The Relation between Financial and Housing Wealth

Evidence from Dutch Households*

Stefan Hochguertel

Finance & Consumption, Department of Economics, European University Institute, Via dei Roccettini 9, 50016 San Domenico di Fiesole (FI), Italy, and Department of Economics, Uppsala University, Sweden.

E-mail: hochguer@iue.it

and

Arthur van Soest

Department of Econometrics and CentER, Tilburg University, P.O. Box 90153, 5000 LE Tilburg, The Netherlands.

E-mail: avas@kub.nl

We analyze households' joint investment decisions for financial wealth and homes. We use a bivariate censored regression model with endogenous switching. Fixed costs or transaction costs are captured by an unobserved nonzero censoring threshold. The model allows for spill–over effects of a binding threshold for one asset on the demand for the other asset. We find that tenure choice affects the level of financial wealth. Our results do not support the view that people first accumulate financial wealth before acquiring homes. This can be due to the absence of down payment constraints in the Netherlands.

D R A F T August 9, 2000, 10:42am D R A F T

Key Words: housing demand, household saving, portfolio choice, limited dependent variables

1. INTRODUCTION

Housing wealth and financial wealth are the most important asset categories in households' portfolios, across all age groups and in many countries. See, among others, the descriptive studies of Alessie *et al.* [1] for the Netherlands, Banks and Blundell [5] for the UK, Kessler and Wolff [21] for France and the US, and Wolff [32] for the US. In this paper we investigate how the investment decisions for housing and financial wealth of households are interrelated.

This relationship is important for various reasons. First, as a substantial part of the wealth of home owners is held in the form of housing wealth, the home ownership decision and the amount of housing wealth will have

* Most of the work for this paper has been done while Hochguertel was at Tilburg University, supported by the VSB savings project; he also acknowledges funding through the TMR network on "Savings and Pensions". Van Soest acknowledges funding through a fellowship of the Netherlands Royal Academy of Arts and Sciences (KNAW). We are grateful to Research International Nederland (RIN) for providing the data. We would like to thank Rob Alessie, Herman Bierens, Richard Blundell, Gary Engelhardt, Arie Kapteyn, and Karl Scholz, editor Jan K. Brueckner, and two referees for useful comments and suggestions, and to conference and seminar participants at CentER, University College London, ESPE '96 at Uppsala, and ESSM '96 at Iowa City for discussions.

an impact on the level and the structure of financial assets. Saving behavior of home owners will therefore differ from that of renters, and the home ownership rate may have implications for the aggregate saving rate. Moreover, house price developments or restrictions in the housing market will not only have an impact on the demand for housing but also on financial wealth holdings. For instance, as has been stressed in the recent literature, down payment constraints can influence renters' decisions to save (Engelhardt [8, 9], Haurin *et al.* [12] and Sheiner [28]).

But there is no reason to expect a one way causal relationship. Changes in the financial wealth market may also have spill–over effects on the housing wealth decisions. Financial and housing wealth are the joint outcomes of one decision process, and are therefore jointly determined. This suggests that the two decisions should be modeled simultaneously.

Theoretical models of this nature have been around since Henderson and Ioannides [14]. An important feature of this model is the restriction that for homeowners, housing consumption leads to a lower bound on investment in housing. Brueckner [6] shows that if this restriction is binding, the financial asset portfolio is no longer efficient in a mean–variance sense. Homeowners then tolerate underconsumption of housing to avoid excessive distortion of their financial portfolio. Flavin and Yamashita [10] estimate the joint distribution of returns to housing investment and investment in several financial assets, and find that the investment/consumption constraint on housing can have a dramatic effect on the life cycle pattern of the structure of the financial assets portfolio.

The empirical literature on the relation between housing and financial wealth focuses on the impact of housing decisions on the financial wealth decisions. Brueckner [6] explains the share of risky assets in the financial portfolio from, among other things, a rental property ownership dummy. Fratantoni [11] provides evidence that commitments to make mortgage payments over a long horizon out of an uncertain stream of labour income lead to higher holdings of safe financial assets. One of the few studies in which a joint model for financial assets and housing is analyzed, is Carroll and Dunn [7]. They find little evidence for a systematic impact of financial asset and debt holdings on housing investment. Ioannides [17] explains housing wealth related variables from non–housing wealth variables and vice versa, but does not take account of the endogeneity in either case. Ioannides and Rosenthal [18] include predicted (total non–pension) wealth in separate equations for housing consumption and housing investment, and find it has a higher impact on investment than on consumption.

In contrast to the existing studies, we develop an empirical model that jointly explains housing investment demand and financial wealth holdings in a symmetric way, and that extends models used in the empirical literature on household portfolio choice (see, for instance, King and Leape [22] or Ioannides [17]). We estimate the model using Dutch cross section data drawn in 1988. About half of the households in our sample do not hold any housing wealth. Also, many households report not to hold any financial wealth. Our econometric model explicitly accounts for these zero asset holdings. The model distinguishes several regimes, according to whether asset amounts are zero or not. It is similar to the demand system of Lee and Pitt [24], which is characterized by different demand functions for each commodity, distinguished by whether the nonnegativity constraints on demands for other commodities are binding or not. Here we allow for differences between the demand for financial wealth between home owners and renters, and between the demand for housing wealth of those who do and those who do not hold financial wealth. Endogeneity of the regime choice is accounted for by analyzing the complete bivariate model.

While the model of Lee and Pitt [24] explains zero amounts from nonnegativity constraints only, we allow for household specific thresholds which can be seen as minimum amounts of assets held. If the optimal amount is lower than the threshold, the amount actually held will be zero. An interpretation of the thresholds is fixed (transaction) costs. We estimate the model separately for gross asset amounts and for equity, i.e. amounts net of debts.

We find that households typically buy their first house when the head is between 20 and 40 years of age. Financial assets of renters in this age group are not higher than in other age groups, however. Thus we do not find evidence for savings of renters prior to buying a house. The reason may be that there are no explicit down-payment constraints in the Netherlands, and it is quite common that the initial mortgage equals the value of the house. This is different from the situation in the US; several US studies have emphasized that renters who plan to buy a house will have to save in advance, to meet the down payment constraints (Engelhardt [8, 9], Haurin *et al.* [12], Sheiner [28] and Carroll and Dunn [7]).[1] Moreover, we find that the renters in our sample typically possess fewer financial resources than the homeowners. This is not in line with the idea that renters save for buying a house either. It does correspond to Jones [19], who finds that home owners use part of their mortgage to hold financial assets.

The interaction effects in the model imply that the demand for financial wealth of home owners differs significantly from that of renters. Our estimates imply that an increase of house prices would reduce the homeownership rate, and would increase the average house values for homeowners by a smaller percentage than the house price increase. At the same time, mortgage values would increase as well. Financial asset holdings would also be affected by a house price increase, which reduces the financial ownership rate and increases the conditional means, leading to a total additional financial accumulation.

The remainder of the paper is organized as follows. In Section 2 we sketch the organization of the Dutch housing market, which differs substantially from that in other countries. In Section 3 we summarize our data and present some prima facie evidence that asset holdings of home owners differ substantially from those of renters, even after controlling for wealth and

[1] It should be noted here that in the US, the effective downpayment constraint has been reduced in recent years. 100% loan to value mortgages are becoming more common, although they carry a higher interest rate. This trend should reduce the threshold–type behavior, since borrowers no longer have to consume less to save for the downpayment.

other variables. We introduce our empirical model in Section 4 before we present results in Section 5. Section 6 concludes.

2. THE HOUSING MARKET IN THE NETHERLANDS

In international perspective, the homeownership rate in the Netherlands is rather low. In 1990, about 45% of all households were home owners, compared to an EC average of about 62%,[2] and 64% in the US.[3] Most rental accomodation (77%) is supplied by municipal housing associations. Only families with modal income or less have access to this segment of the market, where rents are regulated by the government. The remaining 23% of rental accomodation is unregulated. These dwellings are owned by private sector companies (about 40%) or by private households (about 60%). The rents in the free market are much higher than the rents for similar dwellings in the regulated part of the market.

Low income households not only have access to the regulated rental market, they are also eligible for rent subsidies. The subsidy level depends on the actual rent paid, family composition, taxable household income, and age. The maximum rent subsidy decreases with family income and is zero for incomes exceeding the modal income level. See Koning and Ridder [23] for details of the system, as well as for an analysis of rent subsidies on

[2]This is the 1991 average of home ownership rates in 12 EC countries (excl. former East Germany), weighted by total dwelling stock; source: European Commission.

[3]This refers to 1989; see Holmans [16].

housing demand. Subsidies have been cut back in the past decade (see Van der Krabben [30]).

The return to housing as an asset depends critically on house prices. Average real house prices have been quite volatile during the past few decades. They rose by 52% from 1976 and 1978, fell by 38% from 1979 to 1982, remained at a low level until 1985, and have been increasing since 1986.[4] Similar evidence of volatility is found in the UK (Holmans [16]) and the US (Poterba [27], Flavin and Yamashita [10]).

