

HOUSING DECISIONS AND THE U.S. INCOME TAX:

AN ECONOMETRIC ANALYSIS

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I. Introduction

Under the United States individual income tax, homeowners are permitted to deduct local property taxes and payments of mortgage interest. At the same time, imputed rent from homes is excluded from taxable income. With a comprehensive income tax base, net imputed rent would be included in taxable income. In effect, then, the federal tax system can be viewed as implicitly subsidizing owner occupied housing. Each year this subsidy amounts to billions of dollars in foregone federal income tax revenues.¹

The purpose of the current paper is to present some estimates of the efficiency and distributional consequences of this subsidy. This is done using econometric estimates of the parameters of housing demand and tenure choice functions in which both income and price terms are corrected for tax effects. The units of observation are individual households, obviating the need to assume that all households in a given income group behave identically.

The desirability of the subsidy is a matter of controversy, and a number of proposals have arisen to modify or eliminate it altogether. (See for example [1, pp. 70-73].) The analytical framework developed to assess the equity and efficiency implications of the current provisions is also used to predict the consequences of certain changes in the law; e.g., replacing the deductions with tax credits. The results indicate that alternative

treatments of housing have important effects on economic efficiency, the distribution of disposable income, the quantity of housing services demanded, and the choice between renting and owning.

In Section II we review the previous major studies of the income tax subsidy to housing. Attention is focused not only upon their results, but also upon the internal consistency of the methods used to obtain them. Section III has estimates of housing demand and tenure choice functions using 1970 data from the Panel Survey of Income Dynamics [15]. Estimation and data problems are discussed and the parameter estimates are compared with those of earlier econometric studies. Section IV uses these results to assess the probable impact of removing the favorable tax provisions for housing. It also has simulations of some alternative tax rules. A final section contains a brief summary and agenda for future research.

II. Previous Studies

Before discussing earlier efforts to assess the impact of the federal tax treatment of owner-occupied housing, it is useful to describe more carefully the relevant provisions. The exposition closely follows Laidler [11] and Aaron [1, Chapter 4], both of whom provide lucid presentations.

A homeowner receives no cash from the equity he has established in his home, only a stream of housing services. If the homeowner were taxed like other investors, he would have to report as income the gross imputed rent on the house.² And like other investors, he

would be allowed deductions for maintenance, depreciation, interest and property taxes as expenses incurred in earning this income. The difference between gross imputed rent and these expenses, net rent, would be included in taxable income if owner-occupied housing were treated like other investments.

However, the homeowner does not have to include gross imputed rent on his tax return, although he is permitted deductions for mortgage interest and property taxes. Thus, taxable income for homeowners is understated by the sum of net rent, mortgage interest, and property taxes. The amount this is worth to a given homeowner depends upon his marginal tax rate. The higher one's marginal tax rate, the greater the saving associated with a given reduction in taxable income.

To derive the result of the previous paragraph algebraically, let NI = net imputed rent, GI = gross rent, M = maintenance, D = depreciation, T = state and local taxes, and MI = mortgage interest. Then

$$NI = GI - M - D - T - MI$$

If the homeowner's marginal tax rate is t , then with a comprehensive tax base the tax payment on the net imputed rent is $t(NI)$. Under the current tax regime, the individual 'pays' in tax

$$(1) \quad -t(T+MI),$$

i.e., he is allowed to subtract property taxes and mortgage interest from taxable income.

Subtracting (1) from $t(NI)$ and substituting, we find their difference is

$$(2) \quad t(NI+T+MI),$$

as suggested above. Assuming further that the individual's rate of return on capital, r , and the mortgage rate are equal, then the proportion of housing costs which is not taxed can be written

$$(3) \quad \delta = \frac{rV+T}{rV+T+D+M} ,$$

where V is the house value. Alternatively, the implicit subsidy effectively lowers the price of \$1 worth of owner-occupied housing services to $\$(1-t\delta)$.

Aaron computes the change in tax liabilities individuals would face if the tax law were modified.³ His data are the 90,000 federal tax returns for 1966 in the Brookings Tax File. A major finding is that if imputed net rent on owner occupied houses were taxed and deductions of mortgage interest and property taxes were disallowed, then the increase in tax as a percentage of gross income would vary considerably with income level. There is some tendency for the percentage to increase with income, but the relationship certainly is not monotonic. This is true both when all returns are considered and when the group is restricted to homeowners.

Although Aaron's conclusions are of considerable interest, it must be noted that they are strictly relevant only for the short run: "Revenue effects are those that would occur immediately: eventually the pattern of homeownership and the size of the housing stock would change substantially, altering revenue collections." [1, p. 55] Thus, the revenue estimates are unaccompanied by predictions of tax induced changes in the housing stock. One of the main objectives of the current paper is to examine the distribution of the subsidy by income class within a framework

The Laidler-Aaron analysis of housing costs provides a useful framework for studying the distributional and efficiency implications of the implicit tax subsidy of owner occupied housing. A few of its limitations require discussion, however. For example, an implicit assumption in the excess burden calculation is that the property tax is a benefit tax, rather than a 'distortion.' Homeowners shop around for communities with the bundle of public services they prefer, and the local property tax is the price for these services. (See [28] or [19].) To the extent that this is not the case, the favorable federal tax treatment of owner occupied housing can be viewed as offsetting the distorting impact of local property taxes. In the extreme case where none of the property tax yields benefits, δ becomes

$$(4) \quad \delta' = \frac{-T+t(rV+T)}{rV+D+M} .$$

Equation (4) shows explicitly how the federal tax provisions $(+t(rV+T))$ offset the local property taxes $(-T)$.⁶

In some preliminary experiments, an attempt was made to determine which view of the property tax was more consistent with the data. Both hypotheses fit the data equally well. In the absence of strong empirical evidence for either view, this study follows its predecessors in assuming that the property tax is a benefit tax. We also take over the implicit assumption that T would remain the same even if its deductibility were disallowed. There is some possibility that the size of the local government sector would change without the property tax deduction, but consideration of this problem is beyond the scope of this paper.

