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OWNER-OCCUPIED HOUSING AND DEMAND FOR RISKY FINANCIAL ASSETS: SOME FINNISH EVIDENCE*

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This paper studies the linkage between owner-occupied housing and portfolio choice. Using a theoretical simulation model with Finnish asset return data we find that a leveraged position in housing has a clear negative effect on the share of stocks in a mean-variance efficient portfolio. The second part of the paper studies how owner-occupied housing actually affects households' financial portfolios using Finnish household data. The main result indicates that the more valuable house a homeowner resides in, at a given level of net wealth, the less likely it is to own stocks. However, it seems that housing has only a small effect if any on the share of financial assets a household invests in stocks conditional on stockholding. (JEL: D14, D91, G11, R21)

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 must consider investment aspects when choosing their housing tenure mode, the quantity of housing services to consume, and the size of mortgage debt. In fact, housing is by far the largest individual component of households' wealth. Statistics Finland report that in 1998 housing constituted 66 percent of Finnish households' overall gross wealth. Further calculations from household level data (the 1998 Wealth Survey of Statistics Finland) reveal that it is common for a young Finnish homeowner to invest two to three times its entire net wealth into housing using mortgage financing, and even for middle-aged homeowners a house constitutes on average almost 100 percent of their net wealth. At the same time, only about 15 percent of Finnish households had stockholdings and the average share

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of financial wealth invested in stocks was only about 25 percent.

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. Theoretical literature on this issue began with Henderson and Ioannides (1983) who introduced a model where housing consumption motive introduces a lower bound for housing investment for homeowners. This simply 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. Brueckner (1997) connects the Henderson and Ioannides model into a mean-variance portfolio decision framework. He shows that when consumption demand for housing is equal or larger than investment demand, homeowners' investment portfolios are no longer necessarily efficient in a mean-variance sense. Homeowners could attain a larger expected return on their portfolios without increasing its variance by adjusting their housing investment. They are prevented from doing so, however, because their housing investment is constrained by consumption demand. That is, 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.

Flavin and Yamashita (2002) quantify these effects using numerical simulation. They show using historical asset return data in the U.S. 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. This is because a leveraged position in a volatile asset such as housing exposes households to a background risk that has an adverse effect on their desire to take additional risks in their financial portfolios.[1]

[1] *Yamashita (2003) and Yao and Zhang (2005) present microeconometric evidence which shows that investing in owner-occupied housing has a negative effect on the stockholdings of U.S. households.*

The above argumentation suggests that any empirical analysis of households' financial portfolio choices should take housing directly into account. This is particularly true in Finland where the promotion of homeownership has been and still is a central part of housing policy. Mainly this is manifested as lenient tax treatment of owner-occupied housing relative to rental housing. In Finland, imputed rental income and capital gains from owner-occupied housing are untaxed and mortgage interest is tax deductible. On the other hand, rental income and capital gains received by landlords are fully taxed. In addition to a general tax subsidy to all homeowners, the Finnish government promotes homeownership trough partial government guarantee of mortgage loans from private financial institutions and an interest subsidy scheme targeted at low and middle-income households. Not only do these schemes make homeownership the cheapest way to acquire housing services for a majority of Finnish households, but they also encourage young, relatively low-wealth households to hold portfolios consisting mainly of leveraged housing capital. Thus, housing consumption demand in the spirit of Henderson and Ioannides (1983) and Bruekcner (1997) may be a major factor driving the financial portfolio choices of Finnish households.

The purpose of this paper is twofold. First, we employ a simulation approach similar to Flavin and Yamashita (2002) to study how investing in owner-occupied housing affects a homeowner's optimal portfolio choice under current investment environment in Finland. The main contribution, though, is to study how homeownership actually affects households' stockholding behaviour using micro data of Finnish households. This paper is also the first rigorous empirical analysis of the determinants of Finnish household portfolios.

The findings of this study can be summarised as follows. Simulation results show that in the light of historical asset returns a leveraged position in housing has a clear negative effect on the share of stocks in a mean-variance efficient portfolio. This effect is amplified for more risk-averse households. Econometric results reveal that housing investment has an adverse effect on Finnish households' probability to hold stocks.

This result can be interpreted in two ways. First, at a given level of net wealth higher house value exposes households to higher house price risk possibly inducing them to mitigate their stockholding. On the other hand, higher house value at a given level of net wealth and mortgage debt automatically means a lower level of financial wealth for the household. So the result may also indicate that some households do not enter the stock market simply because they do not have funds to invest because almost their entire wealth consists of housing. Although the results hinted that the latter effect is more important, the relative importance of these two effects cannot be deduced explicitly from the data. The results concerning the amount invested in stocks conditional on participating are inconclusive. However, it seems that housing has only a small effect if any on the share of financial assets invested in stocks.

The rest of the paper is organised as follows. Section 2 presents the simulation results based on the model by Flavin and Yamashita (2002) where owner-occupied housing is introduced into a mean-variance portfolio framework. In section 3, econometric results using household level data are presented. Section 4 concludes.

