A list of Working Papers on the last pages

No. 133, 1984

EFFECTS OF TAX REFORM ON THE DEMAND FOR OWNER-OCCUPIED HOUSING: A MICROSIMULATION APPROACH

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December, 1984

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Abstract

The paper analyzes the effects on the demand for owner-occupied housing that are likely to result from the Swedish 1983-85 tax reform. This is done by means of a microsimulation model which takes into account the dichotomous nature of the demand for housing: the consumers choose the mode of tenure (owning versus renting) as well as the quantity of housing conditional on the choice of the mode of tenure. The tax reform consists of a general reduction of marginal tax rates (i.e. an increase in disposable income) together with limitations in the deductibility of mortgage interests. The simulations show that this will cause an increase in home-ownership in the sense that more households will demand owner-occupied housing. At the same time, however, the households will demand smaller houses on the average, and thus aggregate demand for small and medium-sized units will increase while demand for large units will fall sharply.

EFFECTS OF TAX REFORM ON THE DEMAND FOR OWNER-OCCUPIED HOUSING: A MICROSIMULATION APPROACH

I. Introduction

During the last decades, drastic changes have occurred in the market for owner-occupied housing in most Western countries. It is generally acknowledged that at least part of these changes are the results of the prevalent systems of income taxation, coupled with high rates of inflation. The impact of the income tax system on the market for housing has been extensively studied, both from empirical and from theoretical points of view.[1)]

The Swedish tax system underwent some important changes in the beginning of the 1980's. This paper employs an empirically based microsimulation model to analyze how the demand for owner-occupied housing is affected by these changes. It is organized as follows. Section II below gives a presentation of the tax reform that took place. In section III the simulation model that is used to study the housing market is presented. It is based on a binary choice model where the consumer chooses between owning and renting his/her home and simultaneously decides about quantity demanded conditional on tenure chosen. In section IV the simulation results are displayed and discussed. It is shown that the tax reform implied a stimulus to homeownership in the sense that it induced more households to own their homes instead of renting them. On the other hand it caused a reduction in homeownership in the sense that it made people in general demand smaller houses than before the reform. It thus

implied, according to our simulation model, a fairly drastic fall in the demand for large houses, and at the same time a sharp increase in the demand for small and medium-sized units. The simulation results in section IV do not take account of any government budget constraint. In section V it is shown that the reform can be expected to reduce government tax revenue. It is briefly considered how the requirement of budget balance would alter the conclusions reached in section IV.

II. The 1983-85 Tax Reform in Sweden

A general feature of the tax system of most countries is that owner-occupied housing is taxed asymmetrically. Mortgage interest payments are more or less fully tax deductible, while imputed income from homes is - if at all - taxed only to a very small extent. This has two consequences for housing demand. First, if the difference between the (fully deductible) nominal interest rate and the fraction of imputed income that is subject to taxation widens - for example as a result of inflation that drives up the interest rate - the effective price of owner-occupied housing will fall. Second, if the income tax schedule is changed - also perhaps as a result of inflation, which moves all income earners up into higher nominal income brackets - the effective price of housing will be affected.

These two effects have both allocational and distributional consequences, as is well known from the experience of the 1970's. There have been three remedies suggested: either to raise the fraction of imputed income that is subject to taxation,[2] or to limit the tax relief on mortgage interest, or to reduce marginal tax rates.

In the spring of 1981 the Swedish government decided to initiate a reform of the tax system. The argument for the reform was twofold. First, it was generally agreed that the

marginal tax rates were too high primarily in view of the detrimental effects on labor supply. Second, the above-mentioned effects on the housing market of the asymmetry in the treatment of owner-occupied homes were only too evident.

A Government Bill presented inthe spring of 1982 describes the proposed reform.[3] It contains two elements: an overall reduction in marginal tax rates, and a limitation of the interest deductibility. The reform was supposed to start gradually in 1983 and be fully in effect in 1985. Due to various pressures in the political process, the bill was somewhat changed when passed through Parliament, and it is not clear at the moment what the ultimate tax schedules will look like or whether the 1985 schedules will be in any sense final. For the present study, however, we have relied on the original bill, and we will use the tax schedule suggested therein as if it were the final one. Our model can be interpreted to apply to the switch between two tax schedules that both are expected to be stable.[4]

The solid curve in Figure 1 depicts the marginal tax rate according to the old 1982 schedule. As a point of reference, we note that the average yearly wage of a male adult skilled industrial worker in 1982 was 91,608 Swedish Kronor (Skr); thus the average skilled worker in that year faced a marginal tax rate (before capital income, interest deductions etc.) of 63 per cent.[5]

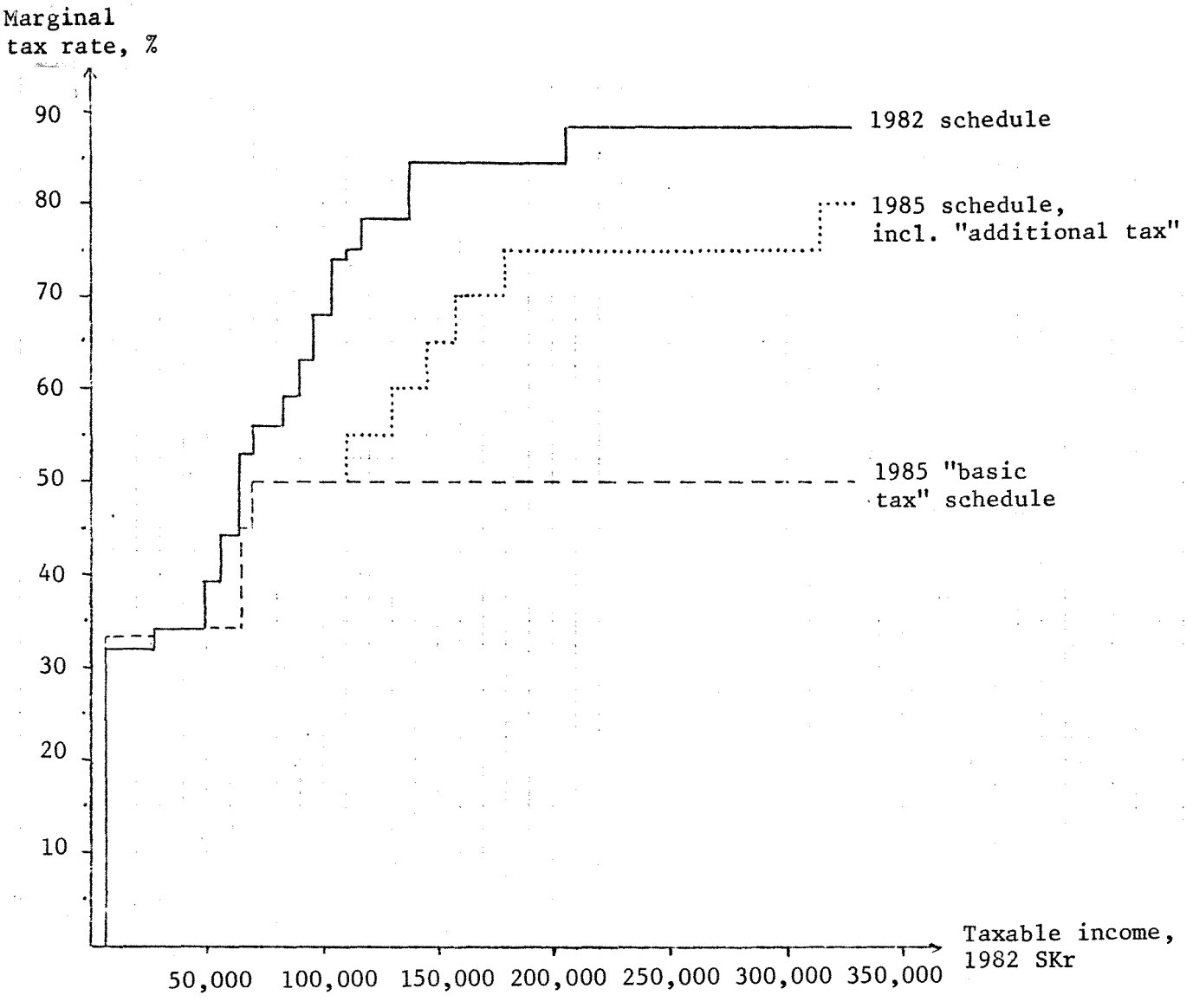
The proposed 1985 schedule consists of two parts. First we have the so-called "basic tax" which displays increasing marginal tax rates up to 50 per cent. This schedule is depicted by the dashed curve in Figure 1. All interest is fully deductible against

"basic taxable income". On top of that schedule, we have the so-called "additional tax", the marginal tax rate of which is zero for incomes less than 110,400 SKr, and is then rising to a maximum of 30 per cent for incomes above 310,500 SKr (1982 prices). Interest payments are not deductible[6] against "additional taxable income" and thus the maximal marginal rate against which net interest can be deducted is the 50 percent of the "basic tax" schedule.

The total marginal tax rates of the "basic" and the "additional" schedules taken together are shown by the dotted curve in Figure 1. We see that the tax reform implies a sizeable overall reduction in marginal tax rates, as was the intention; the marginal tax rate of the average industrial worker will fall to 50 per cent. This has two effects on the demand for owner-occupied housing. First there is an income effect: Since disposable income is increased for most households (except those with large deficits), the demand for housing is stimulated. Second there is a price effect: Lower marginal tax rates actually means a higher price of housing. What matters for the households is the mortgage interest net of taxes, and a reduction in the marginal tax rate against which interest can be deducted means that the net interest cost increases. This effect occurs whenever taxes are lowered, and in this particular case it is reinforced by the arrangement with a split of the income tax schedule into a "basic tax" schedule, against which interest payments can be deducted and an "additional tax" against which they cannot. The income and the price effects thus for most households point in opposite directions, and it is not a priori given which one dominates[7] the other.

The consequences for the homeowner (tenure choice will be introduced in section III) are perhaps more clearly illustrated by depicting his pre- and post-reform budget sets in two-dimensional space. Assume that a person has an exogenous labor income x

Figure 1: 1982 and 1985 Swedish marginal tax rates.



Note: It is assumed that the local government tax rate is 30 per cent, and that the income earner is not affected by the deductibility limitations.

and a net wealth W. His disposable income is then $x + rW - t(x+rW)$, where r is the interest rate and where $t(.)$ is the tax function. If he buys a house of value h, and if interest payments are fully deductible, the amount he can spend on other goods is $z = x + r(W-h) - t[x + r(W-h)]$. In some countries, e.g. in Sweden, part of the house value is taxed as imputed income. Let us denote this taxable imputed income by $\alpha(h)$.[8] Further, expected capital gains from the house (π) as well as depreciation and maintenance costs (δ and m) should be taken into account when writing down the full budget constraint. We thus have

$$z = x + r(W-h) - t[x + r(W-h) + \alpha(h)] + (\pi-\delta-m)h \qquad (1)$$

as the agent's relation between consumption of owner-occupied housing h and consumption of other goods z.

