Limited Stock Market Participation Among Renters and Home Owners

Job Market Paper

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Abstract

Home owners are about twice as likely as renters to participate in the stock market, both in the USA and Sweden. This paper sets up a life-cycle portfolio choice model which generates this pattern of limited stock market participation. Calibrated to Swedish data, the model generates the stock market participation rate of home owners as well as the much lower participation rate of renters. In addition, the model replicates two salient features of the data. First, it replicates the U-shaped life-cycle profile of stock market participation among renters, which is due to sorting. Second, the crowding-out mechanism that leads to limited participation among home owners in the model is consistent with difference-in-difference regressions on a high-quality Swedish panel data set.

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The analysis of households' investment decisions is an active research program. One of the fundamental issues that economists aim to understand is limited stock market participation among households (Campbell, 2006). In short, it seems as if households who stay out of the stock market forego a high expected return on their savings since a substantial risk premium is attached to stocks. In the class of life-cycle portfolio choice models with idiosyncratic risky labor income, the stock market participation puzzle is particularly deep since labor income is typically modeled as bond-like rather than stock-like in terms of stochastic properties. The presence of such bond-like human wealth leads to a particularly strong demand for stocks. Many important contributions modify this basic model. Apart from the addition of a stock market participation cost, the modifications typically involve a change to non-standard preferences or preference heterogeneity (Gomes and Michaelides, 2005; Polkovnichenko, 2007; Wachter and Yogo, 2009) or a change in the risk characteristics of labor income (Cocco, Gomes, and Maenhout, 2005; Lynch and Tan, 2007; Benzoni, Collin-Dufresne, and Goldstein, 2007).[1]

Next to human wealth, the second most important asset class for determining optimal financial savings and portfolio choice of a household is arguably housing wealth. For home owners, it is a pre-dominant asset class on the balance sheet. Further, housing consumption constitutes a large share of total consumption, for both home owners and renters. These characteristics of housing matter in several ways for the households' portfolio choice. First, if house price growth is correlated with stock returns, then the demand for stocks is altered. Second, transaction costs in the housing market implies that holdings of housing may differ from the optimal housing holding, had the market been frictionless, which in turn leads to distortions in financial savings. Stylized models by e.g. Grossman and Laroque (1990), Flavin and Yamashita (2002), Chetty and Szeidl (2007), Flavin and Nakagawa (2008) and Stokey (2009) explore these mechanisms.

Despite the many important insights that this literature provides, the class of models that makes quantitative predictions for renters' and home owners' financial savings and portfolio choice is small, in the sense that there are few models that encompass housing *as well as* idiosyncratic risky labor income and a life-cycle dimension into the household's problem. Two seminal studies in this literature are Cocco (2005) and Yao and Zhang (2005). Cocco (2005) explores stock market participation decisions and optimal equity shares among home owners and shows that home ownership crowds out stock holdings. Unlike Cocco (2005), Yao and Zhang (2005) endogenize the rent-own decision of households and explore optimal consumption and equity shares among both renters and home owners. They find that home owners should hold more equity relative to net worth than renters while they should hold less equity relative to financial wealth. Both find support for their models in U.S. micro data.[2]

Notably, the literature has not yet provided a unified theory of the home ownership decision and the stock market participation decision, despite that the empirical evidence suggest that this *joint decision* is important. Table 1 shows that there are stark differences between renters and home owners. The gap in stock market participation rates between renters and home owners is 33 percentage points in the USA and 40 percentage points in Sweden. As a point of reference, in Sweden this difference is ten percentage points larger than the difference between households whose heads have only elementary schooling and households whose heads have a college degree.[3] Such a large gap in participation rates between renters

[1] Other important contriubtions to this class of models are e.g. Viceira (2001) and Alan (2006).

[2] Hu (2005) explores investment behavior in a model similar to Yao and Zhang (2005).

[3] This is shown later on in table 2 of the paper.

Table 1: Sample Means - U.S. and Swedish Data

	USA		Sweden	
	Renters	Home owners	Renters	Home owners
Fraction of households	27.2%	72.8%	35.8%	64.2%
Total financial wealth	37.2	278.5	21.8	73.3
Net worth	41.6	500.2	3.0	162.5
Wage income	27.5	61.0	20.2	52.1
Housing wealth	0	324.1	0	195.2
Stock market participation	27.8%	61.0%	37.6%	77.6%

Note: Asset values in terms of 1000's of U.S. dollars, adjusted to the 2004 price level. U.S. statistics based on the 2001, 2004 and 2007 waves of the Survey of Consumer Finances (using the population weights and all five implications). For the U.S. data set, a home owner is a household who owns its primary residence. Housing wealth includes primary, secondary and non-residential real estate, financial wealth includes quasi-liquid retirement accounts. Net worth excludes vehicles, businesses, other non-financial assets and vehicle loans. The Swedish statistics are based on the data set described in section 1.

and home owners may at first be perceived as somewhat surprising since renters who do not participate in the stock market hold neither housing wealth nor stocks and therefore save virtually only in bonds and bank accounts with a low and safe return. For this reason it is important to investigate to which extent the stock market participation rates among renters and home owners can be understood in a model.

This paper is the first to develop a model which allows households to simultaneously choose both whether to rent or own their home and whether to participate in the stock market. Relative to Cocco (2005), the paper adds an endogenous rent-own decision. Relative to Yao and Zhang (2005), the paper makes the stock market participation decision non-trivial and revises the housing market frictions. The modifications of the frictions in the housing market enables the model to qualitatively match the hump-shaped life-cycle profile of home ownership in the data. This is an important improvement since it implies that the model produces a non-degenerate distribution of renters and home owners at all stages of the life-cycle. Further, the model introduces a restricted form of preference heterogeneity in the sense that there are two types of households with different aversion to risk and with different preferences for intertemporal smoothing. To be precise, heterogeneity is restricted within the class of Epstein-Zin preferences (Epstein and Zin, 1989, 1991).

The paper calibrates the model to the Swedish economy and to households whose heads have high school education.[4] The model matches the level of stock market participation rate among home owners (77 percent) and it also generates a close to perfect match with renters' stock market participation rate before retirement (49 percent). Including the retirement phase of renters, the mean stock market participation rate is somewhat higher in the model than in the data. The discrepancy late in life may be due to the absence of for instance health-related factors in the model.

The key intuition that the model brings is that the endogenous rent-own decision require different mechanisms to generate limited participation among home owners and renters. Among home owners, financial savings and stockholdings are crowded out by down-payment requirements as in Cocco (2005). However, among renters the savings motive in stocks remains large since renting does not require a similar

[4]In the following, model results are compared with this sub-sample of the data.

lock-in of wealth. Because of this tension between a realistic set of options for shelter, on the one hand, and reproducing a limited demand for stocks on the other hand, a greater stock market participation cost is required than in Cocco (2005) and it is necessary to allow for heterogeneity in preferences within the Epstein-Zin class to reduce renters' motive to save in financial assets. Effectively, the household type with low risk aversion has a smaller savings motive than the second type with higher risk aversion and therefore saves less in financial assets while it at the same time is more likely to rent. Preference heterogeneity also helps to generate sufficient cross-sectional dispersion in financial wealth, a statistic which is key to the analysis of limited stock market participation. The introduction of preference heterogeneity can be viewed as an extension of Gomes and Michaelides (2005) and Alan (2011) to a housing context.

In addition to providing a good match of the levels of stock market participation for both renters and home owners, the model replicates three salient features of the data. First, the model produces a life-cycle profile of stock market participation which is flatter, and hence closer to the data, than in the model of Cocco (2005), who enforces home ownership on even the poorest households.

Second, in both the data and the model there is a U-shaped participation rate over the life-cycle among renters, as a result of sorting. There is a fall in the participation rate among renters from young age to mid-life. As home ownership increases with age (from young to mid-life), renters' characteristics (e.g. labor income) deteriorates and consequently the stock market participation rate of renters decreases too. After the peak of the home ownership rate, the stock market participation rate among renters increases. Since no model before has incorporated *both* an endogenous home ownership-rent decision *and* an endogenous stock market participation decision this paper is the first that replicates this pattern of the data.

Third, the model replicates the crowding out effect of housing wealth on stock market participation. To examine the consistency between model and data of this interaction effect, difference-in-difference (DiD) regressions are run on a Swedish panel data set with annual waves as well as on data generated by model simulations. The DiD-regressions on the Swedish data set confirm the existence of the crowding out effect; in the year of the home purchase the likelihood of stock market participation decreases by 10.8 percentage points among first-time home buyers. Since the stock market participation rate is 62 percent in the years prior to the home purchase this implies that almost every fifth stock market participant who buys a home exits the stock market entirely. DiD-regressions on model-generated data display the same negative effect.

This type of panel regression gives a new insight on how the household's financial portfolio responds to a home purchase. Unlike a regression on pure cross-sections of data, the effect of unobserved heterogeneity can be separated from the effect of home ownership. A regression on pure cross-sections of data would counterfactually suggest that the effect of home ownership on stock market participation is positive. A more compelling interpretation, which is consistent with the DiD-regressions, is that the home ownership effect is negative but that there is unobserved heterogeneity between renters and home owners.

The remainder of the paper is organized as follows. Section 1 describes the Swedish data set. Section 2 outlines the model and section 3 how it is calibrated. Section 4 reports the results of the model. Section 5 then reports differences-in-differences regression on the Swedish panel data set and on model-generated data. Finally, section 6 concludes. The appendix consists of six parts, enumerated from A to F. It covers sample statistics, details on the model calibration and additional empirical and model results.

1 Data

The Swedish data set is the result of a match of two separate registry-based data sets. Statistics Sweden (Sweden's governmental agency for official statistics) is able to provide detailed tax records on individuals' disaggregated financial wealth. These wealth records, known by its acronym KURU, can be matched with LINDA (Longitudinal INdividual DAta for Sweden) and its wealth supplement, a standardized panel data set that covers approximately 320,000 households, or seven percent, of the Swedish population. The result of the match is a panel data set with annual waves between 2000 and 2007 that contains standard socioeconomic variables such as age, education, region of residence, labor market earnings before and after tax, etc., as well as detailed information about financial wealth and housing wealth. The data set is of exceptional quality because of the detailed information about households' disaggregated wealth portfolios, because of its panel dimension, and because of its sample size.

Unlike data sets such as the Survey of Consumer Finances or the wealth supplement of the Panel Study of Income Dynamics the same households are followed at annual frequency. Similar data sets of Swedes' disaggregated wealth holdings have been used in Massa and Simonov (2006) and KURU was first used by Calvet, Campbell, and Sodini (2007) and Calvet, Campbell, and Sodini (2008). The reader is referred to these studies for a more in-depth description of the wealth data. For a detailed description of LINDA, see e.g. Lindqvist and Vestman (2011) and the references therein.

As a third source of information, Statistics Sweden's Household Budget Survey (HBS) was matched to the data set for the years 2003 to 2007, also with the use of the social security numbers. The HBS is an annual survey based on registries, an interview and a consumption diary. It contains information about housing expenses and other types of consumption expenses. For renters, there is information about rent and for home owners there is information on maintenance, interest on mortgages, maintenance and fees (in the case of apartment owners). The match rate is a hundred percent because the HBS uses LINDA as the sample frame since 2003.

A fourth source of information is the real estate registry. It contains information about every transaction of houses and cabins in the country. Using this information, it is possible to identify households who buy or sell additional real estate which is exploited in one of the differences-in-differences regressions in section 5.

Finally, information about individuals' premium pension accounts (PPM accounts) was added with use of each Swedish tax-payer's social security number. PPM savings is a form of government-mandated pension savings that was gradually introduced between 1996 and 2000. Every wage earner contributes with 2.5 percent of the wage earnings to his or her premium pension account. At any point in time, the wage earner can allocate the savings to up to five mutual funds. The default fund, in case no active choice by the wage earner, consists of a well-diversified global equity fund with a low fee. It is not possible to withdraw money from these accounts before retirement. For the period 2000 to 2007 the data set contains information about every individuals' specific fund holdings within PPM. This information is however used only for summary statistics in the present paper (table 2 and 3).

Although the Swedish data set is of exceptional quality it has some weaknesses. First, when Statistics Sweden compiles LINDA it cannot match all partners that live together in the same household without being married and without having common children. This leads to under-sampling of this particular kind of household. Among the households that appear in the 2007 wave of the HBS the number of adults reported in the survey and the number of adults reported in LINDA agree in 85 percent of the households. Second, the data set contains limited information about two types of financial accounts. These accounts are capital insurances and private pension accounts. Both types are surrounded by special tax regulations and therefore it is unknown whether this money is allocated regular savings accounts, stocks, mutual funds, bonds or some other kind of financial asset. For capital insurances the account balance is reported. According to Calvet, Campbell, and Sodini (2007) such savings made up 16 percent of the total financial savings in 2002. For private pension accounts not even the balance is reported - only the annual contribution is reported. Using LINDA from 1993 to 2007, I apply the annual MSCI All Country return to these annual contributions and thus obtain an imputed account balance. Most likely, this imputation method uses a too aggressive realized return on average and therefore it is likely that the balance of these accounts are overstated.

Apart from the incomplete description of the composition of capital insurances and private pension savings the main drawback of the data set is the uncertainty surrounding ownership of apartments (co-ops). Because of differences in different types of co-ops' tax reporting requirements, Statistics Sweden is not able to identify owners of apartments with certainty.[5] In 2004 the method used to identify owners of apartments was overhauled. This lead to a net change of 10,000 apartment owners in the entire population, consisting of nine million individuals.[6] However, 90,000 individuals were no longer classified as owners and 81,000 were now classified as owners, a gross change of 1.9 percent in the population. Apart from a noisy classification of apartment ownerships, there is also uncertainty surrounding the market value of each apartment. Statistics Sweden uses the average sale value of the apartments within a co-op in each year to assign market values to every apartment within that co-op, also for those that were not transacted. If too few sales at the co-op level have occurred the average sale value within the parish is used instead. This implies that there is too little variation in reported apartment values and that small apartments most likely suffer from an upward bias and large apartments suffers from a downward bias. Further, this translates to a bias in the computed net worth of these households. Several robustness checks with respect to apartment owners are therefore performed in the regression analysis.[7]

A final weakness of the Swedish data set is the inaccurate information on balances of bank account. Up until 2004 positive balances are reported only if the accrued interest during that year was greater than 100 SEK (roughly 12 USD). After 2004 the balance of a bank account is reported only if it is greater than 10,000 SEK (roughly 1,200 USD).