2. *Housing in a mean-variance portfolio framework*

2.1. Theoretical model

In this section, we use the model 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 e.g. tax distortions and agency costs related to renting. A homeowner's total net wealth at time t is

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

where $\mathbf{X}_t$ is a $(1 \times n)$ 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 holdings. The constraints on financial asset holdings are

$$(2) \quad -P_t H_t \le X_{n,t} \le 0,$$

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

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 $R_{H,t} = \mu_{H,t} + \varepsilon_{H,t}$, with $E[R_{i,t}] = \mu_i$ and $E[R_{H,t}] = \mu_H$. The covariance matrix of the returns is given by $\Omega = E[\boldsymbol{\varepsilon}_t \boldsymbol{\varepsilon}'_t]$, where $\boldsymbol{\varepsilon}_t \equiv (\varepsilon_{1,t},\ldots,\varepsilon_{n,t}, \varepsilon_{H,t})'$. The vector of expected returns on financial assets is defined as $\boldsymbol{\mu} \equiv (\boldsymbol{\mu}_1,\ldots,\boldsymbol{\mu}_n)'$. Now the household's optimisation problem can be expressed in terms of choosing asset shares $\mathbf{x}_t$:

$$(4) \quad \max_{\mathbf{x}_t} \left\{ \left(\mathbf{x}_t'\boldsymbol{\mu}\right) + h_t \mu_H - \frac{A}{2}\left[\mathbf{x}_t, h_t\right]' \boldsymbol{\Omega}\left[\mathbf{x}_t, h_t\right] \right\}$$

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

where $h_t \equiv P_t H_t / W_t$ and $\mathbf{x}_t \equiv \mathbf{X}_t / W_t$. The idea is that the household maximises expected utility of wealth with respect to holdings of financial assets conditional on the current value of h_t, which we refer to as the housing constraint. The motivation for this is that once a homeowner household commits itself to a particular level of housing consumption, the optimal adjustment interval may be very long because of adjustment costs. Arguably, the costs of adjusting the quantities of financial assets are smaller. The household's risk preferences are represented by

the Arrow-Pratt coefficient of relative risk aversion, A.

2.2 Optimal portfolios with Finnish asset return data

Following Flavin and Yamashita (2002) we estimate $\boldsymbol{\mu}_t$, and $\boldsymbol{\Omega}$ using historical data on Finnish asset and housing returns and solve the optimisation problem in (4) for different values of the housing constraint and the risk aversion parameter. We use 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, major institutional reforms took place during the early 1990's. Most notably, a major reform on capital income taxation 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 1999. 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.[2] 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 1 reports mean quarterly asset returns, standard deviations, and the correlation matrix for the asset returns. Details of the calculations can be found in the appendix. The real after-tax quarterly returns from different assets range from 0.21 percent from bank accounts to 2.15 percent from owner-occupied housing. Housing has been a very profitable investment in Finland during the period. Houses have even outperformed stocks: they offered a slightly higher return and a lower standard deviation. Furthermore, housing returns are negatively correlated with other assets except for stocks. Compared to other countries, housing has offered high returns in Finland.[3] Finnish asset returns 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.

Table 2 reports the simulated optimal portfolios for different levels of the housing constraint and risk aversion using the returns and the correlation matrix reported in Table 1. The values of the housing constraint correspond to age group averages in the parentheses calculated from the 1998 Wealth Survey of Statistics Finland. Table 2 is constructed so that the financial asset shares sum up to one and the value of –1 for mortgage means that the house is fully mortgaged. 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. 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 negatively on the housing constraint. At very high levels of risk aversion and housing constraint it is optimal for a homeowner not to hold stocks. The results are similar to the ones obtained by Flavin and Yamashita (2002).

In Table 2 the decreasing pattern of stock investment is driven by the household's desire to hedge against the increase in the risk of its portfolio induced by housing. If, however, 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

[2] *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.*

[3] *See Iacoviello and Ortalo-Magné (2003) for further discussion on country differences.*

Table 1. Mean quarterly returns and correlation matrix of asset returns, 1995–2005.

	Bank account	Bonds	Stocks	Mortgage	House
Return	0.0021	0.0106	0.0207	0.0083	0.0215
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 2. Optimal portfolio shares with different values of the housing constraint, *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
(18–30)	**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
(31–40)	**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
(41–50)	**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
(51–60)	**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
(61–70)	**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
(71 +)	**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

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.[4] 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 emphasised by Sinai and Souleles (2005).

3. Econometric analysis

3.1 Data and descriptive analysis

In the econometric analysis, we use data from the 1998 Wealth Survey of Statistics Finland. Along with portfolio information, the Wealth Survey includes information on various household characteristics such as socio-economic status, demographics, income, taxes, and housing. 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 which includes all in all 3893 households. The selected households are given sampling weights so that the sample can be made representative of the whole population. We start the empirical analysis by reporting some descriptive statistics. Table 3 presents the percentage of households owning particular assets and liabilities, and the asset shares of total wealth classified by household net wealth and age.

About 15 percent of Finnish households had direct stock investments in 1998. 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, these 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 financial 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 but stronger, age pattern is evident with homeownership which peaks a little later than stock ownership. The figures in Table 3 also give some indication that the age pattern of housing and mortgage choices does not entirely coincide with the age pattern of stockholding in 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.

