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Abstract

This paper studies the link between owner-occupied housing and household portfolio choice. The work follows the results by Flavin and Yamashita (American Economic Review, 92 (2002) 345–362.) who show that the home-owning decision and exposure to house price risk may have a dramatic effect on the mean-variance efficient financial portfolio available to the household. This suggests, that we should observe that homeowners with high house values compared to net wealth hold their liquid financial wealth in a safer form than other homeowners. Using a simulation model with Finnish asset return data we find that a leveraged position on housing has a clear negative effect on the share of stocks in a mean-variance efficient portfolio. The paper tests this prediction using the 1998 Wealth Survey, a household level data set produced by Statistics Finland. According to econometric results, owner-occupied housing has two effects on household stockholding. First, housing capital simply pushes some homeowners away from the stock market altogether because these households do not see it worthwhile to enter the stock market given their low level of liquid financial wealth and possible entry and participation costs. Second, homeowners with a leveraged position on housing hedge themselves against house price risk by holding less stocks than households who own their homes outright.

Keywords: Portfolio choice, owner-occupied housing

JEL classification: D14, D91, G11, R21

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1 Introduction

Housing services are a necessity and a major component of household consumption expenditures. For example, Englund et al. (2002) report that a household living in Western Europe or in North America spends on average 25 to 35 percent of its income on housing. In addition to a consumption motive, households take into account investment aspects when choosing their housing tenure, the quantity of housing services they wish to consume, and the size of mortgage debt they wish to service. In fact, housing is also by far the largest individual component in households' portfolios. Statistics Finland report that in 1998 residential housing constituted 66 percent of Finnish households' overall gross wealth.[1] The strongly unbalanced portfolios induced by investment in owner-occupied housing are illustrated in Table 1 which depicts the house value-to-net wealth ratios by age category in different countries. Despite temporal and institutional differences the life-cycle patterns are strikingly similar, especially in Finland and Sweden. Young homeowners with mortgage financed homes hold portfolios that are highly tilted toward housing capital and even middle-aged households invest almost 100 percent of their net wealth into housing. At the same time, only about 15 percent of Finnish households participated in the stock market and the share of liquid financial wealth invested in stocks was only about 25 percent.

Table 1. Mean house value relative to mean net wealth by age category.

Age of head	Finland 1998	U.S. 1989	Sweden 1991	France 1998
18 - 30 (25 - 34)	2.295	3.511	2.580	1.348
31 - 40 (35 - 44)	1.516	2.366	1.617	1.026
41 - 50 (45 - 54)	1.016	1.588	1.211	0.753
51 - 60 (55 - 64)	0.871	0.969	0.946	0.629
61 - 70 (65 - 74)	0.716	0.757	0.787	0.567
71 + (75 +)	0.789	0.648	0.806	0.422

Note: Age intervals in the parentheses refer to Sweden.

Sources: Flavin and Yamashita (2002), Englund et al. (2002), LeBlanc and Lagarenne (2004) and author's calculations from the 1998 Wealth Survey.

A natural question that arises in light of these figures is whether such a high portfolio share of housing is optimal from portfolio diversification point of view, or whether it's driven by institutional constraints that prevent households from separately choosing the level of housing consumption and investment. Henderson and Ioannides (1983) introduce a basic theoretical

[1] If summer cottages and other holiday residences are included the percentage share rises to 75 percent.

model that allows one to simplify these questions. In their model, a housing consumption motive introduces a lower bound for housing investment for homeowners. This means that a homeowner cannot own only a fraction of the house it resides in. If a homeowner's housing consumption demand is equal or larger than investment demand, consumption and investment decisions are no longer separable.[2]

Brueckner (1997) connects the Henderson and Ioannides model into a mean-variance portfolio decision framework. He shows that when the housing constraint is binding for homeowners, i.e. consumption demand is equal or larger than investment demand, homeowners' investment portfolios are no longer efficient in a mean-variance sense. In other words, homeowners could attain a larger expected return on their portfolios without increasing its variance by adjusting their housing investment. However, homeowners are prevented from doing so because their housing investment is constrained by consumption demand. Thus, homeowners tolerate inefficiency in their portfolios because adjusting the level of housing investment would create utility losses by lowering the amount of housing services consumed.[3] Flavin and Yamashita (2002) show, using historical asset returns data in the U.S. and plausible assumptions about the degree of household risk aversion, that house value-to-net wealth ratio has a dramatic effect on the share of risky financial assets in a household's mean-variance efficient portfolio. In their model, the house value-to-net wealth ratio acts as constraint on the mean-variance efficient financial portfolio attainable to a homeowner. In effect, a leveraged position in a volatile asset exposes homeowner households to a background risk that has an adverse effect on their desire to take additional risks in their financial portfolio choice.

In Finland homeownership is preferable to renting for a number of reasons (tax subsidies, agency and externality cost of rental housing etc.), which is why a majority of Finnish households choose to own a home, at least at some point during their life-cycle.[4] Due to current institutional arrangements in Finland, homeowners are often unable to separate their

[2] Of course, if consumption demand is sufficiently higher than investment demand a household may choose to rent. See Ioannides and Rosenthal (1994) for details.
[3] We can also think of homeowners as consuming less than the optimal amount of housing services because consuming more would lead to a more inefficient portfolio.
[4] Promotion of homeownership is actually one of the most important goals of Finnish housing policy.

housing consumption and investment choices.[5] Thus, a binding housing constraint may be a major factor driving the financial portfolio choices of many Finnish households. Furthermore, because the share of housing of overall net wealth changes during a typical life-cycle, housing may introduce a clear life-cycle pattern in household financial portfolios that is not predicted by simpler portfolio models. From the above argumentation it is clear that any empirical attempt to determine what factors drive households' financial portfolio choices should take housing directly into account.

The purpose of this paper is twofold. First, we employ a simulation approach similar to Flavin and Yamashita (2002) to study how a leveraged position on housing affects a homeowner's optimal portfolio choice under current investment environment in Finland. The main contribution, though, is to test the predictions from the simulation model using micro data of Finnish households. Simulation results show that a leveraged position on housing has a clear negative effect on the share of stocks in an optimal portfolio. This effect is amplified for more risk-averse households. Econometric results support the simulation results. According to them, owner-occupied housing has two effects on household stockholding. First, housing capital simply pushes some homeowners away from the stock market altogether because these households do not see it worthwhile to enter the stock market given their low level of liquid financial wealth and possible entry and participation costs. Second, homeowners with a leveraged position on housing hedge themselves against house price risk by holding less stocks than households who own their homes outright.

The rest of the paper is organized as follows. In section 2, we present the model by Flavin and Yamashita (2002) where owner-occupied housing is introduced into mean-variance portfolio framework. Then we solve the model numerically using Finnish asset return data. This gives us the optimal investment in stocks as a function of house value-to-net-wealth ratio and risk aversion. In section 3, we take the predictions from the numerical model to household level data using econometric models for discrete and limited dependent variables. Section 4 concludes.

[5] Some new tenure forms have been introduced in the last 15 years which combine characteristics of both renting and owning, such as the right of occupancy. But these tenure forms consist to less than a percent of the housing stock in Finland.

2 Housing in a mean-variance portfolio framework

2.1. Theoretical model

In this section, we use the model first introduced by Flavin and Yamashita (2002) to study how owner-occupied housing affects household portfolio choice. The model can be used to simulate what the optimal portfolio shares should be in theory for a homeowner household with a leveraged position in housing using data on historical asset returns. In the model, owner-occupied housing and mortgage debt are introduced as part of a homeowner's portfolio problem in an otherwise traditional mean-variance framework. The model abstracts from the tenure choice problem by assuming that homeownership is the preferred tenure due to tax distortions, and transaction and agency costs related to renting. A homeowner's total net wealth at time *t* is given by

$$W_t = \mathbf{X}_t'\mathbf{I} + P_t H_t, \tag{1}$$

where $\mathbf{X}_t$ is a (1 x *n*) vector of amounts held in $i = 1,\ldots, n$ risky assets, $\mathbf{I}$ is vector of ones, H_t the quantity of housing and P_t the unit price of housing. The last element in $\mathbf{X}_t$ represents mortgage holding. The constraints on financial asset holdings are

$$-P_t H_t \le X_{n,t} \le 0, \tag{2}$$

$$X_{i,t} \ge 0, \quad i = 1,...,n-1. \tag{3}$$

Constraint in (2), the mortgage constraint, states that the household can borrow only up to house value and cannot be a mortgage lender. Constraint (3) requires non-negative financial asset holdings. Thus, the household can only borrow through a mortgage debt. The asset returns are random and are decomposed into the expected return and a stochastic component as follows: $R_{i,t} = \mu_i + \varepsilon_{i,t}$ and $R_{H,t} = \mu_H + \varepsilon_{H,t}$, with $E\left[R_{i,t}\right] = \mu_i$ and $E\left[R_{H,t}\right] = \mu_H$. The covariance matrix of the returns is given by

$$\mathbf{\Omega} = E\left[\boldsymbol{\varepsilon}_t \boldsymbol{\varepsilon}_t'\right], \tag{4}$$

where $\boldsymbol{\varepsilon}_t \equiv \left(\varepsilon_{1,t},...,\varepsilon_{n,t},\varepsilon_{H,t}\right)'$. The vector of expected returns on financial assets is defined as $\boldsymbol{\mu} \equiv \left(\boldsymbol{\mu}_1,...,\boldsymbol{\mu}_n\right)'$. Now a household's optimization problem can be expressed in terms of choosing asset shares $\mathbf{x}_t$:[6]

$$\max_{\mathbf{x}_t}\left\{\left(\mathbf{x}_t'\boldsymbol{\mu}\right)+h_t\mu_H-\frac{A}{2}\left[\mathbf{x}_t,h_t\right]'\boldsymbol{\Omega}\left[\mathbf{x}_t,h_t\right]\right\} \tag{5}$$

$$\text{s.t. } 1=h_t+\mathbf{x}_t'\mathbf{I},$$
$$-h_t\le x_{n,t}\le 0,$$
$$x_{i,t}\ge 0,\quad i=1,...,n-1,$$

where $h_t \equiv \frac{P_tH_t}{W_t}$ and $\mathbf{x}_t \equiv \frac{\mathbf{X}_t}{W_t}$.