Mortgages in the Netherlands are usually obtained from banks. The bank's decision is on whether or not to offer a mortgage contract, and on the maximum amount. There are no explicit down payment constraints, but most banks use similar criteria for evaluating mortgage applications. These criteria mainly relate to the default probability and to the value of the mortgage relative to the value of the house. Thus current income, expected future income, and whether the head of the household has a permanent job matter, as does the loan to value ratio. Thus if families can partly finance their house with savings, banks are more inclined to offer a mortgage. Still, prospective home owners can often obtain a mortgage loan covering 100% (or even more) of the value of the house. For inexpensive houses and household heads with tenured jobs, the default risk is usually covered by the municipality.[5] In these cases, the mortgage interest rate is usually

[4] Van der Krabben [30].

[5] Everyone taking out a new mortgage on a house in the municipality has to contribute a small amount to a special fund which the municipality uses to cover the default risk.

somewhat lower than if the default risk is not covered. Mortgage interest rates were at a minimum in 1988. In the same year, the number of newly registered mortgages reached a maximum (Van der Krabben [30]).

User costs of homeownership and returns to housing assets and financial assets depend on the marginal tax rate faced by the main earner in the household. The Netherlands have an individual based progressive income tax system. The marginal rate in 1988 as a function of taxable income was piece–wise constant in nine brackets, with a maximum of 72%. The tax–free allowance depends on household composition. In addition, interest from savings and dividends are tax–free up to some threshold (Dfl. 1,000 each for individuals; Dfl. 2,000 each for couples). Interest payments on mortgages and consumer credits are fully deductible from the income tax base.

Mortgages are often combined with a life insurance. Under the condition that the life insurance lasts for at least 20 years, the returns to it are tax exempt. In the life insurance mortgage construction, the (monthly) mortgage remittances are used as premiums to buy the life insurance. The payout of the life insurance after 20 years (or more) is used to redeem the mortgage. As a consequence, the amount of mortgage debt does not decrease during the term of the mortgage contract. Interest payments on the mortgage therefore remain constant (at their initial maximum). They are fully tax deductible, while the returns to the life insurance premiums are untaxed. Thus this construction helps mortgage takers to make optimal use of the possibilities created by the tax rules.

Capital gains (both realized and unrealized) are tax–exempt. For homeowners, a virtual rental income amount depending on the value of their house is added to their taxable income. This amount is small compared to the actual rent that should be paid for a similar dwelling, however.

In addition, there is a small municipal tax on housing property (about 0.28% per year of the value of the house), and a tax on wealth exceeding some minimum threshold. The latter tax makes it more attractive to invest in owner occupied housing than in financial wealth, since only 60% of owner occupied housing wealth is taxed.

We conclude that the institutional factors in the Netherlands create incentives in the same direction: renting is made more attractive for low income households, who have access to the regulated rental market and can obtain rent subsidies. On the other hand, home ownership is mainly stimulated for high income groups: the tax favored nature of owner occupied housing is more important for them due to their high marginal tax rates, and access to mortgages is easier for them.

While the US mortgage market has gone through tremendous changes, the institutional features of the Dutch mortgage market have essentially not changed very much during the past decades, apart from the creation of new mortgage products which optimally make use of the tax rules (such as the combination of life insurance and mortgage discussed above).

3. DATA

The micro data we use in the analysis stem from a survey conducted in 1988 by a group of Dutch banks (Dutch Collective Bank Study, CBO). It comprises 10113 individuals in 3704 households. The survey is targeted at the financial structure of household and individual wealth and at the relationships between consumers and banks or other financial intermediaries. It is designed to be representative of the Dutch population in terms of socio–demographic characteristics. Like most other household surveys, it appears to suffer from underreporting on asset amounts. Yet, it resembles national figures on financial wealth better than several comparable Dutch sources, in particular with respect to ownership rates (see Alessie *et al.* [2]).

The survey questions are asked to all household members aged 18 and above. We aggregated the individual responses over all assets within each asset category and over all respondents per household. Due to missing values or severe outliers in the explanatory variable on net monthly income, we had to discard 627 households. The marginal income tax rate is constructed from income, family composition, and labor market status variables. We also include the maximum rent subsidy, constructed from family composition and income. Other background variables pertain to age and family structure, employment status, and a regional house price index. The latter is based on average selling prices of houses by region, provided by the Dutch Association of Real Estate Agents. We differentiated according to the type of dwelling and divided the regional prices by national averages.[6] Missing information on the variables for the degree of

[6] See Polinsky and Ellwood [26] for an empirical justification of using regional prices.

urbanization reduced the sample size by another 189 observations to 2888. An overview of the explanatory variables is given in Table 1.

Table 1 about here

The survey contains questions on ownership of single asset units, and on amounts (conditional on ownership). While nearly all households provided information on ownership, information regarding the amounts is often missing (see Table 3 below). The questionnaire comprises detailed information on general financial behavior, saving accounts, checking accounts and credit cards, stocks, bonds, loans, mortgages, and insurances. Only information on transferable wealth is asked; pension and social security wealth cannot be recovered from the data. Moreover, there is no direct information on amounts in checking account balances, capital accumulation in life insurances, or values of major durables. Thus, total household wealth is not observable.

The data provide information on the value of housing property only. We do not observe variables related to the quality of one's home. The data do not distinguish between owner occupiers and landlords, and provide no information on rents paid by tenants or rental income of landlords. Thus we can only analyze the amounts invested in housing assets, but an analysis which separately considers housing investment and housing consumption, such as Ioannides and Rosenthal [18], is impossible.

Housing equity is constructed as the difference between the self–reported value of the home and the outstanding mortgage debt. For some types of mortgage (linked to life insurances), an outstanding debt was imputed using other mortgage information (127 observations). Some negative values of housing equity were set to missing since they seemed implausibly high (121 observations where the initial mortgage is more than 20% higher than the current value of the house).[7]

Similarly, we consider both financial assets and financial equity. The latter is defined as financial assets net of liabilities, excluding mortgage debt. Financial assets comprise saving accounts, time deposit accounts, saving certificates and certificates of deposit, shares in domestic and foreign companies, shares in investment funds, options, bonds, and mortgage bonds. Financial debt consists of consumer credit (mainly in the form of fixed term bank loans, to buy cars or other durables).[8] Of all households in the sample, 15.7% have financial debt as well as a positive amount on their saving account. Only 3.2% have financial debt and zero holdings in financial assets. Financial asset holdings and liability holdings are virtually uncorrelated (correlation coefficient of −0.011). Only 6.3% of all households hold

[7]It should be admitted that the 20% threshold might be too strict, since some negative values are possible due to the fall of house prices between 1979 and 1982. Using a 50% threshold would reduce the number of values set to missing from 121 to 72. This would not have a large impact on our results.

[8]In the Netherlands, credit card debt plays a minor role, unlike in the US. Neither credit card debt, nor study loans (low interest long term loans obtained from the government for higher education) are observed in our data or included in our financial debt measure.

stocks or bonds, most of them in combination with other, saving related assets.[9]

Table 2 about here

Table 2 contains summary statistics of financial and housing assets and equity (missing values excluded). The means suggest that housing assets are more important for the aggregate composition of wealth than financial assets, in spite of the higher ownership rate for the latter. The distribution of financial assets is strongly skewed to the right. We will therefore apply a log transformation, which improves the fit of the empirical model (with normally distributed errors).[10]

Figure 1 about here

Nonparametric density estimates of the marginal distribution of the log transformed variables on housing and financial assets and equity, excluding zero–observations, are provided in Figure 1. While the distributions of the

[9]Like in the US, ownership of risky assets has risen substantially during the nineties. For example, Alessie *et al.* [3] find that 15.4% of Dutch households held stocks in 1998, versus 11.4% in 1993. The percentage of families owning some type of risky financial assets rose from 21.2% in 1993 to 27.7% in 1998.

[10]To be precise, throughout the paper we use the following sign preserving log transformation:

$$x \mapsto g(x) = \begin{cases} \ln(x+1) & \text{if} \quad x \geq 0 \\ -\ln(-x+1) & \text{if} \quad x < 0. \end{cases}$$

asset variables are not far from normal, those of the equity variables are bimodal, with one positive and one (smaller) negative mode.

Table 3 about here

Table 3 provides an overview of the numbers of positive, zero, and missing amounts. 89% of the households hold housing or financial assets, 85% hold financial assets, 50% invest in housing, 46% in both. Figures for variables including housing and financial debts are similar. For 19.3% of home owners and 14.2% of financial equity owners, the amount is not observed. The numbers of missings are substantial, and ignoring them may seriously bias the results. We take account of this in the model in Section 4.

Figure 2 about here

Figure 2 shows kernel regression estimates of ownership rates as a function of age of the head of the household for financial assets, liabilities, homes, and mortgages.[11] The picture displays the cross–sectional age profiles, which do not necessarily reflect life cycle effects. Ownership of financial assets is widespread across all age groups. Only old age households are less likely to possess financial assets. The home and mortgage ownership rates are hump shaped and peak in the age group 35 to 50. Before age 40 almost all home owners also have a mortgage. Elderly households are less likely to hold mortgage debt, whereas their home–ownership rate is still high. They have not completely liquidated housing equity. Ownership rate

[11] All our kernel regressions use a Quartic kernel, and uniform (nonadaptive) bandwidth = 11.

patterns for financial liabilities are similar to those for homes, albeit on a lower level.