In the econometric models, we concentrate on homeowners and discard the possible sample selection problems associated with dropping renter households from the sample. Since we are interested in portfolio choice, only households who have sufficient funds to form a reasonable portfolio are included in the analysis. We exclude households with financial wealth

[4] *Vissing-Jorgenson (2002) finds that a mere annual cost of 50 dollars (in 2000 prices) was enough to explain the nonparticipation of half of the nonparticipant households 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.*

Table 3. Asset ownership by net 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.

Table 4. Descriptive statistics for key variables in different sub-samples of homeowners.

	All	All, mortgage>0	All, mortgage=0	All, Stocks>0	Stocks>0, mortgage>0	Stocks>0, mortgage=0
N	2 437	1 064	1 373	774	315	459
Percentage holding stocks	0.26	0.27	0.26	1.00	1.00	1.00
	[0.005]	[0.016]	[0.014]	.	.	.
Share of fin. wealth in stocks	0.09	0.08	0.09	0.33	0.32	0.34
	[0.005]	[0.007]	[0.007]	[0.014]	[0.021]	[0.019]
income / 10 000	2.84	3.42	2.46	3.33	3.74	3.04
	[0.038]	[0.056]	[0.046]	[0.080]	[0.122]	[0.100]
net wealth / 10 000	14.1	11.9	15.5	21.0	16.7	24.0
	[0.310]	[0.397]	[0.444]	[0.824]	[1.076]	[1.151]
age	53.0	43.1	59.6	51.1	43.4	56.5
	[0.416]	[0.425]	[0.486]	[0.702]	[0.788]	[0.851]
number of adults	1.88	1.95	1.83	1.96	1.95	1.98
	[0.019]	[0.025]	[0.027]	[0.032]	[0.043]	[0.047]
number of children	0.58	1.05	0.27	0.59	0.95	0.34
	[0.024]	[0.045]	[0.021]	[0.039]	[0.071]	[0.037]
female household head	0.36	0.30	0.40	0.29	0.25	0.31
	[0.013]	[0.019]	[0.018]	[0.023]	[0.031]	[0.031]
University degree (%)	0.09	0.12	0.07	0.19	0.22	0.18
	[0.007]	[0.012]	[0.008]	[0.017]	[0.026]	[0.022]
house / 10 000	9.58	10.7	8.81	11.8	12.4	11.5
	[0.164]	[0.224]	[0.225]	[0.331]	[0.485]	[0.447]
mortgage / 10 000	1.36	3.39	.	1.36	3.31	.
	[0.059]	[0.102]	.	[0.101]	[0.169]	.
h	0.92	1.31	0.65	0.75	1.05	0.55
	[0.020]	[0.044]	[0.008]	[0.027]	[0.058]	[0.013]
m	0.25	0.63	.	0.18	0.44	.
	[0.019]	[0.043]	.	[0.025]	[0.057]	.

Notes: Mean values of key variables in different sub-samples. Stantdard errors are in the brackets. Sampling weights are used in the calculations. Variables h and m refer to house value-to-net wealth and mortgage-to-net wealth ratios, respectively. Source: Author's calculations from the 1998 Wealth Survey.

smaller than € 1000. This eliminates 397 households. We also exclude households with negative overall net wealth and annual income smaller than € 5000 which eliminates additional 54 households. Furthermore, we eliminate outliers by excluding observations with a house value-to-net wealth ratio greater than 20,[5] a mortgage expenses to annual disposable income ratio greater than 1 and a negative net housing wealth. These exclusions eliminate 25 households. Finally, we exclude households where the household head was a student. There were only 6 student households left after the initial trimming and none of them had stockholdings. This leaves us with a final sample size of 2437 homeowners. Table 4 presents descriptive statistics for key variables in various sub-samples that are used in the econometric models.

3.2 Econometric models and endogeneity of key variables

We follow the basic guidelines from previous econometric research on household portfolio

[5] *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.*

choice and model both the participation decision and the share of financial assets held in stocks. The variable of interest in the numerical simulation model was house value-to-net wealth ratio. However, in the econometric models the levels of house value and mortgage debt are used as key explanatory variables because a major multicollinearity problem was found when these variables are divided by net wealth.[6] 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 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.

There are reasons to be suspicious about the exogeneity of the key explanatory variables. For example, homeowners who have high valuations of what their house is worth may also hold more positive expectations on how well the stock market performs, and thus, are more willing to invest in stocks.[7] Even more worrying is that the Wealth Survey data set does not include a proxy variable for risk aversion, which is the main driver of household stockholding under expected utility theory. Since these omitted variables may also be correlated with households' housing choices, our key explanatory variables are possibly endogenous. Dealing with endogeneity in a binary choice model is somewhat difficult, especially when one of the possibly endogenous variables is a corner solution variable, which is the case here with mortgage debt. Roughly half of the homeowners in our sample are outright owners and have zero holdings of mortgage debt. Fortunately, there is a simple way to test exogeneity using a two-step procedure introduced by Rivers and Vuong (1988).[8] Consider a model

$$(5) \quad y_{1i} = 1\left(\mathbf{z}_{1i}'\boldsymbol{\beta}_1 + \alpha y_{2i} + \delta y_{3i} + \varepsilon_{1i} > 0\right),$$