1.1 Household Head and Sample Restrictions

In the analysis, some characteristics of the household head such as education and age, are attributed to the entire household. The head of the household is defined as the oldest male of the household if there is a male who is at least 21 years old. Otherwise, the oldest female, if at least 21 years old, is defined as the household head. If there is no person of age 21 or older then the oldest person is defined to be household

[5]Before 2010 there was no national registry of co-ops and their owners.

[6]According to Statistics Sweden it has identified approximately 900,000 individuals as apartment owners which equals 10 percent of the population.

[7]For further information about the peculiarities of the Swedish registries the reader is referred to Koijen, Van Nieuwerburgh, and Vestman (2011).

head.

Only one sample restrictions are imposed on the Swedish data set. First, in all of the analysis households with net worth in the top percentile, corresponding to approximately SEK 9,000,000 (USD 1,200,000), are excluded. This matters for the calibration of the model which aims at matching the cross-sectional means of net worth, financial assets and housing wealth.

1.2 Descriptive Statistics

Table 2 reports sample means of household characteristics for home owners, renters and three broad educational groups. In the following, all asset values are inflated or deflated to 2005 values. The asset values are in terms of thousands of Swedish kronor (SEK).[8] A household is considered to a be a home owner if it owns any kind of real estate, including co-ops, permanent houses, cabins, and plots of land intended for permanent houses or cabins. Notably, the average home owner is a lot richer than the average renter. The differences between home owners and renters are greater than between households with different levels of education. If capital insurances, private pension accounts and mandatory government premium pension accounts (PPM accounts) are excluded, the stock market participation rate among home owners is 77.6 percent and among renters 37.6 percent, a gap of 40 percentage points. The gap is reduced to 20 percentage points if the PPM accounts are excluded. The implications of other definitions of stock market participation are discussed below.

1.3 Definition of Stock Market Participation

Table 3 reports the fraction of households that own risky assets according to different definitions. Throughout in panel A, participation implies that the household own a positive amount of stocks, directly or indirectly in mutual funds. In terms of risk-taking, it is not clear whether a sensible definition of risky asset ownership should taken into account bond holdings or not. As panel B shows, this distinction matters little. A more important issue is whether to include premium pension accounts, private pension savings and capital insurances as the differences across the columns in panel show. There is no public information on the holdings in private pension accounts and capital insurances. When computing the participation rate in the third column it is assumed that every private pension account and every capital insurance account contains stock holdings. According to table 2, capital insurances and private pension accounts sum to 17.5 percent of total financial assets and it is likely that many of these accounts contains stocks. However, since there is no information on the exact holdings for each household I choose to exclude these assets from the analysis. The holdings in the PPM accounts are however known in detail. As table 2 shows most of the account balances consist of equity funds. Nevertheless, I choose to exclude also the PPM holdings from my definition of net worth and stock market participation because the savings are mandatory and ill-liquid up until retirement. Further, at the present time these accounts sum to a small share of financial assets (ten percent). Although the definition of stock market participation is debatable, the definition that I choose (the left-most one in panel A) is arguably the one that is most consistent with the definition in standard life-cycle portfolio choice models.

Panel C reports alternative definitions of stock market participation based on the value of stock

[8]The exchange rate is about 7.50 SEK/USD.

Table 2: Sample Means - Swedish Data

	All	**Renters**	**Home owners**	**No high school**	**High school**	**College**
Bank accounts	121.6	61.4	155.1	110.5	106.3	148.7
Direct bond holdings	15.7	5.9	21.2	15.7	13.7	18.8
Money market funds	12.8	7.1	16.0	13.0	12.1	13.9
Bond funds	7.8	4.0	31.2	9.9	7.7	7.4
Equity funds	79.2	27.2	108.2	59.3	61.6	113.0
Stocks	52.2	17.2	71.6	29.6	37.0	83.1
Capital insurance	23.2	8.9	31.2	20.9	20.7	27.8
Pension accounts	46.6	10.7	66.5	30.6	31.8	74.6
PPM: money market funds	0.34	0.16	0.45	0.18	0.28	0.50
PPM: bond funds	0.61	0.33	0.76	0.43	0.53	0.79
PPM: equity funds	37.3	19.1	47.5	20.7	31.3	52.3
PPM: unclassified	1.4	0.59	1.9	0.63	1.1	2.2
Partic. excl. PPM	63.3%	37.6%	77.6%	48.3%	56.6%	78.6%
Partic. incl. PPM	86.6%	73.6%	93.9%	82.6%	80.6%	97.2%
Real estate	940.3	0	1,463.8	609.5	722.2	1,386.5
Net worth	790.7	22.3	1,218.5	645.5	642.3	1,066.9
Disposable income	292.8	182.1	354.4	223.1	247.7	385.5
Age of household head	46.6	42.8	48.7	52.4	47.3	43.6
Household size	2.6	2.0	2.9	2.1	2.4	3.0
Number of adults	1.7	1.3	2.0	1.7	1.6	1.9
Marriage rate	45.6%	25.4%	56.9%	41.8%	39.5%	56.4%
Observations	2,434,359	870,577	1,563,782	292,086	1,293,422	848,851

Note: Asset values in terms of 1000's of Swedish kronor (SEK). No high school refers to ten or less years of education of the household head. High school refers to 11-13 years of education and college equal to or more than 14 years. The balance on private pension accounts was imputed using historical installments since 1985. To obtain an estimate of the balance the MSCI World Market return was applied to the installments. Participation excluding PPM refers to the stock market participation rate if government-mandated premium pension accounts, capital insurances and private pension accounts are excluded. Participation including PPM refers to the stock market participation rate if government-mandated premium pension accounts are included but capital insurances and private pension accounts are exluded.

Table 3: Definitions of Participation in Risky Asset Markets

	Panel A: Excluding Bond Holdings		
	Excl pensions	Incl PPM	Incl pensions
All households	63.3%	86.6%	87.7%
Renters	37.6%	73.6%	74.9%
Home owners	77.6%	93.9%	94.8%
	Panel B: Including Bond Holdings		
	Excl pensions	Incl PPM	Incl pensions
All households	65.9%	87.8%	88.6%
Renters	40.1%	74.9%	76.0%
Home owners	80.2%	95.0%	95.6%
	Panel C: Alternative Definitions		
	Stock holdings >10 kSEK	Equity share > 10%	Stock holdings > 10% of disposable income
All households	50.5%	56.6%	42.4%
Renters	25.0%	33.6%	27.7%
Home owners	64.6%	69.3%	50.6%

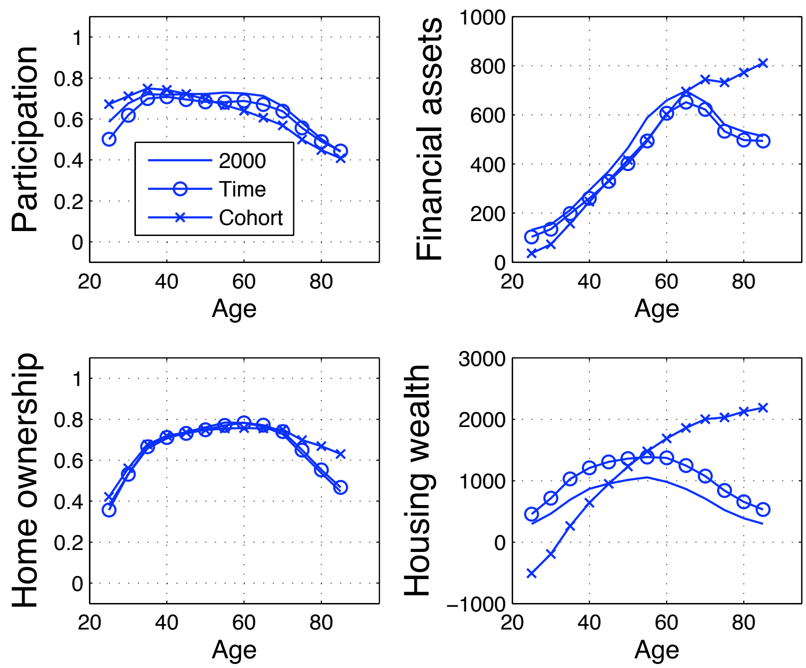
Note: Bond holdings refer to both directly held bonds and holdings of fixed income funds. The left-most column (Excl. pensions) refers to the participation rate if government-mandated premium pension accounts, capital insurances and private pension accounts are excluded. Participation including PPM refers to the stock market participation rate if government-mandated premium pension accounts are included but capital insurances and private pension accounts are exluded. Participation including pensions refers to the participation rate if PPM accounts, capital insurances and private pension accounts are included. The alternative definitions in panel C is based on the exclusion of these three types of savings accounts.

holdings, the equity share (stock holdings relative to other financial assets) and stock holdings relative to disposable income. All of these definitions exclude bond holdings, PPM accounts, private pension accounts and capital insurances as the baseline definition. With the first two alternative definitions the gap in participation rates between home owners and renters does not change markedly - it is still equal to at least 35 percentage points. In relation to disposable income, stock holdings are not as unevenly distributed among home owners and renters. The gap remains large, however, at 22 percentage points. The three alternative definitions in panel C will be used to investigate the robustness of the main results.

1.4 Stock Market Participation, Home Ownership and Assets over the Life-Cycle

Figure 1 reports the life-cycle pattern of stock market participation, home ownership, financial assets and housing wealth. Both asset holdings and participation rates in the stock and housing markets are hump-shaped over the course of life. An issue that arises when calibrating a life-cycle model to data is whether one should control for time effects or cohort effects. As the figure shows it does not matter much, except in the case of housing wealth. Controlling for cohort effects implies a very strong age-component in housing wealth while controlling for time effects implies a sensible hump-shape. This is likely to be due to the spectacular growth in Swedish house and apartment prices from 2000 to 2007. Given the difficulty to credibly incorporate the reasons behind the strong house price appreciation during 2000-2007 in a life-cycle model, it would seem more sensible to control for time effects than cohort effects. However, because of the difficulty to generate the historical series of appreciation rates of home values in the model and its uneven effects across different cohorts, I choose another calibration strategy. In line with the rest of the calibration, the aim will be to match the housing wealth profile in year 2000, before most of the spectacular growth in house and apartment prices had occurred.

Figure 1: Stock Market Participation, Home Ownership and Assets over the Life-Cycle



Note: The figure reports the life-cycle pattern of stock market participation, home ownership, financial assets and housing wealth. The asset values are in terms of thousands of Swedish kronor (SEK). The solid line uses data from 2000, only, the other lines report the life-cycle pattern while controlling for either time effects or cohort effects.

2 Model

This section outlines a life-cycle portfolio choice model that incorporates risky labor income and endogenous decisions about home ownership as well as stock market participation. Apart from housing, households can invest in a bond and a stock. It is costly to enter the stock market for the first time. The decision rules of home owners and renters for financial savings and stock market entry can be compared to one another to shed light on the effects of home ownership on stock market holdings. The decision rules can also be compared to factual data to judge whether renters are further from optimal behavior than home owners, or vice versa.

In terms of its financial portfolio choice features the model resembles Viceira (2001), Cocco, Gomes, and Maenhout (2005), Gomes and Michaelides (2005), Alan (2006), Polkovnichenko (2007) and Ball (2008), among others. In terms of its housing features, the model resembles Cocco (2005), Hu (2005), Yao and Zhang (2005), van Hemert (2010). It also resembles the household problem of Favilukis, Ludvigson, and Van Nieuwerburgh (2011) who sets up an incomplete markets general equilibrium model with housing in the presence of aggregate risk.

The focus of Cocco, van Hemert and Yao and Zhang is on financial choice *conditional* on a given home ownership status. Unlike previous models in the literature on optimal portfolio choice, this model matches the home ownership profile over the life-cycle in at least a qualitative sense. This is a necessary improvement since we wish to study the endogenous generation of limited stock market participation among renters and home owners.

2.1 Demographics

The household lives from age $t = 25$ to $t = 95$. The household leaves no bequest. One time period is equal to two years. The household receives an exogenous stream of labor market earnings net of taxes and transfers up until retirement at $t = 65$. Going forward, the sum of earnings, taxes and transfers is called disposable income.

2.2 Consumption Goods

There are two goods. c_t includes all kinds of consumption goods except housing services. It is a non-durable good. The second good, housing services, is denoted h_t. Its relative price in terms of the non-housing good is given by P_t^h, which follows a stochastic process to be described in section 2.5. The two goods form a consumption basket:

$$C_t \equiv c_t^{1-\omega} h_t^{\omega}$$

where ω denotes the Cobb-Douglas expenditure share of housing services.

2.3 Preferences

The household has Epstein-Zin (Epstein and Zin (1989), Epstein and Zin (1991)) preferences over the consumption basket. The preferences are expressed as:

$$U_t = \left(C_t^{1-\rho} + \beta \mathcal{R}_t(U_{t+1})^{1-\rho} \right)^{\frac{1}{1-\rho}} \tag{1}$$

$$\mathcal{R}_t(U_{t+1}) = E_t \left[U_{t+1}^{1-\gamma} \right]^{\frac{1}{1-\gamma}} \tag{2}$$

$$U_T = C_T \tag{3}$$

where ρ is the inverse of the intertemporal elasticity of substitution between C_t and the certainty equivalent, $\mathcal{R}_t(U_{t+1})$. γ is the coefficient of relative risk aversion. $E_t[.]$ is an expectations operator which is well-defined given the description of the stochastics in the model.