Another criticism of the Laidler-Aaron analysis is the assumption that the long run supply of housing is perfectly elastic (see White and White [31]). Without this assumption, analysis of the implicit subsidy becomes considerably more complicated. If the subsidy induces an increase in housing prices, its impact on renters must also be considered. Given the controversy that surrounds this issue [31, pp. 113-114], we opt for the 'conventional' assumption that the supply curve is horizontal. Estimation problems would simply become intractable if the gross price of housing were allowed to be endogenous.⁷

A related problem is the omission of expected capital gains from the expression for housing related net income. If a homeowner believes that the value of his home will increase (decrease), then this may lower (raise) his perceived cost of housing services. (See [4].) In the absence of any reliable method for estimating each homeowner's expected capital gains, we were forced to ignore them.⁸ Since this study analyzes U.S. data from 1970, a year prior to the recent boom in U.S. housing prices, this omission is not likely to be of major importance.

III. Estimation

In this section we estimate housing demand and tenure choice equations taking special care to adjust price and income terms for the federal income tax. First, the treatment of taxes in previous econometric studies is discussed. Then we describe the specification of the model and the data, which is followed by a presentation of the results.

A. Taxes in Previous Econometric Studies

There is an extensive econometric literature which investigates individuals' housing decisions. Our goal here is not to provide a comprehensive literature review. Rather, we merely want to indicate some of the ways in which federal tax provisions have been handled previously.

In one type of study, some measure of housing services is taken to be a function of an income variable, a price variable, and a set of demographic variables. (See [3] or [21] for reviews of such studies.) As was emphasized above, because of the income tax, family net income and the net price of owner-occupied housing will in general differ from their gross counterparts. The standard theory of consumer demand suggests that for both income and price it is the net magnitudes that are relevant, but most studies neglect to correct one or the other for taxes.

De Leeuw's regression for homeowners based upon metropolitan data [3, p. 9] appears to use both gross price and income. However, he does note that failure to correct for federal income taxes probably biases estimates of the income elasticity. Maisel, Burnham, and Austin's [13] analysis of Federal Housing Administration (FHA) data for 1966 has a net effective income variable and a gross price. Carlner [2] reports corrections neither for price nor income in his study of observations from the Michigan Survey Research Center's "Panel Study of Income Dynamics." In his

study of San Francisco household interview data

Straszheim [25, p. 5] indicates that when taxes were included in the monthly cost of ownership, the results did not change much.

A second type of study investigates the determinants of the rental-owning choice.⁹ In his interactive logit model of the tenure decision, Li includes no price variables and the income variable is gross of tax [12]. Trost [29] specifies a decision equation with the relative prices of owning and renting, but does not correct the price of owning for taxes. Ohls [20] makes a partial correction for tax effects, but is prevented by data limitations from doing so completely. Struyk's [27] attempt to correct for the effect of taxes on effective price is somewhat similar to the one used in this paper. However, he does not compute the effective price of owner-occupied housing for each household in his sample. Rather, Struyk uses Aaron's [1] estimates, which give the effective price only for each of several relatively broad income classes. The errors induced by this computation may account for the fact that the tax subsidy variable appears with an insignificant coefficient in Struyk's tenure-choice equation.

Recently, Trost [29] has provided an econometric framework for unifying the analysis of the housing demand and tenure choice decisions, but taxes are ignored in his study.¹⁰ The model developed in the next section allows investigation of the impact of the implicit tax subsidy on both decisions.

B. Model

We assume that owning and renting housing are mutually exclusive activities. (See [23] or [29].) Both owner-occupied and rental units yield housing services [18], but they are distinct commodities because their characteristics tend to differ. In many cases it is difficult (say) to rent a single unit with a large backyard. Similarly, it may be impractical for a homeowner to contract for the kind of maintenance services available to a renter. Even if dwelling units of different tenure modes were physically identical, individuals could not be expected to be indifferent among them. To the extent homes are viewed as risky assets, it would bias some individuals against owning. Pure pride in ownership could have an opposite effect.

If the j th individual¹¹ chooses to own, then his utility is given by

$$(5) \quad V_{Oj} = V(P_{Oj}, P_{Xj}, Y_j)$$

where $V(\cdot)$ is the indirect utility function, P_{Oj} is the net price of housing services generated by an owner occupied dwelling, P_{Xj} is the price of all other goods and Y_j is permanent net real income.

If the j th individual rents, utility is

$$(6) \quad V_{Rj} = V(P_{Rj}, P_{Xj}, Y_j)$$

where P_{Rj} is the price of renting, and the other variables are defined above.

The individual makes that tenure choice which maximizes utility; i.e., he owns only if

$$(7) \quad V_{Oj} - V_{Rj} > 0.$$

When (7) obtains, the utility maximizing quantity of housing services Q_{Oj} is determined by applying Roy's Identity¹² to (5)

$$(8) \quad Q_{Oj} = Q_O(P_{Oj}, P_{Xj}, Y_j)$$

Similarly, if $V_{Oj} - V_{Rj} \leq 0$

$$(9) \quad Q_{Rj} = Q_R(P_{Rj}, P_{Xj}, Y_j)$$

where Q_R is the quantity of housing services demanded in the rental mode.

The system (7), (8), and (9) determines the individual's tenure choice, and conditional on that choice, the quantity of housing services demanded. In order to obtain estimates of the behavioral elasticities, it is necessary to assume functional and stochastic specifications for these equations. To represent the decision process (7), we choose the probit model.¹³ According to the probit model, there is associated with each family an index, I_j , which measures the likelihood of the family choosing owning over renting. This index cannot be measured directly, but it is a function of the (observable) determinants of the decision process, i.e., the arguments of the utility function.