Note that (1) corresponds to the Swedish pre-reform tax system with interest payments fully deductible - i.e. (W-h) might well be negative. For the post-reform system we would have two $t(.)$ functions with interest deductibility for only one of them. Thus the 1985 budget constraint can be written as

$$z = x + r(W-h) - t_b[x + r(W-h) + \alpha(h)] - \\ - t_a(\xi) + (\pi-\delta-m)h \qquad (2)$$

where the tax base for the "additional tax" is

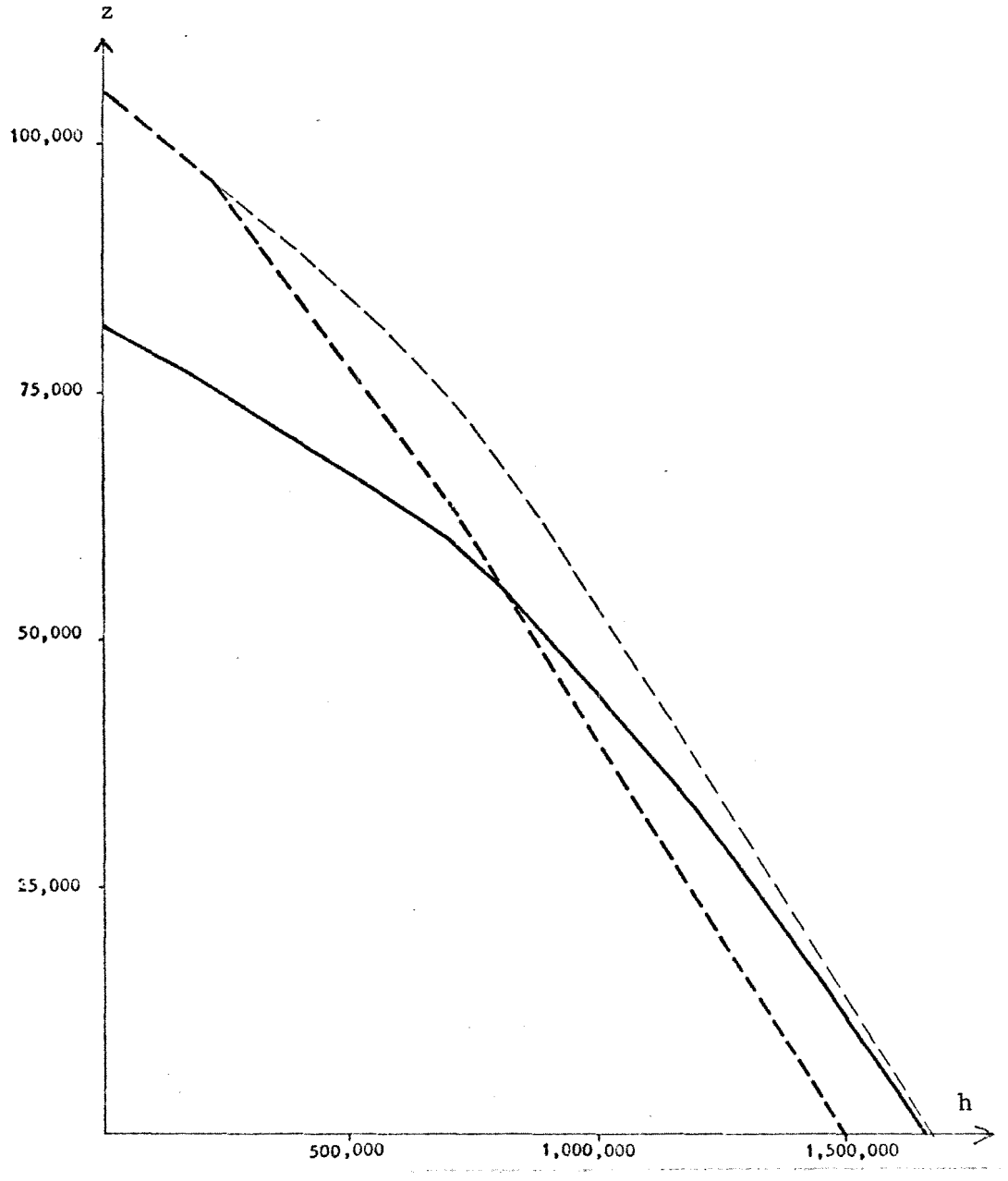
$$\xi \equiv \begin{cases} x + r(W-h) + \alpha(h) & \text{if} \quad r(W-h) + \alpha(h) > 0 \\ x \quad \text{otherwise.} \end{cases}$$

Now, the solid curve in Figure 2 shows the pre-reform budget constraint (1) for a single high-income earner with an income x = 200,000 Swedish Kronor and a wealth W = 200,000 SKr. The parameters have been set at $r = 0.12$, $\pi = 0.06$, and $(\delta+m) = 0.06$ (all these values are of course arbitrary, and the diagram serves as an illustration only). On the horizontal axis is shown the quantity of housing measured by the price of the house, while on the vertical axis is shown the amount of money the consumer can spend on other goods. Since the tax system is progressive in the sense of displaying increasing marginal tax rates, the budget set is convex. Since the tax schedule (as well as the schedule $\alpha(.)$ for computing imputed, taxable income) is piecewise linear, the budget curve consists of a large number of adjoint linear segments.

The thick dashed curve in Figure 2 shows the post-reform 1985 budget set (2) for the same person. We see that its intercept with the vertical axis is considerably higher than the intercept of the 1982 curve; if the person does not choose to buy a house of his own (i.e. he chooses to be a renter) or if he buys only a small house, he would now have much more money left for other consumption. This reflects the general reduction of marginal tax rates. However, the post-reform curve is everywhere (except for very large houses) steeper than the pre-reform curve, which means that the price of housing is higher at almost all consumption levels.

The thin dashed curve in Figure 2 shows what the budget set would have been like if the tax reform had only implied a reduction of the tax rates without any limitation of the interest deductibility[9)], that is the new tax system would have been described by the "1985 total tax" curve of Figure 1 with full interest deductibility. We see that the two 1985 curves

Figure 2: Budget sets for an owner-occupier with income x = 200,000 SKr and wealth W = 200,000 SKR



Solid curve (————): 1982 tax schedule
Thick dashed curve (- - - - - -): 1985 tax schedule
Thin dashed curve (------): Hypothetical 1985 schedule with no limitation in interest deductibility.

coincide as long as net capital income is non-negative. Note also that these curves coincide for all households where the taxable income of the highest income-earner in the family is below 110,400 SKr. This holds for the great majority of the Swedish households (6.6 per cent according to calculations based on our sample).

The curves in Figure 2 divide the tax reform into two elements. They allow us to analyze what effects are due to the overall reduction in marginal tax rates and what effects are due to the limitation in interest deductibility. The thin dashed curve is everywhere outside the 1982 curve, which means that the general reduction of tax rates implied a net gain to the consumer, regardless of his preferences. However, it is everywhere steeper than the 1982 curve (except for very large houses), which means that the marginal prices are higher.

Depending on his preferences, the person whose budget sets are shown in Figure 2 could gain or loose from the tax reform. If his preferences were such that he consumed very little owner-occupied housing, the relevant part of the post-reform (dashed) budget curve would be located outside the pre-reform (solid) curve, and he would benefit from the reform. If on the other hand his preferences were such that he consumed much housing, the relevant part of the new budget curve would be located inside the old one, and he would be a loser. It is also conceivable with a small effect on utility, but a large negative effect on quantity demanded. This would happen with a sufficiently flat indifference curve.

It should be emphasized that Figure 2 refers to a single-person household with a particular income and wealth; for other households the pre- and post-reform budget sets might look quite different. In particular it is important to take into account that both spouses work in most households. In constructing budget sets for such households we have assumed that deductions are divided between the spouses in the most favourable way. Since people differ not only with respect to their budget sets, nothing can be said in

general about the reform's effect on demand and on the distribution of welfare. By using a microsimulation model based on data of actual, individual housing consumption, individual preferences can at least in principle be traced, individual budget sets can be calculated, and individual as well as aggregate changes in demand can be predicted. In the next section the basic properties of such a microsimulation model will be presented.

III. The Model

Assume that the household is the basic decision unit and that each household derives utility from the consumption of housing and "other goods". Housing can be consumed either by owning or by renting. In ensuing expressions we assume for simplicity owner-occupied and rental housing to be the same good, h. However, there is nothing in the simulation model that makes such an interpretation necessary.

If household i chooses to be an owner, it solves the maximization problem

$$\begin{aligned} &\text{Max } u^i(h_i, z_i) \\ &\text{s.t. } z_i = B^i(x_i+rW_i, h_i) \end{aligned} \tag{3}$$

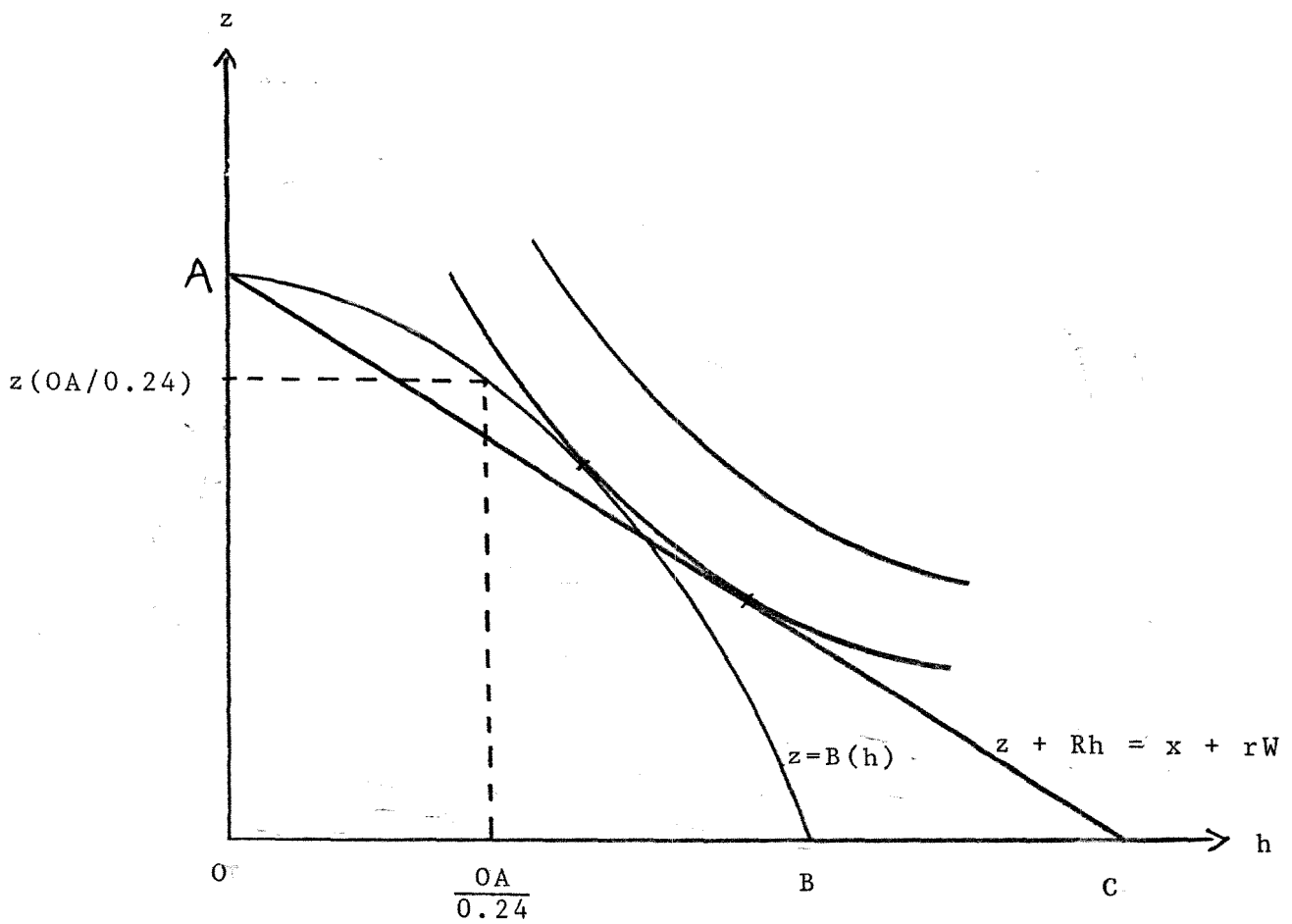
where $B^i(..)$ is a nonlinear budget constraint[10] of type (1) or (2) and where the function $B^i(..)$ can vary over households because of demographic factors, differences in tax treatment etc. If the household chooses to be a renter instead, it solves the maximization problem

$$\begin{aligned} &\text{Max } u^i(h_i, z_i) \\ &\text{s.t. } z_i + Rh_i = B^i(x_i + rW_i) \end{aligned} \tag{4}$$

where R is the unit price of rental housing. Denote the indirect utility of programme (3) by $V_o^i(x_i+rW_i)$ and the indirect utility of programme (4) by $V_R^i(x_i+rW_i)$. The household chooses to be an owner-occupant if

$$V_o^i(x_i+rW_i) \geq V_R^i(x_i+rW_i). \tag{5}$$

Figure 3: The consumer's choice between owning (convex set OAB) and renting (triangular budget set OAC).