2.4 Disposable Income

During its life-time, the household receives an exogenous stream of disposable income. It is calibrated to match labor market earnings minus total taxes plus total transfers to the households. It excludes capital items such as capital gains and subsides on paid interest on loans.[9]. Earnings and its replacement in retirement ($t > 65$) follows an exogenous process of the same kind as in e.g. Carroll and Samwick (1997) and Gourinchas and Parker (2002). Disposable income of household i is denoted by Y_{it} where

$$y_{it} \equiv log(Y_{it}) = g_t + z_{it} + \omega_{it}^o \ \leq 65 \quad (4)$$

$$z_{it} = z_{it-1} + v_{it}^o + \varepsilon_t^o + n_t^o \ t \leq 65 \quad (5)$$

$$Y_{it} = \lambda \cdot exp(g_{65} + z_{i65}) \ t > 65 \quad (6)$$

where g_t represents the age profile of earnings. Each of the four shocks are are iid normally distributed, centered at -0.5 of its variance. v_{it+1}^o represents a permanent shock to the household's earnings capacity. The shocks ε_{t+1}^o and n_{t+1}^o are also permanent, but perfectly correlated with the stock market and the housing market, respectively. Finally, ω_{it+1}^o is a transitory shock to disposable income. Going forward, the subscript i will be suppressed unless it is necessary to avoid confusion.

2.4.1 Welfare System

Two restrictions on earnings outcomes are imposed on the process to capture the progressive nature of the Swedish welfare systems. First, net earnings are, if needed, supplemented by the government so that total net earnings never fall below $\underline{Y}$. Second, retirement benefits provided by the government cannot exceed $\lambda \cdot \bar{Y}$ where $\bar{Y}$ can be viewed as the maximum disposable income that the government replaces in retirement.

2.5 The Financial Market and Relative Prices

To enter the stock market the household must pay a one-time entry cost, κ. This feature is common in portfolio choice and asset pricing models. It is used in for instance Boldrin, Christiano, and Fisher (2001), Gomes and Michaelides (2005), Gomes and Michaelides (2008), Favilukis (2011), Alan (2006) and Ball (2008).

Typically, portfolio choice models choose to specificy the entry cost as a fraction of permanent income with the argument that the entry cost represents an opportunity cost of time. This assumption implies that it is possible to reduce the dimension of the state space by scaling all continuous state variables by permanent labor income. However, the assumption of a proportional cost has been used for computational convenience rather than for its realism. The cost may just as well fall or be constant with the productivity of the household. this model defines κ in terms of money (Swedish kronor) rather than units of permanent income. Since the cost is not expressed relative to permanent income, a higher value of income is always preferred to a lower. Second, the cost is directly comparable to the micro estimates of e.g. Vissing-Jorgensen (2002) who provides an empirical justification for a small entry cost. To my knowledge Cocco (2005) is the only previous study that has expressed an entry cost in monetary terms.

The state variable I_t keeps track of whether entry has occurred up until t. Let α_t denote the fraction

[9] The definition of disposable income closely resembles the one used in Domeij and Flodén (2008)

of financial wealth invested in the stock market. The law of motion for I_t is given by:

$$I_t = \begin{cases} 1 \text{ if } I_{t-1} = 1 \text{ or } \alpha_t > 0 \\ 0 \text{ otherwise} \end{cases} \tag{7}$$

$$I_0 = 0 \tag{8}$$

The entry cost at t is:

$$\kappa(I_t - I_{t-1})$$

The return on the household's stock holdings and the price of housing evolves stochastically relative to the non-durable consumption good c_t with the following log-normal return processes:

$$R_{t+1} = \exp(\log(R_f) + \mu + \varepsilon_{t+1}) \tag{9}$$

$$R^h_{t+1} = \frac{P^h_{t+1}}{P^h_t} = \exp(\mu_h + n_{t+1} + \varepsilon^h_{t+1}) \tag{10}$$

where R_f is the return on a bond with a constant risk-free return and μ is the equity premium, $E_t[R_{t+1} - R_f] = \mu$. The shocks ε_t and n_t are iid normally distributed with the mean of each shocks equal to -0.5 of its variance. The return on the housing good is correlated with the stock market because ε^h_{t+1} is perfectly correlated with ε_t. It is also corrected with labor income growth because n_{t+1} is perfectly correlated with n^o_{t+1} in equation (5). Just as the other shocks, ε^h_{t+1} is centered at -0.5 of its variance.

2.5.1 Restrictions on Borrowing and Investment

In the following, let A_t denote total financial investment in bonds and stocks. Leveraged positions is not allowed and borrowing without ownership of a collateral in the form of a house is not allowed either. These assumptions imply the following two restrictions:

$$A_t \geq 0 \tag{11}$$

$$\alpha_t \in [0, 1] \tag{12}$$

There is a mortgage market with rate of return R_f. A household that owns a home of value $P^h_t h_t$ can borrow any amount M_t such that

$$0 \leq M_t \leq (1 - \delta) P^h_t h_t$$

by using its home as collateral. δ is the necessary down-payment on the mortgage as a fraction of the value of the home. Note that as a long as the rate of return on the risk-free bond and the mortgage is equal and the household is not borrowing constrained ($A_t > 0$ and $\alpha_t < 1$), the household only cares about the net position in the bond and the mortgage. To simplify the solution of the household's problem, it is therefore assumed that the household holds a mortgage of value

$$M_t = (1 - \delta) P^h_t h_t \tag{13}$$

in every period. That is, a household that owns a home h_t must in every period pay back the mortgage in full, have a new mortgage issued, and make a down-payment equal to $\delta P_t^h h_t$. The household then chooses A_t and α subject to (11), (12) and (13). In the model, this implies that only the net of bond holdings is a choice variable and only the net bond-mortgage position is determinate. The cash-flows that these assumptions give rise to our expressed in detail in section C.1 of the Appendix.

Note that unlike Chetty and Szeidl (2010) the model gives no distinct role for home equity versus the mortgage value. An increase in housing wealth of one US dollar is equivalent to a reduction of the mortgage by one US dollar, as long as the net worth of the household remains unchanged. This is the result of the assumptions that mortgage rebalancing is costless and that the interest on the mortgage equals the interest on the risk-free bond.

Though these assumptions are standard for quantitive life-cycle models in macroeconomics and finance, they can be viewed as a limitation.[10] However, in Sweden interest payments on mortages are deductible by 30 percent, which narrows the gap between the risk-free rate and the rate at which households can borrow using their home as a collateral. To further justify the assumption of the risk-free rate paid on the mortgage, the minimum down-payment requirement in the model (δ) can be set higher than in the real economy.[11] In sum, this specification implies that the model produces relatively realistic predictions for the quantities that the analysis focuses on, namely financial savings and stock market participation conditional on age, past stock market participation, disposable income, net worth and home value.

2.6 Renting or Owning a Home

In each time period the household chooses whether to rent or own its home. In between periods the household may be forced to move for exogenous reasons (and thus incurring the house sale cost). The probability of a moving shock depends on age.[12]

The decision to rent or own a home is indicated by $D_t^o = 0$ or $D_t^o = 1$, respectively. If the household is a home owner when entering period t (i.e. $D_{t-1}^o = 1$) and prefers to continue to own rather than to rent, the household needs to choose between selling its current home ($D_t^s = 1$) or staying ($D_t^s = 0$). If $D_t^o = 1$ then the household will enter $t+1$ as a home owner, unless it is hit by the exogenous moving shock. The possibility of owning more housing than what is consumed and lease parts of the house to others is ruled out. The minimum value of a home available for purchase on the market is given by $\underline{h}$. A household must rent if it prefers to consume less housing than that.

Let X_t denote cash-in-hand at age t. It includes proceeds from a potential home sale and labor income in that period (or its replacement in the retirement phase), less any cost from entering the stock market. There are several differences between renting and owning a home. Since the home serves both as a consumption good and an investment it impacts both the static budget constraint and the law of

[10] For instance, Becker and Shabani (2010) demonstrate that the interest paid on debt has strong implications for attractiveness of stocks since, effectively, the earned risk-premium is altered with interest on debt.

[11] During the time period 2000 to 2007 Swedish banks often required only a modest down-payment requirement of ten percent. In 2010, regulatory legislation came in place which required a 15 percent down-payment requirement for mortgages.

[12] The exogenous and endogenous moving rates are reported in section 3.3.2.

motion for cash-in-hand, as will be illustrated in equation (14)-(18). Evidently this can have large effects on a household's optimal behavior and lead to a shift away from the consumption expenditure shares between c_t and h_t that renting implies. Fernandez-Villaverde and Krueger (2005) exploit the dual role of housing as a consumption good and as an investment asset to produce a hump-shaped path of non-durable consumption over the life-cycle.

Much of the discussion of the model so far can be summarized in the following budget constraints.

2.6.1 Budget Constraints

Renting If the household chooses to rent a home of size h_t the static budget constraint reads

$$A_t + c_t + \tau P_t^h h_t \leq X_t \tag{14}$$

where τ is a parameter that governs the rent level relative to the market value.

Buying a new home If the household chooses to buy a home h_t the cash required is $(\phi_b + \chi + \delta)P_t^h h_t$ where ϕ_b denotes the proportional cost of buying a home, χ captures the cost of one period of maintenance and δ is the down-payment on the mortgage as a fraction of the home value, $P_t^h h_t$. The minimum home value available on the market is given by the parameter $\underline{h}$. The budget constraint reads:

$$A_t + c_t + (\phi_b + \chi + \delta)P_t^h h_t \leq X_t \tag{15}$$

Staying in the same home If the household owns a home h_{t-1} from the period before and chooses to stay in it ($D_{t-1}^o = D_t^o = 1,\ D_t^s = 0,\ h_t = h_{t-1}$) then it is cheaper to consume the housing service generated by h_t than if the same home needs to be bought. The budget constraint reads:

$$A_t + c_t + (\chi + \delta - \phi)P_t^h h_t \leq X_t \tag{16}$$

where ϕ captures the selling cost of a home. Note that the term $\phi P_t^h h_t$ indicates that the household *does not* incur a transaction cost. This formulation is consistent with equation (18).

2.6.2 Law of Motion for Cash-in-hand

Renting If the household rents the law of motion for cash-in-hand is:

$$X_{t+1} = A_t R_f + \alpha_t A_t (R_{t+1} - R_f) + Y_{t+1} - \kappa(I_{t+1} - I_t) \tag{17}$$

Owning If the household owns a home h_t (between t and $t+1$) the law of motion for cash-in-hand is:

$$\begin{aligned} X_{t+1} &= A_t R_f + \alpha_t A_t (R_{t+1} - R_f) + Y_{t+1} \\ &\quad -\kappa(I_{t+1} - I_t) + P_t^h h_t \left(R_{t+1}^h (1-\phi) - (1-\delta) R_f \right) \end{aligned} \tag{18}$$

As can be seen in the law of motion for cash in hand of the owner, there is no separation between housing consumption and investment in housing. The household must carry risk for each housing unit that is consumed. Note that $P_t^h h_t R_{t+1}^h(1-\phi)$ is the market value at $t+1$, less the selling cost.[13]

2.7 The Household's Problem

At each t the household must choose whether to rent, buy a new home or, if it already owns a home, whether to stay in it. Let the value associated with the optimal renting decision of a household of age t and with cash-in-hand X_t be denoted $V_t^r(X_t, z_t, P_t^h, I_{t-1})$ and, analogously, let $V_t^b(X_t, z_t, P_t^h, I_{t-1})$ be the value associated with the household's optimal purchase of a new house if it chooses to buy. Finally, let $V_t^s(X_t, h_{t-1}, z_t, P_t^h, I_{t-1})$ be the value associated with staying in a house that was purchased before. The value associated with the optimal choice of the household is then given by:

$$V_t(X_t, D_{t-1}^o h_{t-1}, z_t, P_t^h, I_{t-1}) = \max_{D_t^o, D_t^s} \left\{ V_t^r, V_t^b, V_t^s \right\}$$

Notice that given equation (17) and (18), the state variable cash-in-hand, X_t, could be replaced by net worth which would include financial assets and home equity and transitory shocks to labor income. Further, it can be shown that due to the Cobb-Douglas specification of the basket C_t one does not need to keep track of P_t^h and h_{t-1} as separate state variables, only their product (the house value, if the household owns).[14] Furthermore, it is common to reduce the state space by scaling all the continuous state variables by permanent income, $\exp(z_t)$, or by cash in hand as in Yao and Zhang (2005). However, this would not make it impossible to specify a stock market participation cost κ in terms of Swedish kronor. It would also make it impossible to specify the progressivity in the welfare systems and the minimum house value, $\underline{h}$, in terms of Swedish kronor. Section C.2 to C.4 in the Appendix describe the renter's, buyers's and stayer's problem in detail.

3 Calibration of the Model to Sweden

This section describes the calibration strategy. The set of parameters can be divided into those that govern the stochastic processes (e.g. the processes for Y_t, R_t and R_t^h), other parameters which are determined exogenously and the pair (β,ρ) which is determined internally in the model to match the life-cycle profiles of financial assets, housing wealth and net worth. Table 14 in the Appendix reports a summary of all the parameter values.

3.1 Stochastic Processes

This section describes how the first and second moments for the returns on the stock and housing markets are determined and how the magnitude and correlation structure of the aggregate shocks (ε_t^o,n_t^o,ε_{t+1},ε_{t+1}^h) are determined.

[13]Notice that for computational reasons very low values of X_t must be treated with care. If a home owner's cash in hand X_t falls below $\underline{Y}$, it is assumed that the household defaults on the mortgage and that it has to rent a home for at least one period and consume and save out of $X_t = \underline{Y}$.

[14]The control variable h_t is multiplied by $(P_t^h)^\omega$. $\mathcal{R}_t(V_{t+1})$ and equations (14)-(18) are adjusted accordingly.