We assume that the index can be approximated by a log-linear specification:

$$(10) \quad I_j = \gamma_0 + \gamma_1 \ln(p_{Oj}/P_{Xj}) + \gamma_2 \ln(P_{Rj}/P_{Xj}) + \gamma_3 \ln Y_j \\ + \sum_{i=1}^m \gamma_{3+i} Z_{ij}$$

where the Z_i are a set of m demographic variables which influence the choice between renting and owning.

For each family it is assumed that there exists some critical value of the index, I_j^* , such that if $I_j > I_j^*$, the family will own,

and that otherwise it will rent. Thus, under the assumption that I^* varies randomly among families, the family's tenure choice is determined in part by the variables of equation (10) and in part by a stochastic element. Given a probability distribution function for I^* , it is possible to estimate the parameters of (10) by maximum likelihood.

Turning now to the housing services demand equations, it is assumed that a random error can be appended to each, and that these error terms and the error associated with the decision function have a joint normal distribution. The demand for housing services by owners (8) is assumed to be a translog function in the relative price of owning and income, with an intercept which depends upon the individual's personal characteristics:

$$(11) \quad \ln Q_{Oj} = \alpha_0 + \alpha_1 \ln(P_{Oj}/P_{Xj}) + \alpha_2 \ln(Y_{Oj}) + \alpha_3 (\ln(P_{Oj}/P_{Xj}))^2 \\ + \alpha_4 (\ln Y_{Oj})^2 + \alpha_5 \ln(P_{Oj}/P_{Xj}) \ln Y_{Oj} + \sum_{i=1}^n \alpha_{5+i} X_{ij} + \epsilon_0,$$

where the X_i are a set of n demographic variables which influence the shapes of the indifference curves and ϵ_0 is a random error. The translog specification is more general than the Cobb-Douglas form used in a number of previous studies (e.g., [2], [3], [22]), and allows for the possibility that the income and price elasticities may not be constant.¹⁴

Similarly, the demand for housing services by renters is

$$(12) \quad \ln Q_{Rj} = \beta_0 + \beta_1 \ln(P_{Rj}/P_{Xj}) + \beta_2 \ln Y_j + \beta_3 (\ln(P_{Rj}/P_{Xj}))^2 \\ + \beta_4 (\ln Y_j)^2 + \beta_5 \ln(P_{Rj}/P_{Xj}) \ln Y_j + \sum_{i=1}^n \beta_{5+i} X_{ij} + \epsilon_R,$$

where ϵ_R is the associated error term.

C. Data and Definitions of Variables

The data for this study are from "A Panel Survey of Income Dynamics" conducted by the Survey Research Center of the University of Michigan. These longitudinal data are a rich source of economic and demographic information on a cross section of American families. This study analyzes the housing decision for the year 1970, although data from other years are also employed in the construction of several of the variables. Our sample consists only of those families in the original Survey Research Center sample; a number of non-randomly selected poverty households were excluded. Also excluded were observations in which the head of family had recently changed. For such families there would be severe difficulties in adequately estimating permanent income, and the assumption of equilibrium might be inappropriate. Families which claimed simultaneously to own and rent, or which reported that they received 'free' housing were also dropped. After all these exclusions, the sample consisted of 2150 households.

The variables of equations (10) and (11) are defined as follows:¹⁵ Q_{0j} is the value of the house deflated by the Bureau of Labor Statistics (BLS) index which accounts for differences in the gross price of housing facing different individuals.¹⁶ Since the theory of consumer demand suggests that housing services is the appropriate variable, it is implicitly assumed that the flow of housing services is proportional to the value of the house. This has been the explicit or implicit assumption in most studies of the demand for owner-occupied housing.

P_{0j} is the net price of housing facing the j th individual, i.e., $(1-t_j\delta_j)$ times the gross price index of housing services, where t_j is the marginal tax rate and δ_j is the percentage of each dollar spent on housing services which is deductible.¹⁷ (See equ. (3)). The marginal tax rate is computed by a procedure suggested by Feldstein and Clotfelter [5]: Total deductions are the sum of home related deductions plus a percentage (k) of gross income which varies by gross income. The latter amount represents non-housing itemizeable deductions. A search procedure is used to find that k within each gross income class which makes the proportion of itemizers in each income class equal to the proportion which actually itemized in 1970. Given the total deductions thus calculated, the tax table for 1970 can be used to compute the marginal tax rate and disposable income. (It is assumed that married couples file jointly and that an exemption is taken for each family member.)¹⁸

δ_j is calculated by substituting into (3). Following the assumptions used by Laidler [11], Aaron [1] and White and White [30], depreciation and maintenance are taken to be 2.25% and 1.25% of house value, respectively. The interest rate figure used is 6%. The results reported below were not sensitive to minor changes in these assumptions. For property taxes the Survey Research Center's estimate is employed. (See [16], p. 580.)

Y_{0j} , real net permanent income, is the sum of three components: a) permanent adjusted gross income minus income taxes, b) transfers, and c) net imputed rent. Current adjusted gross

income is computed as the sum of the husband's and wife's labor income, rent, dividends and interest.¹⁹ Permanent adjusted gross income is calculated as a simple average of the current incomes for 1968 through 1971, using the consumer price index to convert all values to 1970 dollars. Carliner [2] has shown that parameter estimates in housing demand equations are not very sensitive to reasonable variations in the weighting schemes used to generate permanent income. However, the use of current rather than permanent income induces substantial downward bias in estimates of income elasticity of demand. ([3], p. 530) Permanent disposable income is then calculated by finding the federal income taxes due under the 1970 tax law and subtracting them from permanent adjusted gross income.

The second component of Y_{oj} , permanent transfer income, is the simple average of yearly payments from aid to dependent children with unemployed fathers (ADC, AFDC), unemployment compensation, welfare, etc. Finally, imputed rent is calculated as the product of one-half the house value and the interest rate of 6^o/o. In order to correct for inter-area differences in the price level, the sum of permanent disposable income, transfers and imputed rent is divided by a total budget index for the county of residence in 1970 [16].