Figure 3 about here

Figure 3 shows kernel regression estimates on age of the total value of the home, the total value of financial assets, home equity (ie. net of mortgages), and financial equity (assets net of liabilities).[12] For the sample as a whole, the pattern of housing assets is hump shaped with a maximum at age 45. Due to falling mortgage debts, however, housing equity falls less steeply at higher ages. Financial assets and financial equity are close to each other and increase with age. This shows that although many young and middle aged households hold some financial debt, these debt holdings are not substantial. In comparison with the ownership patterns, households in the old age group households tend to be less inclined to hold financial assets, but if they do, they hold substantial amounts. None of these age patterns control for cohort effects or other variables like income or tax rates, so they cannot be directly compared to results in other studies. We will come back to this in the discussion of our model estimates, where variables like income and the marginal tax rate are controlled for.

Figure 4 about here

Figure 4 splits wealth holdings by tenant status. Comparing it with Figure 3 shows that the hump shaped age pattern of homeowners' house

[12]Observations with zero holdings of the assets are included; observations for which the amount is missing are not.

values is mainly due to ownership rates. Yet, homeowners in their fifties tend to have the most valuable houses. Homeowners hold more financial assets than renters at almost all ages, and most prominently at old ages. There is no evidence of saving for a down payment: we neither observe that young renters hold particularly high levels of financial wealth, nor that young homeowners hold comparatively low levels of financial assets.

Are homeowners different? Is portfolio behavior of households who own their home different from that of renters, given total wealth? To answer this question, we estimated (univariate) probits for ownership of various types of assets and debts, conditioning on home ownership, total wealth and other background variables. The four asset types considered are short term savings (saving accounts), long term savings (e.g. time deposit accounts and saving certificates), life insurance contracts, and stocks or bonds. We also used an ordered probit model for the number of asset types held.[13]

We found that homeowners hold significantly more types of financial assets than renters, even after controlling for wealth and other characteristics. The homeownership dummy is significantly negative in the equation for short term savings, insignificant only in the stocks and bonds equation, and significantly positive in the other asset ownership equations and in the equation for financial debts. These regressions do not have a structural interpretation, since home ownership and asset ownership will be jointly determined. In the remainder of the paper we will therefore focus on esti-

[13] 42% of the 2888 households hold one and 41% hold two of the four financial asset types while 10% hold none.

mating a model for the joint determination of investment in financial and housing assets.

4. MODEL

Henderson and Ioannides [14] have developed a stylized theoretical model which illustrates the relation between the economic decisions related to housing consumption and housing and financial investment. Their model explains the role of variables like house prices and tax rates. It assumes that a representative household maximizes utility over two periods, and derives utility from the two commodities housing and non–housing. The household can invest its savings in housing wealth or financial assets, and can finance part of its housing wealth by a mortgage loan. Part of the housing stock corresponding to housing wealth can be owner occupied, the remainder can be let to others.

Prices, tax rules, interest rates, etc. enter this model in various ways. For different versions of the model, various authors have looked at comparative statics. In principle, for a given functional form and given details of the tax system, etc., the model can be solved. Many complications arise, however, if it is to be used to construct a structural empirical model: the time periods are not well defined, initial wealth, future income, (expected) returns are unobserved, the tax rules are complicated and lead to nonconvex budget sets (see Section 2), etc. Moreover, our data are not rich enough to identify housing consumption (see Section 3). Our data also show that many people hold financial debts as well as saving accounts, which is not explained by the theory. Furthermore, the theoretical model does not account for minimum purchase requirements, and leads to a censored regression equation with censoring at zero. In empirical models for housing assets in particular, it appears to be important, however, to disentangle the ownership from the amount decision. One way to do this is to use an equation which censors housing investment at a positive (unobserved) threshold. Such a positive threshold can be interpreted as a minimum purchase requirement and can also be due to fixed costs.

Therefore, our empirical model will not incorporate the full structure of the theoretical model, although it does account for the bivariate nature of the financial decision making process and incorporates price and tax rate effects.

We separately consider two models: one explaining housing and financial assets, the other housing and financial equity. In both cases, we use the same type of model. Following the Henderson and Ioannides [14] framework, suppose a household can allocate its budget in three ways: financial wealth, housing wealth, or otherwise (consumption (other than owner–occupied housing), durables, etc.). The optimal allocation will depend on future expectations, tax rules, preferences, etc. The unrestricted allocations to the three options can be compared to notional demands in a demand system with three goods. If one or more restrictions become binding, notional demand has to be replaced with conditional demand, and the form of the optimal allocation function will change. This is the spill–over effect from the restriction on one good on consumption of other goods. See, for example, Lee and Pitt [24] for the case of binding nonnegativity constraints: if one nonnegativity constraint is binding, the notional demand functions for the other goods will be replaced with conditional demand functions given zero consumption of the good for which the constraint is binding. These conditional demand functions can be written in terms of the notional demands. In the case of a linear expenditure system, for example, the conditional demand for one good is a linear combination of the notional demand functions for all goods.

We exploit this idea to formulate a censored regression model with endogenous regimes, in which the allocation into housing wealth depends on whether financial wealth is held, and vice versa. Instead of nonnegativity constraints, we work with unobserved stochastic censoring thresholds, that make the model more flexible (see Nelson [25] for the univariate case), reflecting minimum purchase requirements or fixed transaction costs, for instance. Apart from costs that are linked to the purchase of a home (search costs, legal costs, real estate agent fees and other duties), fixed costs of moving will contribute to the illiquidity of housing wealth. These costs also comprise a psychological component which may depend on age and other household characteristics. Positive thresholds imply that, once a purchase is made, some minimum amount is bought.

The complete model is as follows. We start by specifying 'notional' demand equations y_i^*, and associated thresholds T_i^*, $i = 1, 2$:[14]

$$y_i^* = x\alpha_i + \epsilon_i \qquad (i = 1, 2) \tag{1}$$

$$T_i^* = x\delta_i + u_i \qquad (i = 1, 2) \tag{2}$$

Here y_i^* is notional demand for housing ($i = 1$) or financial ($i = 2$) wealth, not accounting for any constraints. x is a vector of observed explanatory variables, including, among others, income, marginal tax rate, and the house price (see Table 1). The error terms ϵ_i and u_i account for unobserved heterogeneity.

If the threshold for housing assets is binding, then housing assets will be zero, and the demand for financial assets will be given by what we call conditional demand for financial assets, i.e. demand for financial assets conditional on housing assets being zero. Similarly, if the financial assets threshold is binding, demand for housing will be given by the conditional demand function instead of the notional demand function for housing. We expect that the threshold for housing will play a larger role than the threshold for financial assets, since it is clear that the fixed costs of owning certain types of financial assets such as a simple savings account will be much smaller than the fixed costs involved with home ownership. Still, our results will appear to imply that the model with zero financial

[14] The index i denotes the asset types. For notational convenience we suppress the index of the household throughout the presentation of the model.

assets threshold is clearly rejected at any conventional significance level,[15] and we will therefore retain the symmetric approach.

Conditional demand for housing ($\tilde{y}_1$) and financial ($\tilde{y}_2$) wealth are defined by

$$\begin{aligned} \tilde{y}_1 &= y_1^* + \lambda_1 y_2^* \\ \tilde{y}_2 &= y_2^* + \lambda_2 y_1^* \end{aligned} \tag{3}$$

The relation between conditional and notional demand is the same as in a linear expenditure system. Unless $\lambda_1 = 0$ or $\lambda_2 = 0$, notional demand and conditional demand coincide only if the notional demand for the other asset is exactly zero.

The parameters λ_1 and λ_2 refer to the impact of a binding threshold on one asset on the demand for the other asset. A positive value of λ_1 implies that, if the optimal level of financial wealth is positive, but, due to the threshold constraint, financial assets are not held, this will increase the demand for housing assets. In a sense this means that the two types of assets are substitutes.

The thresholds for the conditional demands are modeled in the same way:

$$\begin{aligned} \tilde{T}_1 &= T_1^* + \lambda_1 T_2^* \\ \tilde{T}_2 &= T_2^* + \lambda_2 T_1^*. \end{aligned} \tag{4}$$

[15]A similar result was also found by Hochguertel *et al.* [15] in a univariate model for financial assets, using the same data.

It is not intuitively clear why the same λ_1 and λ_2 must be used here as in (3). For example, it might seem natural to use $\tilde{T}_1 = T_1^*$ and $\tilde{T}_2 = T_2^*$. It can be shown, however, that this generally leads to an incoherent model, i.e. to a model that is not well–defined in the sense that endogenous variables are not uniquely determined for given values of exogenous variables and error terms (see Heckman [13], for example). Thus specification (4) is motivated by the requirement of coherency.