The stock market index is proxied by the MSCI All Country gross index converted to SEK and the house price index that I use is taken from Statistics Sweden's website. The parameters of the process for disposable income, the stock market return and house price growth are set to match the unconditional moments of these series.

3.1.1 First Moments

Matching unconditional moments implies an annual expected house price growth rate (μ_h) of one percent per year, once house price data back until the 1970's are used. This is lower than the average growth rate for the time period 2000 to 2007 which the micro data set covers. Such a low expected growth rate does however imply a very good fit of housing wealth and home ownership over the life-cycle. It is also consistent with the model in the sense that the model does not take into account any of the likely reasons for the drastic house price growth that Sweden and many other countries have witnessed in the past ten to fifteen years. Finally, most households considered in the data set were exposed to the lower house price growth rate between 1970 and 1999 as well.

The equity premium (μ) is set to four percent which is standard in the literature. The age profile for disposable income (g_t), conditional on the household head having a high school education, is determined by the average disposable income for each age group. Given the first moments, the parameters which govern second moments can be estimated.

3.1.2 Second Moments

The total variance of house price growth and the stock market are estimated from the (time-series) variance of the respective index. Similarly, the total variance of the permanent component of disposable income and the variance of the transitory component of disposable income are estimated from the cross-sectional variance of innovations at the household level under time periods of different length which is standard in the literature. The volatility of the permanent component of disposable income is determined to 0.128 which is close to the estimates of Domeij and Flodén (2008). The reader is referred to section E in the Appendix for additional details and references.

The aggregate component in disposable income ($\varepsilon_t^o + n_t^o$) is measured through aggregation of households in the micro data set. Innovations to the disposable income of household i are measured as $(y_{it+1} - y_{it}) - (g_{t+1} - g_t)$ for every year between 1991 and 2007.[15] The aggregate component of these innovations in disposable income at $t+1$ is then given by:

$$\frac{1}{N_{t,t+1}} \Sigma_{i=1}^{N_{t,t+1}} (y_{it+1} - y_{it}) - (g_{it+1} - g_{it}) \tag{19}$$

where only households who are present in both wave t and $t+1$ of the data set are included in the summation. $N_{t,t+1}$ denotes the number of households included. The summation adds to the aggregate component because idiosyncratic innovations cancel by the law of large numbers. The (time-series) volatility of the aggregate component in disposable income is estimated to 0.026. This is somewhat larger than

[15] For this period, there exists a consist variable definition for disposable income, called 'cdispl'. Financial income is extracted from this variable as in).

the number reported in Cocco (2005), 0.019. Part of this difference can depend on the difference in sample period. Cocco's series cover 1970 to 1992.

An interesting finding is that the aggregate component in households' disposable income is strongly positively correlated with the housing market. The top panel of figure 2 displays this feature of the data. Although the aggregate component in disposable income is small, its correlation with the nationwide housing market is as high as 0.63 and significant at the one-percent level (using only 17 observations of data!). [16] The addition of the idiosyncratic component of the permanent component of income, ν_{it}, does however reduce the correlation at the household level to 0.14, which is lower than the correlations that Yao and Zhang (2005) and van Hemert (2010) have used. Both of them set it to 0.2. The income process of Yao and Zhang (2005) is however different since they only consider a transitory shock to labor income. The magnitude of the correlation is similar to Cocco (2005) who finds a correlation of 0.553 in his data.

The bottom panel of figure 2 plots the same aggregate innovations to disposable income together with innovations to the MSCI All Country gross index (converted to SEK). The correlation is as high as 0.46 which is very different to the correlation that Cocco reports, 0.047. This can be a result of Sweden's high dependence of exports and thereby dependence of the state of the world economy. The correlation is however not significantly different from zero at any conventional level of significance. This gives two choices. Either, the variance of ε_t^o could be set to zero or it could be set to a number obtained using international data or to a number frequently used in the literature. To facilitate comparison with the existing literature, and to facilitate the match of the stock market participation rate, I choose to set the variance to 0.013^2 which implies a correlation between permanent labor income and the stock market equal to 0.1. This value is in between Gomes and Michaelides (2005) (who set it to 0.15) and Yao and Zhang (2005) and Cocco (2005) who set it to zero in their baseline calibrations. This implies that the volatility of the aggregate component in the model is 0.021 which is considerably lower than the one estimated in the data.

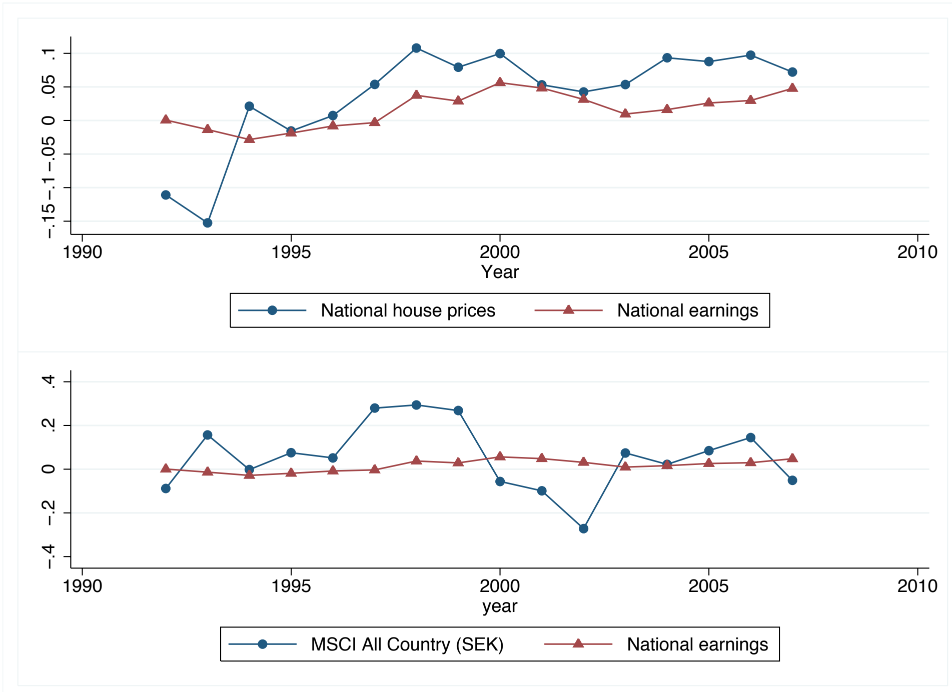
It is worthwhile to reflect on the findings on the aggregate component in disposable income to previous calibration strategies in the portfolio choice literature which abstract from housing. Several studies, such as Davis and Willen (2000), Lynch and Tan (2007) and Benzoni, Collin-Dufresne, and Goldstein (2007) focus on the correlation between household earnings and aggregate risks. By aggregate risk, however, these studies limit themselves to stock market risk. Since it is difficult to establish a correlation between labor income and the stock market it is therefore often said that household labor income is bond-like rather than stock-like. However, the strong correlation between disposable income and house prices suggests that labor income is house-like rather than bond-like in terms of its statistical properties.

The correlation between house price growth and the return on the stock market was moderately negative but insignificant between 1982 and 1996. After 1996 it has been positive but insignificant. Figure 13 in the Appendix displays a graph of this where the stock market is taken to be the MSCI All Country index.[17] In the calibration, I find a modest positive correlation to be plausible and set it to 0.15 which is a value also considered by Yao and Zhang (2005). In the results section I explore the effect of a zero correlation too.

[16] Figure 14 in the Appendix shows the same innovations, broken down to three regions and the three largest cities. The correlations at the this regional level are in the span 0.52-0.65 and are also significant at the one-percent level.

[17] The pattern is essentially the same if the MSCI index is replaced by the Swedish All Share index, SIXRX.

Figure 2: Innovations to House Prices, MSCI All Country and Household Disposable Income



3.1.3 Parameters for the Welfare System

The parameters $\underline{Y}$ and are set to mimic the Swedish welfare system. $\underline{Y}$ is set to 60,000 SEK as a lower bound to account for Swedish welfare assistance of roughly 5,000 SEK per month. $\bar{Y}$ is set to account for the ceiling in replacement rate in the public pension system. The ceiling is 7.5 times 45,000 SEK which I adjust upwards to by a factor of 1.5 to account for household size. The parameter λ is set to 0.65 which is said to be the average replacement rate in retirement in Sweden, including occupational pension.

3.2 Participation Cost and Risk Aversion

The parameter κ is set to 20,000 SEK which equals 2,600 USD. An important conceptual difference to most previous models is that the entry cost in this model is not proportional to productivity, $\exp(z)$. Thus, a higher level of productivity is unambiguously preferred to a lower value in this model.

A value of 20,000 SEK is within the range of typical parameter values in the literature, but on the high side. Cocco (2005) sets it to 1,000 USD only and Gomes and Michaelides (2005) sets it to 2.5 percent of permanent income[18] which on average corresponds to 1,000 USD given an average annual labor income of 40,000 USD. But there are also studies which use higher values, such as Gomes, Michaelides, and Polkovnichenko (2009) who set the cost of 5 percent of permanent income or Gomes and Michaelides (2008) who set it to 2,100 USD or Favilukis (2011) who set the one-time cost to 1,535 USD (on average) and in addition uses a per-period cost of 219 USD.

[18] Recall that most portfolio choice models scale the state space by permanent income or total wealth.

The risk aversion coefficient γ is set to five, which is standard. Such a high value limits the equity share conditional on stock market participation.

3.3 Housing Parameters

The other housing parameters are set as follows. The preferences parameter ω is set to 0.25. This value gives a reasonable match of consumption expenditure shares for renters (see table 17 in the appendix).

The rent-house value is set to $\tau = 0.05$ which is reasonable given Swedish rent values which at the present remains somewhat subsidized in metropolitan areas. Yao and Zhang (2005) set it to 0.06 for the U.S. economy. The maintenance cost for home owners is set to $\chi = 0.043$ which is motivated as follows. In the model, the per-period difference in home expenses for similar housing units, ignoring foregone asset returns, is given by $\tau - \chi - (1 - \delta) \cdot r_f$. Given the other parameter values, $\chi = 0.043$ implies a per-period difference equal to zero. Given the expected appreciation in house prices, there is still a long-term gain from home ownership built into the model, as equation (23) indicates. Yao and Zhang (2005) set the maintenance ratio to 0.015 but consider also 0.025. Another way to motivate a high value for χ is to consider the cross-sectional distribution of maintenance cost in the Swedish Household Budget Survey. Table 15 in the appendix shows that the median value among home owners is 0.015 but that there is considerable variation and skewness to the right. For instance, at the 75th percentile the maintenance ratio equals 0.032. Note also that these values only consider the monetary cost of maintenance, not the time and effort that home owners put in for maintenance.

The minimum house value available for purchase is set to $\underline{h}$ = SEK 500,000 (approx. USD 67,000). This can be compared to the average house value which is close to SEK 1,500,000 according to table 2. It can also be compared to the cross-sectional variation in LINDA among households whose heads have high school education. Table 15 in the appendix shows that the value at the 30th percentile equals 434,000 SEK and 576,500 SEK at the 40th percentile.

3.3.1 Down-Payment Requirement

Typically, the literature assumes a flat down-payment requirement throughout life of 20 percent of the home value ($\delta = 0.2$). A complexity when determining this number is that households in the model borrow at the risk-free rate whereas in real life not even generous tax deductions make the paid interest rate that low. This suggests that δ should be set to a higher value than the claimed minimum down-payment in real life.[19]

To improve our understanding of households' down payments, table 16 in the Appendix reports how it varies over age. For the table, households who transits from being renters to home owners in the panel data set have been singled out. This sample restriction is important since δ in the model represents the minimum down-payment requirement, which is likely to not be a binding constraint among households who have been home owners for a long time given the steep house price increase in the 2000's. Among the households the median leverage ratios are reported. The table shows that leverage is non-monotone over life. It reaches it peak around age 35 and is lower among both younger and older households. It is reasonable that this pattern arises due to factors such as credit scoring, income security, stability of the

[19] For the time period considered, it was said to be 0.1 in Sweden. In 2010, it was then raised to 0.15.

household structure, and health status.

As a reasonable compromise between the variation in the data, and the fact that borrowing rates in real life is not equal to the risk-free rate, I set δ to 0.30. It implies that the value is almost twice as high as the value for the 35-year old households but only marginally higher than the median values among 25 and 45 year-old households. Yao and Zhang (2005) and van Hemert (2010) use a value of 0.20, which seems too low given the difference in the rate between mortgages and the risk-free rate. Cocco (2005) uses a value of 0.15 but sets a spread of two percent between the risk-free bond rate and the interest rate on mortgages.

3.3.2 Purchase and Selling Costs

To improve the match of the home ownership rate I separate the purchase cost, ϕ_b, from the sale cost, ϕ.

The purchase cost is set to eight percent. It can be argued that such a high value is needed to capture both taxes and search costs that buyers face. In Sweden, house buyers face 1.5 percent tax upon the registration of the title deeds. The registration of mortgage deeds costs another 2 percent.[20] The remainder of ϕ_b (4.5 percent) can be interpreted as an actual cost for moving and renovations made to the home as a result of idiosyncratic taste.

The relatively high value of ϕ_b dampens the home ownership rate among the young. To allow for a substantial shift towards renting at the end of life, as in the data, the selling cost is set to a modest $\phi = 0.02$. It can be motivated by few costs associated with a sale. For instance, none of the costs associated with a purchase apply at the time of a sale. Sellers in Sweden do however face a brokerage fee of around two percent. Typical values for the transaction costs considered in U.S. calibrations are in the range of six to ten percent.

3.4 Internal Parameters

In the baseline calibration, I consider a model with two types of households which differ in terms of preferences. The first type has preferences such that its savings motive is small and the second type has preferences such that its savings motive is greater. Each type has equal population weight. The aim is to match the profiles for housing wealth, net worth and financial assets as well as possible. I let three parameters determine the households' savings motive, namely β, ρ and γ It turns out that β=0.92 (together with the high value of δ) provides a good fit for net worth up until mid-life so I fix the discount factor to this value for both types.