$$(6) \quad y_{2i} = \mathbf{z}_i'\boldsymbol{\beta}_2 + \varepsilon_{2i},$$

$$(7) \quad y_{3i} = \mathbf{z}_i'\boldsymbol{\beta}_3 + \varepsilon_{3i},$$

where y_1 indicates stockholding and 1(.) is an indicator function taking the value 1 if the statement in the parenthesis is true and 0 otherwise. Equation (5) is the structural equation of interest and (6) and (7) are the reduced forms for house value and mortgage debt, denoted by y_2 and y_3, respectively. The vector $\mathbf{z}$ 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 $\mathbf{z}$. However, if the error term in the structural equation is correlated with y_2 and y_3, the usual univariate probit estimation of (5) leads to inconsistent estimates. The Rivers-Voung test procedure involves two steps. First, estimate the reduced form models in (6) and (7) using OLS to obtain the residuals for each model. Second, add these residuals as additional right-hand side variables in (5) and estimate the model as a univariate probit using maximum likelihood. A joint test on the significance of the coefficients of the residuals is a test for exogeneity.[9] The share of financial wealth invested in stocks or mutual funds is modelled using the sample selection framework. Using instrumental variables in a sample selection model is more straightforward because the second step can be estimated simply as a linear regression as proposed by Heckman (1979).

In order to perform exogeneity tests, we need instruments that are correlated with house value and mortgage debt but are not correlated with the omitted variables in the error term in (5). As an instrument for house value, we use a quality adjusted regional house price index obtained

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

[7] *Dominitz and Manski (2007) find evidence that U.S. households have heterogeneous expectations on stock returns, and that households with more positive expectations also hold more stocks.*

[8] *See Wooldridge (2002) pp. 474–478 for further details.*

[9] *The corner solution nature of mortgage debt does not invalidate the testing procedure because the distribution of the error term in (7) plays no role under the null hypothesis. If exogeneity of mortgage debt is rejected, however, the two-step procedure cannot be used to consistently estimate the marginal effects of interest in (5).*

from a hedonic regression.[10] Obviously, regional house prices affect housing choices of households, but regional house prices should not be correlated with the unobserved household characteristics. Of course, this is true only to the extent that particular types of households are not endogenously selected into particular housing market regions. It is not implausible that a household's location choice is correlated with, say, risk aversion. However, it is more plausible that risk aversion affects a household's location choice within a given labour market or urban area. In order to avoid this sorting problem, we use a broad regional division, i.e. NUTS 4, in constructing the house price index. The NUTS 4 level division corresponds quite nicely to labour market regions. To reiterate the motive for this instrument, it may be that households' location choice within a given labour market is partly driven by the same unobservable household characteristics as stockholding. However, we do not believe that households living in, for example, the Turku region are fundamentally different from the ones living in the Helsinki region after we control for observable household characteristics, such as income, wealth, age, education and occupation type.[11]

Three variables are used to instrument mortgage debt. The first is an indicator that the household has used a bequest to finance the purchase of its first own house. Receiving a bequest can be seen as an exogenous wealth shock and should not be correlated with unobservable household characteristics. The second instrument is an indicator that the household is a first-time homeowner, i.e. it currently serves its first mortgage. This makes the household eligible for a larger tax deduction for mortgage interest than other households.[12] The third instrument is the price difference between the purchase price of the household's current dwelling and the selling price of its previous dwelling. This difference is positive (negative) for households who moved to a more (less) valuable dwelling. If this difference is positive households are more likely to use a mortgage to finance their new house, and the larger the positive difference is the larger is the needed mortgage to bridge the gap.

A rich set of household characteristics is controlled in the econometric models. These include current income, net wealth, age, education level, household composition, and socio-economic position or occupation type. Urbanisation rate is controlled to capture differences in access to financial services, opportunities for social interaction, and knowledge spill-over associated with urban environments.[13] We also include a dummy indicating that the household has inherited financial assets within the last five years. The results for first stage instrument performance and exogeneity tests are presented in Table 5. The first four rows in Table 5 include the first stage partial F-statistics for the explanatory power of the instruments and the Rivers-Vuong test statistics for all homeowners and also for sub-samples with and without a mortgage which are used later in the econometric analysis.[14] The lower part of Table 5 includes

[10] *See the appendix for details.*

[11] *As an auxiliary informal test for the exogeneity of the house price index we estimated a stockholding model for renters who serve as a control group. The idea is that if the sorting story is credible we should probably observe that among renters as well. So we included the regional house price index along with all our controls directly into a probit regression explaining renter households' stockholding. The house price index had no explanatory power in the sub-sample of renters (a p-value of 0.423) suggesting that there is no direct channel through which regional house price level affects households portfolio choice, but instead the possible effect comes indirectly trough housing choices of homeowners.*

[12] *From 1993 onwards the mortgage interest deduction has been made from capital income according to a flat tax schedule. If a household's mortgage interest payments exceed capital income, which is the case for many young first-time buyers, the household is allowed to deduct the resulting tax deficit from its labour income tax liability in form of a tax credit. In this situation, the deduction rate is equal to the capital income tax rate except for first-time buyers. From 1993 to 1996 the capital income tax rate was 25 percent, and in 1997 and 1998 the tax rate was 28 percent. During this time the tax credit deduction rate for first-time buyers was 30 percent.*

[13] *Hong at al. (2004) find that social interactions play a role in stock market participation of U.S. households.*

[14] *Dividing the sample into homeowners with and without a mortgage also serves as an auxiliary test on the validity of the instruments. Households who own outright are likely to have lived in their homes longer, and thus, their location choice should not be as correlated with current house prices compared to homeowners with a mortgage who are likely to be more recent owners. The instruments perform well in both sub-samples.*

Table 5. Results for first stage instrument performance and exogeneity tests.