The idea is that the household maximizes expected utility of wealth with respect to holdings of financial assets conditional on the current value of h_t. Household's risk preferences are represented by the coefficient of relative risk aversion, A. Thus, for a given value of h_t, the mean-variance efficient frontier available to the household can be calculated by finding the value of $\mathbf{x}_t$ which achieves the minimum variance portfolio for a given expected return. The chosen optimal portfolio from these frontiers naturally depends on risk aversion. We stress that the solution is conditional on housing investment, h_t. Once a home-owning household commits itself to a particular level of housing consumption, the optimal adjustment interval may be very long because of adjustment costs.[7] Arguably, the costs of adjusting the quantities of financial assets are smaller.

2.2 Optimal portfolios using Finnish asset return data

Following Flavin and Yamashita (2002) we estimate $\boldsymbol{\mu}_t$, μ_H and $\boldsymbol{\Omega}$ using historical data on asset and housing returns and solve the optimization problem in (5) for different values of h

[6] This formulation of the objective function is based on the assumptions that asset returns are normally distributed and the utility function is of the constant relative or absolute risk aversion (CRRA or CARA) form. See Flavin and Yamashita (1998) for details.
[7] See e.g. Grossman and Laroque (1990).

and A.[8] Mean-variance optimal portfolios associated with (5) are calculated using Finnish quarterly asset return data on five broad asset classes from 1995 to 2005. Eleven years is a rather short period, especially when considering homebuyers investment horizons. However, data on government bond returns are not available prior to 1995. The upshot of this period is that major institutional reforms took place in the early and mid 1990s. Most notably, a major tax reform was implemented in 1993, rent controls were phased out on private rental dwellings during 1992–1995, and Finland joined the EU in 1995 and EMU in 2001. The last mentioned have meant a period of low inflation and nominal interest rates. Furthermore, from 1993 onwards foreign investors have been allowed to freely invest in Finnish securities.[9] Using data from before 1995 would not give a true picture of the current investment opportunities available to households and the linkages between different asset returns.

Table 2 reports quarterly mean asset returns, standard deviations, and the respective correlation matrix for the assets.[10] The real after-tax quarterly returns from different assets range from 0.21 percent from bank accounts to 2.29 percent from owner-occupied housing. Housing investment has been very profitable in Finland during the period. Houses have even outperformed stocks: they show a higher mean return and a lower standard deviation. Furthermore, housing returns are negatively correlated with other assets except stocks. Compared to other countries, housing offers high returns in Finland.[11] The results are most comparable to the ones found by Iacoviello and Ortalo-Magné (2003) with U.K. data except that in Finland housing and bond returns have a negative correlation as opposed to a positive one in the U.K. This may be because our data on bond returns include short maturities, which are found to have a negative correlation with housing returns in the U.K. Flavin and Yamashita (2002) find negative but insignificantly small correlations between housing and all financial asset returns in the U.S. Of course, some of the differences may be driven by different investment horizons.

[8] Flavin and Yamashita use government T-bills, government bonds, stocks along with mortgage and housing. Le Blanc and Lagarenne (2004) do similar calculations using French data.
[9] Oikarinen (2006) finds evidence of a structural break in the long-run relationship between stock and house prices in Finland at beginning of 1993. He concludes that this was probably due to the abolition of foreign ownership restrictions in the stock market.
[10] The calculation of asset returns is described in Appendix 1.
[11] See Iacoviello and Ortalo-Magné (2003) for further discussion on country differences.

Table 2. Mean quarterly returns and correlation matrix of assets, 1995–2005.

	Bank account	Bonds	Stocks	Mortgage	House
Return	0.0021	0.0106	0.0207	0.0083	0.0229
s.d.	0.0016	0.0151	0.0860	0.0030	0.0190

Correlation matrix

	Bank account	Bonds	Stocks	Mortgage	House
Bank account	1.0000				
Bonds	0.7263	1.0000			
Stocks	0.0338	-0.1954	1.0000		
Mortgage	0.8528	0.6420	-0.0214	1.0000	
House	**-0.2263**	**-0.2208**	**0.3689**	**-0.2317**	1.0000

Table 3 reports the simulated optimal portfolios for different levels of h and A using the returns and the correlation matrix reported in Table 2. The values of h correspond to the age group averages in Table 1. With low levels of risk aversion (A = 1) the optimal portfolio consist of only stocks, regardless of the housing constraint. However, with higher levels of risk aversion the share of stocks declines as the household replaces stocks with bonds. Interestingly, even at very high levels of risk aversion bank accounts are not included in the optimal portfolio.[12] This is true even when the housing constraint is introduced. With moderate and high levels of risk aversion $(A \geq 2)$, the optimal share of stocks depends on the housing constraint, with higher values of h being associated with lower shares of stocks. Furthermore, at very high levels of risk aversion and house value it is optimal for a homeowner not to hold stocks. The value -1 for mortgage means that the house is fully mortgaged, i.e. the amount of mortgage debt equals house value. These results are in line with the results obtained by Flavin and Yamashita (2002) using U.S. data.

[12] Of course in reality, money is kept in bank accounts due to liquidity and possibly buffer-stock considerations.

Table 3. Optimal portfolio shares with different values of *h*.

House value-to-net wealth ratio	Assets	Degree of risk aversion				
		A = 1	A = 2	A = 4	A = 8	A = 10
h = 2.295	Bank account	0	0	0	0	0
	Bonds	0	0.5088	0.8217	0.9782	1
	Stocks	1	0.4912	0.1783	0.0218	0
	Mortgage	-1	-1	-1	-1	-1
h = 1.516	Bank account	0	0	0	0	0
	Bonds	0	0.4432	0.7561	0.9126	0.9439
	Stocks	1	0.5568	0.2439	0.0874	0.0561
	Mortgage	-1	-1	-1	-1	-1
h = 1.016	Bank account	0	0	0	0	0
	Bonds	0	0.4011	0.7140	0.8705	0.9018
	Stocks	1	0.5989	0.2860	0.1295	0.0982
	Mortgage	-1	-1	-1	-1	-1
h = 0.871	Bank account	0	0	0	0	0
	Bonds	0	0.3889	0.7018	0.8583	0.8896
	Stocks	1	0.6111	0.2982	0.1417	0.1104
	Mortgage	-1	-1	-1	-1	-1
h = 0.716	Bank account	0	0	0	0	0
	Bonds	0	0.3758	0.6888	0.8453	0.8766
	Stocks	1	0.6242	0.3112	0.1547	0.1234
	Mortgage	-1	-1	-1	-1	-1
h = 0.789	Bank account	0	0	0	0	0
	Bonds	0	0.3820	0.6949	0.8514	0.8827
	Stocks	1	0.6180	0.3051	0.1486	0.1173
	Mortgage	-1	-1	-1	-1	-1

In Table 3 the decreasing investment into stock markets is driven by the household's desire to hedge against house price risk. However, if there are entry or participation costs to stock markets housing investment may, in effect, crowd-out investment in stocks. In other words, if the house takes a sufficiently large share of overall wealth, it may be optimal for the household not to participate in the stock market, simply because the gain from doing so does not exceed the costs. Empirical evidence suggests that surprisingly small participation costs are sufficient to deter households from participating in the stock market.[13] We will return to this in the econometric part. Furthermore, for homeowners who are expecting to move up the housing ladder in the future, it may optimal to accumulate housing wealth because it works as an insurance against house price risk. This is true especially if the household is expecting to move within the same housing market where house prices are highly correlated. This aspect is

[13]Vissing-Jorgenson (2002) finds that a mere cost of 50 dollars a year (in 2000 prices) was enough to explain the nonparticipation of half of the nonparticipants in the U.S. in 1994. 260 dollars was enough to explain the behavior of 75 percent of nonparticipants. This reflects the fact that nonparticipants had very little financial wealth to invest in the first place.

emphasized by Sinai and Souleles (2005). Thus, it may not be optimal for a young homeowner to invest in the stock market even if house price and stock market risks are un- or negatively correlated.