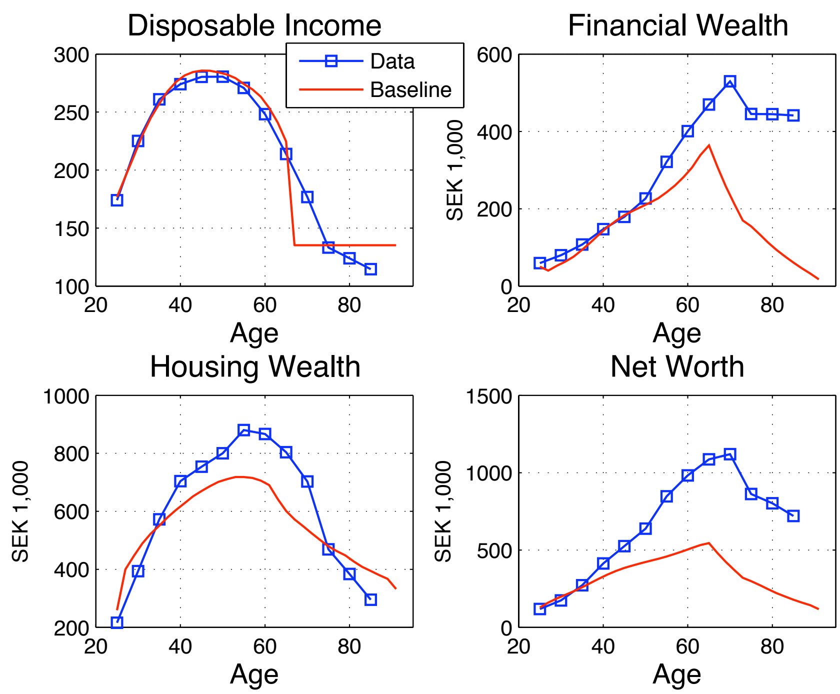
As in Gomes and Michaelides (2005, 2008), Guvenen (2009) and Alan (2011), I let the risk aversion coefficient and EIS vary between the two household types. I choose to endow the first type with with CRRA preferences and risk aversion coefficient equal to 1.2 ($\gamma = \rho = 1.2$). This type has a small savings motive.

For the second type, the one with a greater savings motive, I choose to set the parameters for risk aversion equal to five ($\gamma = 5$) and the EIS to 0.33 ($\rho = 3$). A value of ρ which is smaller than γ prevents over-saving. The logic behind the effect on savings of this parameter choice is the same as in Gomes

[20]These costs apply for houses. The costs are smaller for apartments purchases.

and Michaelides (2005). A high value of risk aversion stimulates savings but this can be off-set by the elasticity of intertemporal substitution.

Figure 3: Mean Assets



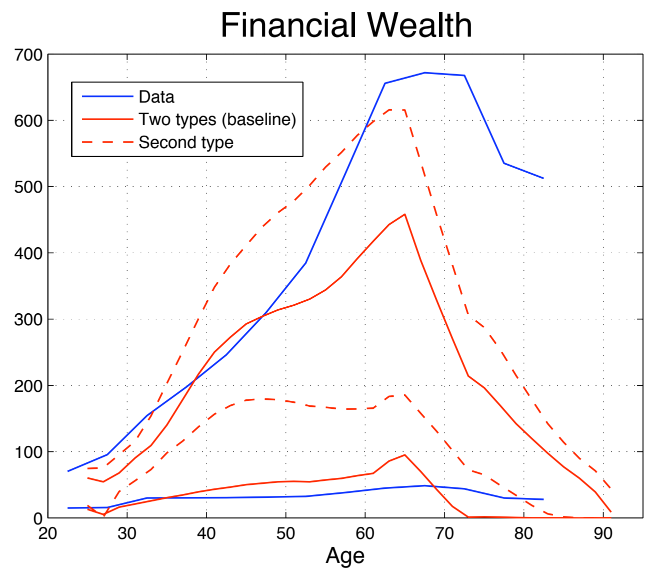
Note: The figure displays cross-sectional means of disposable income, financial assets, housing wealth and net worth. Data from year 2000 (restricted to households whose heads have high school education). The model means are based on simulations of 5,000 households.

Figure 3 displays the fit of the life-cycle profiles given this choice of parameter values.[21] The fit is very good for financial wealth up until and the profile for housing wealth is also matched quite well. Net worth is matched well early in life up until age 45. After age 45 or 50, the fit could be improved further if a bequest motive was introduced. Due to the nature of the participation cost structure (a one-time cost, typically paid early in life), it is however unlikely that the current discrepancy late in life would give rise a very different life-cycle profile for stock market participation.

A big advantage of the two-type model is that it can generate greater wealth inequality, i.e. sufficient cross-sectional dispersion in for instance financial wealth. Figure 4 shows the interquartile range for financial wealth, i.e. the 25th and 75th percentile, in the data, in the baseline two-type model and as comparison the same percentiles for the second household type, only. As can be seen, the second type does not by itself contain enough dispersion. This is true even early on in the life-cycle. Particularly far off is the 25th percentile, which overshoots by a lot. If a such a model calibration would stand on its own (i.e. if this type would be given the full population weight) too few households would be poor and the stock market entry cost would be too small relative to the poorest households' accumulated financial savings.

[21] Just as for the other results in section 4.2 the figure was produced by simulating 5,000 households of each type, with the initial conditions of table 18 in the Appendix.

Figure 4: Interquartile Range for Financial Wealth (P25-P75)



Note: The figure displays percentile 25 and 75 for financial wealth in the data, for the second type and for the two types (the baseline model). Data from year 2000 (restricted to households whose heads have high school education). The model results are based on 5,000 simulations of each household type.

4 Model Results

This section reports the results of the model. Section 4.1 displays the policy functions of the model which provide a great deal of intuition for how the savings motive and the willingness to enter the stock market is determined for renters and home owners. Section 4.2 reports simulations of the model. Section 4.3 demonstrates how the results change if some of the parameter values are changed. Finally, section **??** reports the result of a simple experiment with preference heterogeneity.

4.1 Decision Rules

This section analyzes the model decision rules for households of the same age as in table 4 who earn a labor income which is average within the age group. Home values are also picked according to the values reported in panel A and B of that table. Using the terminology introduced in section 2, the group of home owners is broken down into those who stay in a home and households who purchase a home. The group of stayers is in turn broken down into owners of small homes and owners of large homes. Behavior at an early stage of the life cycle is also compared with behavior at middle-age since the savings motive for retirement is greater closer to the peak of the hump-shaped income profile.

Table 4 gives empirical guidance for which policy functions to focus on (in terms of home values). It shows the characteristics of households whose heads are 30 to 31 years old (panel A) and 44 to 45 years old (panel B). Small home owners are defined as those households who own a home smaller than the median value within the age group. Consequently, large home owners are defined as those households who own a home greater than the median within the age group. The sample is restricted to those households

Table 4: Summary Statistics: Stock Market Participation

Household group	Renters	Small homes	Large homes
Stock market participation	57.4%	75.0%	78.5%
Age	30.5	30.5	30.5
Disposable income, kSEK	254	256	256
House value, kSEK	0	429	1522
Net worth, kSEK	-63.8	123	845
Observations	3,888	2,236	1,987
	Panel B: 44-45 years		
Household group	Renters	Small homes	Large homes
Stock market participation	48.4%	77.8%	85.5%
Age	44.5	44.5	44.5
Disposable income, kSEK	353	354	355
House value, kSEK	0	589	1951
Net worth, kSEK	-55.7	327	1427
Observations	2,023	4,442	4,227

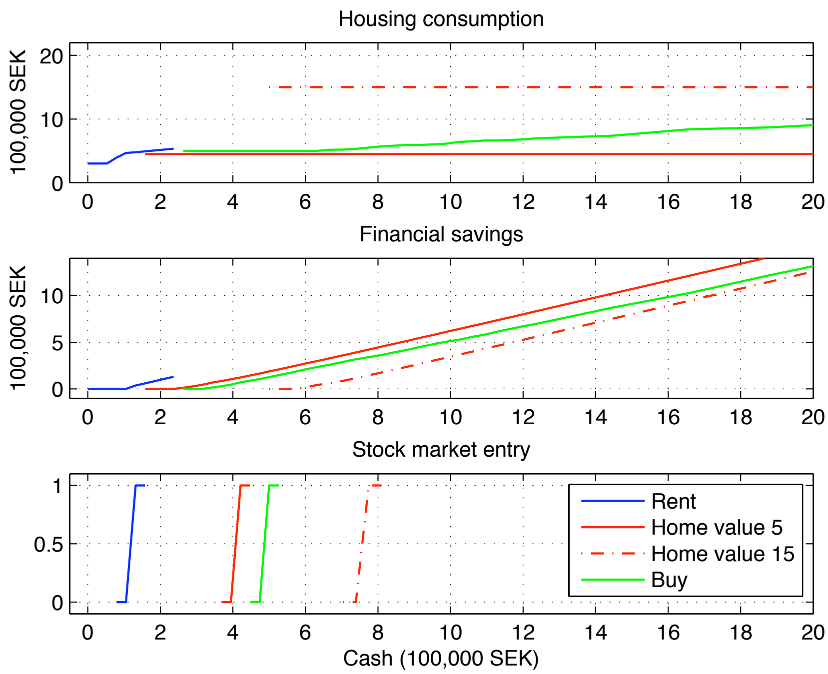
Note: The table reports summary statistics for the households that are selected for the comparison with the model decision rules. For all age groups households with disposable income in the interval of the 45th to 55th percentile were selected. For the 30-31 year-old age group this corresponds to 233 to 277 kSEK. For the 44-45 year-old age group the interval corresponds to 334 to 374 kSEK. Small homes are defined as a home value below the median home value within the age group. The median home values are 784 kSEK (30-31 years), and 977 kSEK (44-45 years).

who have a disposable income around the median within its age group, specifically disposable income is restricted to range from percentile 45 to 55.

Figure 5 displays the policy functions for housing consumption, financial savings and stock market entry for a household whose head is 30 years old and whose permanent income equals the average in that age group. Combined, the two top panels display the total savings motive of different households since they depict the optimal decision rules with respect to housing choice and financial savings. To understand the household's incentive to enter the stock market it is enlightening to consider the household's motive to save in financial assets because Gomes and Michaelides (2005) show that the entry decision is driven by the savings motive and not by the degree of risk aversion. The overall savings motive is in turn determined by both life-cycle and precautionary considerations (and the latter factor is indeed determined by risk aversion). The bottom panel shows the trigger point, in terms of cash in hand, for stock market entry.

Going through each of the three panels, the top panel shows that at a fairly low level of cash-in-hand it is no longer to optimal to rent. Instead, the household chooses to buy a home. Due to the fact that housing transactions are costly, households who own a small home (equal to 500,000 SEK) or a large home (1,500,000 SEK) choose to stay. These bounds on net worth are often referred to as (s,S) bounds in the literature. Note that the (s,S) bound for the small home and the bound for the large home are overlapping. Home owners who stay in homes which are different from the home buyer's choice of home value, compensate by saving less or more in financial assets, as can be seen in the middle panel. The renter represents an extreme case in this sense. Renters choose to save in financial assets at lower levels of cash-in-hand and their marginal propensity to save (the slope of the savings function) is greater than the ones of home owners. If average renters and home owners are considered in terms of stock market entry, it is clear that the relatively poor renter faces a trade-off in terms of either paying the entry cost or saving more in bonds. It turns out that just below the level of cash in hand that triggers a home purchase the renters chooses to enter the stock market, as can be seen in the bottom left panel. At the other extreme, the owner of the large home chooses to enter only at substantially higher levels of cash-in-hand, much higher than the trigger point of the owner of the small home or the trigger point of the home purchaser.[22] The policy functions for 45 year-old households that match panel B are very similar to the ones of 30 year-old households. They are therefore not reported but available upon request.

Figure 5: Policy Functions at Age 30 for the Second Type

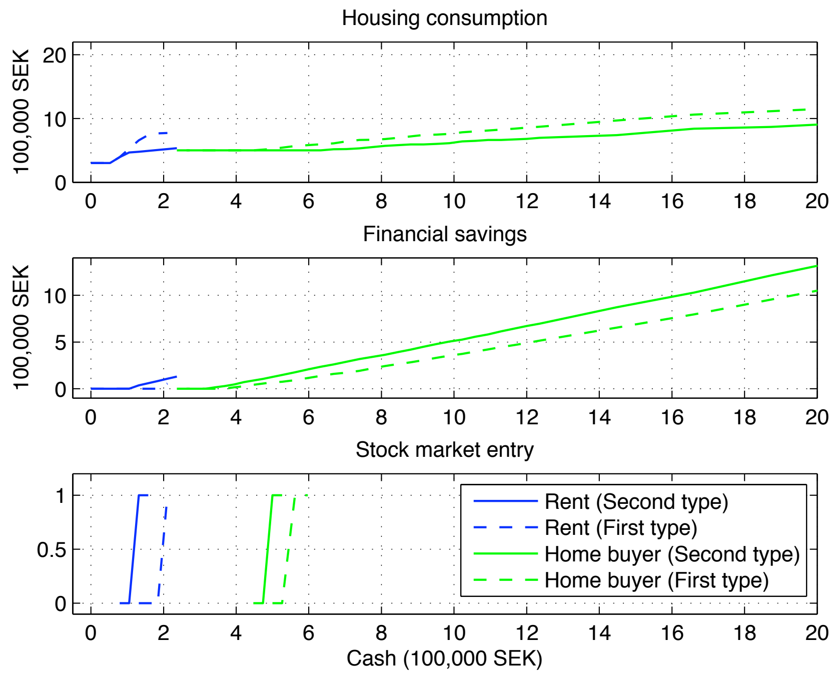


Note: The three panels show the optimal decision rules in terms of housing choice, financial savings and stock market entry for the second type, i.e. households with $\gamma = 5$ and $\rho = 3$. The decision rules for stock market entry are binary. The permanent income of the household is equal to the average among households whose head has a high school education and is 30 years old. Cash-in-hand (X_t) is defined as net worth plus disposable income.