This choice situation is illustrated in Figure 3, where the subscript i has been suppressed, and where we have drawn the indifference curve so that the household happens to be indifferent between owning and renting.

In an earlier paper[11] we have employed logit estimation procedures to analyze the determinants of tenure choice and demand for owner-occupied homes. Based on a cross-sectional data set from 1978-79 of approximately 3,000 households, we have estimated simultaneously

(a) the probability that a particular household with characteristics A_i will choose to own its home instead of renting it, and

(b) the household's demand for owner-occupied housing, conditional on its decision to be an owner, as a function of a set of characteristics B_i.

The system estimated can be written as

$$\log h_i = B_i\beta + \sigma u_i \quad \text{if } D_i = 1 \tag{6}$$

$$D_i = 1 \quad \text{if and only if } A_i\gamma \geq \varepsilon_i \tag{7}$$

$$P_i \equiv \text{Prob}(D_i = 1 | A_i\gamma) = \left(1 + e^{-A_i\gamma}\right)^{-1}, \tag{8}$$

where the dichotomous variable D_i is unity if the household owns and zero otherwise. The stochastic variable ε_i follows a Weibull distribution and u_i is N(0,1). The sets of household characteristics A_i and B_i may but need not be the same in the two functions; in our model we have however used the same two sets for the two estimations. The estimation procedure allows for a non-zero correlation between ε and u. It also accounts for the fact that the sample is heavily stratified and that the sample selection weights are endogenous.

In Table 1 is given the set of independent variables used, together with the estimated values of their coefficients in equations (6)-(8). Most of the variable definitions are self-explanatory. All except the first four ones can be regarded as demographic or geographic characteristics; the first four ones are obviously economic variables, and they need some explanation.

When an agent solves the maximization problems (3) and (4), and makes the comparison (5), he takes the entire budget curve $z_i = B^i(x_i + rW_i, h_i)$ into account. In our estimation equations (6), (7) and (8), however, the B^i curve is represented by four variables: the level and the slope (i.e. z_i and dz_i/dh_i) of the curve at two exogenous points.[12] The variable LRDI (Renter's Disposable Income) is thus (the log of) the value of z that satisfies the budget constraint for h = 0, which is equal to the distance OA in Figure 3. Similarly, RMP (Renter's Marginal Price) is the absolute value of the slope of the budget curve at that point. As the other point of reference, we have chosen the point where the household buys a house of size RDI/0.24. At this point, half of the disposable income would be spent on payments for a fully mortgaged house if the interest rate were 0.12 - an exogenous point which seems as reasonable as any. The variable LODI (Owner's Disposable Income) is thus defined as (the log of) the value of z that satisfies the budget constraint (1) for h = OA/0.24, while OMP (Owner's Marginal Price) is defined as the absolute value of the slope of the budget curve at that point. The variables RDI and ODI can thus be regarded as "disposable incomes", i.e. the amount of money to be spent on other goods for different levels of housing consumption, while RMP and OMP can be looked upon as price variables.

Table 1: The Estimated Model

Variable name	Variable definition	The choice equation		The conditional demand	
		Coefficient estimates	Standard errors	Coefficient estimates	Standard errors
LRDI	$\ln[z_i(0)]$	5.722	4.869	-1.215	1.106
LODI	$\ln[z_i(z_i(0)/0.24)]$	-0.849	5.171	1.206	1.118
RMP	$-\frac{dz_i(0)}{dh}$	1.90	26.82	-10.30	5.708
OMP	$-\frac{dz_i(z_i(0)/0.24)}{dh}$	-25.28	15.81	2.153	3.567
LPRICE	Regional price index	-0.6464	0.3536	0.5373	0.1009
PCCOOP	Percentage of coops and condos in the local community	-1.175	0.609	0.1807	0.1562
RATIO	Ratio of highest income in household to the total household income	4.300	0.754	-0.3751	0.1566
AGE	Age of head of household	0.0516	0.0632	-0.0522	0.1522
AGE2	Age squared	-0.0002	0.0007	0.0005	0.0002
SEX	Sex of head of household: 0=M, 1=F	-0.4706	0.2902	0.0462	0.0713
CHILD	Number of children in household	0.2003	0.1079	0.0721	0.0251
ADULT	Number of adults	0.7537	0.3561	-0.0765	0.1088
LO	Educational dummy for head of household if blue-collar worker	-0.1709	0.1138	0.0225	0.0231
TCO	Educational dummy for head of household if white-collar worker	-0.1825	0.0727	0.0381	0.0155
BUSINESS	Dummy for self-employed	-0.4385	0.2877	0.3122	0.0542
CONSTANT		-11.68	2.96	3.561	0.0676
SIGMA	σ in (6)	0.3731	0.0110		
RHO	$\text{cov}(\varepsilon,u)$	0.0749	0.2832		

Note: the dependent variable is the logarithm of house value divided by 10,000 SKr.

Now, this model can be used to study how the demand of each individual household is affected by changes in the tax schedules, i.e. by changes in the variables LRDI, LODI, RMP and OMP. Before proceeding to these simulation results, however, a few words about some further assumptions underlying the model are warranted. First, as is evident from the budget constraints (1) and (2), the variables π, δ and m are of importance for the marginal prices RMP and OMP. The assumption underlying the estimates shown in Table 1 is that inflation is such that capital gains, depreciation and maintenance outweigh each other: $(\pi-\delta+m) = 0$. Second, when computing LRDI and RMP for households that are observed owning a house, we calculate the disposable income and the marginal price that the household would have if it sold the house and became a renter. Performing this calculation, we have to make some hopefully realistic assumption about how a household that sells its house invests the money received. In principle, the household pays back a fraction v of the loans on the house,[13] invests a fraction w of the proceeds at the market interest rate (which has been assumed to be 12 per cent), and invests a fraction (1-w) in non-taxable assets (e.g. consumer durables) that yield a tax-free rate of return equal to the rate of inflation ($\pi = 0.06$). We have set these fractions to be $v = w = .0.5$.

From the regression results in Table 1 one cannot directly read off standard concepts like price effects and income effects. This is so because a change in, say, pre-tax income will affect all four variables LRDI, LODI, RMP and OMP. But the model's implications in these respects can be illustrated by simulating the effects on predicted demand from appropriately defined experiments. Table 2 presents the results from two experiments:

Income increase: Raise RDI for all households by 10 per cent and ODI by the same absolute amount. This means making a lump-sum non-taxable transfer to all households in proportion to their disposable income as renters.

Price increase: Raise maintenance costs (δ) by 0.5 per cent of the house value. Evaluated at mean values this corresponds to a change in RMP by +7.7 per cent, in OMP by +6.4 per cent and in ODI by -3.1 per cent.

The table shows percentage changes in the predicted number of owner-occupiers (Δ_N) and the predicted total value of owner-occupied homes demanded (Δ_H). A more precise definition of these magnitudes is given in Section IV below.[14] We see that the rate of homeownership increases strongly with income, while the estimated price effect is rather weak. When we look at the overall effect Δ_H, on the other hand, the price effect appears to be quite strong.

It needs to be emphasized that the results are quite sensitive to the assumptions discussed above. We have estimated the model and run the experiments for a few alternative assumptions concerning v, w and π. In particular, the price effects differ strongly, even to the point of becoming positive under some sets of assumptions (see Brownstone et al. (1983), appendix).

Table 2: Mean Percentage Demand Predictor Changes
(Standard Deviations in Parenthesis)

	Δ_N	Δ_H
Income increase	18.70 (6.07)	22.61 (7.83)
Price increase	-3.83 (1.74)	-10.68 (1.53)

IV. Simulation Results

In interpreting our model we should take account of the peculiarities of housing as a commodity. In distinction from many other goods it is, usually, only consumed in one unit by each household. When we talk of a household's quantity of housing, we do not mean the number of units, but rather the "size" or "quality" of the one unit consumed. In our model we have used the value of the house as a quantity index. This has a clearcut interpretation if we assume that the housing market was in long-run equilibrium in the year of estimation, 1979. This means that observed house values are assumed to coincide with production costs. Let us further assume constant returns to scale in the production of new houses, in particular the absence of land rents. We can now interpret the regression coefficient for, say, the number of children in the conditional demand equation, which is .0721 according to Table 1; one extra child is predicted to lead a household to demand a house that costs 7.21 per cent more to produce. Further we assume that the households are in equilibrium, in the sense that their observed consumption conforms with the solution of an optimization problem like (3)-(5). This means that we disregard the possible influence of transactions costs and rationing. The latter factor is perhaps not prevalent in the market for owner-occupied housing per se, but it is nevertheless important in the rental and in the credit markets.[15)]

By assuming that observed consumption reflects actual demand, we can use the model of Table 1 to predict how changes in the tax system will affect future demand in a new long-run equilibrium. In the short run, supply will not respond to this new demand pattern, and prices will adjust so that the price of some types of housing will rise while the price of other types will fall.[16)] In the long run, assuming an infinite elasticity of supply[17)],

the simulation results will also reflect consumption patterns, and our model can thus be regarded as a partial equilibrium model of the housing market.

Table 3 describes how the tax reform affects the independent variables of the model. It is very clear that the most important part is the general reduction of marginal tax rates. The impact of the deductibility limitation per se is quite modest, as evidenced by the small difference between the last two columns. This is mainly due to the fact that, as noted above, there are rather few households with a taxable income above the point where the "additional tax" comes into operation. The difference between the first two columns shows a strong impact on the price variables. In particular this is so for owners, which on average have higher income than renters, and for OMP, since this is calculated at a higher taxable income than RMP. See Figure 1, which illustrates how the decrease in marginal tax rates is larger at high taxable incomes.