3 Econometric analysis

3.1 Data description

In the econometric analyses we use data from the 1998 Wealth Survey conducted by Statistics Finland. Along with portfolio information, the Wealth Survey includes information on various household characteristics such as socio-economic status, demographics, income, taxes, housing and wealth. Part of the information in the survey is collected from various administrative registers. The amounts of various assets are collected through interviews. The sample is a stratified sample drawn from all private households in Finland where the strata are created according to socio-economic status and income. For practical reasons, entrepreneurs and high-income households are assigned a higher inclusion probability to the final sample. The selected households are given sampling weights so that the sample can be made representative of the whole population. The weights are the inverses of inclusion probabilities to the sample and are included in the data sets. We start the empirical analysis by reporting some descriptive statistics. Table 4 presents the percentage of households owning particular assets and liabilities, and the asset shares of total wealth classified by household net wealth and age. All the results, including the construction of the percentiles, are weighted using the sampling weights.

Table 4. Asset ownership by wealth quartiles and age in Finland, 1998.

	Net wealth quartile					
	All	**I**	**II**	**III**	**IV**	**top 5 %**
	Percentage holding the asset					
Listed stocks	14.9	2.6	9.8	11.5	35.7	56.6
Mutual funds	3.4	1.6	0.9	1.8	9.3	16.8
Bonds	2.6	0.6	1.1	1.4	7.0	12.1
Owner-occupied dwelling	63.7	4.4	56.0	95.2	99.3	98.6
Mortgage	28.3	8.6	35.1	38.5	31.1	28.5
	Percentage of total financial assets					
Listed stocks	19.5	2.4	8.1	5.0	24.2	33.9
Mutual funds	2.9	0.4	0.8	1.4	4.2	5.0
Bonds	2.6	1.3	0.4	0.7	3.3	2.8
	Percentage of total gross assets					
Owner-occupied dwelling	59.2	42.4	66.0	73.3	53.0	42.5
Mortgage	10.0	82.3	31.0	11.9	4.2	2.6
	Average holdings					
Average total net wealth, €	86 865	1 292	28 062	83 059	239 473	501 749
Average stockholding, €	17 298	1 961	4 637	4 471	28 801	79 473
Average house value, €	92 166	45 540	52 004	73 964	134 395	223 112
Average mortgage, €	34 873	45 285	38 990	29 772	33 637	47 690
	Age group					
	Under 25	**25 - 34**	**35 - 44**	**45 - 54**	**55 - 64**	**Over 64**
	Percentage holding the asset					
Listed stocks	10.6	11.6	14.9	19.9	18.0	12.1
Mutual funds	2.4	3.6	3.0	4.1	4.2	2.9
Bonds	1.5	1.7	2.3	1.8	3.9	3.7
Owner-occupied dwelling	11.3	39.4	66.5	77.6	81.9	72.6
Mortgage	10.7	36.2	49.3	37.5	19.3	5.2
	Percentage of total financial assets					
Listed stocks	8.8	18.4	17.3	18.5	21.7	21.5
Mutual funds	3.1	1.0	3.6	2.6	6.9	1.8
Bonds	2.6	0.4	2.7	3.3	2.3	2.9
	Percentage of total gross assets					
Owner-occupied dwelling	46.3	61.3	66.8	58.8	53.1	57.9
Mortgage	25.5	28.1	20.0	7.6	3.2	0.6
	Average holdings					
Average total net wealth, €	15 363	51 260	90 387	123 419	141 556	104 261
Average stockholding, €	4 254	10 662	13 857	16 071	25 238	22 075
Average house value, €	68 876	88 834	102 982	96 333	91 734	81 428
Average mortgage, €	39 894	44 381	41 586	25 838	23 148	12 392

Notes: House refers to the households primary dwelling. Average holdings are calculated conditional on ownership. Sampling weigths are used in the calculations.
Source: Author's calculations from the 1998 Wealth Survey.

About 15 percent of Finnish households have direct stock investments. Households' participation in the stock market (both directly and trough mutual funds) clearly increases with household wealth level. The same is true for bond ownership indicating that wealthier households have more complete portfolios. Similar pattern is evident in the share of financial

wealth invested in stocks. Furthermore, households in the top half of the wealth distribution are almost exclusively homeowners. Interestingly, wealthy households also hold significant amounts of mortgage debt. This seems to indicate that mortgage debt is used for portfolio balancing purposes. In other words, financially sophisticated households understand that paying down the mortgage may not be the ideal investment strategy, but instead it may be optimal to invest in stocks and enjoy arbitrage returns. This opportunity is enhanced by the deductibility of mortgage interest in taxation and is more attractive for wealthy households for whom a leveraged position in housing does not necessarily induce a highly risky position.

Stock ownership follows a hump-shaped age pattern peaking after the age of 45 and dropping again after retirement. However, once a household owns stocks there is no clear age pattern in the share of financial wealth invested in stocks. Similar, although stronger, age pattern is evident with homeownership peaking a little later than stock ownership. The figures in Table 4 also give some indication that the age pattern of housing and mortgage choices does not exclusively coincide with the age pattern of stockholding the way the simulation model predicts. Thus, either age has a direct effect on stockholding or age is correlated with something that is not accounted for in these simple calculations.[14]

3.2 Previous studies

Next we investigate whether the observed pattern of optimal portfolios depicted in Table 3 actually holds among Finnish households. We review first the main empirical literature on this issue. Table 5 summarizes the most relevant studies regarding our undertaking, highlighting the most important econometric problems that arise in this setting. The main problem is the possible endogeneity of the key explanatory variables. Thus, instrumental variable techniques are needed. The second problem involves sample selection issues and/or censoring because most households hold zero amounts of stocks. These problems arise, for example, if stock market participation involves entry costs that prohibit some households from participating. Thus, we only observe positive holdings for households whose optimal investment is higher than the entry threshold.

[14] See Jagannathan and Kocherlakota (1996) for a lucid presentation on how age can affect household stockholdings.

All but one of the papers listed in Table 5 use U.S. data.[15] The papers most similar to ours are Fratantoni (1998), Yamashita (2003), Kullman and Siegel (2004), and Yao and Zhang (2005). Fratantoni (1998) investigates how homeownership and especially the committed expenditures related to it, namely mortgage interest and repayment, affect households' investment in risky assets. Fratantoni (1998) argues that besides the house price risk a home-owning household is exposed to a risk related to committed long term housing-related expenditures, such as mortgage expenses. This is because a home-owning household with a mortgage debt commits itself to making payments out of its uncertain labor income stream for an extended period of time. The failure to meet these payments may cause high costs in form of moving, for example. Fratantoni (1998) finds empirical evidence using U.S. data from the 1989 Survey of Consumer Finances (SCF) that households with a high mortgage expenses-to-income ratio tend to hold a smaller share of their financial wealth in the form of risky assets. Yamashita (2003) also uses the 1989 cross-section of the SCF and finds evidence that house value-to-net wealth ratio (h in Section 3) has a negative effect on the share of risky assets of all financial assets after controlling for income, age, family size, education, and a proxy for risk aversion. However, Yamashita (2003) does not control for net wealth level, so the results are difficult to interpret.[16]

[15] The reader can find empirical studies on stockholding in general in a variety of European countries in Guiso et al. (2003).

[16] By not directly including net wealth level Yamashita (2003) implicitly assumes that housing wealth and net wealth have opposite effects on stockholding. Since it is a well-established empirical regularity that wealthier households hold more stocks, Yamashita's negative sign on the housing variable may be driven by this.

Table 5. Summary of previous studies.