The X_{ij} , a set of dichotomous demographic variables to control for 'tastes' in owner-occupied housing, are:²⁰

AGE1_j = age of household head is ≥ 26 and ≤ 40

AGE2_j = age of household head is ≥ 41 and ≤ 55

AGE3_j = age of household head is ≥ 56

DEP1_j = 1 child under the age of seventeen in the family unit

DEP2_j = 2 children under the age of seventeen in the family unit

DEP3_j = 3 or more children under the age of seventeen in the family unit

RACE_j = head of household is non-white

FEM_j = head of household is female.

The age variables account for the possibility that the demand for housing services varies with stage of the life cycle. Number of children is expected to increase the quantity of housing demanded, cet par. The race and sex variables are included because demographic differences may influence preferences between housing and other goods. In the case of the RACE variable, the coefficient may also reflect the presence of racial discrimination in the housing market.

Turning now to the definitions of the variables in the choice equation (10), the Z_{ij} are the same as the X_{ij} defined above.²¹ The relative price of renting, P_{Rj}/P_{Xj} , is calculated by taking the BLS rental housing price index for the household's area and dividing it by the price index for non-housing goods. In order to compute the relative price of owning facing individuals who choose to rent, some kind of imputation procedure is required. We calculate t_j and δ_j for each renter on the assumption that if he owned, the value of the house would equal the house of mean value for individuals in his adjusted gross income class.²²

This technique may lead to selectivity bias in the estimates if renters face systematically higher effective prices for owner-occupied housing than owners with the same adjusted gross income. However, given the quality of the price data, more sophisticated techniques for estimating the price of owner occupied housing for renters seemed inappropriate.²³ The income variable Y_j is net income before housing related tax deductions.

D. Econometric Issues

In this section we begin by describing briefly the probit estimation technique for the tenure choice equation (10). This is followed by a discussion of the statistical complications which may arise when the error terms of equs. (10), (11) and (12) are correlated. Finally, some potential problems due to the endogeneity of the marginal tax rate are considered.

The probit model assumes that the error term I^* defined above has a standard normal distribution. The likelihood function that follows from this assumption is well-known (see [14]), and its maximization yields maximum likelihood estimates of the parameters of (10). Given these estimates, the fitted value of the index for the j^{th} family, \hat{I}_j , can be computed. The estimated probability that the j^{th} family owns a house is $F(\hat{I}_j)$, where $F(\cdot)$ is the value of the cumulative normal distribution.

However, the decision equation is part of a system which includes the demand for housing services equations, and its error may be correlated with ϵ_0 and ϵ_R . One possible estimation procedure would involve writing the likelihood function associated with the 3 equations (10), (11), and (12), and estimating the entire system's parameters simultaneously by maximum likelihood. This method would be a cumbersome and expensive. Trost [29] has shown how to obtain consistent estimates of the housing demand equation by a two stage procedure which is computationally much simpler. In the first stage, the choice function is estimated by maximum likelihood as just described. In the second stage, the variable

$$(13) \quad \frac{-f(\hat{I}_j)}{F(\hat{I}_j)}$$

is added to the list of regressors in the demand for housing by owners equation (11), and

$$(14) \quad \frac{f(\hat{I}_j)}{F(-\hat{I}_j)}$$

is added to the rental equation (12), where $f(\cdot)$ is the ordinate of the standard normal distribution. Trost shows that when the augmented regressions are estimated by ordinary least squares, the estimates are consistent. Furthermore, the coefficient of (13) in the demand for owner occupied housing equation is an estimate of the covariance between the error term in the choice equation and ϵ_0 . (Similarly, the coefficient of (14) in the rental demand

equation gives an estimate of covariance between the error term in the choice equation and ϵ_R .) A t-test on (13) in the owner-occupied housing demand equation indicates whether or not there is statistically significant correlation between ϵ_0 and the error of the probit equation.²⁴ (An analogous test can be done on the coefficient of (14) in the rental housing demand equation.)

A final econometric issue arises because marginal tax rates and home-related deductions vary with house value. The price and income terms in (11) may therefore be correlated with the error term. The more owner-occupied housing one consumes, cet. par., the greater one's deductions, and the smaller one's marginal tax rate. This implies a higher effective price for owner-occupied housing. Thus, a spurious positive correlation between the price of housing and the quantity of housing demanded exists, biasing estimates of the price elasticity of demand toward zero.

Ideally, one would want to parameterize the entire tax structure to represent completely the choices open to the family. Since this cannot be done, one possibility would be to evaluate net price and income at 'standardized' levels of house value. This is a technique used by Feldstein to correct for endogeneity in his study of the impact of taxes on portfolio choice [6]. Our attempts to apply this technique to the demand for owner-occupied housing equation resulted in estimates with nonsensical values. It therefore seemed preferable to use the actual values for price and income, even though the price elasticity would be biased toward zero. It will be seen below that even these conservative estimates generate large behavioral responses when the tax treatment of housing is changed.

E. Results

In this section the parameter estimates of the tenure choice and owner-occupied housing demand functions are presented. (The results for the renters are of secondary interest for the purposes of this study, and are relegated to an appendix available upon request to the author.) The price elasticity of demand for owner occupied housing conditional on owning is close to -1.0; the income elasticity, about 0.76. The effective price of owner occupied housing also enters the tenure choice function with a negative sign.

The estimates for the choice equation are shown in column 1 of Table III.1. Since these are estimates of the parameters of the probit index, a coefficient indicates only how the estimated value of the index \hat{I} changes when its associated variable changes, not how the expected probability of owning changes. However, the coefficients do indicate the direction in which a change in a right hand side variable moves the expected probability of owning, because the latter, $F(\hat{I})$, is a strictly increasing function. Thus, any variable which increases (decreases) the value of the index will increase (decrease) the probability of owning.

The results of column 1 indicate that income has a positive impact on the probability of owning. As suggested above, this might be because the 'characteristics' associated with owner-occupied housing are normal, or because risk aversion declines with income. The positive coefficient may also be due to imperfections in the mortgage market which make financing the purchase of a home difficult for low income people.