	All homeowners		Mortgage > 0		Mortgage = 0	
N	2 437		1 064		1 373	
1st stage tests:	house	mortgage	house	mortgage	house	mortgage
Partial F-test for instruments	110	74.6	59.1	12.6	81.4	
Rivers-Vuong test (p-value)	0.20 (0.904)		0.18 (0.916)		0.13 (0.714)	

Homeowners with stockholdings:

	Stocks>0, all		Stocks>0, mortgage>0		Stocks>0, mortgage=0	
N	774		315		459	
1st stage tests:	house	mortgage	house	mortgage	house	mortgage
Partial F-test for instruments	37.8	24.6	29.0	4.3	16.4	
Hausman (p-value)	0.74 (0.996)		1.87 (0.393)		0.87 (0.351)	

the first stage partial F-statistics and Hausman test statistics for exogeneity in the sub-sample of homeowners with stockholdings used in the second step of the sample selection model. The Hausman tests were implemented using an auxiliary regression approach.

High partial F-statistics in the first stage indicate that the instruments have good explanatory power. The only specification where there is some doubt about the explanatory power of the instruments is in the sub-sample of stockowners with positive holdings of mortgage debt. The problem there was instrumenting mortgage debt. In that case, we reduced the number of instruments and used only the difference between purchase and selling price. The other two instruments had no explanatory power in this sub-sample. The price difference variable was statistically significant at 5 percent level; however, the F-statistic is small indicating the possibility of a weak instrument. Interestingly, the test results indicate that exogeneity is clearly not rejected in any model specification.

3.3 Econometric results

We start the analysis with the discrete choice of stockholding. The results of probit models are presented in Table 6. Because exogeneity of key variables was not rejected in any specification and the difficulty of estimating a model that allows for endogeneity in this setting, the reported marginal effects are from usual univariate probit models. The marginal effects are calculated at the sample means of the other covariates.

In the first model in Table 6, house value gets the expected negative sign and is clearly statistically significant, whereas mortgage debt is not. Thus, a higher house value decreases the probability of stockholding. The result can be interpreted in two ways. First, households may be hedging against house price risk induced by a valuable house compared to net wealth, a result that would be in line with the simulation results in section 2. Second, since increasing house value at given net wealth and mortgage levels necessarily lowers financial wealth available for stock investment, a negative sign of house value may simply indicate that entry and participation costs become prohibitive. Moreover, households with low financial wealth may be reluctant to hold stocks because they cannot diversify their stock portfolios efficiently.

In order to further investigate the role of leverage, we divide the sample of homeowners into those who have a mortgage and to those who do not. For the latter group, house value-to-net wealth ratio (h) cannot exceed 1, and so the division should give clearer evidence whether a risky leveraged position in housing is driving the results. We find no support for this hypothesis. House value has a negative effect of similar magnitude on stockholding of both types of homeowners suggesting that the result is driven primarily by the crowd-out effect not by the risk

Table 6. Probit models for stock market participation.

	All homeowners		Mortgage > 0		Mortgage = 0	
	Marginal effect	**Std. error**	**Marginal effect**	**Std. error**	**Marginal effect**	**Std. error**
income / 10 000	0.017	0.015	-0.008	0.038	0.010	0.019
(income / 10 000)^2	-5.2E-04	8.8E-04	3.1E-03	3.9E-03	-4.0E-04	9.7E-04
net wealth / 10 000	0.016**	0.002	0.019**	0.003	0.017**	0.002
(net wealth / 10 000)^2	-5.5E-05**	9.4E-06	-9.6E-05**	3.0E-05	-5.8E-05**	1.1E-05
age 25–34 (ref. < 25)	-0.022	0.090	-0.097	0.089	0.237	0.286
age 35–44	-0.093	0.079	-0.127	0.095	-0.011	0.209
age 45–54	-0.097	0.080	-0.174*	0.083	0.055	0.224
age 55–64	-0.120	0.075	-0.179**	0.064	0.029	0.219
age 65–	-0.093	0.086	-0.114	0.104	0.081	0.223
education = 1[a]	0.037	0.029	0.102	0.051	-0.013	0.036
education = 2	0.105**	0.032	0.119*	0.050	0.096*	0.043
education = 3	0.207**	0.052	0.212**	0.077	0.215**	0.076
house value / 10 000	**-0.009****	**0.002**	**-0.010****	**0.004**	**-0.008****	**0.003**
mortgage / 10 000	**0.002**	**0.005**	**0.0004**	**0.006**		
N (y = 1)	2 437 (774)		1 064 (315)		1 373 (459)	
Correctly predicted as 1	258 (33 %)		81 (26 %)		191 (42 %)	
Correctly predicted as 0	1 537 (92 %)		694 (93 %)		823 (90 %)	
Log-L	-1 194		-535		-637	