Paper	Dependent variables	Housing related RHS variables	Wealth variable controlled	Data set and type	Model type	Instruments for housing variables
Fratantoni (1998)	*risky assets / financial wealth, stocks / financial wealth*	*total mortgage payment / income, primary mortgage payment / income, rent / income, predicted homeownership status*	*total net wealth, total financial wealth*	*Survey of Consumer Finances (US), 1989*	*Heckman sample selection*	*number of credit cards (used as an instrument for mortgage payments)*
Heaton and Lucas (2000b)	*stocks / liquid wealth, stocks / financial wealth, stocks / total net wealth, amount of stocks ($)*	*house value / net wealth, mortgage / net wealth, house value, mortgage balance*	*total financial wealth*	*Survey of Consumer Finances (US), 1992; Panel of Individual Tax Return Data (US), 1979–1990, panel*	*linear regression conditional on participation*	*none*
Hochguertel and van Soest (2001)	*housing wealth, financial wealth, gross and net*	*none*	*none*	*Ducth collective Bank Study, 1988*	*cencored bivariate regression*	*none*
Yamashita (2003)	*stocks / financial wealth*	*house value / net wealth, mortgage payments / income*	*none*	*Survey of Consumer Finances (US), 1989*	*Heckman sample selection*	*age, family size, home tenure in years, housing return during tenure*
Kullman and Siegel (2004)	*participation, stocks / financial wealth*	*house value / net wealth, mortgage / net wealth, other real estate / net wealth*	*total net wealth*	*Panel Study of Income Dynamics (US), 1984–1999, panel*	*dynamic probit, sample selection with panel data*	*in first difference models past levels of RHS are used as instruments*
Yao and Zhang (2005)	*participation, stocks / financial wealth, stocks / total net wealth*	*house value / net wealth, mortgage / net wealth*	*total net wealth*	*Panel Study of Income Dynamics (US), 1984–2001, panel*	*conditional logit, sample selection with panel data*	*none*
Chetty and Szeidl (2005)	*amount of stocks ($), stocks / total net wealth*	*home tenure (years), regional house price variation*	*total net wealth, spline*	*Survey of Income and Survey Participation (US), 1990–1996, panel*	*linear 2SLS, no sample selection correction*	*age at first marriage, age at first marriage termination, remarriage*
Shum and Faig (2006)	*participation, stocks / financial wealth*	*house value / net wealth, investment real estate / net wealth*	*total financial wealth*	*Survey of Consumer Finances (US), 1992–2001, repeated cross-sections*	*probit, tobit, linear regression conditional on participation*	*none*

Yao and Zhang (2005) use the Panel Study of Income Dynamics (PSID) and find that a higher house-value-to-net wealth ratio is associated with lower participation in financial markets and with a lower wealth share of stocks. They also use mortgage debt-to-net wealth ratio as an explanatory variable and find that it has a positive effect on the demand for risky assets. Kullman and Siegel (2004) also use the PSID data and find that homeowners are more likely to participate in the stock market than renters. Among homeowners, higher levels of housing investment decreases the share of financial assets invested in stocks, whereas again higher mortgage holdings relative to net wealth increase the share. Kullman and Siegel also find that controlling for unobserved, time-invariant, household heterogeneity significantly increases the negative effect of house value-to-net wealth ratio.

Heaton and Lucas (2000) concentrate on entrepreneurial background risk but also control for real estate investments. They find that households with a large share of their wealth invested in real estate tend to hold smaller shares of their financial wealth in stocks. Chetty and Szeidl (2005) test a prediction from a theoretical model by Grossman and Laroque (1990). The Grossman and Laroque model predicts that when adjusting the level of an illiquid durable consumption good is costly, households are more risk averse just after the purchase of a durable. Chetty and Szeidl test this prediction by regressing the amount of stocks (in dollars) held by a homeowner household to home tenure length. Because home tenure may be endogenously determined they instrument it using marital shocks as instruments.[17] They find that homeowners' stock holding increases with longer tenure. However, as home tenure increases the portfolio share of housing usually decreases when households accumulate more financial wealth. Thus, one would expect a high negative correlation between the length of housing tenure and house value-to-net wealth ratio which was also suggested by the age-pattern in Table 1.

Shum and Faig (2006) study what factors explain the stock market participation decision and the share of stocks of household financial wealth. They control for housing investment using two variables. The first is the value of a household's primary residence relative to total net wealth, and the other, the value of investment real estate relative to total net wealth. Interestingly, the housing variables are statistically insignificant both in the extensive and

[17] More precisely, they use age at first marriage, age at first marriage termination and an indicator variable for remarriage as their instruments. In our opinion, this is by far the most credible instrumental variables approach used in the papers cited here.

intensive margins in all of their model specifications. Shum and Faig do not use instrumental variables techniques. The SCF data sets that they use also includes information on the saving motives of households. Using this information Shum and Faig construct dummy variables that indicate whether a particular saving motive is in the top three of most important motives. Saving for the purpose of investing in own home had a negative and statistically significant effect on the share of financial wealth invested in stocks but not on participation.

The paper by Hochguertel and van Soest (2001) differs considerably from the other papers in Table 5. Although they do not explicitly model household investment in risky assets as a function of housing choices, they do find some interesting patterns. Hochguertel and van Soest are more concerned with the spillover effects that housing investment may have on the demand for financial assets and vice versa. They find that demand for financial wealth is systematically different for renters and homeowners among Dutch households. Furthermore, they find evidence that investing in financial wealth involves a positive threshold which has to be overcome before positive financial asset holdings are possible. Moreover, this threshold is magnified by the level of housing investment. This finding is in line with the assumption of entry and participation costs and that housing investment crowds out financial investment.

3.3 Estimation results

We follow the basic guidelines from previous econometric research on household portfolio choice and model both the participation decision (the extensive margin) and the share of financial assets households hold in stocks (the intensive margin). We concentrate on homeowners and discard the possible sample selection problems associated with dropping renter households from the sample. The variable of interest in the numerical simulation model was house value-to-net wealth ratio. However, in the econometric models we will use the levels of house value and mortgage debt as our key explanatory variables because a major multicollinearity problem was found when we used these variables divided by net wealth.[18] This choice of variables should not have a major effect on the results since we are directly controlling for net wealth. The house value variable is estimated by the homeowner. This, of course, is a biased estimate of the true market value of the house. However, this variable is

[18] The correlation coefficient for these variables in the sample of homeowners was 0.96. The correlation for the level variables was only 0.26.

exactly what we are interested in because the portfolio choices of homeowners are based on their own evaluation of their situation, including the value of their house.[19]

We made some further restrictions on the sample of households we are studying. First, since we are interested in portfolio choice we include only households who have sufficient funds to form a reasonable portfolio. We exclude households with financial wealth smaller than €1,000. We also exclude households with a negative overall net wealth and annual income smaller than €5,000. Furthermore, we eliminate outliers by deleting observations with a house value-to-net wealth ratio greater than 20,[20] and mortgage expenses to income ratio greater than 1. This leaves us with a total sample size of 2 443 homeowners.

Some comments on the explanatory variables are in order. Important determinants of portfolio choice are missing from our data, namely proxies for the degree of risk aversion, labor income uncertainty and credit constraints. Since these omitted variables are likely to be correlated with households' housing choices, our key explanatory variables are possibly endogenous. We are forced to assume that these differences can be captured by the observable characteristics of the households that are included in the model or that we can recover consistent estimates trough instrumental variable techniques. However, since exogeneity of house value was not rejected in any of our instrumental variable models we present the estimation frameworks and results for these models in Appendix 2. Income uncertainty is proxied with occupation category dummies. Education variables should capture differences in human capital and possibly in the level of financial sophistication. Urbanization rate dummies are included to capture differences in access to financial services, opportunities for social interaction, and knowledge spill-over associated with urban environments.[21]

The results of probit models for participation are presented in Table 6. We report marginal effects calculated at the sample means of the other covariates. The results indicate that overall

[19] Of course, if homeowners who have high valuations of what their house is worth also hold more positive expectations on how well the stock market performs, the house value may be an endogenous variable. This may seem far fetched. We come back to endogeneity shortly.
[20] This figure corresponds to a 95 percent mortgage loan to house value ratio. Usually banks offering mortgages in Finland require that the loan-to-value ratio does not exceed 80 or 85 percent when the house is bought. Of course, due to house price fluctuations after purchase a loan-to-value ratio exceeding 1 is possible if house prices deflate sufficiently.
[21] Hong at al. (2004) find evidence that social interactions play a role in stock market participation among U.S. households.

net wealth and education are important determinants of stock market participation. On the other hand, current income (labor and entrepreneur income) has no effect. Interestingly, age has no effect on stock market participation when all homeowners are included in the model.

We add the housing variables of interest in steps. First, we include only house value. The results indicate that at a given level of net wealth, higher house value is associated with a lower probability of stockholding. It is important to understand what this result means. Since we are controlling for net wealth an increase in house value must be accompanied by a euro-to-euro increase in mortgage debt, a decrease in financial wealth or a combination of the two that holds net wealth fixed.[22] Next we include house value and also control for the size of the mortgage. In this case, we are comparing households who are similar in all other ways except in the composition of their financial and housing wealth. Thus, a higher house value automatically means a lower level of financial wealth because net wealth and mortgage debt are fixed. With this in mind the results tell us that increasing house value at a given level of net wealth and mortgage debt decreases the probability of stockholding. This result can be interpreted in two ways. First, households may be hedging against house price risk, a result that is in line with Flavin and Yamashita (2002) story and our simulation results. Second, since higher house value means lower financial wealth, high house value may simply indicate that a household's financial wealth is lower than the costs of participating.

The positive effect (although not statistically significant) of mortgage debt on stockholding seems surprising. However, holding net wealth and house value fixed means that a household with a higher mortgage has also more wealth in liquid financial form. It is tempting to interpret this so that households are using mortgage debt as means of portfolio diversification, not just for obtaining a desired level of housing services. The descriptive statistics in Table 4 also hinted this possibility. However, these speculations should be taken cautiously because the marginal effect is not statistically significant.

[22] We assume that households do not use consumer debt for investment purposes.

Table 6. Probit models for stock market participation.