Figure 6 shows the renter's and home buyer's policy functions for both household types (thus some of the policy functions from figure 5 are reproduced). As can the be seen in the first panel, the first type with the smaller savings motive consumes more housing services, both as a renter and as a home owner. Consequently, the second panel shows that the first type saves less in financial assets. This, in turn, has consequences for the incentive to enter the stock market. The third panel shows that the trigger point for stock market entry, in terms of cash in hand, is a lot greater for the first type. If being a renter, the first type enters the stock market just below the point that triggers a home purchase. This trigger point is rougly 100,000 SEK above the trigger point of the second type. Interestingly, the difference in trigger point between the two types is somewhat smaller for home buyers.

[22]It is also worth to note that the home purchaser's financial savings gradually go from being equal to the small home owner's savings to the large home owner's savings as one moves along the horizontal axis. In effect, the large home owner enters the stock market if the value of her home is not too different from the optimal home, defined by the home purchaser's choice of home.

Figure 6: Comparison of Policy Functions between the Two Types



Note: The figure displays policy rules for both types of households at age 30. The first type has CRRA preferences ($\gamma = \rho = 1.2$) and the second type has preferences equal to $\gamma = 5$ and $\rho = 3$. Permanent income of the household is equal to the average among that age group. See figure 5 for additional details.

Overall, the following can be concluded from figure 5 and 6. Renters enter at much lower levels of wealth (cash in hand minus disposable income, which is held constant in the figure). In this sense, the figure reveals that the crowding out effect highlighted in Cocco (2005) operates also in a model with an endogenous rent-own decision. This is promising in terms of the model's ability to generate non-participation. In terms of new insights, the figure shows that the fraction of renters who participate in the stock market is likely to be low if the trigger point (in terms of cash-in-hand) for stock market entry is close to the trigger point for home ownership. In practice it could even be the case that the trigger point for home purchase could be lower than the trigger point for stock market entry, which is almost true for the first household type with low risk aversion. Ultimately, the fraction of renters who participate in the stock market will be a quantitative issue, which is further explored in section 4.2.

4.2 Simulation Results

This section presents the main model results. They are based on simulations of 5,000 households of each type. The initial conditions, e.g. starting values for disposable income, financial assets and housing wealth at age 25, are reported in table 18 in the Appendix. Notice that all households start outside of the stock market. Hence, they all need to pay the participation cost κ. This is standard in the literature but prevents a good fit in the beginning of the life-cycle since the stock market participation rate in the data is substantially higher than zero even at an early age.

4.2.1 Home Ownership Profile

A growing literature in macroeconomics pays a great deal of attention to the matching of the life-cycle profile of home ownership. The emphasis on the home ownership rate over the life-cycle is motivated by the fact that this feature of the data is thought to give important information about the types of frictions that surround the housing market (see e.g. Chambers, Garriga, and Schlagenhauf, 2009; Fisher and Gervais, 2009 and the discussion in Halket and Vasudev, 2009).

Macro contributions aside, this study is the first to pay attention to this of the data in a portfolio choice context. Given that the aim is to investigate limited stock market participation among renters and home owners it is important to generate renters endogenously in the model for several reasons but first and foremost, it is not possible to study endogenous choice of stock market participation among renters unless a subset of households choose to rent in the model.

Although the fit to the data is not perfect, column 5 of table 5 shows that there are households in the model who choose to rent in all stages of the life-cycle. The home ownership rate does however overshoot among young households and peaks earlier than in the data, displayed in column 4.

The fact that the home ownership rate is greater in the model is because of the down-payment constraint's and the purchase cost's inability to off-set the favorable risk-return characteristics of the housing asset. It has the same expected return as the risk-free bond, but unlike the bond it provides a hedge against house price risk. That is, if houses appreciate (and rent levels increases) then the home owner is compensated through an increase in home equity. This effect of home ownership as providing a hedge is explored in Sinai and Souleles (2005). They find that house prices relative to rent levels, as well as the home ownership rate, increase with the amount of rent risk. The model does however produce renters at all stages of the life-cycle, in contrast to, as column 2 shows, Yao and Zhang (2005) who essentially produce only home owners in their simulations except at the very beginning of life.[23] Column 3 and 6 report the absolute differences between the models and the data. The numbers show that overall, the life-cycle profile is somewhat better matched to Swedish data than Yao and Zhang's calibration to the PSID. This is despite the fact that the home ownership rate is lower among Swedish households whose heads have high school education than among U.S. households whose heads have a college degree (the sample of Yao and Zhang, 2005).

The fact that the home ownership profile is matched in at least in a qualitative sense (i.e. a hump-shape over the life-cycle) is satisfying because household in the model view housing wealth and savings in financial assets as substitutes. If the home ownership rate is not matched at least qualitatively , then this is an indication that the investment opportunity in housing has not been correctly specified and that this misspecification in turn could spill over to a misspecified demand for stocks and bonds.

In addition to the home ownership profile, I match the moving rates of home owners reasonably well by including exogenous moving shocks. The probability of being forced to move is conditional on age. They are meant to capture life circumstances that are not present in the model, such as career concerns, divorce, etc. The probabilities are based on changes in parish, the smallest administrative region, in the data. The total moving rate for home owners fits the data reasonably well since the endogenous moves are infrequent and the exogenous ones are calibrated to the moving rates observed in the data.[24]

[23] This is also true for van Hemert (2010).

[24] Statistics on the frequency of exogenous and endogenous moving rates are available upon request.

Table 5: Home Ownership Rate Relative to the Data and the Literature

	USA			Sweden		
Age	PSID	YZ	Abs. Diff.	LINDA	Model	Abs. Diff.
<35	0.51	0.31	0.20	0.52	0.74	0.22
35-44	0.79	1.0	0.21	0.72	0.93	0.21
45-54	0.86	1.0	0.14	0.76	0.92	0.16
55-64	0.89	1.0	0.11	0.78	0.83	0.05
65-74	0.90	1.0	0.10	0.70	0.65	0.05
74>	0.78	1.0	0.22	0.51	0.63	0.12
Sum	-	-	**0.98**			**0.81**

Note: The home ownership rate for the USA reported in column 1 is based on the PSID 1984-2001, as reported in Yao and Zhang (2005). Column 2 (YZ) reports the home ownership rate generated in Yao and Zhang (2005) (taken from table 1, column 1). Column 3 reports the absolute difference between column 1 and 2. Column 3 to 6 report the same statistics for this model.

Table 6: Stock Market Participation Relative to the Data and the Literature

	USA			Sweden		
Age	PSID	Cocco	Abs. Diff	LINDA	Model	Abs. Diff
<35	0.26	0.02	0.24	0.66	0.35	0.31
35-49	0.34	0.21	0.13	0.70	0.65	0.05
50-64	0.32	0.62	0.30	0.71	0.81	0.10
65>	0.27	0.73	0.46	0.58	0.84	0.26
Sum	-	-	**1.13**	-	-	**0.72**

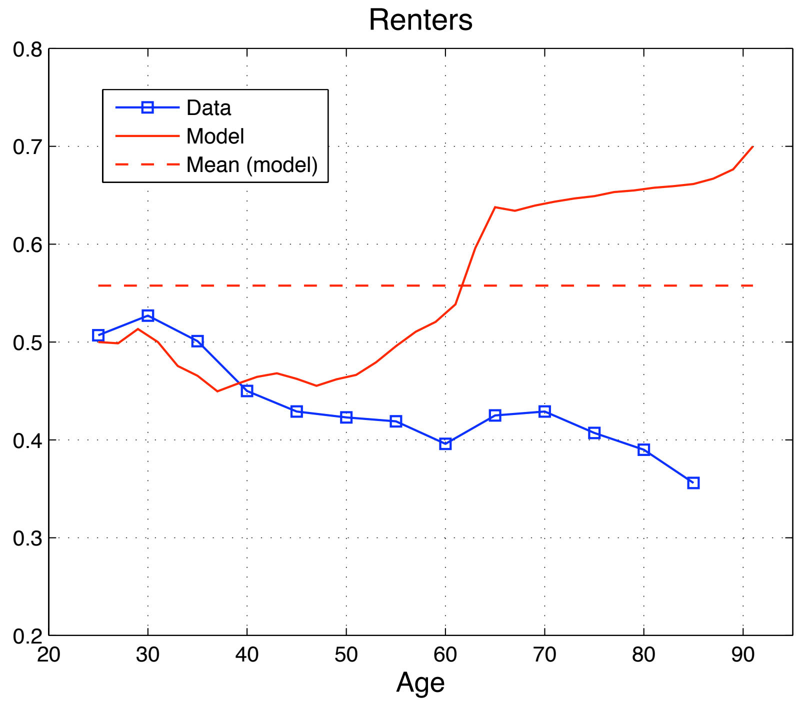
Note: The stock market participation rates in the PSID are from table 9 of Cocco (2005) and are based on the 1989 wave of the PSID. The participation rates in Cocco's model are taken from table 5. Column 3 reports the absolute difference between the PSID and the model of Cocco. Column 6 reports the absolute difference between the LINDA data set and the model.

4.2.2 Stock Market Participation

This section reports the stock market participation rates in the model. Table 6 reports the participation rate for both renters and home owners combined over the life-cycle. It also reports the stock market participation rate in the USA and in the model of Cocco (2005). Comparing column 4 and 5, it is clear that the baseline calibration of the model produces a little too much stock market participation from mid-life and onwards. This is particularly the case among the older households since the the participation rate falls in the data. The deviation in the beginning of life could possibly be addressed by letting some households start their life as stock market participants.

Relative to Cocco (2005), however, the deviations are much smaller at all stages of the life-cycle except among 35- to 49-year olds. The reason is that in Cocco's model, the participation rate increases too much over the life-cycle. The crowding out effect (of home equity on financial savings) seems too large among the young, who are relatively poor, and among the old no other mechanism in the model of Cocco (2005) prevents the stock market participation rate from over-shooting. In this sense, the model with an endogenous rent-own decision provides a drastic improvement of the life-cycle profile since some households choose to rent when young.

Figure 7: Stock Market Participation Among Renters



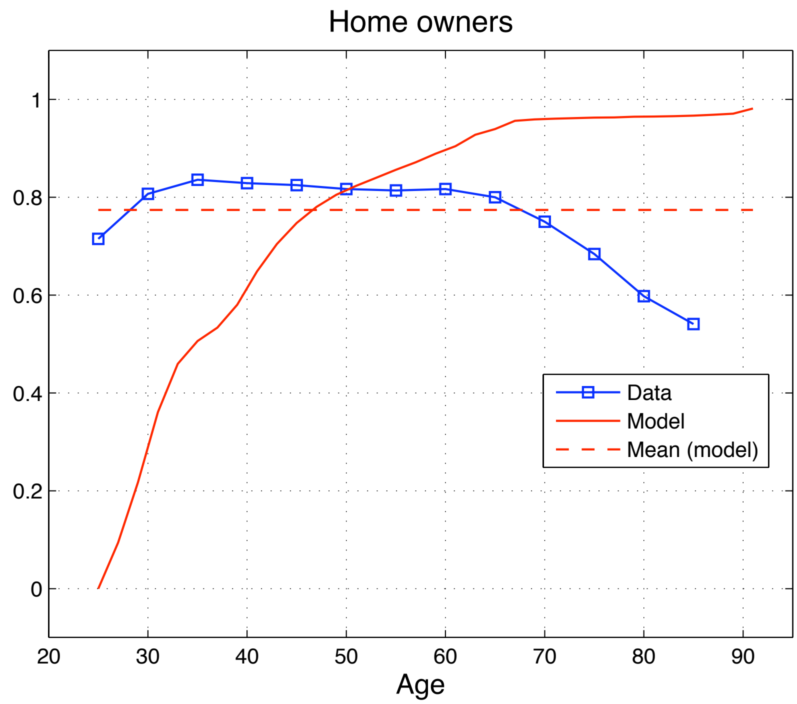
Note: The figure displays the stock market participation rate over the life-cycle among renters in the data and for a simulation of the model. The dashed line shows the mean participation rate in the model. The simulation is based on 5,000 households of each type.

Figure 7 and 8 report the life-cycle profiles of stock market participation for renters and home owners. Starting with the participation rates of renters in figure 7, the first striking feature is the life-cycle profile in the data. The rate is higher among the young than among the older and the rate gradually falls between age 30 and age 60. Qualitatively, the model is able to replicate this pattern, although the participation rate is slightly higher. To be precise, the mean participation rate for renters is 44 percent in the data and 55 percent in the model. Before retirement, the fit is even better with corresponding rates of 49 and 45 percent. Hence, the fit is less good late in life, most likely driven by many real-world factors which are not present in the model. For instance, around the time of retirement (age 65) the change is particularly noteworthy in the model, a result of the assumption that retirement income is safe throughout the remainder of life.

The U-shaped life-cycle pattern has previously not been highlighted in the literature. The explanation for it is the sorting that takes place endogenously. As the home ownership rate increases with age (from young to middle-age), the characteristics (e.g. labor income, adjusted relative to the age profile) in the population of renters deteriorates. This leads to the gradual fall in the stock market participation rate. Then, when the home ownership rate falls, the characteristics of renters gradually improve and the stock market participation rate increases. It is worthwhile to emphasize that no model before has produced this pattern of stock market participation among renters since it requires *both* an endogenous home ownership-rent decision *and* an endogenous stock market participation decision.