Whether or not financial or housing assets are held depends on whether notional or conditional demands exceed the corresponding thresholds. This can be written as a selection mechanism, using $S_i^* = y_i^* - T_i^*$ and $\tilde{S}_i = \tilde{y}_i - \tilde{T}_i, \ (i = 1, 2)$. The selection equations can be written as

$$\begin{aligned} S_i^* &= y_i^* - T_i^* &= \upsilon\zeta_i + \nu_i \qquad (i = 1, 2) \\ \tilde{S}_i &= \tilde{y}_i - \tilde{T}_i &= S_i^* + \lambda_i S_j^* \quad (j = 2, 1) \end{aligned} \tag{5}$$

If the threshold on financial assets is not binding, then housing assets are nonzero if and only if $S_1^* > 0$. If the threshold on financial assets is binding, then housing assets are nonzero if and only if $\tilde{S}_1 > 0$. Similar conditions apply for whether or not financial assets are held. The complete joint model is thus given by (1), (3), (5), and the following regime allocation rules, which determine the observed amounts of housing and financial wealth y_1

and y_2:

$$
\begin{aligned}
&(a)\quad S_1^* > 0, S_2^* > 0 : \\
&\qquad y_1 = y_1^*; \qquad y_2 = y_2^* \\
&(b)\quad \tilde{S}_1 > 0, S_2^* < 0 : \\
&\qquad y_1 = \tilde{y}_1 = y_1^* + \lambda_1 y_2^*; \qquad y_2 = 0 \\
&(c)\quad S_1^* < 0, \tilde{S}_2 > 0 : \\
&\qquad y_1 = 0; \qquad y_2 = \tilde{y}_2 = y_2^* + \lambda_2 y_1^* \\
&(d)\quad \tilde{S}_1 < 0, \tilde{S}_2 < 0 : \\
&\qquad y_1 = 0; \qquad y_2 = 0.
\end{aligned}
\tag{6}
$$

Regimes $(a) - (d)$ correspond to the entries in Table 3. The model reduces to the model with nonnegativity constraints if (with probability one) $T_i^* = 0,\ i = 1,2$. Unlike the model with nonnegativity constraints only, our specification allows for separation of the ownership decision and the decision on the amount to invest. For housing assets, this may be particularly important if higher house prices decrease the tendency to own but at the same time raise housing wealth for those households who have chosen to own (see Haurin *et al.* [12]).

We assume that the four error terms in the model are jointly normal and independent of the regressors. The variances of ν_1 and ν_2 are normalized to 1. We allow for arbitrary correlations between the error terms in the two notional demand equations and between the error terms in the two selection equations. This is an additional way in which simultaneity of asset choices is incorporated. Because we also allow for correlation between notional demand and selection equation for the same asset, the general model with without restrictions on α_i in (1) is only identified due to functional form and distributional assumptions. We identify the model nonparametrically by imposing exclusion restrictions on the notional demand equations.

To estimate this model, we have to guarantee that it is coherent. It can be shown that this is the case if $\lambda_1 \lambda_2 \leq 1$.[16] Thus in this censored regression model, coherency does not require limiting the support of the distribution of the error terms, as it would in a simultaneous binary choice model.

The empirical model described so far does not account for item nonresponse on the amount invested in housing or financial wealth. As we have seen in Table 3, however, the data are characterized by a large number of observations for whom we know that housing or financial wealth is nonzero, but for which the amount is not known. Simply deleting these observations would lead to inconsistent estimates, due to selection on the basis of endogenous variables: observations with $y_1^* < T_1^*$ or $y_2^* < T_2^*$ would be deleted with some probability, while other observations would always be included.

[16]An appendix discussing the coherency requirements for the model is available upon request from the authors.

We could model whether or not a nonzero amount of asset type i was observed by specifying a set of equations like

$$D_i^* = z\beta_i + u_i, \qquad i = 1, 2. \tag{7}$$

- y_i is observed if either $y_i = 0$ according to (6), or, according to (6), $y_i \neq 0$ and $D_i^* > 0$
- y_i is not observed if, according to (6), $y_i \neq 0$ and $D_i^* < 0$

Thus zero values of y_i are always observed, no matter whether D_i^* is positive or negative. This corresponds to the data: we always know whether the amount is zero or not, but only if it is not zero, the exact value of the amount can be unknown.

We assume that u_1 and u_2 are independent of the other error terms in the model, and that the parameters β_1 and β_2 are not related to the other parameters in the model. Under these assumptions, the log–likelihood contribution can be written as the sum of a function of the parameters in the model of interest, excluding the auxiliary parameters β_1, β_2 and the parameters determining the distribution of u_1 and u_2, and a function of these auxiliary parameters. This essentially implies that Maximum Likelihood estimates the parameters of interest and the auxiliary parameters separately, so that we can ignore the auxiliary equation for estimation of the parameters of interest.[17] The assumption that u_1 and u_2 are independent from the other errors in the model will be maintained throughout the paper.

[17]For example, the likelihood of an observation with $y_1 \neq 0$, observed, and $y_2 \neq 0$, missing, can be written as $\Pr[D_1^* > 0, D_2^* < 0]\ f(y_1) \Pr[T_1^* < y_1^*, T_2^* < y_2^* | y_1^* = y_1]$,

Relaxing this would require too much from the data and the optimization routines.

5. EMPIRICAL RESULTS

We separately consider the model for assets and equity variables. The models are estimated by Maximum Likelihood. For each asset, we distinguish three cases: the amount is zero, the amount is nonzero and observed, or the amount is nonzero and missing (i.e. only ownership information is available). This leads to nine regimes in the likelihood corresponding to the four regimes in (6) (see Table 3).

For each observation, we know which regime applies. The likelihood contribution of the observation then follows straightforwardly from (1), (2), (3) and (6). In each case, the likelihood contribution can be written as a bivariate normal probability, or as the product of a (univariate or bivariate) normal density and a bivariate normal probability. For example, if for a given observation $y_1 = 0$ and $y_2 \neq 0$ is observed, the likelihood is given by $\Pr(S_1^* < 0, \tilde{S}_2 > 0 | y_2)\tilde{f}_2(y_2)$, where $\tilde{f}_2$ is the density of $\tilde{y}_2$ in (3) (conditional on the regressors). If both $y_1 = 0$ and $y_2 = 0$, the likelihood contribution is given by $\Pr(\tilde{S}_1 < 0, \tilde{S}_2 < 0)$, etc. The likelihood contributions for all nine regimes can be found in an appendix available upon request from the authors.

---

where f denotes the density of y_1^* (both density and probabilities are conditional on x). The first factor is a function of auxiliary parameters only, the remaining factor only involves parameters of interest. Observations in other regimes lead to similar expressions.

A priori, there are no strong reasons to prefer a specification where dependent variables are measured in currency units over a specification with a log transformation. We selected the specification which gives the best fit to the data, using Vuong's [31] tests for nonnested models. This leads to the conclusion that specifications in logs give a better fit to the data than specifications in levels, for the asset as well as the equity variables.

For nonparametric identification, we need exclusion restrictions on both demand equations (i.e., on α_1 and α_2 in (1)). A natural candidate, particularly for the homeownership decision, is the maximum rent subsidy. The subsidy level will affect the choice between renting and owning, but becomes irrelevant once the choice to own is made. Second, the degree of urbanization may affect the home ownership decision due to the lack of supply of rental accommodation in larger cities, but it is not clear why it should affect the demand for financial assets. A third candidate is current income. Although it may be argued that there is not much reason to exclude income from the equations *a priori*, we found in all specifications we tested that income variables were insignificant in the housing investment equation, both in a statistical and in an economic sense. The reason is probably that we already condition on the marginal tax rate and on other covariates like education and age.

We estimated various specifications. The maximum rent subsidy was always insignificant in both demand equations. The degree of urbanization dummies were insignificant in the demand equation for financial assets but not in the demand equation for housing assets, as expected. Income variables were jointly insignificant in the housing asset equation but not in the financial asset equation. In the specification we present, we have therefore excluded the maximum rent subsidy from both demand equations, we have excluded degree of urbanization dummies from the financial assets demand equation, and we have excluded income variables from the housing assets equation. Since the latter exclusions are not justified by theory but inspired by test results only, we have also investigated the results with income variables retained in the housing asset equations. These results (available upon request from the authors) are very similar to those we present here, and do not change any of the conclusions.

The results for the specification for the asset variables thus obtained are presented in Table 4. Table 5 presents the results for the preferred model for the equity variables. We have estimated a number of alternative specifications whose results will serve as sensitivity checks. These results will not be presented in detail, but will briefly be referred to in the discussion. We will focus on the most interesting effects: marginal tax rates and incomes, maximum rent subsidies, age patterns, housing prices, and spill–over effects.

Tables 4 and 5 about here

The marginal tax rate has a significant positive effect in the home ownership (selection) equation. This reflects the tax favored status of home ownership versus renting. As discussed above, complete deductibility of mortgage interest rates, low imputed rent values for owner–occupied housing, and no taxes on capital gains including the value of the house, make owner–occupied housing particularly attractive. Much of these gains are directly related to the marginal tax rate which can be as high as 72%, so it does not come as a surprise that the marginal tax rate plays an important role in the tenure decision, though it certainly is not the only significant determinant. For example, conditional on the marginal tax rate, income is still significant, with a positive effect in the range which covers most income values observed in the data.[18]

On the other hand, neither the marginal tax rate nor the income variables are significant for the amount of housing assets held. As mentioned above, the results we present are those where income variables are deleted from this equation. This does not change the insignificance of the marginal tax rate. These same results are found when income variables are included in the demand equations, and when equity instead of asset variables are modeled (see Table 5). The negative sign of the marginal tax rate in the housing equity equation confirms the finding of Jones [20] that higher marginal tax rates would increase excess mortgage demand, but the t–value on this parameter is quite small.