	All homeowners		All homeowners		Mortgage > 0		Mortgage = 0	
	Marginal effect	**Std. error**	**Marginal effect**	**Std. error**	**Marginal effect**	**Std. error**	**Marginal effect**	**Std. error**
income / 1000	0.002	0.0014	0.002	0.0014	-0.001	0.004	0.001	0.002
(income / 1000)^2	-6.8E-06	8.7E-06	-6.5E-06	8.7E-06	3.1E-05	3.9E-05	-5.4E-06	9.6E-06
net wealth / 1000	0.002**	0.0002	0.002**	0.0002	0.002**	0.0003	0.002**	0.0002
(net wealth / 1000)^2	-5.5E-07**	9.3E-08	-5.5E-07**	9.3E-08	-1.0E-06**	3.0E-07	-5.7E-07**	1.1E-07
age 25–34 (ref. < 25)	-0.010	0.090	-0.009	0.091	-0.090	0.091	0.287	0.273
age 35–44	-0.086	0.079	-0.084	0.080	-0.123	0.096	0.023	0.210
age 45–54	-0.091	0.079	-0.087	0.080	-0.172*	0.084	0.097	0.219
age 55–64	-0.114	0.074	-0.110	0.075	-0.175**	0.066	0.067	0.215
age 65–	-0.086	0.085	-0.081	0.087	-0.112	0.106	0.120	0.214
number of adults	-0.023	0.018	-0.022	0.018	-0.039	0.030	-0.013	0.023
number of children	-0.016	0.011	-0.016	0.011	-0.018	0.014	-0.002	0.020
female household head	-0.049**	0.020	-0.049*	0.020	-0.096**	0.030	-0.015	0.027
education, hh's head[a]								
education = 1	0.038	0.029	0.037	0.029	0.099*	0.050	-0.015	0.036
education = 2	0.114**	0.030	0.113**	0.030	0.139**	0.049	0.093*	0.041
education = 3	0.229**	0.049	0.229**	0.049	0.220**	0.071	0.247**	0.071
education, others								
education = 1	-0.029	0.032	-0.028	0.032	-0.083*	0.042	0.030	0.049
education = 2	0.074	0.047	0.075	0.047	0.017	0.057	0.168*	0.081
education = 3	0.052	0.074	0.051	0.074	0.086	0.097	-0.006	0.117
entrepreneur[b]	-0.018	0.036	-0.018	0.036	-0.065	0.046	0.013	0.058
executive	0.061	0.045	0.059	0.045	0.013	0.049	0.175	0.095
farmer	0.116	0.059	0.119	0.059	0.136	0.112	0.101	0.071
retired	-0.020	0.038	-0.020	0.038	0.144	0.094	-0.055	0.046
long-term unemployed	0.110	0.078	0.111	0.078	0.206	0.149	0.096	0.095
Inherited fin. wealth[c]	0.055*	0.026	0.055*	0.026	0.028	0.036	0.069*	0.037
semi-urban[d]	-0.050*	0.024	-0.051*	0.024	-0.110**	0.032	-0.009	0.035
rural	-0.027	0.023	-0.027	0.023	-0.071*	0.035	0.006	0.032
house value / 1000	**-0.0008***	**0.0002**	**-0.0009****	**0.0002**	**-0.0010****	**0.0004**	**-0.0009****	**0.0003**
mortgage / 1000			**0.0003**	**0.0005**	**0.0001**	**0.0006**		
N (y = 1)	2 443 (775)		2 443 (775)		1 065 (316)		1 378 (459)	
Correctly predicted as 1	262 (34 %)		259 (33 %)		82 (26 %)		185 (40 %)	
Correctly predicted as 0	1 545 (93 %)		1 544 (93 %)		694 (93 %)		830 (90 %)	
Log-L	-1 196		-1 196		-537		-640	

*Notes: The dependent variable indicates participation in the stock market either directly or trough mutual funds. Sampling weights are used in the estimation. ** and * indicate statistical significance at 1and 5 percent level, respectively.*

[a] *Dummy variables for education. Reference group is comprehensive school only. Education of other members takes a value of one if there are two or more persons with the particular degree in the household. 1 = high school or vocational school, 2 = higher vocational, 3 = university degree.*

[b] *Occupation type dummies, reference group is employees.*

[c] *Dummy indicating that the household has inherited financial assets in the last five years.*

[d] *Urbanisation rate dummy variables, reference group is urban areas.*

To further investigate the effect of mortgage debt, we divide the sample of homeowners into those who have a mortgage and to those who do not. This should give clearer evidence whether it is the leveraged position in owner-occupied housing that is driving the results. We

find no support for this claim. House value has a negative effect of similar magnitude on stockholding for both types of homeowners. This suggests that the result is driven primarily by the crowd-out effect which says that homeowners with valuable homes simply have fewer funds available for stock market investment than homeowners with less valuable homes and identical net wealth level. However, there are some other interesting differences between the sub-samples. First of all, age effect becomes significant for homeowners with a mortgage. They decrease their participation rate after reaching 45 and again increase it after retirement. Second, the urbanization rate dummies are much larger in absolute terms for the sample of mortgaged homeowners. This seems to indicate that the urbanization dummies also capture some effects of local housing market conditions that are not picked up by house value or mortgage debt, such as expectations on house price fluctuations which maybe more important for households with a mortgage debt.

The marginal effect of house value may seem small. However, the results are also economically meaningful as is illustrated in Figure 1 which plots the predicted probability of stockholding from the probit models as a function of house value. The horizontal axis is in thousands of euros Predictions are calculated from models where mortgage debt is not controlled so the rise in house value is accompanied by an increase in mortgage debt or a decrease in financial wealth. Other covariates are kept at their sample means. For example, a one standard deviation increase in house value from the sample mean (about €95 000) decreases the probability of stockholding by about 8 percentage points.

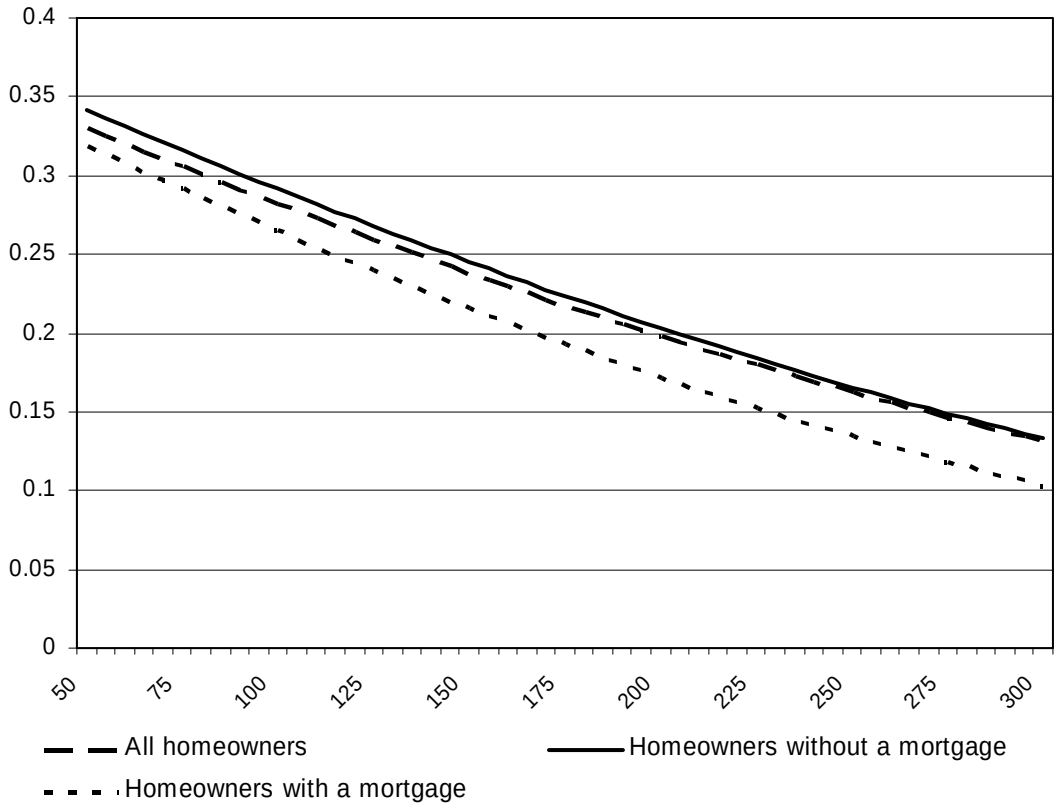

Figure 1. Predicted probability of stockholding as a function of house value.

The interpretation of the effect of total net wealth is interesting as well. When we control for house value and the size of mortgage debt, changes in net wealth are actually changes in financial wealth. In this case, the positive effect of net wealth can be interpreted in two ways. First, as financial wealth increases households are more likely to be able to overcome any fixed participation costs involved with entering the stock market. Second, this result suggests that households (or at least homeowners) become less risk averse as they gain more wealth.