Moving to the stock market participation among home owners, displayed in figure 8, there is also a good fit between the model and the data. On average, the stock market participation rate in the model is

Figure 8: Stock Market Participation Among Home Owners



Note: The figure displays the stock market participation rate over the life-cycle among home owners in the data and for a simulation of the model. The dashed line shows the mean participation rate in the model.The simulation is based on 5,000 households of each type.

77 percent, and 76 percent in the data. From age 25 to age 50, the participation rate is low in the model, lower than in the data. The explanation follows the logic of the policy functions presented in section 4.1 namely that as households make the transition from being renters to being home owners, savings in financial assets are crowded out.[25] The fit is also good from age 50 to age 60, with a deviation of less than ten percentage points. Once the household receives a safe retirement income, however, the discrepancy is greater.

In sum, the analysis of this section shows that the model matches several features of the data. In particular, the model endogenously matches the mean stock market participation rate of home owners and the rate among renters is much lower than among home owners. Before retirement, the model matches participation rate among renters almost perfectly. Overall, this results in a mean participation gap of 22 percentage points in the model whereas it is 32 percentage points in the data (for households whose heads have high school education).

4.3 Comparative Statics

This section discusses how the model responds to changes in some of the parameters. In turn, I consider a change in the preference parameters of the second type to CRRA type, a change in the correlation between house price growth and the return on the stock market and decrease in the down-payment requirement. Figures 17 to 23 in Appendix F.3 accompany this analysis.

[25]With initial conditions that allow some home owner to participate right from the outset it is possible that the fit early in life would be better.

4.3.1 CRRA Preferences vs. Epstein-Zin Preferences of the Second Type

In the baseline calibration, the second household type is endowed with relative risk aversion equal to five and an EIS equal to 0.33. If the EIS is lowered to 0.20 so that preferences are equal to constant relative risk aversion (CRRA with a coefficient of 5), there is a dramatic effect on savings. Households respond by smoothing consumption less and saving more. Both asset accumulation and stock market participation rates are counterfactually high. This can be seen in figure 17 and 18 which compare the second type of the baseline calibration with a household with CRRA preferences. It is noteworthy that the change primarily affects financial savings whereas the response to housing wealth is much smaller. Figure 19 displays another disadvantage with CRRA preferences. The figure compares the interquartile range for financial wealth in the baseline calibration (i.e. both household types are included) with an alternative calibration that mixes the first household type of the baseline calibration with the CRRA=5 type. Evidently, financial savings overshoot quite a bit in this alternative calibrations which restricts preferences to the CRRA class.

4.3.2 Lower Correlation Between the Housing Market and the Stock Market

Intuitively, the correlation between the housing market and the stock market seems to be a very important calibration choice. However, figure 20 shows that the effect on asset accumulation is quite small. A change in the correlation does however affect the stock market participation rate of renters and home owners asymmetrically. Figure 21 shows that it reduces the attractiveness of stock holdings for renters (since it now not even provides an imperfect hedge for house price risk) but increases the attractiveness of stocks holdings for home owners. The reason is that with a low correlation stock holdings provide improved diversification to home owners whereas it no longer provides a partial hedge for house price risk for renters.

4.3.3 Smaller Down-Payment Requirement

A smaller down-payment requirement of 20 percent mainly affects the home ownership rate among the youngest households who now can afford the down-payment. It also stimulates financial savings, while net worth remains intact relative to the baseline calibration (this is displayed in figure 22). The fact that the home ownership rate increases in turn implies stronger sorting between renters and home owners. As a result, the stock market participation rate among renters decreases quite a bit (see figure 23). The participation rate among home owners is however virtually unaffected.

5 Regressions

This section exploits the fact that the sample size of the Swedish data set is large and that there is an annual longitudinal (panel) dimension of the data. This feature of the data set enables a focus on future home owners, who currently rent, and households who used to rent but recently purchased a home. By categorizing households in this way, it is possible to separate the effect of (constant) unobservable differences between renters and homeowners from the direct effect of a home purchase on financial portfolio choice. Furthermore, comparisons between model and data can be made along this longitudinal dimension.

This can be viewed both as an empirical investigation of the crowding out effect of housing and an empirical test of one of the main mechanisms of the model.

To estimate the effect of a home purchase, I employ a Differences-in-Differences (DiD) regression. To formalize the approach, let time t be defined as the year relative to a home purchase. The home purchase takes place in year $t = 0$. The implementation then formalized in equation (20) to (22):

$$Pr(D_{it}^{P}) = f(\Psi_{it}) + \varepsilon_{it} \tag{20}$$

In the first stage, the regression in (20) is estimated using OLS on all households i in the sample in all years t. The choice of covariates to include in Ψ_{ij} is largely motivated by the state variables of the model. These covariates are the age of the household head, net worth and disposable income.[26] In the regressions on the LINDA data set a few additional variables are included to control for features of the real-world environment that are not present in the model. These variables are first of all year dummies (i.e. time effects) and education dummies for the household head but also a variable for the number of adults in the household. Care is given to properly account for wealth and income effects since there is considerable skewness in the Swedish earnings and wealth distributions, just as this is well-known to be the case in the U.S. data. This can be seen in figures 10 to 12 of the Appendix which report the cross-sectional distributions of disposable income and net worth. Therefore, I include ten-piece linear spline functions in net worth and in disposable income, as well as in the age of household head.

Equation (21) and (22) describe two versions of the second stage. In both versions, the dependent variable is the residuals from the first stage among the future and recent home purchasers, i.e, those households that can be categorized into the time periods -2,-1,...,2 relative to the home purchase at time zero.[27] In the first version, equation (21), the residuals from the first stage are regressed on a constant and the dummy that indicates whether the household has purchased a home, $D(0 \leq t \leq 2)$. This implies that the time dimension is collapsed into to two periods, a "pre" and "post" home purchase period. This is a convenient approach to account for serially correlated error terms, as discussed in Bertrand, Duflo, and Mullainathan (2004). It is also a convenient specification to qualitatively illustrate the effect in tables.

$$\varepsilon_{it} = \alpha + \beta \cdot D(0 \leq t \leq 2) + \hat{\varepsilon}_{it} \tag{21}$$

Another version of the second stage is defined by equation (22). In that version, the time line covers five distinct periods and is not collapsed into two periods. Separate time dummies are included for each of the years -2 to 2. This specification is illustrative for plots.

$$\varepsilon_{it} = \alpha + \beta_{-2} \cdot D(t = -2) + ... + \beta_2 \cdot D(t = 2) + \hat{\varepsilon}_{it} \tag{22}$$

[26]Notice that in the model cash in hand equals disposable income plus net worth. In the regressions I do however choose to include the two of them as separate covariates.

[27]Using the DiD terminology, the sample in the second stage consists of the households that undergo treatment, only.

Most similar to this analysis is Chetty and Szeidl (2010). They use a model similar to the one in Chetty and Szeidl (2007) to motivate the use of a specific regression framework.[28] The framework can be used to understand the role of home equity and mortgage balances for portfolio choice through analytical decision rules. They use the Survey of Income and Program Participation (SIPP) to run a regression similar to the one of this paper. However, the Swedish data set is much higher quality since Chetty and Szeidl (2010) only retain four percent of their sample over two waves. Further, the sample for their panel analysis consists of only 2,784 households.[29]

Apart from Chetty and Szeidl (2010), the existing empirical literature the study of stock market participation rates between renters and home owners has been given little attention. The relationship between home ownership and portfolio choice has typically been studied in terms of choice of equity share conditional on selection into the stock market in a first stage. Curcuru, Heaton, Lucas, and Moore (2004) and Kullmann and Siegel (2005) use selection models to investigate the role of housing wealth for both stock market participation and equity shares conditional on participation. In the selection stage, Curcuru, Heaton, Lucas, and Moore (2004) report a positive effect of home equity to net worth and a negative effect of the house value to financial wealth on participation. Kullmann and Siegel (2005) report a positive effect of the house value and a negative effect of the riskiness of the house value. However, as most of the literature, the focus of these studies is on the effect on the equity share, conditional on participation, rather than the participation decision. One limitation with such cross-sectional regressions is that it is not possible to disentangle the effect of home ownership from households fixed effects. In Appendix A.1 I demonstrate that such regressions would lead the econometrician to conclude that the effect of home ownership on stock market participation is positive, a result that the following DiD-regressions below challenges.

5.1 LINDA

Table 7 reports the DiD results for the specification given by equation (20) to (21). The estimate in column 1 is based on the full sample of households (except for the exclusion of the wealthiest one percent, discussed in section 1.1). The intercept in the second stage regression reveals that current and future home purchasers are on average 7.6 percentage points more likely than the average Swedish household to be stock market participants, controlling for observable characteristics (Ψ). However, upon the home purchase the likelihood of participation decreases by 10.8 percentage points. Evidently, many home purchasers sell their stocks or mutual funds to fund the down-payment. Column 2 to 5 present estimates based on variations in the set of covariates included in the first stage and based on different sample restrictions in the second stage. The exclusion of apartment buyers (column 2) changes the estimated effect just a little bit and the inclusion of six regional dummies (one each for the three biggest cities plus "south", "middle" and "north") has essentially no effect, as seen in column 3. The heated housing market in Stockholm does however make its mark because once households who reside in Stockholm are excluded (column 4) the effect is reduced from from a negative of 10.8 to a negative of 9.5 percentage

[28]Chetty and Szeidl (2007) investigate the role of consumption commitments for portfolio choice in a model without a full life-cycle, without income uncertainty using somewhat non-standard preferences.

[29]In addition to the panel analysis, Chetty and Szeidl (2010) also use instrumental variable techniques and a selection model to establish a casual negative effect of mortgage values and a casual positive effect of home equity for both stock market participation and the equity share conditional on participation.

points. Conversely, once the sample is restricted to households in Stockholm (column 5) the estimated effect is minus 14 percentage points.

As an alternative illustration, figure 9 shows the effect for the main same sample of column 1 in table 7, but based on the other version of the second-stage regression defined by equation (22). The likelihood of participation is constant at $t = -2$ and $t = -1$. Then there is a distinct drop at $t = 0$ and a modest insignificant increase from $t = 0$ to $t = 2$.

In all of the specifications in column 1 to 5, a negative effect of home purchase in the order of 9.5 to 14 percentage points is found. It is noteworthy that the intercept term in the second stage is positive and only slightly smaller, in absolute magnitude, than the effect of treatment. This can be viewed as evidence that unobserved heterogeneity between home owners and renters is important and that regressions on cross-sectional data sets are problematic for at least two reasons. First, the effect of unobserved heterogeneity between renters and future home owners, measured as the average residual for households who are at $t = -2$ or $t = -1$ (7.6 percent), and the crowding out effect of home equity on stock market participation (minus 14 to minus 9 percent) tend to cancel each other out. Second, the inclusion of a home ownership dummy in a cross-sectional regression (see table 11 in the Appendix) yields a positive estimate simply because of the unobserved heterogeneity between the renters and home owners.

It is also worth to note that the stock market participation rate before the time of the purchase is 62.1 percent in the main sample of column 1, implying that 17 percent of the home purchasers leave the stock market completely (controlling for the observable differences in the first stage). For the Stockholm sample in column 5, the stock market participation rate equals 61.7 percent before the home purchase, implying that 22 percent of all home purchasers based in Stockholm exit the stock market entirely.

Finally, column 6 of table 7 considers an alternative specification. In this specification, the second stage sample consists of households who own a home already at $t = -2$ and then upgrades to a home of greater value at $t = 0$. In particular, only upgrades to a house, not apartment, are considered since such purchases are recorded in the real estate registry. In addition to a recorded transaction in that registry, the sample is also limited to those households who own real estate of greater value at $t = 0, 1, 2$ than at $t = -2, -1$. Thus, this specification considers the effect on stock market participation of an intensive margin adjustment of housing. The effect is significant and estimated to a negative of 1.7 percentage points. This is however a lot smaller than the effects of column 1 to 5.

5.2 Model

Turning to the effect of home purchase in the model, I run the essentially the same regression on model-generated as on LINDA. There however a few discrepancies in the details. The first difference is that one period equals two years in the model so that the term $\mathrm{D}(0 \leq \mathrm{t} \leq 2)$ in fact covers four years but only to two model periods. Second, the first-stage regression of course does not include covariates for household characteristics (other than the state variables of the model) and year dummies. Third, the fact that the data is model-generated means that the same regression specification can be run for different parameter values of the model, such as different values of the elasticity of intertemporal substitution (EIS), of the correlation between the stock market and the housing market and of the minimum down-payment requirement (δ).

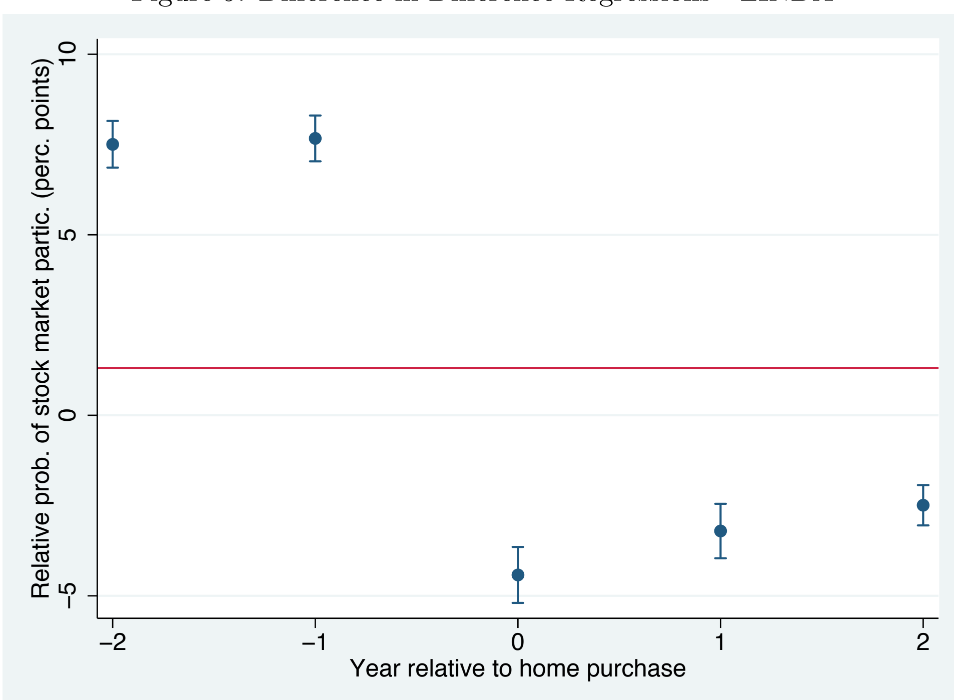
Table 8 reports the result of these regressions. Column 1 reports the result for the baseline calibration.