For financial assets, we find the reverse: an insignificant (positive) effect on the probability of ownership, but a significant positive effect on the amount. Interestingly, the latter effect turns smaller and insignificant if we

[18] To avoid a strong impact of outliers, we use a linear spline function in income. The positive effect is found for the income range between the 10th and 90th percentile of the income distribution.

consider financial assets net of debts. The income tax rules stimulate having (a limited amount of) financial assets and debts at the same time, and apparently the two effects cancel. The other reason why the marginal tax rate could be positively related to financial asset amounts and ownership decisions is that capital gains are untaxed, including capital gains on stocks and bonds. Hochguertel *et al.* [15] indeed find a positive effect of the marginal tax rate on the share of stocks and bonds in financial assets.

The maximum rent subsidy has the expected negative effect on the decision to own: families who can get a higher rent subsidy have a larger tendency to rent. The same variable has an even stronger negative impact on the decision to hold financial assets. Apparently, those who can get a high rent subsidy have a smaller tendency to save. This could be the case because these families have a smaller incentive to save for buying a house.

To get some idea about the size of these effects, we used model simulations. For 23.3% of all families, family income is so low that the maximum rent subsidy they can get is nonzero. Increasing their maximum rent subsidies by 10% would reduce the home ownership rate as well as the financial wealth ownership rate in this group by about 0.3%. Thus the effect is statistically significant, but economically not very meaningful.

We include a linear spline in age. The age patterns we find are in line with those in Figure 2, but the negative slope after age 45 is very small. In the current paper we cannot distinguish between cohort effects and age effects, but panel data evidence by Alessie *et al.* [1, Table 2(b)] suggests that a negative cohort effect in the age groups 45-70 is a likely explanation, while negative age effects play a large role for the older age groups. This is in line with US evidence of Sheiner and Weil [29], who find that the elderly do not decrease their housing equity until they are very old.

Comparing age patterns for home ownership and financial wealth holdings, we find no evidence that younger households hold high amounts of financial wealth at ages before they typically would buy a home. This may reflect the absence of effective down payment constraints. This finding is robust for the chosen specification, and is also obtained for the equity instead of the asset variables. Of course it may also be the case that our cross–section data are not detailed enough to find any evidence of savings to finance buying a house. We do not know whether or when the renters in our sample intend to buy a house in the future. If they save enough within a short time period (which may be possible given the lack of down-payment constraint), the effect on financial assets will be hard to detect by just looking at the aggregate age pattern.

The probability of home ownership is lower in regions where housing prices are higher. This effect of the house price is significant at the 10% level in all specifications, though insignificant at the 5% level in some specifications.[19] On the other hand, conditional on ownership, the amount of

[19] It would have been closer to economic modeling, if we had included the relative price of owning versus renting. Lack of comparable data on regional rent levels prevented us from doing so. But due to the fact that a large part of the rental market is regulated with rents based on uniform national rules, we would not expect this to lead to very different results.

housing assets increases with the price of the house. Both findings are in line with the findings of Haurin *et al.* [12]. An interpretation is that households are discouraged from investing in houses where house prices are high, but once they have chosen to do so, they need to invest more to attain their desired housing consumption level. They will consume less due to the increased user cost, but their expenditure will rise since the price elasticity of housing consumption is less than one, i.e. housing is inelastic. Whether the differences in housing prices also lead to differences in attractivity of housing for investment purposes, is unclear. The return to housing will not depend on current prices but on the expected growth rate of prices, and there is no evidence that these would be correlated with current price levels.

Simulations using the estimated model show that a 10% increase of house prices would reduce the homeownership rate by 2.4% (1.2 percentage points). The average amount of housing assets of homeowners would increase by 4.6%, or, in other words, housing consumption would fall by 5.4%. The total amount of housing assets would thus increase by about $4.6 - 2.4 = 2.2\%$.

If equity is considered instead of assets, the effect of house prices on housing selection remains, but the effect on the amount invested in housing disappears. This cannot be explained by the discouraged investor's argument. The difference between housing assets and housing equity is obviously determined by the mortgage level. Thus we find that higher house prices also lead to higher mortgages. This is in line with the fact that the maximum mortgage a family can obtain depends on the value of their house.

The house price has a significant negative impact on the probability of holding financial wealth. For renters, this might mean that higher house prices discourage saving for a house. For owners, it may simply mean that higher house prices make it more attractive to hold all wealth as housing wealth. Conditional on holding financial wealth, on the other hand, the effect of the housing price on the amount of financial assets is positive. This may mean that renters who have decided to save for a house, save more if houses are more expensive. This result is in line with Sheiner [28], who finds that higher housing prices increase the savings of renters. For owners, the result is in line with Jones [19]. He finds that rather than taking up the minimum mortgage needed to finance the house, households often take a higher mortgage, and use part of this to invest in other financial assets.

We thus find that the total effect of house prices on financial assets would be ambiguous: fewer people hold financial wealth, but those who do hold more. This reflects an important source of heterogeneity of savings behavior. Simulations for the assets model show that a 10% house price increase would reduce the financial ownership rate by 1.8% but would increase the financial asset holdings of those who own financial assets by about 5.3%. Thus the total level of financial assets would increase by about 3.5%.

The effect of the housing price on the conditional demand for financial equity, however, has the opposite sign, though it is insignificant at the

5% level. Apparently, higher house prices lead to higher financial assets for some people, but to higher financial debts as well. We have no good explanation for this, since it is not clear why higher house prices should stimulate both financial assets and financial debts.

Apart from the impact of housing prices, our model also allows for an interaction between the two assets through the parameters λ_1 and λ_2, which refer to the impact of binding thresholds (equation (3)). In the asset equations, λ_1 is significantly positive, whereas λ_2 is negative but insignificant at all conventional levels. The coherency condition for the empirical model is amply met. A positive value of the λ_1 implies that the two types of assets are substitutes: if the optimal level of financial wealth is positive but, due to the threshold constraint, financial assets are not held, this will increase the demand for housing assets. On the other hand, if people are forced to rent while the optimal level of housing assets y_2^* is positive, this reduces the demand for financial wealth. This is not in line with the idea that financial assets are mainly held to finance down payments for a future house purchase. It should be noted, though, that the size of both λ_1 and λ_2 is small, so that the economic significance of these spill–over effects is limited. Moreover, while the sign of both λ–s remains the same, the significance levels vary substantially across specifications.

If we consider equity variables instead of assets, the estimate of λ_2 is significantly negative and large compared to the assets case (-0.096 with $t-$value -2.84), implying that the spill–over effect from housing to financial equity is larger than for the gross asset amounts. Thus people whose desired housing equity is positive but too small so that they rent instead, also have lower financial equity than similar people who own a house. In a sense, this means that housing and financial equity are complements. Again this is in line with the finding of Jones [19], that homeowners use an excess mortgage to adjust their financial assets portfolio. The estimate of λ_1 is virtually equal to zero.

Other demographics and other socio–economic variables are included for various reasons. First, some variables proxy total lifetime wealth (education level, type of employment, marital status). Our finding that the higher educated hold more housing assets and have a larger probability of home ownership, may thus reflect their higher human capital wealth.

Second, some demographic variables may have a direct impact on housing demand. The estimates by and large confirm our expectations based on other studies in the field. For example, married couples have a larger home ownership probability and demand for housing than singles, and housing assets are positively related to the number of children. Although not all the parameters are significant at the 5% level, their joint significance confirms that there is a positive relation between housing demand and family size.

Several occupational status variables are significant. The reference group here consists of blue collar employees. The self–employed have a higher probability of home–ownership than the reference group. They also have higher levels of housing assets and financial assets, while their equity is not significantly different from that of similar blue collar employees. The reason for this could be that the self–employed are typically less risk averse, and thus more willing to accept financial debts and mortgage debt, combined with an investment in risky housing assets or own business assets. White collar employees have lower housing equity than blue collar workers, possibly because their higher expected life time income gives them access to higher mortgages. They also have a larger probability to own financial assets than blue collar workers, but the level of their financial assets is not significantly different. The degree of urbanization has no effect on the home ownership decision or on housing equity, but people in less urbanized areas have more expensive homes. Surprisingly, households in the three biggest cities (the reference category; see notes Table 1) have a smaller probability to hold financial assets. On the other hand, their probability to have nonzero equity is not significantly different from that of other households, implying that they more often have financial debts.

A final way in which correlation between financial and housing assets or equity enters our model is through the covariances of the error terms in the notional demand equations as well as the selection equations. In Table 4, the covariances between the errors in the two notional demand equations is insignificant, and this also holds for the covariance between the errors in the two selection equations. (Only the covariances between notional demand and selection equation errors for the same asset are significant.) In the equity equations, however, both covariances are significantly positive. This can point at unobserved heterogeneity, in the sense that the same people who have a preference for housing equity also tend to have a preference for financial equity.

We have checked the fit of the models by comparing simulated and actual sample means and housing and financial wealth ownership rates.[20] We find that the model captures the ownership rates and the correlation between holding financial and housing wealth quite well. The models for assets are able to capture the mean asset levels rather well. For the equity variables, the fit is less good. This may be due to the bimodal nature of the distribution of the equity variables (see Figure 1). Partitioning the sample by income quintile leads to the same conclusions: the model for assets fits the data reasonably well, but for the equity variables there are some substantial deviations between predicted and actual conditional means.

6. CONCLUSIONS

This paper has presented an empirical model for households' joint demand of financial and housing wealth, the two most important categories in household assets. We have considered both the amounts of assets held, and the amounts net of liabilities and mortgages (equity). The model is of a bivariate censored regression type with endogenous switching, enhanced by two threshold equations which have to be overcome before investments are made. The model has been estimated on a representative sample of Dutch households, including both renters and home owners and both financial asset holders and nonholders. We allow for spill–over effects between asset demands, when one of the assets is not held.