A final note on the probit models is that we are not really doing a good job in explaining the participation of homeowners to stock markets. Although good and intuitive fit measures for discrete choice models do not exist, the percentage of homeowners we are able to correctly predict as stockholders gives us some indication of model performance.[23] According to this measure, we can explain the stock market participation decision by homeowners without a mortgage much better than the behavior of homeowners with a mortgage. This is not surprising because homeowners without a mortgage are typically older households probably with less overall uncertainty in their current situation.

[23] A homeowner is predicted as a stockholder if the predicted probability is 0.5 or higher.

Next we turn to explaining the share of liquid financial wealth invested in stocks or mutual funds.[24] As our first specification, we use the tobit model for censored dependent variables. However, the tobit model may be inflexible because it assumes that same factors affect the participation and the share of stocks in the portfolio the same way. Furthermore, it is unclear whether the zero holdings of stocks are corner solution outcomes where households would actually want to go short on stocks, or whether the households are unable to participate in the stock market because of, for example, entry costs. For these reasons we use, as our alternative approach, the sample selection framework. In this specification, the sample is divided into those that participate in the stock market and into those who do not. If participation is conditional on some threshold that the households have to overcome before investing in stocks is desirable, estimation using only the sample of positive holdings may lead to inconsistent estimates if overcoming the threshold and the amount invested are driven by same unobservable factors. To overcome this problem, we use the two step method proposed by Heckman (1979). We use the probit models in Table 6 to obtain an estimate of the hazard rate of participating (so-called inverse Mills' ratio), and use it as an additional explanatory variable in the level regression. Although, the model is identified even if the same variables are used in both parts, usually some exclusion restrictions are used to guarantee identification. We exclude the urbanization rate variables from the level equation. Thus, we assume that once a household has entered the stock market, differences in access to financial services, opportunities for social interaction, and knowledge spill-over should not affect the amount invested in stocks.

The results for the tobit models are presented in Table 7. We report the marginal effects for the observed dependent variable calculated at sample means of the covariates. The results for the tobit specification are very similar to the probit results. This gives us some assurance that the tobit specification is correct.[25] House value has a negative and statistically significant effect on the share of financial wealth invested in stocks. Again mortgage debt gets a positive sign but the effect is not statistically significant.

[24] The dependent variable is the euro amount invested in stocks and mutual funds divided by total financial wealth.

[25] An informal test for the appropriateness of the tobit specification is that the tobit coefficients should be close to the probit coefficients when they are divided by the standard deviation of the error terms in the tobit model.

Table 7. Tobit models for the share of risky assets in financial portfolios.

	All homeowners		All homeowners		Mortgage > 0		Mortgage = 0	
	Marginal effect	**Std. error**	**Marginal effect**	**Std. error**	**Marginal effect**	**Std. error**	**Marginal effect**	**Std. error**
income / 1000	0.0001	0.0005	0.0001	0.0005	-0.0001	0.001	0.0001	0.001
(income / 1000)^2	1.7E-07	2.7E-06	2.5E-07	2.7E-06	2.4E-06	9.6E-06	4.7E-07	2.9E-06
net wealth / 1000	0.001**	4.6E-05	0.001**	4.8E-05	0.001**	0.0001	0.001**	0.0001
(net wealth / 1000)^2	-2.0E-07**	3.0E-08	-2.0E-07**	3.0E-08	-2.6E-07**	8.8E-08	-2.0E-07**	3.3E-08
age 25–34 (ref. < 25)	-0.014	0.031	-0.014	0.031	-0.052	0.035	0.100	0.069
age 35–44	-0.049	0.031	-0.048	0.031	-0.067*	0.035	0.014	0.067
age 45–54	-0.044	0.030	-0.042	0.030	-0.077*	0.035	0.045	0.066
age 55–64	-0.053	0.031	-0.051	0.031	-0.088*	0.039	0.036	0.066
age 65–	-0.050	0.033	-0.048	0.033	-0.047	0.051	0.045	0.067
number of adults	-0.010	0.006	-0.010	0.006	-0.014	0.010	-0.008	0.007
number of children	-0.005	0.004	-0.005	0.004	-0.003	0.005	-0.002	0.006
female household head	-0.016*	0.007	-0.016*	0.007	-0.029**	0.011	-0.004	0.009
education, hh's head[a]								
education = 1	0.013	0.010	0.013	0.010	0.044**	0.017	-0.009	0.012
education = 2	0.048**	0.009	0.048**	0.009	0.057**	0.016	0.042**	0.012
education = 3	0.069**	0.013	0.069**	0.013	0.073**	0.020	0.065**	0.016
education, others								
education = 1	0.003	0.011	0.003	0.011	-0.021*	0.017	0.023	0.015
education = 2	0.016	0.014	0.016	0.014	0.000	0.019	0.034*	0.019
education = 3	0.017	0.020	0.017	0.020	0.020	0.026	0.015	0.031
entrepreneur[b]	-0.013	0.013	-0.013	0.013	-0.010	0.018	-0.022	0.018
executive	0.020	0.013	0.020	0.013	0.021	0.016	0.018	0.020
farmer	0.024	0.017	0.025	0.017	0.041	0.031	0.013	0.019
retired	-0.001	0.013	-0.001	0.013	0.056*	0.026	-0.017**	0.015
long-term unemployed	0.045*	0.022	0.046	0.022	0.055	0.040	0.046	0.025
Inherited fin. wealth[c]	0.019*	0.008	0.019*	0.008	0.011	0.012	0.022*	0.010
semi-urban[d]	-0.022*	0.009	-0.022*	0.009	-0.044**	0.013	-0.007	0.012
rural	-0.010	0.008	-0.010	0.008	-0.035**	0.014	0.007	0.010
house value / 1000	**-0.0002***	**0.0001**	**-0.0002****	**0.0001**	**-0.0004****	**0.0001**	**-0.0001**	**0.0001**
mortgage / 1000			**0.0001**	**0.0002**	**0.0001**	**0.0002**		
N	2 443		2 443		1 065		1 378	
censored (0, 1)	(1 668, 10)		(1 668, 10)		(749, 4)		(919, 6)	
sigma	0.492		0.492		0.489		0.476	
OLS R^2	0.16		0.16		0.13		0.22	
log-L	-1 138		-1 137		-503		-1 251	

*Notes: Dependent variable is the share of financial assets invested in stocks or mutual funds. Sampling weights are used in the estimation. ** and * indicate statistical significance at 1and 5 percent level, respectively.*

[a] *Dummy variables for education. Reference group is comprehensive school only. Education of other members takes a value of one if there are two or more persons with the particular degree in the household. 1 = high school or vocational school, 2 = higher vocational, 3 = university degree.*

[b] *Occupation type dummies, reference group is employees.*

[c] *Dummy indicating that the household has inherited financial assets in the last five years.*

[d] *Urbanisation rate dummy variables, reference group is urban areas.*

This time an interesting thing happens when we divide our sample in two. House value is no longer significant for the homeowners without a mortgage. This finding is in line with

numerical model since for these households house value cannot exceed net wealth ($h \leq 1$). It is somewhat puzzling why we don't see this already in the probit model. We interpret this as evidence in favor of the house price risk story. In other words, the result of the probit model is driven by crowding-out but we can see the house price risk at work when we look at the share of financial wealth invested in stocks.

Table 8 includes the results for sample selection models where the dependent variable is again the share of liquid financial wealth invested in stocks. The results are qualitatively similar to the probit and tobit results. House value gets the expected sign but is significant only when mortgage debt is controlled. For households with a mortgage, the effect of house value is marginally larger than it was for all homeowners but it is not statistically significant. In fact, all the coefficients in this model are highly imprecise. Interestingly, for homeowners without a mortgage the relationship between house value and stockholding is positive, but not significant. This is another indication that it is the leveraged position on owner-occupied housing that has an adverse effect on the share of liquid financial wealth invested in stocks. We attribute this to hedging against house price risk. Sample selection bias does not seem to be a major concern here. The sample selection correction variable is significant only in one of our specifications. Furthermore, simple OLS estimates (not reported here) were very similar to the ones obtained using the Heckman two-step method.

Table 8. Sample selection models for the share of risky assets in financial portfolios.