Table III.1

Probit Estimates of the Tenure Choice Function*

| <u>Variable</u> | (1) | (2) |
|-----------------|------------------|------------------|
| $\ln Y$ | .470 (.071) | .507 (.0654) |
| $\ln(P_O/P_X)$ | -1.391 (.452) | |
| $\ln(P_R/P_X)$ | 1.869 (.470) | |
| AGE1 | .717 (.166) | .682 (.164) |
| AGE2 | 1.191 (.163) | 1.146 (.161) |
| AGE3 | 1.666 (.172) | 1.594 (.169) |
| DEP1 | .137 (.105) | .114 (.104) |
| DEP2 | .399 (.113) | .354 (.112) |
| DEP3 | .286 (.108) | .226 (.105) |
| FEM | -.399 (.0962) | -.418 (.095) |
| RACE | -.572 (.0971) | -.570 (.0957) |
| CONSTANT | -2.605 (.339) | -2.420 (.329) |
| log likelihood | -907.0 | -921.6 |

*Variables are defined in the text. Numbers in parentheses are estimated standard errors.

The coefficient on $\ln(P_O/P_X)$ suggests that the higher the effective relative price of owner occupied housing, the less likely the family is to own; the opposite is true for the relative price of renting, (P_R/P_X) . Both coefficients exceed their standard errors by factors greater than two. In order to assess the impact of omitting the relative price terms from the tenure choice decision, the equation was re-estimated without them. The results are shown in column 2 of Table III.1. A likelihood ratio test of the hypothesis that both the coefficients are zero yields a test statistic of 29.2, suggesting that at a .005 significance level, the hypothesis that relative prices do not matter in the tenure choice decision can be rejected. This is counter to the result found by Struyk [27]. As suggested above, the insignificance of Struyk's tax variable may be due to errors in its measurement.

Returning now to the basic results in column 1, the probability of owning increases strictly with age of head of household and generally increases with the number of children, although the relationship is not strictly monotonic. (However, the coefficient on DEP3 does not differ significantly from that of DEP2.) Both the sex and race of the head of household have statistically significant effects on the probability of owning a home. Females and blacks are less likely to own, cet. par., than males and whites.

In order to develop a sense for the quantitative significance of the probit coefficients, it is useful to work through a specific numerical example. Consider an individual who faces

the mean income and price in the sample, and for whom $AGE1 = 1$, $DEP1 = 1$, $RACE = 1$, and all the other dichotomous variables are zero. When each of these is substituted into (10) with the coefficients from column 1, the value of the index (\hat{I}) is 0.34. From the tables of the cumulative normal distribution, this corresponds to a probability of 0.63. If the price of owning increases by 10% and the index is re-computed, the probability of owning falls to .46. Thus, our results imply that for this individual, a 10% rise in the price of owning would lead to a 17 percentage point decrease in the probability of owning. Note, however, that the responsiveness to given price (and other) changes will vary considerably among individuals because of the non-linearity of the probit transformation.

The parameter estimates for the demand for owner-occupied housing (equ. (11)) appear in column 1 of Table III.2. The estimated covariance of the errors in the housing demand and probit equations, σ_{OC} , is near the bottom of the column. The ratio of the coefficient to its standard error is only 0.017, suggesting that the hypothesis that σ_{OC} equals zero cannot be rejected. Therefore, the equation was reestimated constraining it to be zero. The results, shown in column 2, indicate that omission of the 'missing variable' has essentially no impact on the estimated coefficients.

Before discussing the price and income terms in column 2, consider the coefficients on the demographic variables. These indicate that house value increases with age and when the head of the household is female, and decreases when the family is non-white. These results appear quite plausible. For the number of children

Table III.2

Quantity of Housing Services Demanded by Homeowners

Dependent variable is $\ln Q_o^*$

| Variable | (1) | (2) | (3) | (4) |
|-----------------------|--------------------|--------------------|-------------------|-------------------|
| $\ln Y_o$ | -.129 (.225) | -.127 (.196) | -.124 (.195) | .692 (.0285) |
| $\ln P_o/P_x$ | -5.751 (1.24) | -5.752 (1.244) | -5.72 (1.243) | -.939 (.175) |
| $(\ln Y_o)^2$ | .118 (.0270) | .118 (.0252) | .117 (.0251) | |
| $(\ln P_o/P_x)^2$ | -.741 (1.339) | -.743 (1.333) | -.748 (1.332) | |
| $\ln(P_o/P_x)\ln Y_o$ | 1.011 (.304) | 1.011 (.303) | .998 (.303) | |
| AGE1 | .165 (.126) | .166 (.0957) | .159 (.0952) | .187 (.0953) |
| AGE2 | .185 (.151) | .188 (.0946) | .185 (.0943) | .220 (.0942) |
| AGE3 | .303 (.181) | .306 (.0974) | .320 (.0949) | .340 (.0950) |
| DEP1 | -.0427 (.0417) | -.0425 (.0406) | | |
| DEP2 | -.00715 (.0468) | -.00667 (.0417) | | |
| DEP3 | -.0499 (.0468) | -.0496 (.0418) | | |
| FEM | .336 (.063) | .335 (.0460) | .341 (.0457) | .355 (.0452) |
| RACE | -.0359 (.0776) | -.0369 (.0485) | -.0441 (.0481) | -.0463 (.0485) |
| CONSTANT | 7.49 (.654) | 7.49 (.419) | 7.463 (.417) | 6.180 (.151) |
| σ_{oc} | .00356 (.211) | . | | |
| R^2 | .411 | .411 | .411 | .401 |

*Variable names are defined in the text. Numbers in parentheses are standard errors.

variables, the negative signs may seem somewhat counterintuitive.²⁵ However, examined on a one-by-one basis, these coefficients differ insignificantly from zero. A more appropriate statistical test is whether or not the three variables DEP1, DEP2, DEP3 jointly add significantly to the explanatory power of the regression. This can be done by estimating equation (11) without these variables, and conducting the usual analysis of variance tests. The regression results for the constrained equation are exhibited in column (3). The F-statistic associated with the hypothesis that the coefficients on DEP1, DEP2 and DEP3 are zero is .769, suggesting that it cannot be rejected. In light of this result, the specification in column (3) is accepted as the appropriate one. Although the presence of children matters in the owner-renter decision, the data suggest that given the decision to own, children tend not to influence the value of house purchased.