[20] Details are available upon request from the authors.

Compared to most exisiting studies in the literature, our model treats housing and financial assets in a symmetric way. Both are dependent variables, and we allow for thresholds in both. As expected, the financial assets thresholds are less important than the housing thresholds, since the magnitude of fixed costs related to financial investment are much smaller than those for housing investment. Still, the substantial differences between selection equation for financial assets (reflecting the difference between demand and threshold) and demand for financial assets, show that the threshold for financial assets does play a role, and the model with zero threshold for financial assets would be clearly rejected. For example, higher house prices significantly decrease the probability of holding financial wealth, but increase the amount conditional on ownership. This implies that they increase the threshold of financial assets.

A major difference with the existing literature is that we allow for mutual spill–over effects. Our main finding is that demand for financial wealth for home owners and for renters is systematically different, while housing wealth is not affected by whether or not financial wealth is held. Consistent with previous studies in this field is the finding that higher regional house prices reduce the likelihood of homeownership. At the same time, housing wealth of home owners responds positively to house price variation, whereas it does not affect their housing equity. Higher house prices also decrease the probability of holding financial wealth, whereas they increase the conditional demand for financial assets but have an insignificant effect on conditional demand for financial equity.

As has been widely discussed in the recent literature, down payment restrictions operate like certain liquidity constraints and influence households' saving behavior (cf. Engelhardt [8, 9], Haurin *et al.* [12], Sheiner [28]): both in Canada and in the U.S. a down payment is specified as a percentage (usually in the range of 5–25%) of the purchase price of the house, such that an increase in house prices can lead to a higher down payment and thus can induce higher saving. On the other hand, if those increased down payments are too high, renter households might become discouraged from buying a house at all or be willing to only buy a smaller house to compensate for the increase in down payments, or even to delay the date of home buying. A higher down payment amount implies a greater intertemporal distortion of the consumption plan such that the discounted benefits of homeowning might fall short of the discounted costs of consumption distortion (cf. Artle and Varaiya [4] for a theoretical exposition). Thus, both timing and extent of preownership saving are affected. In the Netherlands however, the low homeownership rate and the effective absence of down payment constraints imply that this type of liquidity constraints are not of major importance for Dutch households' saving behavior. This presumption is corroborated by our empirical findings.

REFERENCES

1. R. Alessie, A. Lusardi, and A. Kapteyn. Saving and wealth holdings of the elderly. *Ricerche Economiche*, 49:293–315, 1995.

2. R. Alessie, M. Pradhan, and C. Zandvliet. An exploratory analysis of the socio–economic panel with regard to the financial position of households. VSB–CentER Savings Project Progress Report, 1993. No. 14. Tilburg University.

3. R. Alessie, S. Hochguertel, and A. van Soest. Household portfolios in the Netherlands. In L. Guiso, M. Haliassos, and T. Jappelli, editors, *Household Portfolios*. MIT Press, Cambridge, MA (forthcoming), 2000.

4. R. Artle and P. Varaiya. Homeownership and life cycle consumption. *Journal of Economic Theory*, 18:38–58, 1978.

5. J. Banks and R. Blundell. Household saving behavior in the United Kingdom. In James Poterba, editor, *International Comparisons of Household Saving*, pages 169–205. University of Chicago Press, Chicago, 1994.

6. J. K. Brueckner. Consumption and investment motives and the portfolio choices of homeowners. *Journal of Real Estate Finance and Economics*, 15:159–180, 1997.

7. C. D. Carroll and W. E. Dunn. Unemployment expectations, jumping (S,s) triggers, and household balance sheets. NBER Working Paper No. 6081., 1997.

8. G. V. Engelhardt. House prices and the decision to save for down payments. *Journal of Urban Economics*, 36:209–237, 1994.

9. G. V. Engelhardt. Consumption, down payments, and liquidity constraints. *Journal of Money, Credit, and Banking*, 28:255–271, 1996.

10. M. Flavin and T. Yamashita. Owner–occupied housing and the composition of the household portfolio over the life cycle. NBER Working Paper No. 6389, 1998.

11. M. C. Fratantoni. Homeownership and investment in risky assets. *Journal of Urban Economics*, 44:27–42, 1998.

12. D. R. Haurin, P. H. Hendershott, and S. M. Wachter. Expected home ownership and real wealth accumulation of youth. NBER Working Paper No. 5629, 1996.

13. J. J. Heckman. Dummy endogenous variables in a simultaneous equation system. *Econometrica*, 46:931–959, 1978.

14. J. V. Henderson and Y. M. Ioannides. A model of housing tenure choice. *American Economic Review*, 73:98–113, 1983.

15. S. Hochguertel, R. Alessie, and A. van Soest. Saving accounts versus stocks and bonds in household portfolio allocation. *Scandinavian Journal of Economics*, 99:81–97, 1997.

16. A. E. Holmans. House prices, land prices, the housing market and house purchase debt in the UK and other countries. *Economic Modelling*, 11:157–199, 1994.

17. Y. M. Ioannides. Housing, other real estate, and wealth portfolios: An empirical investigation based on the 1983 Survey of Consumer Finances. *Regional Science and Urban Economics*, 19:259–280, 1989.

18. Y. M. Ioannides and S. S. Rosenthal. Estimating the consumption and investment demands for housing and their effect on housing tenure status. *Review of Economics and Statistics*, 76:127–141, 1994.

19. L. D. Jones. The demand for home mortgage debt. *Journal of Urban Economics*, 33:10–28, 1993.

20. L. D. Jones. Net wealth, marginal tax rates and the demand for home mortgage debt. *Regional Science and Urban Economics*, 25:297–322, 1995.

21. D. Kessler and E. N. Wolff. A comparative analysis of household wealth patterns in France and the United States. *Review of Income and Wealth*, 37:249–266, 1991.

22. M. A. King and J. I. Leape. Asset accumulation, information, and the life cycle. NBER Working Paper, No. 2392, 1987.

23. R. H. Koning and G. Ridder. Rent assistance and housing demand. *Journal of Public Economics*, 66:1–31, 1997.

24. L.-F. Lee and M. M. Pitt. Microeconometric demand systems with binding nonnegativity constraints. *Econometrica*, 54:1237–1243, 1986.

25. F. D. Nelson. Censored regression models with unobserved, stochastic censoring thresholds. *Journal of Econometrics*, 6:309–327, 1977.

26. A. M. Polinsky and D. T. Ellwood. An empirical reconciliation of micro and grouped estimates of the demand for housing. *Review of Economics and Statistics*, 61:199–205, 1979.

27. J. M. Poterba. House price dynamics: The role of tax policy and demography. *Brookings Papers on Economic Activity*, 2:1991:143–203, 1991.

28. L. Sheiner. House prices and the savings of renters. *Journal of Urban Economics*, 38:94–125, 1995.

29. L. Sheiner and D. N. Weil. The housing wealth of the aged. NBER Working Paper No. 4115, 1992.

30. E. Van der Krabben. Urban dynamics: A real estate perspective. CentER PhD–thesis, Tilburg University, 1995.

31. Q. H. Vuong. Likelihood ratio tests for model selection and non–nested hypotheses. *Econometrica*, 57:307–333, 1989.

32. E. N. Wolff. Trends in household wealth in the United States, 1962–1983 and 1983–1989. *Review of Income and Wealth*, 40:143–174, 1994.

TABLES AND FIGURES

TABLE 1.

Summary Statistics of Exogenous Variables (2888 observations)*

Variable	mean	stdv.	min	max	median
ln(income+1)	7.739	0.675	0	11.495	7.753
age of head	43.937	15.286	18	89	40
ln(max. rent subsidy+1)	1.761	3.212	0	8.425	0
marg. tax rate	0.474	0.133	0	0.72	0.51
interm. education	0.326	0.469	0	1	0
high education	0.159	0.365	0	1	0
self–employed	0.105	0.306	0	1	0
white collar	0.449	0.498	0	1	0
other occupation	0.199	0.399	0	1	0
part–time	0.050	0.218	0	1	0
other status	0.347	0.476	0	1	0
female	0.202	0.401	0	1	0
couples	0.700	0.458	0	1	1
divorced / widowed	0.163	0.370	0	1	0
no. children	0.984	1.122	0	8	1
house price index	0.963	0.154	0.626	1.230	0.982
bigger cities	0.222	0.416	0	1	0
smaller cities	0.200	0.400	0	1	0
country towns	0.416	0.493	0	1	0
country side	0.124	0.330	0	1	0

* *Definition of variables:* income: sum of net labor income (Dfl/month) of head and partner; (7 households report zero income); in the regressions we employ a linear spline in ln(income+1) with knots at income levels Dfl. 1200 and Dfl. 4400; age: in the regressions we employ a linear spline with knots at ages 35 and 45; max. rent subsidy: is the maximum annual subsidy a renter household could obtain, given their age, family status, and gross income; marginal tax rate: calculated from individual net earnings and family composition; the household rate is set equal to the maximum of the two individual rates; the house price index is based on average regional selling prices of houses, provided by the Dutch Association of Real Estate Agents (we differentiated according to the type of dwelling and divided the regional prices by national averages); the remaining variables (except for the number of children) are dummies: intermediate education: technical and vocational training for 16+ years old, and preuniversity education; high education: university degree or higher vocational training; labor supply: part–time employment (10–35 hours per week); other status: disabled, unemployed, retired, students and housewives/men without alternative occupation (reference group is full–time (36 hours per week or more)); occupational status: self–employed (includes free lancers, directors or owners of firms, farmers or market gardeners), whitecollar employees and other occupation (people without paid employment and others); reference group is bluecollar workers; couples: married or living together; urbanization: (reference group: the three big cities Amsterdam, Rotterdam, The Hague).