Table 3: Average Values of Independent Variables with 1982 and 1985 Tax Schedules

		1982	1985	
			Full interest deductibility	Deductibility limitations
LRDI	Owners*	2.0831	2.1232	2.1231
	Renters*	1.3877	1.4033	1.4032
LODI	Owners	1.7522	1.7457	1.7424
	Renters	0.9911	0.9650	0.9637
RMP	Owners	0.05406	0.06729	0.06742
	Renters	0.07155	0.07707	0.07729
OMP	Owners	0.07665	0.08080	0.08119
	Renters	0.08243	0.08400	0.08414

* Averages over all households that in the data are observed as owners and renters respectively.

We can now look at the effects of the tax reform on housing demand. Let us start with a few summary statistics. In 1979, when the data were collected, 1296 households out of the total sample of 2950 were owners.[18] The sample being heavily stratified in various respects, we have to apply stratification weights, W_i, to transform these numbers to nation-wide numbers. We can then use the model to make a prediction of the number of owners N by defining

$$N = \sum_{i=1}^{2950} w_i \, D \quad (\hat{\gamma}, A_i(\xi)), \tag{9}$$

where D_i is the dichotomous variable ($D_i = 1$ if household i owns, $D_i = 0$ otherwise) of equations (6) - (8) above, where $\hat{\gamma}$ is the estimated coefficient vector of the tenure choice equation (e.g. the estimates reported in Table 1 above, and where $A_i(\xi)$ is the vector of exogenous variables used in the tenure choice equation. The index ξ stands for the particular tax system in effect, i.e. $\xi = 1982$ for the pre-reform case and $\xi = 1985$ for the post-reform case.

Formula (9) can however not be immediately employed, since D_i is a random variable. Instead we can use the predictor

$$\hat{N} \equiv E_{\varepsilon_i}\left[N|\hat{\gamma}\right] = \sum_{i=1}^{2950} w_i P\,[\hat{\gamma}, A_i(\xi)] \tag{10}$$

where P_i is the probability of owning, defined by equation (8). Using (10) could be interpreted as regarding each household in our sample as representing a large number of observationally equivalent households, a fraction P_i of which will own while a fraction $(1 - P_i)$ will rent. However, only using the point estimates does not take into account that the estimated coefficient vector $\hat{\gamma}$ is itself a random variable, the standard errors of which are indicated in Table 1. We have instead used the predictor

$$\bar{N} = E_{\hat{\gamma}}\left[\sum_{i=1}^{2950} w_i P\,[\hat{\gamma}, A_i(\xi)]\right].$$

We have estimated this by drawing 21 realizations from the estimated distribution of the parameter vector $\hat{\gamma}$. This has been done both for pre- and post-reform values of A. The result is a predicted increase in the

number of home-owners[19] by 5.72 per cent, with a standard deviation of 4.45 per cent. This perhaps counter-intuitive finding is explained by the fact that the tax reform in general increases household income, which according to our model increases the propensity to own. This effect appears to be stronger than that of the increase in the price variable, which tends to decrease the rate of homeownership.

Looking at the number of homeowners, we thus get the impression that the reform stimulates homeownership, an effect which is significant at the 90 per cent level. Let us now look at total demand, i.e. at the aggregate value of the houses demanded, defined by

$$H = \sum_{i=1}^{2950} w_i D\,[\hat{\gamma},\ A_i(\xi)] \cdot h[\hat{\beta},\ A_i(\xi)] \qquad (11)$$

where h_i is the conditional demand for housing, defined by equation (6) above, and where $\hat{\beta}$ is a vector of parameter estimates for the conditional demand function. It would seem appropriate to use the expectation of H, conditional on the parameter vectors $\hat{\gamma}$ and $\hat{\beta}$ in the same fashion as equation (10) above, as our predictor of total housing demand. Unfortunately, this expectation does not exist if the correlation between the stochastic disturbances ε_i and u_i is greater than 0.5 in absolute value (which it is for some of our scenarios); under such circumstances, the tails of the joint distribution would be too thick. We therefore use the predictor

$$\hat{H} \equiv \text{Plim } H = \sum_{i=1}^{2950} w_i \text{ Plim } \left[D[\hat{\gamma},\ A_i(\xi)] \cdot h[\hat{\beta},\ A_i(\xi)]\right]$$

$$= \sum_{i=1}^{2950} w_i\ P_i\ [\hat{\gamma},\ A_i(\xi)] \cdot \exp[A_i(\xi)\hat{\beta} + \hat{\sigma}\hat{\rho}\lambda_i]$$

where $\hat{\sigma}$ is the estimate of sigma in equation (6) while $\hat{\rho}$ is the estimate of the correlation between ε_i and u_i. The variable λ_i, finally, is Mill's ratio,[20] defined by

$$\lambda_i = \frac{-\,f[A_i(\xi)\hat{\gamma}]}{F[A_i(\xi)\hat{\gamma}]}$$

where f(x) is the logit density function and F(x) is the logit distribution function:

$$F(x) \equiv \frac{1}{1 + e^{-x}} ,$$

$$f(x) \equiv F'(x).$$

Like with our predictor $\hat{N}$ above, we note that $\hat{H}$ is conditional upon a particular set of parameter estimates $\hat{\theta} \equiv \{\hat{\gamma}, \hat{\beta}, \hat{\sigma}, \hat{\rho}\}$. We then use the expectation

$$\bar{H} \equiv E_{\hat{\theta}}[\hat{H}] \tag{12}$$

as our prediction for aggregate housing demand. The expectation $E_{\hat{\theta}}[\hat{H}]$ has been obtained as the average of 21 drawings from the estimated distribution of the parameters $\hat{\theta}$. Calculating $\bar{H}$ according to (12) for both pre-reform and post-reform demand shows a decrease in total value demanded by 14.62 per cent (standard deviation 3.85 per cent). The interpretation is that the tax reform induces more households to be owners, but that they demand smaller houses on the average.

This draws the attention to the size distribution of houses. The histogram in Figure 4 shows the pre-reform consumption of various sizes of owner-occupied homes. On the vertical axis is given the number of households that will demand a house of a particular size class Ω, where the predicted number of households demanding $h_i \in \Omega$ is defined by

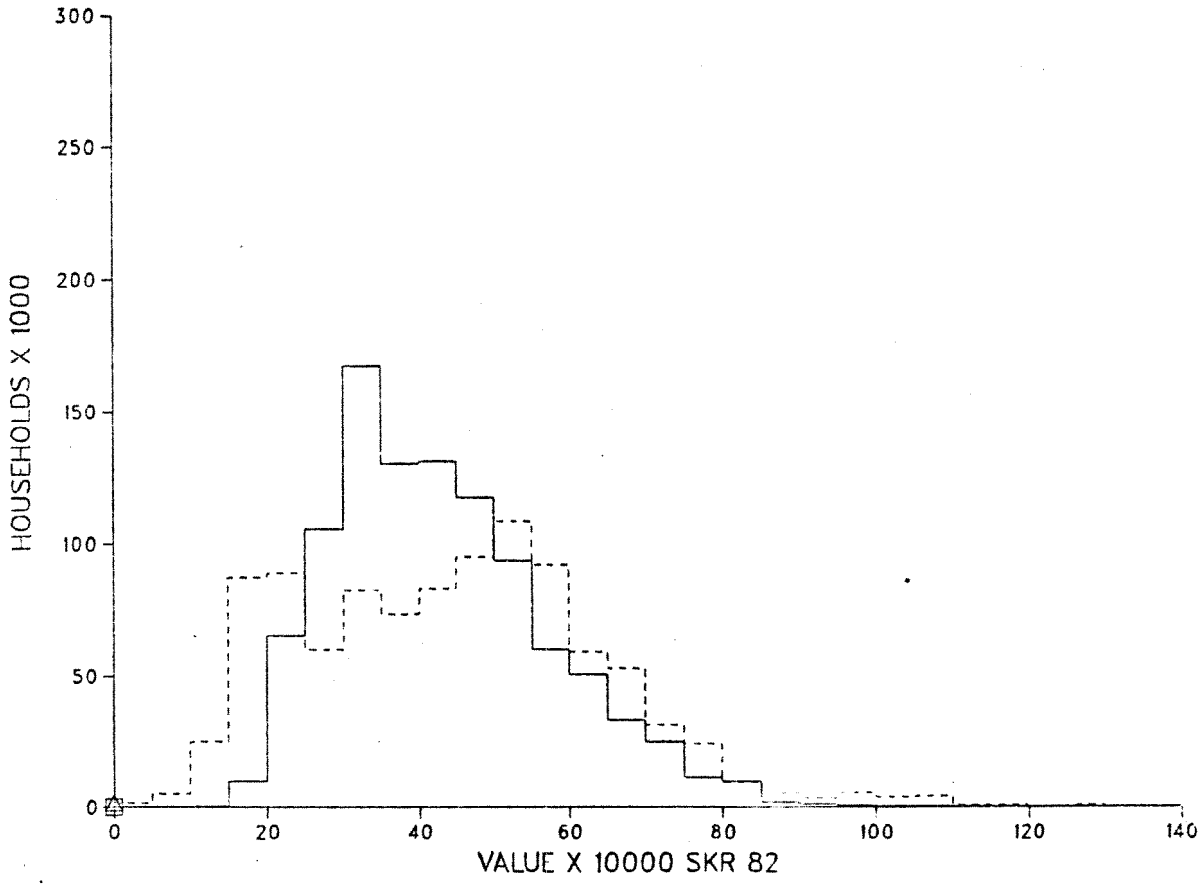
$$\hat{N}_{\Omega} \equiv \sum_{i \in I_{\Omega}} w_i \, P_i\left(\hat{\gamma}, A_i(\xi)\right)$$

and where the set I_{Ω} is defined as

$$I_{\Omega} \equiv \left\{ i \,|\, h_i\left(\hat{\gamma}, B_i(\xi)\right) \in \Omega \right\}$$

The size classes in Figure 4 are given in intervals of 50,000 SKr [21]; the solid curve shows the predicted pre-reform demand using the vector of point estimates reported in Table 1, while the dashed curve shows