	All homeowners		All homeowners		Mortgage > 0		Mortgage = 0	
	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error
constant	0.138	0.244	0.156	0.239	0.659	0.216	-0.060	0.351
income / 1000	-0.004*	0.002	-0.004*	0.002	-0.004	0.003	-0.004*	0.002
(income / 1000)^2	1.5E-05	8.9E-06	1.6E-05	8.7E-06	6.1E-06	2.6E-05	1.8E-05*	8.6E-06
net wealth / 1000	0.001**	0.0004	0.001**	0.0004	0.0001	0.0006	0.001**	0.0004
(net wealth / 1000)^2	-5.4E-07**	1.9E-07	-5.2E-07**	1.9E-07	3.6E-07	4.0E-07	-4.8E-07**	1.8E-07
age 25–34 (ref. < 25)	-0.124	0.117	-0.120	0.115	-0.185	0.125	0.308	0.238
age 35–44	-0.272*	0.120	-0.262*	0.118	-0.232	0.131	0.057	0.226
age 45–54	-0.200	0.117	-0.182	0.116	-0.123	0.139	0.178	0.223
age 55–64	-0.229	0.123	-0.210	0.122	-0.130	0.160	0.171	0.222
age 65–	-0.272*	0.127	-0.252*	0.125	-0.056	0.184	0.142	0.228
number of adults	-0.066**	0.024	-0.064**	0.024	-0.040	0.040	-0.063**	0.025
number of children	-0.006	0.016	-0.006	0.016	0.033	0.020	-0.006	0.022
female household head	-0.028	0.030	-0.024	0.030	0.047	0.051	-0.012	0.031
education, hh's head[a]								
education = 1	0.042	0.040	0.038	0.039	0.057	0.069	-0.050	0.044
education = 2	0.185**	0.050	0.177**	0.049	0.083	0.075	0.138*	0.050
education = 3	0.235**	0.074	0.225**	0.073	0.077	0.092	0.170*	0.073
education, others								
education = 1	0.124**	0.045	0.128**	0.045	0.161*	0.069	0.153**	0.053
education = 2	0.034	0.051	0.033	0.050	-0.061	0.061	0.076*	0.065
education = 3	0.099	0.065	0.095	0.063	0.040	0.077	0.163	0.087
entrepreneur[b]	-0.107*	0.047	-0.105*	0.046	0.101	0.068	-0.225**	0.057
executive	0.071	0.045	0.070	0.044	0.111*	0.051	-0.021	0.063
farmer	-0.024	0.064	-0.023	0.062	-0.084	0.103	-0.046	0.067
retired	0.030	0.049	0.034	0.049	0.079	0.099	-0.046	0.056
long-term unemployed	0.165	0.090	0.162	0.088	-0.080	0.161	0.193*	0.095
Inherited fin. wealth[c]	0.052	0.033	0.048	0.032	0.009	0.040	0.055	0.038
house value / 1000	**-0.00049**	**0.00028**	**-0.00055***	**0.00028**	**-0.0006**	**0.0004**	**1.6E-06**	**0.0003**
mortgage / 1000			**0.0007**	**0.0006**	**0.0011**	**0.0007**		
Inverse mills ratio	0.278*	0.139	0.254	0.137	-0.093	0.146	0.173	0.137
N	775		775		316		459	
OLS R^2	0.15		0.15		0.17		0.22	

*Notes: Dependent variable is the share of financial assets invested in stocks or mutual funds. Sampling weights are used in the estimation. ** and * indicate statistical significance at 1and 5 percent level, respectively. Standard errors are calculated using the White method.*

[a] *Dummy variables for education. Reference group is comprehensive school only. Education of other members takes a value of one if there are two or more persons with the particular degree in the household. 1 = high school or vocational school, 2 = higher vocational, 3 = university degree.*

[b] *Occupation type dummies, reference group is employees.*

[c] *Dummy indicating that the household has inherited financial assets in the last five years.*

The empirical results differ considerably from the predictions drawn from the simulation model. The most striking difference is the low level of participation. Some of this can be explained by adding to the model entry and participation costs and buffer stock saving motives. According to our econometric results, owner-occupied housing does offer a partial explanation for low levels of stockholding. However, considerable amount of unexplained

heterogeneity remains. This is in line with previous empirical findings on household portfolio choice from a number of countries.[26] Perhaps a partial solution can be traced back to the most simple portfolio models where stock holding is driven solely by the degree of risk aversion and the expected return of stocks compared to a safe asset. A recent finding by Dominitz and Manski (2007) is very interesting in this respect. They report that nearly two-thirds of the respondents in the American 2004 Health and Retirement Study report no better than a 50-50 change of a positive nominal return from the stock market. This means that some households may not actually perceive that stocks offer a return premium. Moreover, Dominitz and Manski find large heterogeneity in stock market perceptions of the respondents.[27] Since a necessary condition for a risk-averse individual to invest in stocks (given that the return is uncertain) is that the expected return is higher than the safe return, Dominitz and Manski's finding may be valuable for future research.

Some clear patterns do emerge from our models in addition to housing. The levels of net wealth and education have a positive effect on both the discrete decision of participating in the stock market and the share of financial wealth invested in stocks. Furthermore, households living in urban areas are more likely to own stocks and households whose head (household head is defined as the person with the highest income in the household) was female were less likely to invest in stocks.

4 Conclusions

This paper studied the link between homeownership and household portfolio choice. The starting point for the paper was the finding by Flavin and Yamashita (2002) that given the historical returns on different assets in the U.S. homeowners with a leveraged position on housing should hedge against house price risk by holding fewer stocks. We replicated the simulation results using Finnish asset return data and showed that house price risk may indeed be an important reason for the low level of stock market investment by Finnish households. The main contribution of the paper was to put this prediction into a microeconometric test.

[26] See e.g. Guiso et al. (2003) and Curcuru et al. (2005).

[27] Dominitz and Manski (2007) also find that expectations of stock market performance varied systematically according respondent's characteristics. Women are more likely to have more negative attitude towards the possibility that stock markets will do well. They also report that expectations clearly varied with age, older people being more pessimistic. Furthermore, those respondents who were more pessimistic about stock market performance also were less likely to actually hold stocks.

Econometric results tell us that owner-occupied housing has two effects on household stockholding. First, housing capital simply pushes some homeowners away from the stock market altogether because these households do not see it worthwhile to enter the stock market given their low level of liquid financial wealth. Second, homeowners with a leveraged position on housing hedge against house price risk by holding less stocks than households who own their houses outright. What comes to other important factors behind stockholding, we find that wealthier and more educated households are clearly more prone to own stocks and also invest a larger share of their liquid financial wealth into stocks. However, considerable amount of unexplained heterogeneity remains in households' stockholding behavior, both in participation and in the amounts invested.

Some open questions remain for future work concerning housing and financial portfolio choice. In a recent paper, Sinai and Souleles (2005) argue that owner-occupied housing should not be treated straightforwardly as a simple asset inducing a background risk for homeowners. Instead, the asset price risk depends on households expected tenure length and moving behavior. An interesting extension in this line of research would be to explicitly control for expected tenure length, and interact it with house value. One would also want to control for whether a homeowner is expected to move up or down the housing ladder. Unfortunately this cannot be done with the current data set and must be left for future work. In addition, an interesting future avenue would be to study how households adjust their financial portfolios just before and after the purchase of their first owner-occupied dwelling. However, this line of research probably requires the use of panel data.

Furthermore, two important institutional changes have occurred in Finland that should also be of interest for future research. Namely, new longer maturity mortgages have been introduced in Finland only recently. This should have a clear effect on the way households save during their life-cycle and on their expected moving frequency, both of which are closely connected to portfolio choice. In addition, mutual funds have become available more and more in recent years which may induce also lower wealth households to invest in stocks because trough mutual funds these households are better able to diversify their risk. Both of these recent developments should have a clear effect on household portfolios.

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Appendix 1. Calculating asset returns for the simulation model.

The return from owner-occupied housing consists of capital gains, the rental value of housing services minus the costs of ownership, maintenance and depreciation. We estimate the capital gain using a national-level, quality adjusted house price index produced by Statistics Finland.[1] An estimate of the gross rental value of housing services is obtained using the 1998 Wealth Survey the following way. Homeowners in the survey were asked an estimate of their current house value. Using these values we estimate a hedonic regression to obtain a value for a constant quality house.[2] From renter households the data includes the rents they paid during the survey year. Again we used a hedonic regression to obtain a monthly rent for a constant quality dwelling. The annual gross rental return was obtained by dividing the constant quality annual rent by house value. This gave us an estimate of 5.2 percent for the average annual gross rental return. We assume that this stayed constant during 1995–2005. From this gross measure we subtract depreciation and property taxes.[3] Unfortunately, there exits no measures of depreciation of physical housing stock in Finland, thus, we use a commonly used annual rate of 2 percent as our measure.[4] The municipal property tax is calculated as the annual national average weighted by municipal property values. The imputed rental income is not taxed in Finland. Also capital gains are tax-exempt if the owner or her family has used the house as their primary home for at least two consecutive years. We assume that this is the case and set the tax rate on capital gains from owner-occupied housing to zero.

Stock returns are based on a dividend adjusted stock index of the Helsinki Stock Exchange (previously HEX and now OMX Helsinki index). The stock returns are taxed with a proportional capital income tax rate which varied from 25 to 29 percent during the research period. Government bond return data is obtained from Datastream and includes bonds of all maturities. The return to bank accounts is obtained from the statistics services of Bank of Finland. We subtract the stamp tax which equals the capital income tax rate from interest and government bond returns. Mortgage interest is also obtained from the Bank of Finland and it

[1] This approach has its drawbacks because using a nationwide house price index understates the true level of uncertainty a homeowner faces by ignoring the idiosyncratic or house specific part of the risk. See e.g. Englund et al. (2002).
[2] The housing attributes in the hedonic models included house age and type, living area, building material, urbanization rate of the municipality and dummy variables for 77 NUTS 4 regions.
[3] We assume that households spend annually on maintenance an amount that keeps the house in constant condition. This way we don't have to separately account for maintenance costs and depreciation.
[4] See Le Blanc and Lagarenne (2004) among others.

equals the average rate on new mortgage contracts. Nominal mortgage interest is tax deductible according to a flat rate equal to the capital income tax rate. The cost of living index produced by Statistics Finland is used to convert the returns into real terms.