*Notes: Results are from probit models where all explanatory variables are treated as exogenous. The dependent variable indicates participation in the stock market either directly or trough mutual funds. All the models include the following control variables: occupation type of household head (9 categories), urbanisation rate of municipality (3 categories), education level of other household members (3 categories), an indicator that the household has inhereted financial assets within the last five years, number of adults and children in the household, and whether the household head was female. Sampling weights are used in the estimation. ** and * indicate statistical significance at 1and 5 percent level, respectively.*

[a] Dummy variables for education level of household head. Reference group is comprehensive school only. 1 = high school or vocational school, 2 = higher vocational, 3 = university degree.

induced by leveraged position in housing. This means that homeowners with more valuable homes simply have fewer funds available for stock market investment than homeowners with less valuable homes and identical net wealth level.[15] The marginal effect of house value may seem small but the result is economically meaningful. For example, a one standard deviation increase in house value from the sample mean (about €95 000) decreases the probability of stockholding by about 6.5 percentage points.

The interpretation of the effect of total net wealth is interesting as well. When house value and the size of mortgage debt are controlled for, changes in net wealth are actually changes in financial wealth. Now, 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 participation costs involved with entering the stock market. Second, this result suggests that households become less risk averse as they gain more wealth. Unfortunately, it is impossible to substantiate the relative importance of these two effects from the data. A final note on the probit models is that according to prediction percentages we are not really doing a good job in explaining the participation of homeowners to stock markets.

[15] *To further test whether the results are different for the two sub-samples we implemented a likelihood ratio test that is an equivalent of the Chow-test. The test did not reject the null hypothesis of no difference between the two sub-samples, which again indicates that mortgage debt is not a major factor influencing the participation decision.*

Table 7. Sample selection models for the share of stocks in financial portfolios.

	OLS		2SLS		2SLS		
	Coeff.	**Std. error**	**Coeff.**	**Std. error**	**Coeff.**	**Std. error**	**VIF**
constant	0.186	0.246	0.307	0.187	0.542	0.086	
income / 10 000	-0.041*	0.017	-0.049*	0.024	-0.048**	0.013	6.938
(income / 10 000)^2	0.002*	0.001	0.002	0.002	0.002**	0.0005	4.693
net wealth / 10 000	0.013**	4.4E-03	0.008*	4.0E-03	0.007**	2.0E-03	57.80
(net wealth / 10 000)^2	-4.9E-05*	1.9E-05	-2.7E-05*	2.2E-05	-2.1E-05**	5.3E-06	23.72
age 25–34 (ref. < 25)	-0.110	0.114	0.049	5.7E-02	-0.107	0.069	11.41
age 35–44	-0.248*	0.117	-0.055	0.061	-0.201**	0.067	22.72
age 45–54	-0.170	0.115	0.032	0.058	-0.124	0.069	28.64
age 55–64	-0.192	0.121	0.034	0.065	-0.129	0.072	21.73
age 65–	-0.236	0.125	dropped		-0.192*	0.084	12.82
education = 1[a]	0.033	0.039	0.023	0.029	0.015	0.033	2.542
education = 2	0.173**	0.048	0.132**	0.036	0.121**	0.033	4.307
education = 3	0.209**	0.070	0.138**	0.052	0.125**	0.042	6.687
house value / 10 000	**-0.0053**	**0.0028**	**-0.0042**	**0.0066**	**-0.0049**	**0.0058**	3.586
mortgage / 10 000	**0.0071**	**0.0057**	**0.0139**	**0.0154**	**0.0096**	**0.0150**	1.418
Inverse mills' ratio	0.232	0.140	0.041	0.101			27.96
N	774		774		774		
OLS R^2	0.15		0.15		0.14		

*Notes: Dependent variable is the share of financial assets invested in stocks or mutual funds. All the models include the following control variables: occupation type of household head (9 categories), education level of other household members (3 categories), an indicator that the household has inhereted financial assets within the last five years, number of adults and children in the household, and whether the household head was female. In the second model, standard errors are estimated using a non-parametric bootstrap with 1000 replications because a generated regressor is included. One age group is dropped because it included so few observations that the resampling often resulted in a sample that did not include households in that age group. Sampling weights are used in the estimation. ** and * indicate statistical significance at 1and 5 percent level, respectively. The last column includes the variance inflation factors for the variables.*

[a] Dummy variables for education level of household head. Reference group is comprehensive school only. 1 = high school or vocational school, 2 = higher vocational, 3 = university degree.

Next we look at share of financial wealth invested in stocks or mutual funds. Estimation is carried out in two steps as proposed by Heckman (1979). Identification of the model requires an exclusion restriction, i.e. a variable or variables that affect the participation decision but not the share invested.[16] Prime candidates in this context are variables that affect the cost of participating, such as availability of financial services near a household's residence. To achieve identification, we exclude the urbanisation rate variables from the level equation. Urbanisation rate can be seen as a proxy for the availability of financial services, and thus, as a proxy for participation costs. 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 share of financial wealth invested in stocks.[17] Table 7 presents the results.