We turn now to the coefficients of the price and income terms in column 3, which, incidentally, do not differ greatly from their counterparts in column 2. The price and income elasticities evaluated at the means are $-.97$ (s.e. = $.18$) and $.76$ (s.e. = $.035$), respectively. These estimates are comparable in magnitude to those which have been reported in earlier cross-section studies. (See Polinsky [21] for a survey of these results.)

Since most previous housing demand studies have relied upon a log linear specification in income and price, it is of some interest to determine whether or not the second order price and

income terms are statistically significant. The results when the Cobb-Douglas functional form is taken as a maintained hypothesis are shown in column 4. The F-statistic associated with the hypothesis that the coefficients on the second order terms are zero is 8.81, so the specification of column (3) is retained as the favored one. In this sample, there appears to be significant interaction between price and income--as income increases, responsiveness to price changes becomes more inelastic.

IV. Simulations

In this section the parameter estimates are used to investigate the efficiency and distributional implications of the implicit income tax subsidy for owner occupied housing. After calculating the excess burden under current law, we predict changes in the demand for owner occupied housing and taxes paid which would occur under some alternative rules. In all the computations, we use the probit coefficients of column 1, Table III.1, and the housing demand parameters of column 3, Table III.2.

A. Excess Burden

Excess burden is calculated using the Laidler model discussed in Section II. The excess burden for the j th family is

$$.5(t_j \delta_j)^2 v_j \eta_j$$

where η_j is the expected compensated price elasticity of demand for the j th household and the other variables are defined above. (See [11] for a demonstration of this result.) All the variables required have already been computed except η_j . It is found by calculating the implied expected income and uncompensated price

elasticities for each household from equations (10) and (11), and substituting into the Slutsky equation.²⁶

Table IV.1 shows the excess burden per family for each gross income group along with corresponding average disposable income and average house value for homeowners under the status quo. Throughout most of the income range, excess burden rises with income. At the highest income levels, excess burden falls because the decrease in the compensated price elasticity more than offsets the increase in the implicit subsidy. The average annual excess burden for the entire sample is \$107.

It is difficult to decide whether or not to characterize these figures as 'large'.²⁷ Ultimately, the decision to eliminate an excess burden depends upon the social and political costs of doing so. It would be of considerable interest to compute excess burden in a framework which takes into account the taxation of other types of property income and tax induced distortions in housing production, but these topics are beyond the scope of the current paper.

B. Analyses of Alternative Tax Regimes

We now investigate how disposable incomes and housing decisions might vary under alternative tax regimes. The basic strategy is to convert tax law changes into the appropriate price and income changes, and then substitute into equations (10) and (11). This method is similar to that used by Feldstein and Taylor [7] to simulate the impact of tax law changes on charitable giving.

TABLE IV.1

Excess Burden Calculations (1970)

| <u>Gross Income Group</u> | <u>Average Disposable Income</u> | <u>Average House Value</u> | <u>Average Excess Burden</u> |
|---------------------------|----------------------------------|----------------------------|------------------------------|
| \$ 0-4000 | \$ 2686 | \$ 10991 | \$ 27 |
| 4-8000 | 6024 | 14022 | 81 |
| 8-12000 | 9452 | 17856 | 119 |
| 12-16000 | 12715 | 21134 | 151 |
| 16-20000 | 15829 | 26665 | 155 |
| 20-24000 | 19088 | 29893 | 147 |
| 24-28000 | 22248 | 36477 | 93 |
| > 28000 | 33306 | 48031 | 29 |

Call the j th household's price of owner occupied housing and disposable income under the current regime P'_{oj} and Y'_{oj} , respectively. A new tax law will in general change both price and income to some values P''_{oj} and Y''_{oj} . Assume that none of the demographic variables is affected. Then by substituting the new values for price and income into the probit equation, the expected probability of owning under the new regime can be computed. Similarly, by substituting into the demand equation, the expected amount of housing demanded conditional on owning can be computed.²⁷ Using these calculations together, the expected change in the amount of owner-occupied housing under the new regime can be found. In general, when house value changes, so too will price and income, which in turn changes the expected amount of housing, etc. The interdependent set of relations is solved iteratively. Thus, the disposable income, change in probability of owning, and change in house value associated with any given tax regime can be found.

The tax regimes to be investigated are:

Regime 1: net imputed rent is included in taxable income and additional deductions for mortgage interest and property taxes are disallowed.

Regime 2: same as regime 1, except marginal tax rates are adjusted proportionately so as to keep tax revenues the same as they were under the status quo.

Regime 3: deductions that are allowed under the current system are replaced by a 25% tax credit.

Regime 4: same as regime 3, except marginal tax rates are adjusted proportionately so as to keep tax revenues the same as they were under the status quo.

Clearly, many other rules are possible; these represent some of the more interesting ones. Regimes 2 and 4 are included because of the possibility that the government would want to offset changes in revenue collections induced by modifications of the tax law.

The simulation results are shown in Table IV.2.²⁹ The values for the status quo are given for purposes of reference. For each regime, changes in house value and in percentage owners refer to changes from the status quo. The figures in all columns are weighted averages; the weights are those provided by the Survey Research Center [15].