TABLE 2.

Summary Statistics of Endogenous Variables (2888 observations)*

Variable**	nobs.	mean	stdv.	min	max	median	skewn.
house value	2866	79.59	99.59	0	850.00	0	1.55
zeros excluded	1413	161.43	83.09	10.00	850.00	145.00	2.40
log house value	2866	5.85	5.95	0	13.65	0	0.04
zeros excluded	1413	11.88	0.51	9.21	13.65	11.88	–1.13
fin. assets	2573	16.53	70.77	0	1415.25	3.14	11.80
zeros excluded	2126	20.01	77.41	1	1415.25	4.99	10.78
log fin. assets	2573	6.88	3.58	0	14.16	8.05	–0.98
zeros excluded	2126	8.32	1.86	0.69	14.16	8.52	–0.59
house equity	2611	40.29	72.57	–28.00	806.73	0	3.01
zeros excluded	1149	91.56	85.29	–28.00	806.73	72.40	2.33
log house equity	2611	4.49	5.75	–10.24	13.60	0	0.18
zeros excluded	1149	10.21	4.09	–10.24	13.60	11.19	–4.10
fin. equity	2528	14.71	72.21	–479.49	1415.25	2.66	11.14
zeros excluded	2171	17.13	77.65	–479.49	1415.25	4.04	10.33
log fin. equity	2528	5.13	6.16	–13.08	14.16	7.88	–1.26
zeros excluded	2171	5.97	6.26	–13.08	14.16	8.31	–1.72

* *Definition of variables:* house value: gross housing assets (in 1,000 Dfl. or using the log–transformation, cf. fn. 10); house equity: value of the house net of outstanding mortgage debt; fin. assets: sum of the amounts held in saving account balances, time deposit accounts, saving certificates, certificates of deposit, shares in domestic and foreign companies, shares in investment funds, options, bonds and mortgage bonds; fin. equity: financial assets net of liabilities; skewness is measured as skewness$(x) \equiv \mathrm{E}(x - \mathrm{E}(x))^3/\sigma^3$, where σ^2 is the variance of x.

** for all variables, the first line refers to all observations for which the amount is not missing; the second line excludes both missings and zero amounts.

TABLE 3.

Number of Observations per Regime

a value of the home vs. financial assets

number of observations (%)	financial assets > 0 (observed)	financial assets > 0 (missing)	financial assets $= 0$	sum
value of the home > 0 (observed)	regime (a) 1097 (37.98)	201 (6.96)	regime (b) 115 (3.98)	1413 (48.93)
value of the home > 0 (missing)	12 (0.42)	7 (0.24)	3 (0.10)	22 (0.76)
value of the home $= 0$	regime (c) 1017 (35.21)	107 (3.70)	regime (d) 329 (11.39)	1453 (50.31)
sum	2126 (73.61)	315 (10.91)	447 (15.48)	2888 (100.00)

b housing equity (net of mortgages) vs. financial equity (net of liabilities)

number of observations (%)	financial equity $\neq 0$ (observed)	financial equity $\neq 0$ (missing)	financial equity $= 0$	sum
housing equity $\neq 0$ (observed)	regime (a) 918 (31.79)	175 (6.06)	regime (b) 65 (2.25)	1158 (40.10)
housing equity $\neq 0$ (missing)	200 (6.93)	48 (1.66)	29 (1.00)	277 (9.59)
housing equity $= 0$	regime (c) 1055 (36.53)	137 (4.74)	regime (d) 261 (9.04)	1453 (50.31)
sum	2173 (75.24)	360 (12.47)	355 (12.29)	2888 (100.00)

TABLE 4.

Estimation Results for Assets

	housing assets	selection equation	financial assets	selection equation
constant	11.668	–2.114	7.891	0.694
	(42.64)	(–3.27)	(5.09)	(1.15)
ln(income+1)	—	–0.218	–0.153	0.010
income $\leq$ 1200	—	(–3.11)	(–0.69)	(0.14)
ln(income+1)	—	0.482	0.278	0.298
income $\in$ (1200; 4400]	—	(3.78)	(1.20)	(1.59)
ln(income+1)	—	0.043	0.569	–0.337
income $>$ 4400	—	(0.29)	(2.83)	(–1.64)
ln(max. rent subsidy+1)	—	–0.024	—	–0.065
	—	(–2.07)	—	(–4.23)
marginal tax rate	0.052	1.547	1.525	0.194
	(0.31)	(3.69)	(2.06)	(0.35)
age $\leq$ 35	–0.015	0.078	–0.001	0.005
	(–2.01)	(6.23)	(–0.07)	(0.46)
age $\in$ (35; 45]	0.019	–0.020	0.034	0.004
	(3.44)	(–1.96)	(2.31)	(0.37)
age $>$ 45	–0.005	0.017	0.051	0.001
	(–2.10)	(3.69)	(6.85)	(0.12)
intermed. education	0.011	0.118	0.083	0.007
	(0.30)	(1.74)	(0.83)	(0.09)
high education	0.102	0.187	0.233	0.006
	(2.16)	(1.97)	(1.75)	(0.06)
self–employed	0.203	0.340	0.420	0.056
	(3.81)	(3.09)	(2.46)	(0.43)
white collar	0.028	0.097	–0.123	0.239
	(0.69)	(1.30)	(–1.06)	(2.51)
other occupation	0.009	0.098	0.229	0.343
	(0.16)	(0.92)	(1.52)	(3.12)
part time	0.174	–0.229	–0.432	0.105
	(2.63)	(–1.78)	(–2.45)	(0.75)
other labor	0.064	–0.327	–0.435	–0.004
	(1.24)	(–3.32)	(–3.26)	(–0.03)
female	0.104	–0.034	–0.259	0.232
	(1.88)	(–0.31)	(–1.72)	(2.21)
couple	0.113	0.247	–0.046	–0.003
	(1.93)	(2.21)	(–0.27)	(–0.03)

continued on next page

TABLE 4—*Continued*

	housing assets	selection equation	financial assets	selection equation
divorced / widows	0.170	–0.059	–0.060	–0.410
	(2.59)	(–0.48)	(–0.32)	(–3.31)
number of children	0.019	0.052	–0.095	0.169
	(1.21)	(1.72)	(–1.97)	(4.96)
house price index	0.510	–0.389	0.832	–0.699
	(5.30)	(–2.14)	(3.12)	(–3.36)
bigger cities	0.034	0.200	—	0.318
	(0.42)	(1.37)	—	(2.11)
smaller cities	0.089	0.226	—	0.319
	(1.14)	(1.53)	—	(2.08)
country towns	0.188	0.111	—	0.300
	(2.55)	(0.80)	—	(2.09)
country side	0.256	0.102	—	0.445
	(3.07)	(0.66)	—	(2.65)
		correlation matrix		
housing assets	1	·	·	·
	—	·	·	·
selection equation	–0.831	1	·	·
	(–5.46)	—	·	·
financial assets	–0.013	0.034	1	·
	(–0.09)	(0.23)	—	·
selection equation	0.165	0.195	–0.610	1
	(1.09)	(1.28)	(–4.00)	—
σ	0.555	1.000	1.791	1.000
	(55.59)	(fixed)	(56.08)	(fixed)
λ_1		0.031		
		(2.73)		
λ_2		–0.013		
		(–0.48)		
log likelihood		–42033.95		
number of obs.		2888		

note: t–values in parentheses; cf. Tables 1 and 2 for definition of variables

TABLE 5.