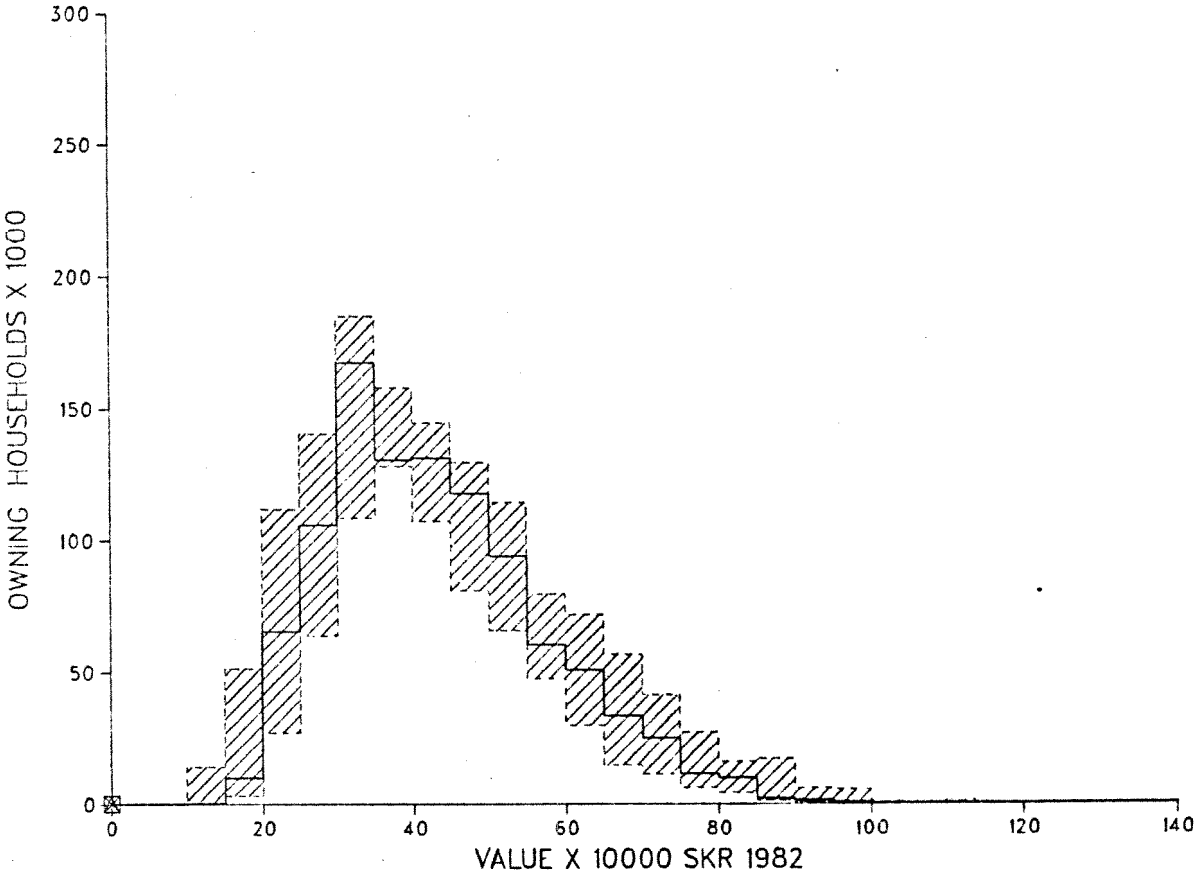
Figure 4: Pre-reform housing demand for various size classes.
Solid curve (———): Predicted demand
Dashed curve (-----): Actual demand.



the actual pre-reform demand. Although the model predicts the total number of owners fairly well, it evidently has a tendency to overstate the number of owners in the medium-size classes.[22)]

The histogram in Figure 4 is based on point estimates. Figure 5 is based on 20 random draws from the estimated distribution of parameter estimates. To each realization corresponds a separate histogram. For each size class we have deleted the realization that yielded the highest and that which yielded the lowest, number of owners $\hat{N}_{\Omega}$ in that class. The spread of the remaining 18 draws, for each size class, is represented by the shaded area in Figure 5. One can therefore say that this shaded area gives a 90 per cent confidence interval for the predicted distribution of owner-occupied homes. For example, for the size class of 400,000-450,000 SKr, 90 per cent of the realizations yielded a number of owners between 144,617 and 107,200. For comparison, the predicted size distribution using the means of the parameter estimates (i.e. the solid curve of Figure 4 above) is shown by the thick, solid curve. We see that this "average curve" often is located more or less in the center of the confidence bound, but that there are some obvious exceptions. For example, for the size class 350,000-400,000 the solid curve is almost at the bottom of the interval, as is the case for the size class 150,000-200,000. There are two reasons for these excentricities. First, there is a very minor possibility ($9.5 \cdot 10^{-7}$) that out of 20 random draws from a probability distribution almost all could fall on one side of the mean, thereby creating an image like the one in the figure. The second reason for excentricities to appear is perhaps more intriguing. The estimates reported in Table 1, i.e. the ones used for plotting the solid curve in Figure 5 , are the means of the distributions of parameter estimates. Due to the nonlinearity of the model, the housing demand of the average parameter vector is not necessarily identical to the average demand over the distribution of parameter vectors.

Figure 5: Predicted pre-reform housing demand.
Solid curve (———): Predicted demand using the point estimates of Table 1.
Shaded area ////// : 90 per cent "confidence interval".



Let us now look at the post-reform demand. Figure 6 contains the same type of information as Figure 5 above, but with the 1985 tax schedule. The thick, solid curve is the one obtained by using the parameter estimates of Table 1, and the shaded area indicates a 90 per cent confidence interval for each size class. To facilitate the comparison of pre-reform and post--reform demand, we have superimposed the solid curve of Figure 5 and the solid curve of Figure 6 on each other, and displayed them in Figure 7, where the solid curve refers to the 1982 tax schedule and the dashed curve refers to the 1985 tax schedule.[23)] It is evident that the reform has caused demand for large houses to fall, and demand for small and medium-sized houses to increase. This reflects both an increased number of homeowners and the tendency for previous homeowners to demand cheaper houses. The changes appear quite drastic. According to the point-estimates the demand for the size class 200,000-250,000 almost doubles, while the demand for the size class 250,000-300,000 more than doubles. On the other hand, demand for all size classes above 500,000 falls by considerably more than 50 per cent.

V. Tax-Revenue Effects

The above analysis is incomplete in a crucial respect. It ignores the government's budget constraint. It is standard practice to analyze tax returns under the assumption of a balanced budget; after all a reform will always be "financed" one way or the other, by compensating tax adjustments or by inflation. However, since the reform studied here is rather complex, we believe that adding an - necessarily arbitrary - assumption about compensating tax changes might have obscured the analysis. Also, it would have involved computational problems with iterations needed to calculate the exact tax change needed to restore budget balance.

As a substitute for a balanced-budget analysis, we will in this section present estimates of the effects on government tax revenue under the assumption that other tax rates are unchanged. Predicted aggregate tax revenue, T, can be expressed as

Figure 6: Predicted post-reform housing demand.
Solid curve (———): Predicted demand using the point estimated of Table 1.
Shaded area ////// : 90 per cent "confidence interval".

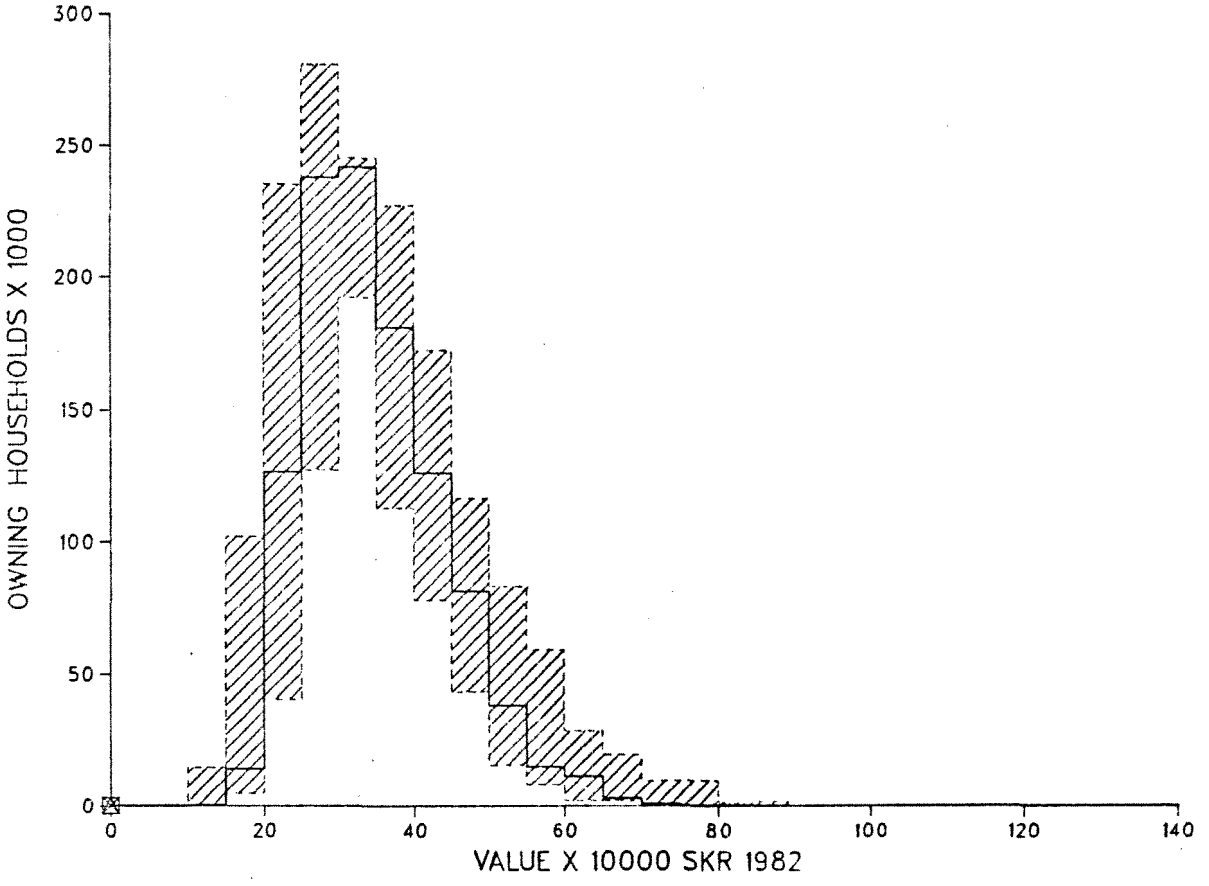
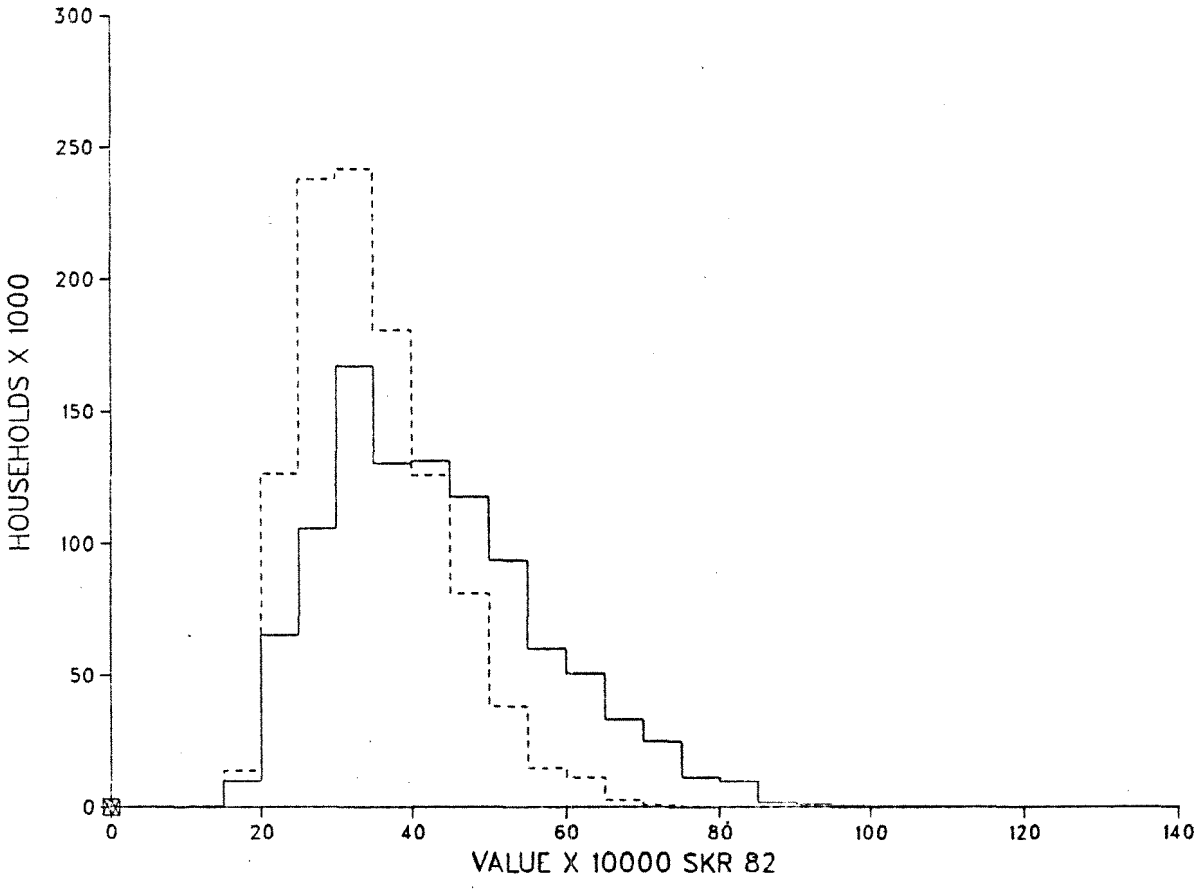