Regime 1, which removes all provisions for favorable tax treatment to homeowners, changes the price of housing for the j th household from $(1 - \delta_j t_j) GP_j$ to GP_j , where GP_j is the gross price of owning. This corresponds to what has sometimes been characterized as a 'neutral' treatment of housing.³⁰ When this regime is imposed, disposable income falls by increasing amounts as income increases. The implied percentage decreases in income are somewhat higher than Aaron's [1, p. 58], and rise a bit more rapidly with increases in income. (However, his figures show change in tax as a percentage of gross income, while ours are related to disposable income.)

What appears most striking is the impact of removing the subsidy upon the demand for owner-occupied housing. Removal of all favorable tax provisions for housing produces substantial

TABLE IV.2

Simulation Results (1970)

| Gross Income Group | Status Quo | | Regime 1 | | Regime 2 | | Change in o/o Owners |
|--------------------|-------------------|-------------|-------------------|-----------------------|-------------------|-----------------------|----------------------|
| | Disposable Income | House Value | Disposable Income | Change in House Value | Disposable Income | Change in House Value | |
| \$ 0-4000 | \$ 2686 | \$ 10991 | \$ 2666 | \$ -1254 | \$ 2675 | \$ -1235 | -2.5 |
| 4-8000 | 6024 | 14022 | 5953 | -2549 | 6018 | -2427 | -3.8 |
| 8-12000 | 9452 | 17856 | 9317 | -3107 | 9478 | -2850 | -4.5 |
| 12-16000 | 12715 | 21134 | 12465 | -3756 | 12736 | -3323 | -4.7 |
| 16-20000 | 15829 | 26665 | 15396 | -4343 | 15795 | -3680 | -4.8 |
| 20-24000 | 19088 | 29893 | 18521 | -4879 | 19086 | -3880 | -5.1 |
| 24-28000 | 22248 | 36477 | 21482 | -4379 | 22208 | -3195 | -4.8 |
| > 28000 | 30306 | 48031 | 28800 | -4250 | 30186 | -2380 | -4.5 |

| Gross Income Group | Regime 3 | | Regime 4 | | Regime 4 | | Change in o/o Owners |
|--------------------|-------------------|-----------------------|------------------|-------------------|-----------------------|----------------------|----------------------|
| | Disposable Income | Change in House Value | Change in Owners | Disposable Income | Change in House Value | Change in o/o Owners | |
| \$ 0-4000 | \$ 2822 | \$ 1145 | 1.9 | \$ 2819 | \$ 1138 | 1.8 | 1.8 |
| 4-8000 | 6157 | 1408 | 1.7 | 6134 | 1367 | 1.7 | 1.7 |
| 8-12000 | 9603 | 1001 | 1.2 | 9548 | 918 | 1.2 | 1.2 |
| 12-16000 | 12823 | 590 | .65 | 12730 | 454 | .58 | .58 |
| 15-20000 | 15856 | 180 | .21 | 15717 | -24 | .14 | .14 |
| 20-24000 | 19036 | -361 | -.44 | 18840 | -667 | -.52 | -.52 |
| 24-28000 | 22099 | -664 | -.85 | 21848 | -1044 | -.93 | -.93 |
| > 28000 | 29696 | -1488 | -1.5 | 29215 | -2120 | -1.6 | -1.6 |

reductions in the expected amount of owner-occupied housing demanded. For families with gross incomes above \$24,000, the expected change in house value is less than that for families in the \$20-24,000 range. Although families in the highest income brackets face greater increases in the price of housing, their demand is sufficiently less price elastic that their demands actually fall by smaller amounts. The third column of figures for regime 1 shows how the expected percentage of homeowners decreases due to the removal of the tax advantages. Due to the non-linearity of the probit transformation, families in the two highest income brackets experience a smaller change in percent owners than those in the group immediately below them. (The average change in the incidence of owner-occupied housing for the entire sample is 4.4%.) It would be of interest to ascertain the impact of these changes on factor incomes in the housing industry, but like previous studies, ours focuses on the uses rather than the sources side of the incidence problem.

As suggested above, removal of the housing tax subsidy might be accompanied by some adjustment to keep tax revenues constant. This could be accomplished in many ways; we assume a proportional reduction in all marginal tax rates. As the figures for regime 2 indicate, this results in a distribution of disposable income quite similar to that of the status quo. Although lost income has now been restored (compared to regime 1), there are still quite large decreases in the quantity of housing demanded and in the percentage homeowners in each income bracket.

In regime 3 the deductions of the status quo are replaced with a 25^o/o credit. The credit in effect changes the jth household's price of housing from $(1-t_j\delta_j)GP_j$ to $(1-.25\delta_j)GP_j$. Thus, for individuals with marginal tax rates below 25^o/o, regime 3 lowers the effective price of housing and lessens tax liability as well. It is not surprising, then, that at the lower end of the income scale this regime leads to increases in quantity demanded and percent owners, while at the upper end the opposite is true. As expected when a credit replaces a deduction, tax liabilities increase for high income households, and decrease for low income households.

In regime 4 tax rates are raised to make up for the revenue loss which accompanies regime 3. Compared to regime 3, each income group on average consumes less housing. For members of the upper income groups, substitution of the credit for the deduction is a large enough change in the effective price to induce a marked change in their consumption.

V. Concluding Remarks

Our goal has been to examine the efficiency and distributional consequences of the federal income tax treatment of owner-occupied housing. To do this it was first necessary to estimate the parameters of housing demand and tenure-choice functions whose arguments were net of tax. The tax-corrected price of owner-occupied housing had statistically and quantitatively important influences on both decisions.

Using the estimated parameters, the effects of a variety of tax rules were simulated. Even tax rule changes that held tax revenues constant had sizeable effects on the demand for housing because of their impact on the net price of housing. Both removing the favorable tax treatment for owner-occupied housing or replacing the current system with a 25⁰/o tax credit would tend to distribute disposable income away from the higher income groups.

The Laidler-Aaron analysis of housing costs has provided a simple yet useful framework for econometric study of the effect of the implicit income tax subsidy for homeowners. There are several ways (in addition to those already mentioned) in which this framework could be improved in future work. The analysis views housing only as a consumption decision; it would be useful to model the portfolio aspects of the problem as well. Moreover, the model provides no way to calculate the short run capital gains and losses in housing which might occur between equilibrium positions. Thus, formulation of a dynamic model is needed in order to obtain a more complete picture of the distributional consequences of the federal tax treatment of housing.