Appendix 2. Econometric models using instrumental variables.

In this Appendix, we present some further econometric results using instrumental variable techniques. Like we argued in the main text, the reason we are using instrumental variable techniques is due to omitted variables, such as risk aversion and credit constraints, not simultaneity. For example, if we think of stock- and homeownership as risky investments, omitting a measure of risk aversion from the models might lead to a correlation between house value and the error term, and to biased and inconsistent estimates. We concentrate on house value and omit mortgage from the models. Let y_1 indicate stockholding and y_2 is house value. An instrumental variable probit model can be defined as

$$y_{1i} = 1\left(\mathbf{z}_{1i}'\boldsymbol{\beta}_1 + \alpha y_2 + \varepsilon_{1i} > 0\right) \tag{A1}$$

$$y_{2i} = \mathbf{z}_i'\boldsymbol{\beta}_2 + \varepsilon_{2i}, \tag{A2}$$

where 1(.) is an indicator function taking the value 1 if the statement in the parenthesis is true and 0 otherwise. The vector **z** includes all exogenous variables including the ones in $\mathbf{z_1}$ with some elements (the instruments) that are not included in $\mathbf{z_1}$. The error terms are assumed to be independent of $\mathbf{z}_1$ and **z**, and to follow a bivariate normal distribution with mean zero and correlation ρ_ε. If $\rho_\varepsilon \neq 0$, y_2 is endogenous and the usual univariate probit estimation of (A1) leads to inconsistent estimates.[1] Similarly, an instrumental variables tobit model with censoring at 0 and 1 can be written as

$$y_{1i}^* = \mathbf{z}_{1i}'\boldsymbol{\beta}_1 + \alpha y_2 + u_{1i}, \tag{A3}$$

$$y_{1i} = \begin{cases} 0, & \text{if } \ y_i^* \leq 0 \\ y_{1i}^*, & \text{if } \ 0 < y_i^* < 1 \\ 1, & \text{if } \ y_i^* \geq 1, \end{cases} \tag{A4}$$

$$y_{2i} = \mathbf{z}_i'\boldsymbol{\beta}_2 + u_{2i}, \tag{A5}$$

where y_1^* is now a latent variable and y_1 its observed continuous counterpart. Again, the error terms are assumed to be independent of $\mathbf{z}_1$ and **z**, and to follow a bivariate normal distribution

[1] See Wooldridge (2002) pp. 477–478 for details.

with correlation ρ_u. Both the probit and tobit specifications can be extended to include multiple endogenous explanatory variables. The instrumental variable probit and tobit models were estimated using the ivprobit and ivtobit maximum likelihood procedures in Stata 9. The sample selection model was estimated using 2SLS with the inverse Mills' ratio (IMR) obtained from a probit model as an additional explanatory variable. This method produces consistent estimates as long as the first-step probit estimates used to construct the IMR are consistent.[2] This model is denoted as heckit in Table A1. Finally, we estimate a simple 2SLS model using only homeowners with positive stockholdings.

We need an instrument that is correlated with house value but is not correlated with the omitted variables in the error term. Obviously, regional housing supply conditions affect the housing choices of households, but they should not be correlated with the unobserved individual characteristics omitted from our models.[3] As our instrument for house value, we use the regional price of a constant quality house obtained using hedonic regression techniques.[4] The idea is that the regional house price level affects the level of the housing investment because of consumption demand. The results for the models are presented in Table A1.

The results are supportive of our conclusions in the main text. House value gets a negative sign in all the models and the effects are larger in absolute terms than in the main text. However, house value is not significant in any of the instrumented models. Furthermore, exogeneity of house value is not rejected in any of the specifications.[5] This gives us some assurance that the results in the main text are consistent. The validity of the test depends, of course, on the validity of the instrument. The instrument does have good explanatory power, a t-ratio of 11.1 in the whole sample of homeowners and 8.0 in the sample with positive stockholding.

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[2] Because exogeneity of house value was not rejected in the ivprobit model, the IMR is constructed using the standard probit model not the instrumental variable probit.

[3] Of course, this is true only to the extent that households are not endogenously selected into particular housing market regions.

[4] This model was used also in Appendix 1. The housing attributes in the hedonic models included house age and type, living area, building material, urbanization rate and dummy variables for 77 NUTS 4 regions. Due to small sample size, we assume that the marginal prices are equal across regions and allow the regional prices vary only through the intercept. Our instrument gets 77 different values.

[5] Exogeneity is tested in the probit and tobit models using a Wald test where the null hypothesis is that the correlation between the error terms is zero. The exogeneity test in the heckit and 2SLS models is the usual Hausman test.

Table A1. Instrumental variable models.

	Probit, IV		Tobit, IV		Heckit, IV		2SLS	
	m.e.	**SE**	**m.e.**	**SE**	**Coeff.**	**SE**	**Coeff.**	**SE**
constant					0.044	0.299	0.571	0.098
income / 1000	0.008	0.006	0.001	0.002	-0.003	0.002	-0.004**	0.002
(income / 1000)^2	-2.6E-05	3.0E-05	-1.5E-06	1.0E-05	1.4E-05*	6.4E-06	1.8E-05**	5.6E-06
net wealth / 1000	0.006**	0.001	0.002**	0.0005	0.002*	0.0007	0.001**	0.0002
(net wealth / 1000)^2	-1.8E-06**	0.0E+00	-8.1E-07**	0.0E+00	-6.2E-07**	2.3E-07	-2.0E-07**	6.8E-08
age 25–34 (ref. < 25)	-0.023	0.381	-0.052	0.183	-0.130	0.069	-0.129	0.081
age 35–44	-0.295	0.379	-0.201	0.180	-0.290**	0.083	-0.221**	0.080
age 45–54	-0.331	0.372	-0.194	0.179	-0.219**	0.082	-0.158*	0.079
age 55–64	-0.434	0.381	-0.241	0.182	-0.256**	0.098	-0.168*	0.083
age 65–	-0.321	0.406	-0.204	0.190	-0.295**	0.095	-0.234*	0.101
number of adults	-0.078	0.066	-0.040	0.028	-0.072**	0.024	-0.053*	0.024
number of children	-0.043	0.042	-0.016	0.018	-0.008	0.016	0.008	0.017
female household head	-0.155	0.084	-0.066	0.036	-0.035	0.032	0.000	0.031
education, hh's head[a]								
education = 1	0.121	0.116	0.061	0.051	0.049	0.038	0.023	0.046
education = 2	0.350**	0.110	0.193**	0.049	0.204**	0.064	0.116**	0.041
education = 3	0.653**	0.147	0.300**	0.060	0.268*	0.100	0.124**	0.048
education, others								
education = 1	-0.101	0.120	0.004	0.055	0.121**	0.042	0.141**	0.048
education = 2	0.219	0.157	0.072	0.061	0.042	0.045	-0.008	0.046
education = 3	0.174	0.209	0.071	0.073	0.106*	0.057	0.088	0.059
entrepreneur[b]	-0.047	0.135	-0.058	0.053	-0.109*	0.043	-0.098*	0.045
executive	0.182	0.143	0.075	0.056	0.076	0.041	0.044	0.045
farmer	0.347**	0.131	0.098	0.055	-0.016	0.054	-0.091	0.048
retired	-0.051	0.156	-0.018	0.067	0.033	0.045	0.053	0.062
long-term unemployed	0.335	0.241	0.188	0.119	0.190	0.107	0.111	0.118
Inherited fin. wealth[c]	0.162	0.093	0.073	0.039	0.057*	0.030	0.018	0.034
semi-urban[d]	-0.185*	0.093	-0.095*	0.041				
rural	-0.115	0.104	-0.056	0.046				
house value / 1000	**-0.0042**	**0.003**	**-0.0018**	**0.001**	**-0.0008**	**0.0007**	**-0.0006**	**0.0008**
Inverse mills ratio					0.348	0.206		
N	2 443		2 443		775		775	
Exogeneity test (Wald)	0.26 (0.610)		0.49 (0.483)		1.69 (0.999)		0.40 (1.000)	
1. stage t-test (p-value)	11.1 (0.000)		11.1 (0.000)		8.00 (0.000)		8.00 (0.000)	
Log L	-6 627 460		-6 580 039					

*Notes: Instrumental variable models. Sampling weights are used in the estimation. ** and * indicate statistical significance at 1and 5 percent level, respectively.*

[a] *Dummy variables for education. Reference group is comprehensive school only. Education of other members takes a value of one if there are two or more persons with the particular degree in the household. 1 = high school or vocational school, 2 = higher vocational, 3 = university degree.*

[b] *Occupation type dummies, reference group is employees.*

[c] *Dummy indicating that the household has inherited financial assets in the last five years.*

[d] *Urbanisation rate dummy variables, reference group is urban areas.*