of Rates of Return and Wealth," by Alan C. Hess published in the Review in February 1973, page 9, second column first and second sentences should read:

However, he did not determine the relative importance of these variables as sources of fluctu-