Figure 7: Point estimates for pre-reform (solid curve) and post-reform (dashed curve) housing demand in various size classes.



$$T^{j,k} = \frac{1}{2950} \sum_{i=1}^{2950} W_i \Big[P_i^j \cdot t^k(x_i, W_i, h_i^j) + \\ + (1 - P_i^j) \cdot t^k(x_i, W_i, 0) \Big] \qquad j,k = 1982,1985 \qquad (13)$$

Here t is a compact notation for the functions t_a and t_b in (2), i.e. it expresses taxes paid as a function of exogenous income and wealth and the amount of owner-occupied housing. T is indexed by superscripts j and k. This indicates that tax revenue depends both on the tax schedule t^k and the values of the arguments h^j and P^j. Here h^j and P^j are the predicted values using the point estimates in Table 1 and the tax schedule t^j.

The effect on T of going from the 1982 to the 1985 system is shown in Table 4. There are two sources of revenue changes: the change in tax schedules per se, and the behavioural effects on the probability of owning, P, and housing demand, h. As King (1983) has noted calculations made by government departments tend to disregard the second source. We see from the table, however, that it is rather important. The introduction of the 1985 tax schedule would, if P and h remained constant at their 1982 levels, reduce tax payments from 30,351 SKr to 27,903 SKr, i.e. a fall by 8.1 per cent. But, since the reform also reduces h and P, and thereby increases taxable income, the overall effect on tax revenue is smaller; it will fall to 28,978 SKr, that is by 5.1 per cent.

Table 4: Estimated Tax Revenue, Household Average

j \ k	1982	1985
1982	30,351	27,903
1985	-	28,798

Note: The numbers are calculated according to expression (13).

We can now get a rough idea of the possible effects on housing demand when we account for the balanced-budget requirement. Assume that after the reform has taken place, average tax payments have to be increased to their pre-reform level (i.e. 30,351 SKr) which means an increase by

5.4 per cent. Assume further that this is done in a lump-sum fashion for all households. By our data, we can see that this is equivalent to an average reduction in RDI by 2.7 per cent. And by the "income elasticity" experiment reported in Table 2 above we see that a fall in RDI by 2.7 per cent will reduce aggregate housing demand by roughly 6 per cent (2.7 x 2.261 = 6.1). Hence it appears that a balanced reform would imply a considerably larger decrease in aggregate demand than reported above. This conclusion, however, depends crucially on how budget balance is assumed to be achieved. If it instead would be done by increasing marginal tax rates, i.e. modifying the cut in these rates proposed in the reform, the conclusions would be radically different. In such case the price variables (RMP and OMP) would tend to fall and demand would be stimulated. We have to conclude that the way chosen to restore budget balance is crucially important for how demand is affected.

Finally, it needs to be re-emphasized here that our calculations are of a partial equilibrium nature, particularly since we ignore the effects on labor supply. Indeed, a major reason for the reform was to stimulate labor supply, and any such effects may be much more important for tax revenue than those stemming from the housing market.

VI. Concluding Comments

In this paper we have used a microsimulation model to study the effects of a particular tax reform on housing demand. There has recently been a burst of interest in the use of simulation methods for policy analysis; see e.g. the volume Behavioral Simulation Methods in Tax Policy Analysis (1983) and the SSRC/NBER Conference on Micro-Data and Public Economics (1984). In most cases the analyst uses actual micro data combined with point estimates (and/or guesses) of behavioral parameters. In contrast, our model makes full use of the stochastic properties of estimated parameters, and we express the forecasts of the model in probabilistic terms. We have rejected the hypothesis that the reform will leave the aggregate demand for owner-occupied housing unaltered in favor of the hypothesis that it tends to decrease demand. On the

other hand, the forecast that the number of home-owners will tend to increase as a result of the reform is not statistically significant. It should also be pointed out that the mean forecasts presented differ substantively from those that would be generated by using point estimates of the parameters evaluated at mean values of the indpendent variables. This is further discussed in Brownstone et al. (1983).

Microsimulation methods allow analysis at a disaggregate level. In this paper we have been able to show that the projected decrease in demand is concentrated to large houses, whereas the demand for small houses actually is forecasted to increase. We could also present results that are disaggregated across households and study the distribution of welfare gains and losses. Previous related work, e.g. King (1983), have used model specifications where utility function parameters are identified. Since we have chosen not to do this, we have to use welfare measures based on Harberger-type approximation formulae. That will involve some complications in a model with both discrete choice and non-linear budget constraints, and we will leave that issue for a separate paper.

FOOTNOTES

* This research was done, while we were all at the Stockholm School of Economics, as a part of a research program on taxation financed by the Bank of Sweden Tercentenary Foundation. We wish to thank the Foundation for its generosity and Bo Nordin for research assistance.

1) See Rosen (1983) for references.

2) If a fraction r of the house value is regarded as taxable income, where r is equal to the nominal interest rate, the asymmetry will disappear.

3) Prop. 1981/82:197.

4) In fact, the uncertainty surrounding future tax rates may be a quite important factor in determining housing demand. For an analysis emphasizing this, see Rosen et al. (1983).

5) Statistisk Årsbok (Statistical Abstract of Sweden) 1984, p. 207. The corresponding figure for unskilled workers was 77,820 SKr, i.e. a marginal tax rate of 56 per cent.

6) More precisely this limitation applies to "underskott i förvärvskälla"; interest payments are deductible against imputed income from owner-occupied homes and against capital and business income. Deficits in either of these categories are not.

7) For a theoretical analysis of these questions, see Englund and Persson (1982).

8) In Sweden, this is calculated according to a schedule which is progressive with regard to the assessed value of the house.

9) I.e. the tax base for the "additional tax" in (2) is $\xi \equiv x + r(W-h) + \alpha(h)$ regardless of the sign of $x + r(W-h) + \alpha(h)$.

10) For the brevity of notation, we have suppressed all arguments except $x + rW$ and h.

11) Brownstone, Englund and Persson (1983).

12) For a different approach to the problem of estimating supply and demand functions in the presence of non-linear budget sets, see Burtless and Hausman (1978) and Blomqvist (1983). This method allows estimation of utility function parameters. However, it would be too complicated to compute given the other aspects of our model.

13) The reason why the household does not necessarily pay back all the loans is that especially for households who bought the house long ago and have a large equity in it, a considerable fraction of the loans may be taken not to finance the purchase of the house, but may be of more recent origin to finance e.g. the purchase of consumer durables etc. And while it is of course practical to use the house as collateral for such loans, the household may very well renew the loans after having sold the house, using some other asset as collateral.

14) See Brownstone et al. (1983) for details.

15) For an attempt to estimate housing demand functions taking rationing explicitly into account, see King (1980).

16) The pattern of the short-run price responses is a rather complicated matter treated in the urban economics literature, see e.g. Sweeney (1974) and Braid (1981).

17) Most studies of the housing market have assumed supply to be infinitely price elastic; cf. the survey by Rosen (1983).

18) All demographic data that have been used as explanatory variables in the estimations (age, number of children etc.) refer to 1979. All income and wealth variables are averages for 1978 and 1979 in order to get a proxy for "permanent" income and wealth. The tax system in 1979 was very similar to that of 1982; we have made predictions based on the 1979 schedule as well as that of 1982, and all results have been very similar. In the following, the terms "1982 demand" or "pre-reform demand" will be used for predictions based on the 1982 tax schedule and the 1979 exogenous variables. The terms "1985 demand" or "post-reform demand" will similarly be used for predictions based on the 1985 tax schedule and the 1979 exogenous variables.

19) The mean predicted number of home-owners, based on the 1982 tax schedule, is 1,027,499. This figure may appear low compared with the actual number of home-owners in Sweden. However, it is reconciled with this as follows, taking account of deletions from the sample reported in an appendix to Brownstone et al. op. cit. The total number of home-owners at Nov. 1 1975 according to the Population and Housing Census was 1,350,932 ("bebodda småhus ägda av enskild person"). Out of these 244,378 were farm-houses, which are excluded from the present study. Further we have excluded two-family houses. The total of these is 171,640. However, it is not possible to read from published statistics how many of these are owner-occupied non farm-houses. Assuming this to be around 100,000 brings us down to around 1 million home-owners.
Source: Population and Housing Census 1975, Part 4, Tables 5 and 6.

20) See e.g. Rosen (1979, p. 12).

21) All values are given in 1982 prices.

22) As noted, the model has been estimated for three alternative sets of assumptions. Corresponding histograms for these scenarios are shown in appendix.

23) Corresponding histograms for the other three scenarios are displayed in appendix. They give the same general impression.