[16] *Technically the model is identified even if exactly the same variables are used in both steps. However, in that case identification relies on the normality assumption in the probit model and the second step is suspect to severe multicollinearity.*

[17] *We also estimated the models without exclusion restrictions and the results were almost identical. However, this may indicate that the exclusion restrictions are not valid in the sense that they do not explain participation particularly well and do not create much additional variation in the inverse Mills' ratio. An LR-test for joint significance of the urbanisation rate dummies in the probit model*

The first model is the usual sample selection model estimated using OLS, and the other two are estimated using 2SLS with and without the sample selection correction term.[18]

The results are qualitatively similar to the probit results when it comes to variables that are statistically significant in both steps. In the first model in Table 7, house value gets the expected negative sign but the estimate is not very precise. The p-value for the coefficient is 0.060. Clearly this effect cannot be due to entry or participation costs since here we are dealing with homeowners with stockholdings. This would indicate that for homeowners with stockholdings, higher house value translates into a more risky portfolio which they balance by lowering the amount of stockholding.[19] In the 2SLS models, the coefficient of house value is negative and of similar magnitude as in the OLS but standard errors more than double and the coefficients are clearly not statistically significant. Furthermore, even if the assumption of exogeneity is true, the effect of house value seems rather small; a €10 000 increase in house value reduces the share of stocks by merely 0.5 percentage points.

Net wealth has a statistically significant positive effect on the share of financial wealth invested in stocks. Now that entry costs can be ruled out, the positive effect of net wealth suggests that households become less risk averse as they gain more wealth. This would indicate that household preferences exhibit decreasing absolute risk aversion, a result that is often found in empirical portfolio research. However, it must be emphasised that the discussion concerning the results from the sample selection models should be taken cautiously because of possibly poor exclusion restrictions and impreciseness of the coefficients of key housing variables. Furthermore, high standard errors induced by multicollinearity may also be partially responsible for not rejecting exogeneity using the Hausman test. On the other hand, the results concerning net wealth and education level seem robust across specifications.

The fact that exogeneity of house value or mortgage debt was not rejected in any of our model specifications is interesting. This suggests that homeowners' stockholding and housing choices are not driven by same unobservable variables. This means that either we are able to control for differences in risk aversion through control variables or that risk aversion does not significantly affect the housing and mortgage choices of Finnish homeowners. The latter case would indicate that housing and mortgage choices are driven primarily by consumption demand for housing services instead of investment demand for housing capital or mortgage debt. So it seems that Finnish households think of owner-occupied houses as homes rather than investment vehicles and do not necessarily understand the financial risks involved. Of course this speculation critically hinges on the validity of our instruments and the power of the exogeneity tests. Nevertheless, this seems a fruitful avenue for future research on how households perceive the risks involved with homeownership.

The empirical results differ considerably from the predictions drawn from the simulation model in section 2. The most striking difference is the low level of actual stock market participation. Some of this can be explained by entry and participation costs and buffer stock saving motives. According to the econometric results, owner-occupied housing does offer a partial explanation for low levels of stockholding. However, considerable unexplained heterogeneity remains. This is in line with previous empirical

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produced a p-value of 0.114. This suggests that we may have a problem with multicollinearity even with exclusion restrictions. High standard errors induced by multicollinearity may be one reason why we cannot reject the null hypothesis of no sample selection bias. The last column in Table 7 reports the variance inflation factors (VIF) for the key variables used in the model. They suggest that multicollinearity is a problem mainly for net wealth variables and the inverse Mills' ratio.

[18] *Because exogeneity was not rejected in the first step probit models, the inverse Mills' ratios are calculated in the usual way.*

[19] *Again we divided the sample into sub-samples with and without a mortgage. When using OLS, the coefficient of house value changed considerably closer to zero for the latter group but the difference between the coefficients in the two sub samples was not statistically significant. We also implemented a Chow test. The test rejects the null hypothesis that the coefficients are the same in both models. However, it is unclear what exactly drives this result because the sub-samples differ in many respects as can be seen from Table 4.*

findings on household portfolio choice from a number of countries as reported in e.g. Guiso et al. (2003). Some clear patterns do emerge from the econometric models in addition to housing. The most robust results were that net wealth and education level have a positive effect on both the decision to participate in the stock market and the share of financial wealth invested 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. This paper replicated the simulation results using Finnish asset return data and showed that house price risk may indeed be an important factor influencing Finnish households' financial portfolios. The main contribution of the paper, however, was to put this prediction into an econometric test using the 1998 Wealth Survey, a household level data produced by Statistics Finland.