FOOTNOTES

¹There are also subsidies for rental housing in the form of accelerated depreciation. However, White and White [31, p.116] estimate that these amount to only 4⁰/₀ of the value of the subsidy to owner-occupied housing, and are therefore ignored in our analysis.

²Traditionally, owner-occupied homes have been the main focus of discussions concerning the omission of imputed income from the tax base. In theory, this concern is equally appropriate for all consumer durables, as well as the stream of 'enjoyment' yielded by an individual's stock of human capital.

³He considers three alternative rules: disallow homeowner deductions for property tax and mortgage interest, include net imputed rent in taxable income of homeowners, and include imputed net rent and disallow deductions for homeowners. [1, p. 55]

⁴Possible divergences between social and private costs are ignored in our analysis. There is some controversy as to whether or not such divergence is important in the analysis of owner occupied housing. (See [1, Chap. 1]). This analysis implicitly assumes that the property tax is a benefit tax rather than a 'distortion'. The implications of this assumption are discussed below.

⁵Laidler calculates t on the assumption that each family takes the standard deduction [11, p. 62]. In the work reported below, we estimate t on the more appropriate assumption that some households itemize.

⁶There is another way in which the federal tax provisions can be viewed as offsetting a previously existing distortion. If a first best solution from the point of view of efficiency would omit interest income from taxation, then omitting net imputed rent might decrease excess burden.

⁷This is not a major problem for White and White, because they do not estimate behavioral parameters. They compute excess burden and equity effects conditional on different sets of assumed parameter values. After permitting the supply curve to slope upward and following through its implications, the Whites use the basic framework discussed above.

⁸In one experiment, we assumed that each family had expected capital gains equal to three percent of house value. When the net price of housing term was adjusted appropriately, the estimated behavioral parameters reported below did not change very much.

⁹For an interesting non-econometric attempt to estimate the impact of federal taxes on the tenure choice, see [4].

¹⁰Using FHA data for 1969, Rosen [24] estimates a demand for owner-occupied housing services equation in which the price and income terms are corrected for taxes, but no attempt is made to study the tenure choice.

¹¹The family rather than the individual may be making the decision. In this case, utility functions should be viewed as 'social welfare' functions for the family.

¹²Roy's Identity states that the demand function for a commodity can be written as a function of the partial derivatives of the indirect utility function:

$$Q_0 = -(\partial V / \partial P_0) / (\partial V / \partial Y).$$

¹³See [14] for a discussion of the probit model and some alternatives to it.

¹⁴In the probit model, the expected probability of owning is non-linear in the variables, so the second order terms were not deemed necessary.

¹⁵The variables and parameters of the rental demand equation (12) are not of immediate import for this paper, and are reported in an appendix which is available upon request to the author.

¹⁶For each observation, the data on the city and region of the household were used to select the appropriate BLS figure. See [29, pp. 21-23] for details. I am grateful to R. Trost for providing me with the computer algorithm which matches the observations to the BLS tables.

A more appropriate gross price index might be price per unit of housing services as calculated from a housing cost function. Such an approach was not possible with our data. However, in the only study in which the two approaches are compared, it is shown that for micro observations, they generate virtually identical parameter estimates. See [22].

¹⁷The relative gross price of owning is found by taking the gross price of owning and dividing by P_{xj} , the BLS price index for non-housing goods.

¹⁸The tax law for 1970 and information on percentage of itemizers is found in [10].

¹⁹Unfortunately, no data on capital gains were available.

²⁰The following convention is used to define dichotomous variables: " $G_j = 1$ if β " means that G_j takes the value of 1 if β is true, and otherwise is zero.

²¹Of course, the data may suggest rejection of the hypothesis that any of these variables matters significantly. Note that there is no logical necessity that a variable which effects the tenure decision must also influence the size of the house given it is purchased, and vice versa. Indeed, one can imagine that a variable could work in opposite directions in the two equations.

²²Because the tax brackets are several thousand dollars wide, even fairly large errors in predicting house value will have only small impacts upon the estimated marginal tax rates.

²³Such techniques have been used in the literature on the estimation of labor supply functions. See, e.g., [9]. The selectivity bias here, if any, would be expected to be much smaller than would occur in a wage imputation procedure.

²⁴ Under the hypothesis that the covariance between the errors is zero, the estimated standard errors generated by ordinary least squares are correct. Otherwise, they may be biased.

²⁵ Since the income variable is not divided by the number of family members, to some extent the children variables are reflecting the fact that larger families may have less income available to spend on housing services. Income was not deflated by family size in order to avoid the difficulties involved in computing per adult equivalents, and to facilitate comparisons with earlier studies.

²⁶ In elasticity form, the Slutsky equation states that the compensated demand elasticity of a commodity is equal to its price elasticity minus the product of the income elasticity and the budget share.

²⁷ A comparison of the results in Table IV.1 with those of Laidler [11, p. 62] indicates that as a proportion of the value of housing stock, most of our excess burdens tend to be higher. Partly this is because marginal tax rates were higher in 1970 than they were in 1960, the year Laidler studies. Part is also due to the fact that our computations take into account tax induced changes in the tenure choice. At the top of the income scale, our figures are smaller. This is because the absolute value of the price elasticity in this study falls with income level, while Laidler assumes it is constant.

²⁸ In the highest income groups, the estimated demand elasticity was positive in a few cases. For these observations, we imposed a price elasticity of zero.

²⁸In an appendix available upon request to the author, these responses are broken down on the basis of tenure choice during the status quo.

²⁹See [12]. It is now recognized that 'neutral' taxation is not necessarily efficient. Efficient tax rates depend upon elasticities of demand, and when these are unequal, so in general are the efficient tax rates. See [25].

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