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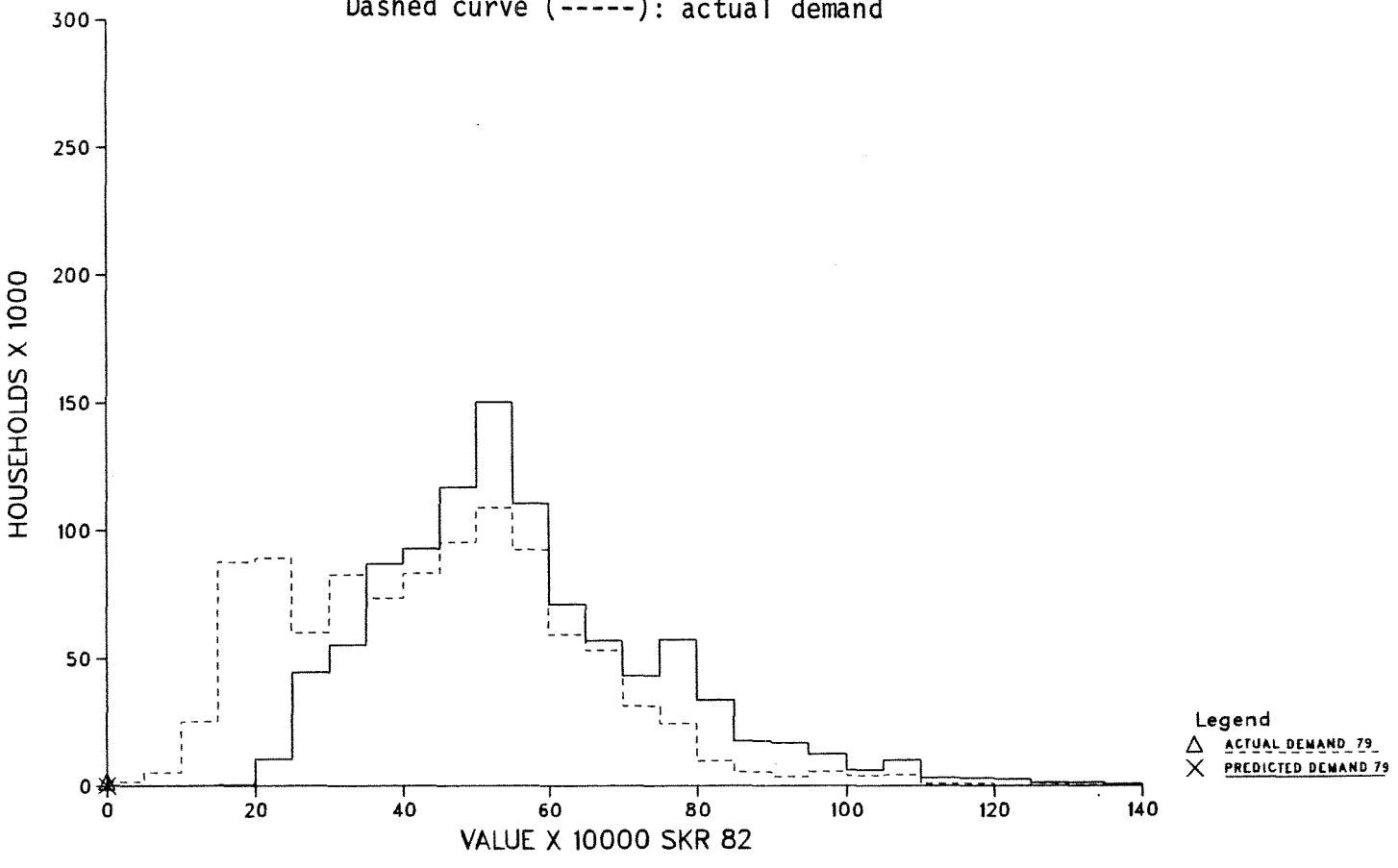
APPENDIX

DEMAND PREDICTIONS UNDER ALTERNATIVE PARAMETER ASSUMPTIONS

Figure 4a: Pre-reform housing demand for various size classes;
$v = w = 0.25$, $\pi = 0.06$
Solid curve (———): predicted demand
Dashed curve (-----): actual demand



Note: See p. 11 for definitions of v, w, and π.

Figure 4b: Pre-reform housing demand for various size classes;
$v = w = 0.50$, $\pi = 0.10$
Solid curve (———): predicted demand
Dashed curve (-----): actual demand

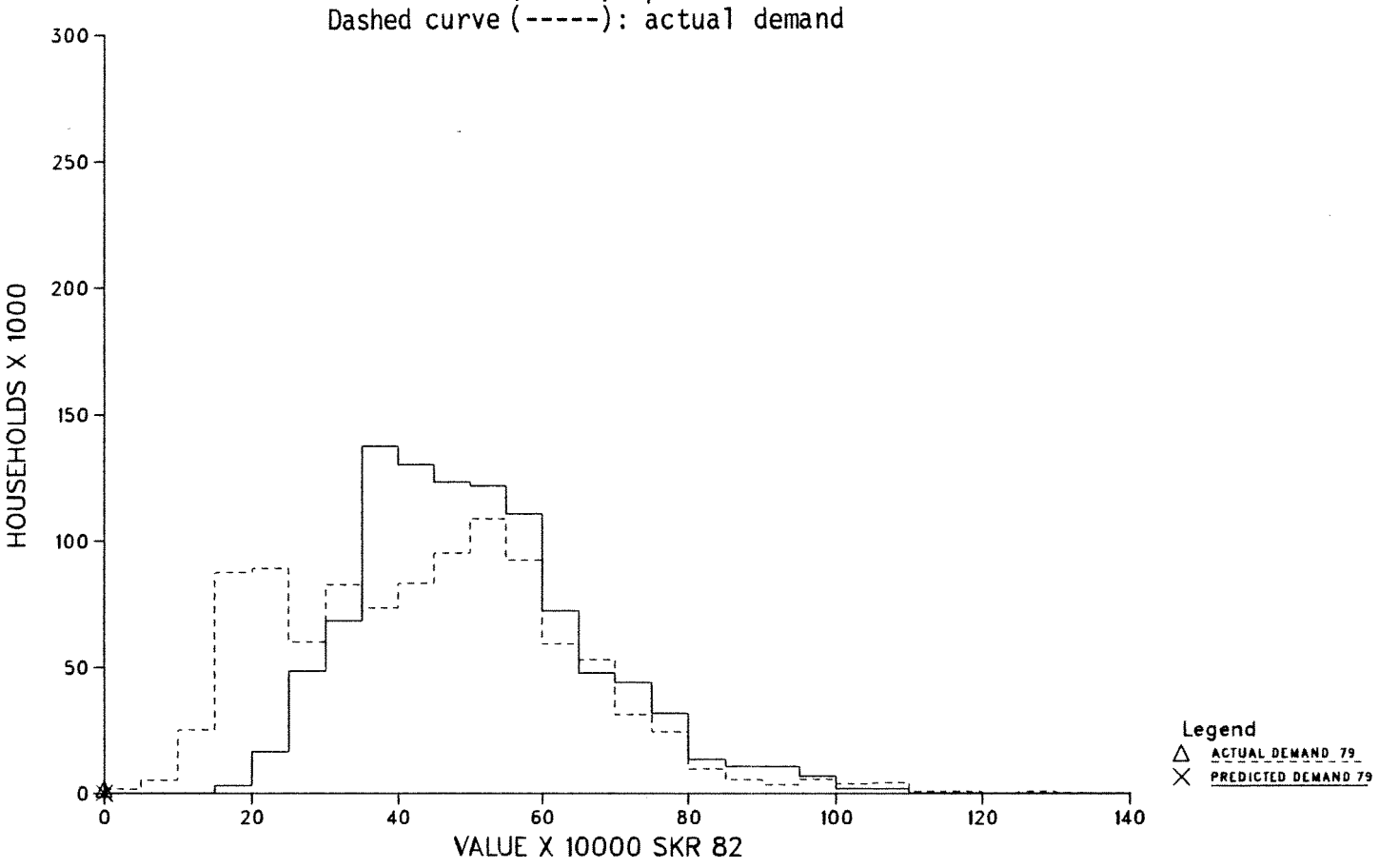


Figure 4c: Pre-reform housing demand for various size classes;
$v = w = 0.25$, $\pi = 0.10$
Solid curve (———): predicted demand
Dashed curve (-----): actual demand

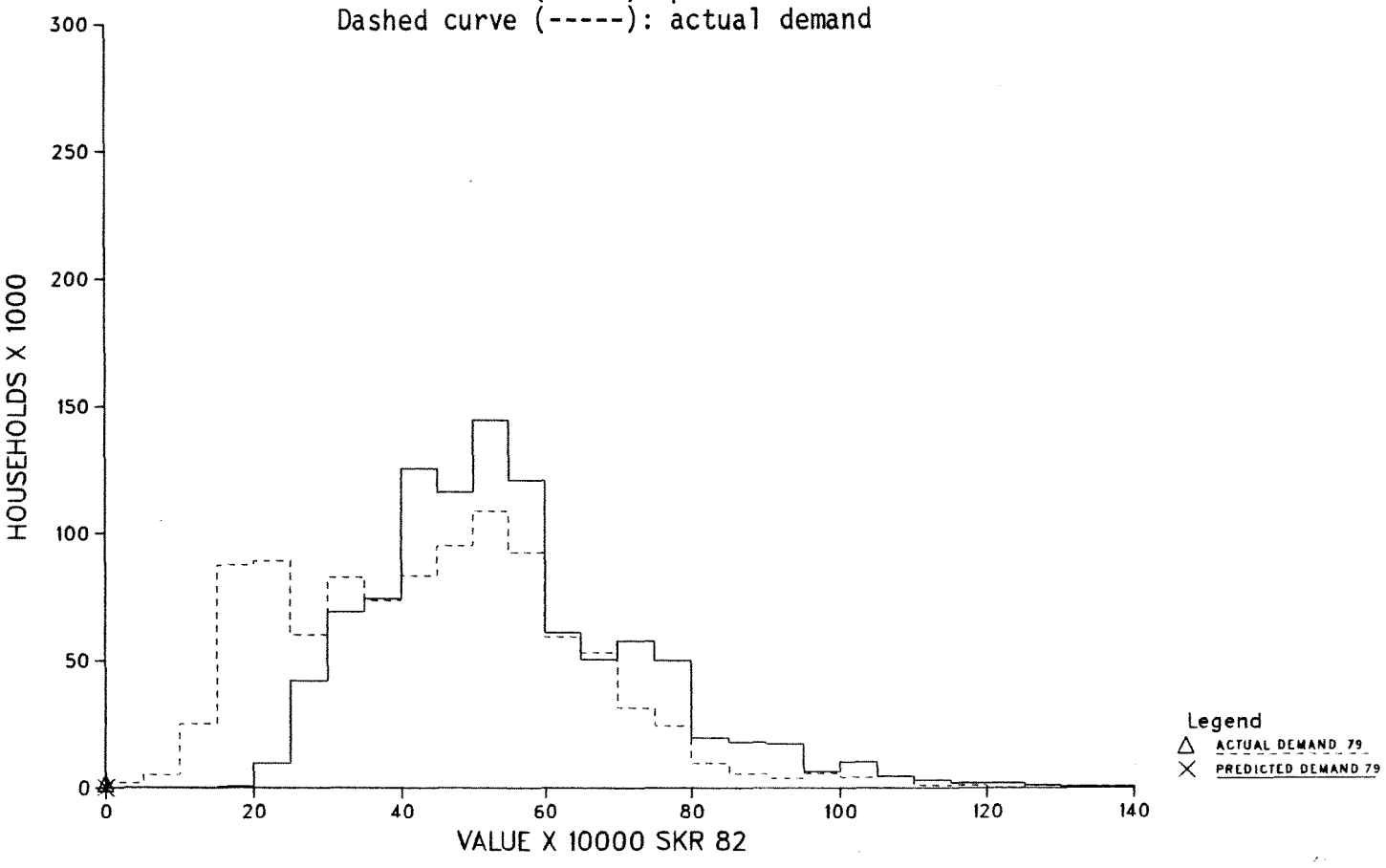


Figure 7a: Point estimates for pre-reform (solid curve) and post-reform (dashed curve) housing demand; $v = w = 0.25$; $\pi = 0.06$