Econometric results tell us that owner-occupied housing has an adverse effect on household stockholding. More precisely, a higher house value at a given level of net wealth clearly reduces the probability that a household enters the stock market. This result can be interpreted in two ways. First, at a given net wealth level higher house value exposes households to house price risk which might induce them to mitigate their stockholding. On the other hand, higher house value at a given level of net wealth and mortgage debt automatically means a lower level of financial wealth for the household. So the result may indicate that some households do not see it worthwhile to enter the stock market given their low level of financial wealth and possible entry and participation costs. Although, the results hinted that the latter effect is more important, the relative importance of these two effects cannot be deduced explicitly from the data we used. On the other hand, it seems that housing has only a small effect if any on the share of financial assets a household invests in stocks conditional on stockholding. However, the results concerning the share invested in stocks may suffer from a poorly identified model and should be taken only as suggestive. Further work is needed in this respect. What comes to other important factors behind stockholding, we find that wealthier and more educated households are clearly more likely to own stocks and also invest a larger share of their financial wealth into stocks.

The results have also policy relevance as they suggest that the prevailing Finnish housing policy of promoting homeownership has an unintended effect of inducing households to hold fewer stocks. This is in contradiction with the ongoing public debate where encouraging stockownership and long-term savings of Finnish households is seen as an important policy goal. This should be taken into account when evaluating housing policy and the adverse effects should be weighed against the benefits of promoting homeownership.

Some open questions remain for future work concerning housing and portfolio choice. Sinai and Souleles (2005) argue that owner-occupied housing should not be treated simply as an asset inducing a background risk for homeowners. Instead, the effective asset price risk depends on households' expected tenure length and moving behaviour. An interesting extension in this line of research would be to explicitly control for expected tenure length. One would also want to control for whether a homeowner is expected to move up or down the housing ladder. These extensions might also explain why we couldn't find evidence of risk aversion affecting the housing choices of Finnish households.

An interesting future avenue would also be to study how households adjust their financial portfolios just before and after the purchase of their first owner-occupied house. However, this line of research requires the use of panel data. Furthermore, two important institutional changes have occurred in Finland that should be of interest for future research. Namely, new longer maturity mortgages have been introduced in Finland only recently. This should have an 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 made stockholding a possibility also for lower wealth households because through mutual funds these households are better able to diversify their portfolios. Both of these developments may have had a clear effect on household portfolios.

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Appendix. Calculation of 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.[20] An estimate of the gross rental value of housing services is obtained using the 1998 Wealth Survey, where homeowners were asked to estimate their current house value. Using these values we estimate a hedonic regression to obtain a value for a constant quality house.[21] From renter households the data includes the rents they paid during the survey year. Again we used a hedonic regression to obtain an annual rent for a constant quality dwelling. The results are presented in Table A1. Due to small sample size, we assume that the marginal prices of attributes are equal across regions and allow the regional prices vary only through the intercept. The hedonic regression for house value is also used in constructing the regional house price

[20] 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.

[21] There is empirical evidence suggesting that homeowners are fairly accurate in estimating their house value. There is also evidence that the estimation errors are not correlated with house or owner characteristics. See, for example, Kiel and Zabel (1999) who find that American homeowner's tend to overvalue their house by about 5 percent on average. If Finnish households have a similar tendency this would lead to underestimation of the rental return to owner-occupied housing with the method used here.

index that is used as an instrument in the econometric models.

The annual gross rental return from housing was obtained by dividing the constant quality annual rent by constant quality house value. This gave us an estimate of roughly 5 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.[22] Unfortunately, there exits no measures of the depreciation rate of physical housing stock in Finland, thus, we use a commonly used annual rate of 2 percent as our measure. The municipal property tax is calculated as the annual national average weighted by municipal property values. Imputed rental income is not taxed in Finland. Also capital gains are tax-exempt if the household has used the house as a primary home for at least two years which we assume is the case.

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 a government bond total return index produced by 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 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 of Statistics Finland is used to convert the returns into real terms.

Table A1. Results for the hedonic regression models.

	House value			Rent		
	Coeff.	**Std. Error**	**p-value**	**Coeff.**	**Std. Error**	**p-value**
constant	72 539	5 822	0.000	1 668	796.6	0.038
age	-669.0	96.82	0.000	-26.99	12.06	0.026
$(age)^2$	5.210	0.850	0.000	0.140	0.112	0.214
floor area	470.1	61.23	0.000	65.99	13.99	0.000
$(floor\ area)^2$	0.935	0.170	0.000	-0.082	0.086	0.342
detached[a]	29 881	5 231	0.000	125.9	585.2	0.830
two-family house	35 308	5 348	0.000	295.0	640.4	0.646
terraced	20 011	3 874	0.000	899.8	393.6	0.023
own lot	-4 569	3 877	0.239			
building material wood	-17 137	3 047	0.000	-997.6	382.3	0.010
urban[b]	27 190	2 989	0.000	1 647	485.5	0.001
semi-urban	5 881	3 153	0.062	285	557.6	0.610
Number of obs.		2 922			254	
F-test (p-value)		39.2 (0.000)			5.88 (0.000)	
Adjusted R^2		0.53			0.55	

Notes: The dependent variables are house value and annual rent in euros. In both models the explanatory variables include 76 NUTS 4 regional dummies. Omitted category is the Helsinki Region.

[a] Dwelling type dummies, reference is multi-storey block

[b] Dummy variables indicating the urbanisation rate of municipality, reference is rural regions

[22] *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.*