Estimation Results for Equities

	housing equity	selection equation	financial equity	selection equation
constant	10.133	–2.358	10.749	0.744
	(3.77)	(–3.58)	(0.94)	(1.18)
ln(income+1)	—	–0.238	–0.528	0.060
income $\leq$ 1200	—	(–3.34)	(–0.32)	(0.85)
ln(income+1)	—	0.487	–0.950	0.448
income $\in$ (1200; 4400]	—	(3.11)	(–1.26)	(2.09)
ln(income+1)	—	–0.085	0.009	–0.321
income $>$ 4400	—	(–0.52)	(0.01)	(–1.47)
ln(max. rent subsidy+1)	—	–0.023	—	–0.074
	—	(–1.57)	—	(–4.24)
marginal tax rate	–0.191	1.969	3.127	–0.219
	(–0.11)	(4.31)	(1.32)	(–0.35)
age $\leq$ 35	–0.039	0.080	–0.030	0.008
	(–0.69)	(6.43)	(–0.57)	(0.58)
age $\in$ (35; 45]	0.195	–0.025	0.053	0.008
	(3.95)	(–2.48)	(1.12)	(0.59)
age $>$ 45	0.037	0.017	0.158	–0.007
	(0.60)	(3.55)	(4.76)	(–1.30)
intermed. education	0.117	0.099	–0.037	–0.070
	(0.37)	(1.44)	(–0.11)	(–0.79)
high education	0.727	0.176	0.056	–0.073
	(1.71)	(1.81)	(0.13)	(–0.59)
self–employed	–0.138	0.328	0.535	0.064
	(–0.24)	(2.82)	(0.90)	(0.45)
white collar	–0.981	0.128	–0.576	0.350
	(–2.18)	(1.67)	(–1.41)	(3.38)
other occupation	–0.014	0.137	0.411	0.329
	(–0.01)	(1.28)	(0.63)	(2.80)
part time	0.463	–0.268	–1.624	–0.074
	(0.38)	(–2.01)	(–2.74)	(–0.49)
other labor	–0.427	–0.328	–1.267	0.054
	(–0.58)	(–3.23)	(–2.27)	(0.44)
female	–0.004	–0.038	1.575	0.109
	(–0.01)	(–0.34)	(2.50)	(0.95)
couple	1.668	0.297	0.362	–0.030
	(3.38)	(2.44)	(0.60)	(–0.22)

continued on next page

TABLE 5—*Continued*

	housing equity	selection equation	financial equity	selection equation
divorced / widows	1.560	–0.030	–1.477	–0.402
	(1.86)	(–0.23)	(–2.01)	(–2.99)
number of children	0.060	0.062	–0.159	0.219
	(0.33)	(1.98)	(–1.05)	(6.19)
house price index	0.112	–0.348	–1.136	–0.582
	(0.12)	(–1.91)	(–1.26)	(–2.53)
bigger cities	–1.725	0.287	—	–0.003
	(–1.07)	(1.87)	—	(–0.01)
smaller cities	–1.447	0.296	—	–0.044
	(–0.89)	(1.90)	—	(–0.23)
country towns	–1.045	0.146	—	–0.039
	(–0.65)	(0.99)	—	(–0.22)
country side	–0.444	0.168	—	0.077
	(–0.26)	(1.03)	—	(0.37)
		correlation matrix		
housing equity	1	.	.	.
	—	.	.	.
selection equation	0	1	.	.
	—	—	.	.
financial equity	0.166	0	1	.
	(2.09)	—	—	.
selection equation	0	0.214	0	1
	—	(2.69)	—	—
σ	3.962	1.000	6.089	1.000
	(42.14)	(fixed)	(34.72)	(fixed)
λ_1			0.004	
			(0.02)	
λ_2			–0.096	
			(–2.84)	
loglikelihood			–43648.30	
number of obs.			2888	

note: t–values in parentheses; cf. Tables 1 and 2 for definition of variables

FIG. 1. Marginal Distributions of Assets, Continuous Parts

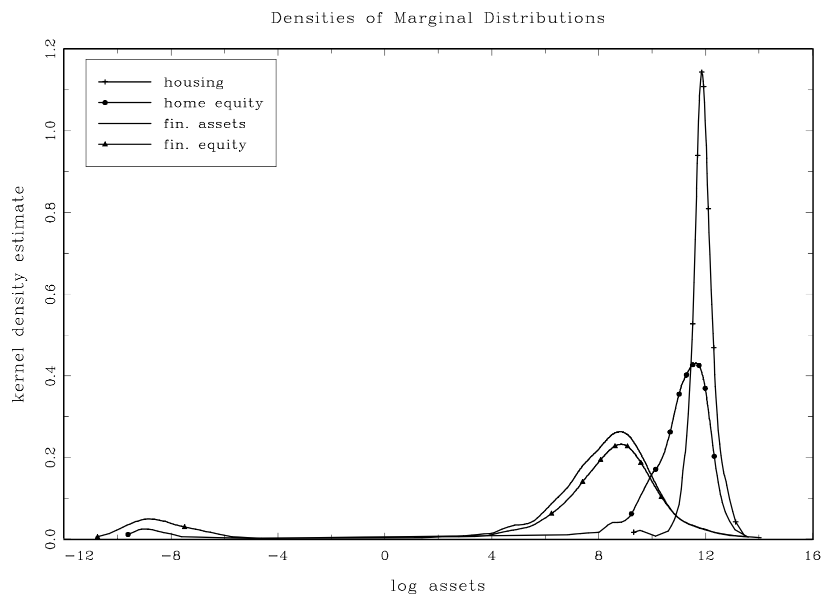

FIG. 2. Ownership Rates

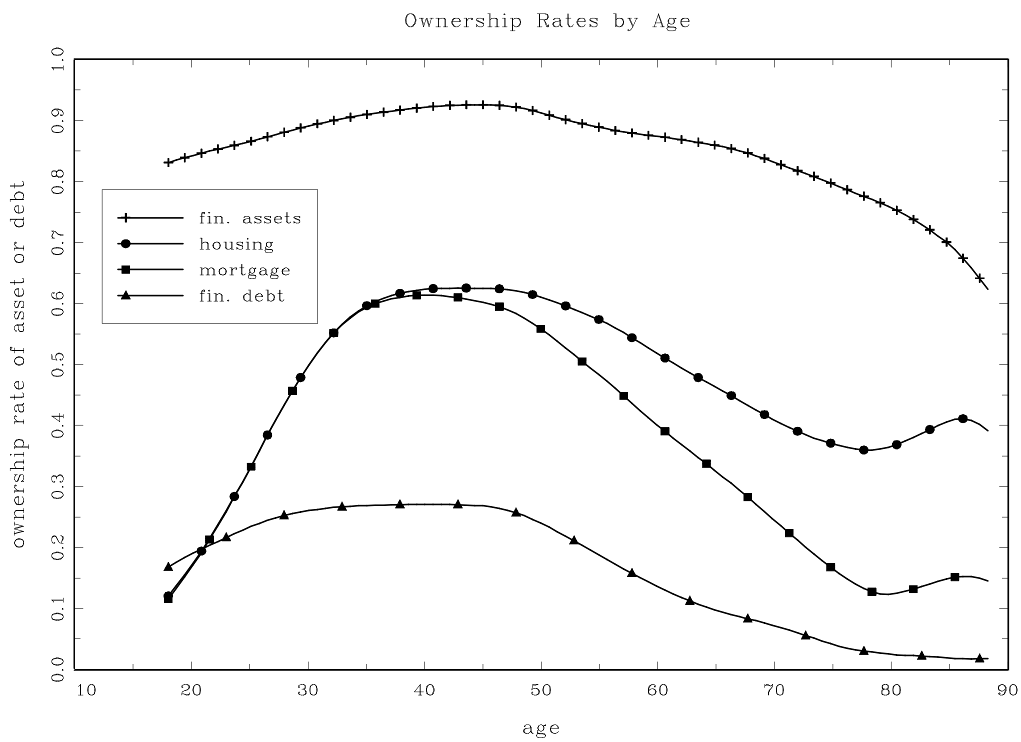

FIG. 3. Wealth Holding

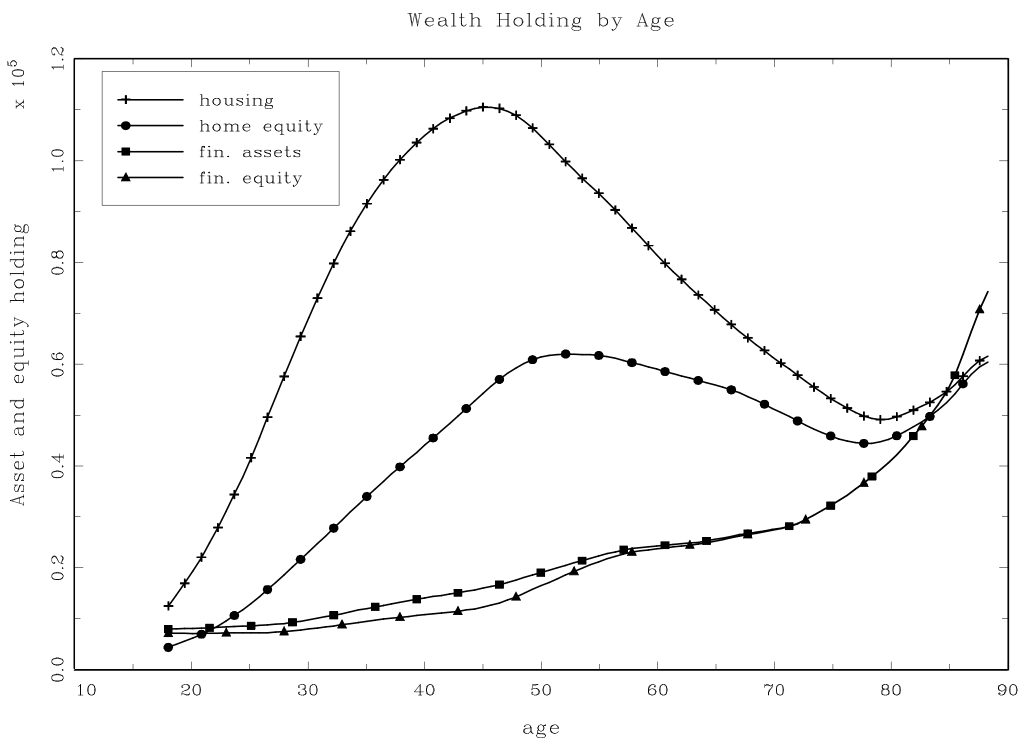

FIG. 4. Wealth Holding by Tenant Status