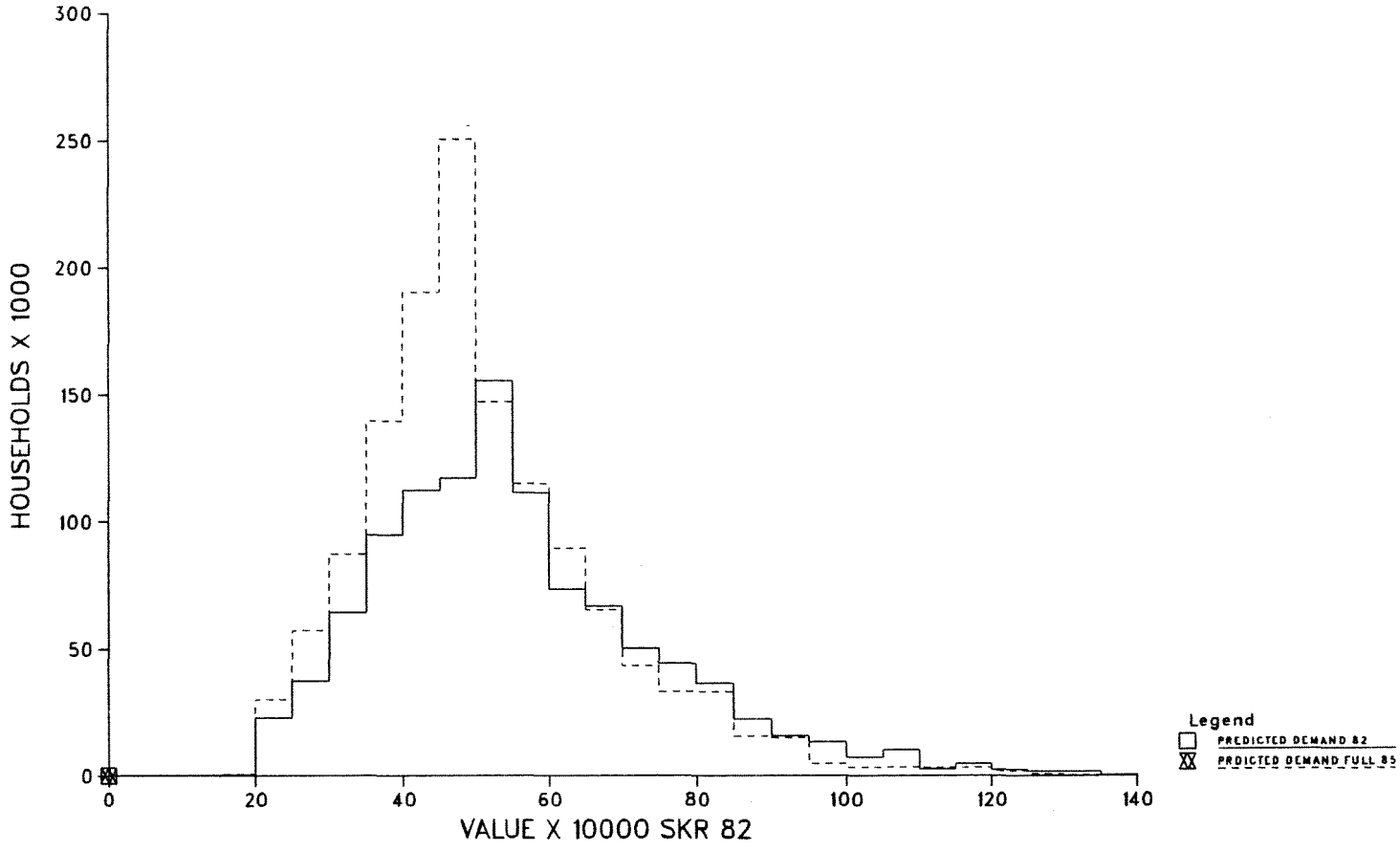


Figure 7b: Point estimates for pre-reform (solid curve) and post-reform (dashed curve) housing demand; $v = w = 0.50$, $\pi = 0.10$

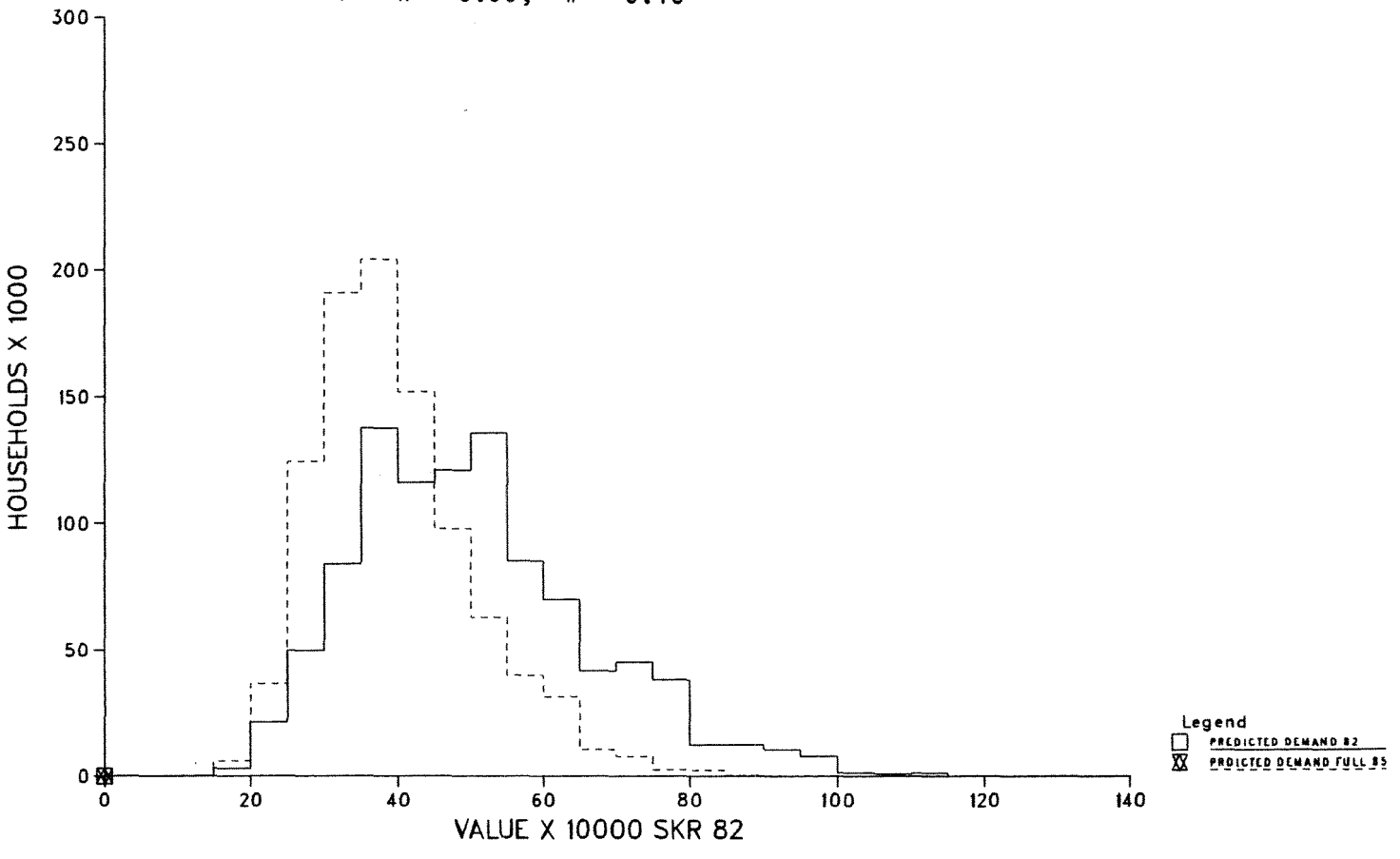
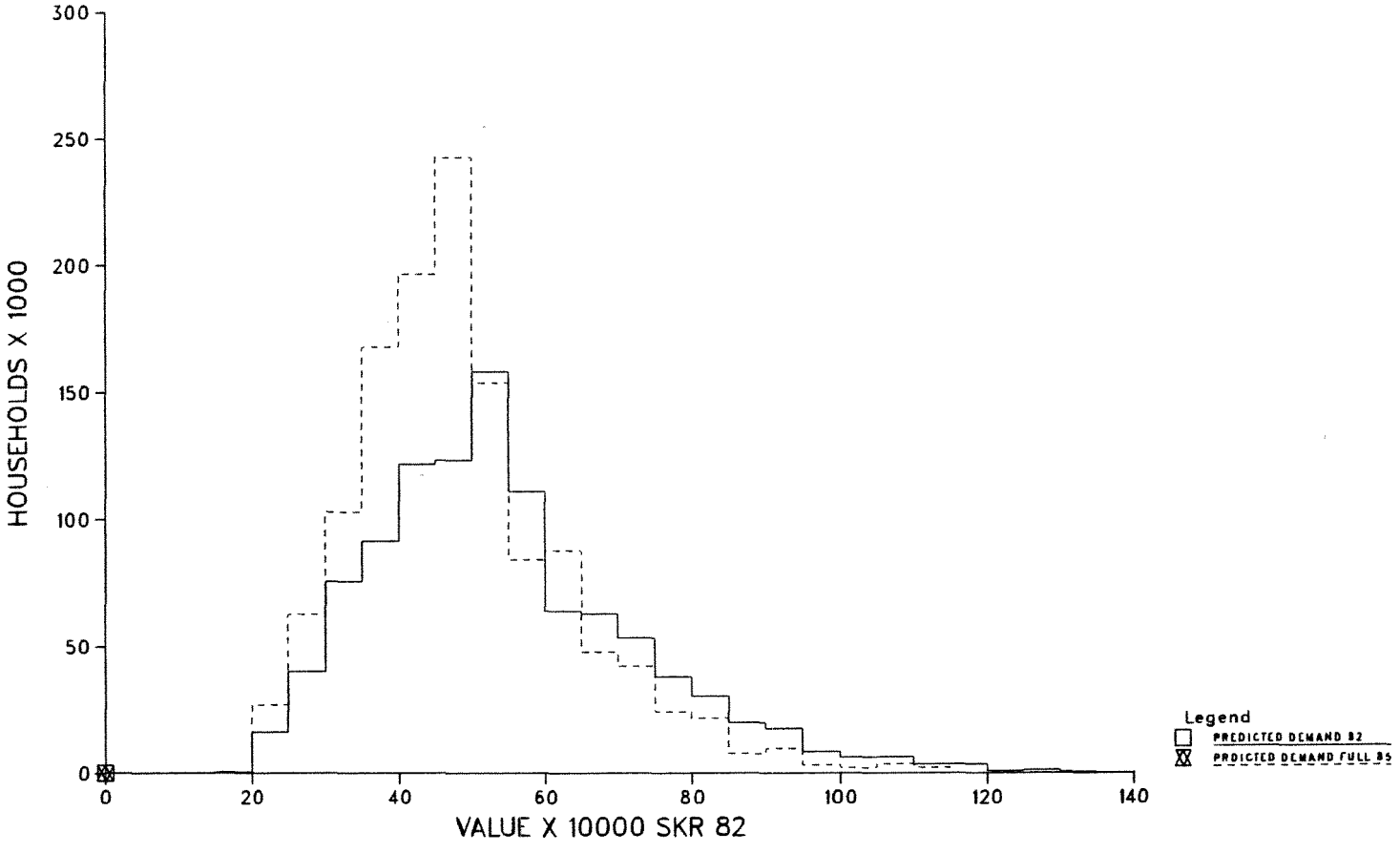


Figure 7c: Point estimates for pre-reform (solid curve) and post-reform (dashed curve) housing demand; $w = w = 0.25$, $\pi = 0.10$



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