Table 7: Differences-in-Differences Regression - LINDA

	(1)	(2)	(3)	(4)	(5)	(6)
			Second stage			
D($0 \leq t \leq 2$)	-0.108***	-0.097***	-0.108***	-0.095***	-0.140***	-0.017***
	(0.0027)	(0.0042)	(0.0035)	(0.0035)	(0.0060)	(0.0035)
Constant	0.076***	0.105***	0.084***	0.074***	0.105***	0.033***
	(0.0030)	(0.0032)	(0.0023)	(0.0026)	(0.0045)	(0.0018)
Apartments	Yes	No	Yes	Yes	Yes	Yes
Upgrades	No	No	No	No	No	Yes
R^2	0.014	0.012	0.014	0.011	0.023	0.0006
Observations	93,401	44,180	93,401	69,943	23,458	83,532
			First stage			
Region dummies	No	No	Yes	No	No	No
Stockholm	Yes	Yes	Yes	No	Yes	Yes
Sweden excl. Stockholm	Yes	Yes	Yes	Yes	No	Yes
R^2	0.271	0.271	0.274	0.264	0.303	0.271
Observations	2,094,658	2,094,658	2,094,658	1,696,018	398,640	2,094,658

Note: All regressions are based on OLS. The first stage is run on all households, subject to the specified sample restrictions. The second stage is only run on households which can be categorized as future or recent home purchasers, subject to the additional sample restrictions. Column 6 singles out existing home owners who upgrade to a home of greater value at $t = 0$. Those households were identified using transaction data from the real estate registry. Standard errors are reported in parenthesis and are based on clustering of error terms at the household level. *, ** and *** indicate significance at the 10-, 5- or 1- percent level in a two-sided test.

Figure 9: Difference-in-Difference Regressions - LINDA



Note: The figure displays the point estimates of the coefficients in the second-step regression, defined by equation (22). The 5%-confidence interval are plotted around the estimate. The sample is the same as in column 1 of table 7. The solid line reports the average first-stage residual among those households which are included in the second-step regression.

Table 8: Difference-in-Difference Regressions - Model

	(1)	(2)	(3)	(4)
		Second stage		
D($0 \leq t \leq 2$)	-0.128***	-0.298***	-0.131***	-0.212***
	(0.0049)	(0.004)	(0.0048)	(0.007)
Constant	0.236***	0.264***	0.229***	0.316***
	(0.006)	(0.001)	(0.006)	(0.009)
R^2	0.018	0.148	0.019	0.052
Observations	24,883	29,260	24,822	12,824
		First stage		
EIS, second type	0.33	0.20	0.33	0.33
$corr(R_t, R_t^h)$	0.15	0.15	0.00	0.15
δ	0.30	0.30	0.30	0.20
R^2	0.502	0.414	0.509	0.596
Observations	360,000	360,000	360,000	360,000

Note: Regressions on model-generated data. 5,000 households of each type were simulated between age 25 and 95. The different specifications in column 1 to 4 correspond to the comparative static exercises in section 4.3. Standard errors are reported in parenthesis and are based on clustering of error terms at the household level. *, ** and *** indicate significance at the 10-, 5- or 1- percent level in a two-sided test.

From the periods before the home purchase to the periods of the home purchase the effect on the likelihood is negative, as in the data. However, the magnitude is slightly larger, equal to 12.8 percentage points, compared to minus 10.8 in LINDA. Column 2 shows that a switch to CRRA preferences for the second type (i.e. a reduction of the EIS from 0.33 to 0.20) leads to a greater effect. The relative probability is minus 29.8 percentage points. The reason is that with a coefficient of relative risk aversion of five, there is greater dispersion in financial wealth and net worth (see figure 17 in the Appendix), which means that the probability of participation is very high for some households. Upon the home purchase the negative effect (adjusted for the fact that some of the home purchasers are very rich) is estimated to be large. In contrast, a zero correlation between the stock market and the housing market seems not to make a big difference for the crowding out effect since the estimated effect in column 3 is minus 13.1 percentage points. If anything, it would have been expected that the improved diversification effect for home owners would have lead to a smaller crowding out effect than in the baseline specification. Finally, a reduction in the down-payment requirement from 30 to 20 percent (column 4) implies a greater crowding out effect. This is the result of a composition effect among home purchasers and the intuition is the same as in section 4.3; a smaller down-payment requirement implies that home purchasers on average are somewhat poorer.

Overall, the magnitude of the estimates in the data and in the model are very similar. Therefore, the main point is that the crowding-out effect of housing wealth on stock market participation in the model is found to be present also in the Swedish panel data set. This can be viewed as strong empirical support for the model and for the importance of incorporating housing into the analysis of household portfolio choice.

6 Conclusion

This paper documents the stock market participation rates among home owners and renters in the USA and Sweden. In both countries, there is a considerable gap of thirty to forty percentage points between the two groups, in the sense that the participation rate is a lot higher among home owners than among renters.

The paper develops a life-cycle portfolio choice model with an endogenous rent-own decision as well as an endogenous stock market participation decision. Calibrated to Sweden, the model generates the stock market participation rate of home owners and a much lower stock market participation rate of renters. Before the retirement phase the match is almost perfect for renters. Further, the model reproduces three important features of the data. First, the participation rate over the life-cycle is flatter, and closer to the data, than in a model with exogenously forced home ownership for all households. Second, the model replicates the U-shaped life-cycle pattern of stock market participation among renters which is a result of sorting. As the home ownership rate increases from young age to mid-life, the participation rate among renters decreases. After the peak of home ownership rate, the participation rate among renters increases. Third, the crowding out mechanism which generates limited participation among home owners is supported by difference-in-difference regressions on a Swedish panel data set. Since households must finance a down-payment upon a home purchase, almost every fifth first-time home buyer in the data completely exits the stock market at the time of the purchase. The regression results on model-generated data are very similar.

Building on this paper, there are ample avenues for future research. First, the results of this paper calls for investigations of differences in economic environment between poor and rich households. It is possible that many renters are exposed to different economic risks than the population as a whole. This could provide another rationale than preference heterogeneity for the low stock market participation rate among this group of households.

Second, the indication that housing carries some information about unobservable characteristics of households provides guidance for future research. In the literature on life-cycle portfolio choice, essentially three mechanisms for limited stock market participation have been proposed. Those mechanisms are modified risk properties of labor income (Lynch and Tan, 2007; Benzoni, Collin-Dufresne, and Goldstein, 2007; Storesletten, Telmer, and Yaron, 2007), the existence of rare disastrous events (Cocco, Gomes, and Maenhout, 2005; Ball, 2008), and preference heterogeneity (Gomes and Michaelides, 2005). However, the all of the proposed mechanisms are difficult to establish in the sense of statistical significance (e.g. the properties of labor income risk) or only indirectly observable (e.g. preferences). Housing provides a means to test these proposals since home ownership is such an important decision and thereby is likely to reveal information about households' preferences and subjective views on their own income risk.

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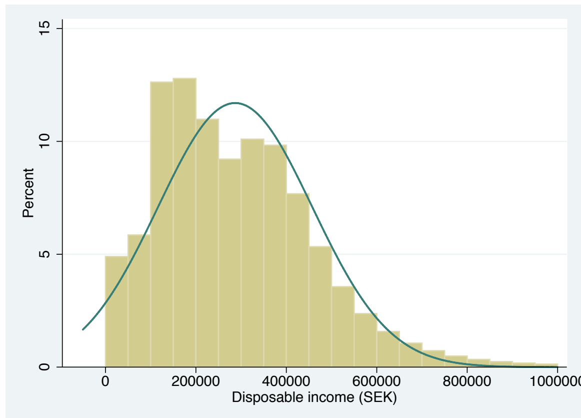
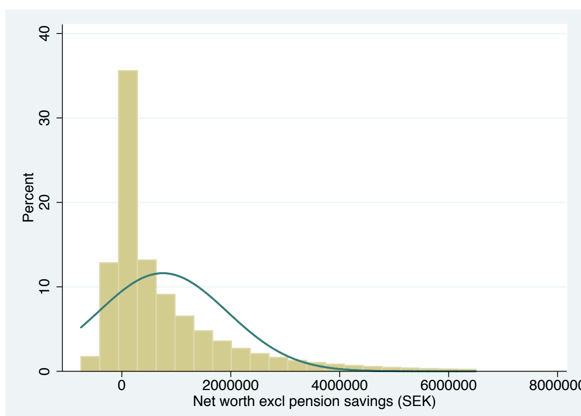
A Additional Statistics - Swedish Data

Figure 10: Distribution of Disposable Income



Note: The figure reports the cross-sectional distribution of disposable income. The solid line fits a normal distribution to the data.

Figure 11: Distribution of Net Worth



Note: The figure reports the cross-sectional distribution of net worth. The solid line fits a normal distribution to the data.

A.1 Cross-sectional regressions

Table 11 reports cross-sectional regression estimates based on the Swedish data set. Column 1 indicates that there is a raw stock market participation gap of 38 percentage points between renters and home owners once time effects are accounted for. Once basic sociodemographic variables (age, number of adults in the household) are controlled for as well the gap decreases by nine percentage points to 28.1 percentage points. Column 3 to 5 investigate how much of the gap that can be accounted for by education (column 3), disposable income (column 4), and net worth (column 5). Education has only a small marginal impact on the estimated home ownership effect. A careful account of disposable income reduces the estimated effect of home ownership from 28.1 percentage points to 21.5 percentage points, a reduction by 23 percent. The most striking result is the large impact of the inclusion of net worth. A careful account of net worth reduces the estimated effect of home ownership

Table 9: Characteristics of future home owners and recent home purchasers

	t=-2	t=-1	t=0	t=1	t=2
Bank accounts (raw)	49.5	53.5	49.0	58.2	74.5
Bank accounts (imputed)	60.8	65.6	62.8	87.2	108
Direct bond holdings	7.0	6.6	7.0	7.7	9.5
Mutual funds	42.2	40.7	37.2	42.7	47.4
Direct stock holdings	31.5	32.4	30.1	33.7	36.1
Capital insurances	10.5	10.5	10.3	11.9	14.0
Private pension accounts	17.3	18.7	21.7	26.1	30.2
Premium pension accunts	20.3	28.7	34.4	52.5	61.8
Real estate	0	0	840	996	1165
Value of primary residence	0	0	769	912	1046
Net worth (raw)	18.2	-61.5	349	375	546
Net worth (imputed)	29.4	-49.5	362	404	580
Age of HH head	38.5	39.3	40.6	41.6	42.6
Household size	2.31	2.37	2.54	2.63	2.71
Number of adults	1.51	1.53	1.61	1.65	1.69
Marriage rate	30.9%	32.3%	35.9%	38.2%	40.15
Disposable income	244	256	284	302	317
Stock market partic.	62.1%	62.1%	63.8%	64.2%	66.7%
Stock holdings >10 kSEK	42.3%	43.4%	44.5%	46.9%	50.2%
Equity share >10%	56.8%	56.7%	58.0%	57.7%	58.9%
Stock holdings > 10% of disp. income	32.4%	32.7%	31.5%	33.2%	35.0%
Observations	19,869	20,462	14,509	14,855	25,744

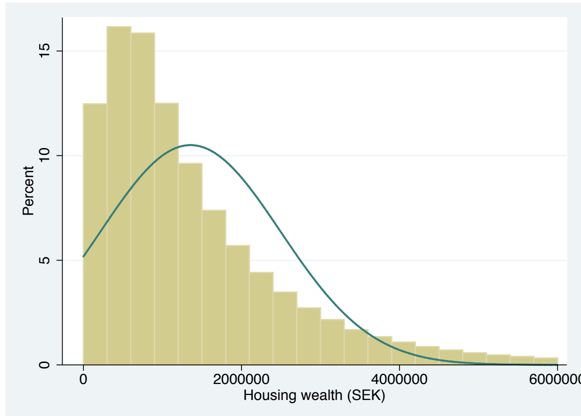
Note: t=j denotes home ownership since j=-2,1,...,2 years. t<0 indicates current renters that will purchase a home in the future. t=0 denotes current home purchasers. t> 0 indicates recent home purchasers. The values are in terms of 1000's of Swedish kronor (SEK).

Table 10: Difference-in-Difference Regressions - Alt. Definitions of Stock Market Participation

	(1)	(2)	(3)
		Second stage	
D(t≥ 0)	-0.135***	-0.092***	-0.143***
	(0.0028)	(0.0029)	(0.0027)
Constant	0.087***	0.062***	0.092***
	(0.0029)	(0.0031)	(0.0028)
R^2	0.021	0.009	0.026
Observations	93,401	93,401	93,401
		First stage	
Region dummies	No	No	No
Stockholm incl.	Yes	Yes	Yes
Apartments incl.	Yes	Yes	Yes
Fixed effects	No	No	No
R^2	0.306	0.209	0.250
Stock mkt partic.	Stock holdings >10 kSEK	Equity share > 10%	Stock holdings > 10% of disposable income
Observations	2,094,658	2,094,658	2,094,658

Note: Standard errors are reported in parenthesis and are based on clustering of error terms at the household level. *, ** and *** indicate significance at the 10-, 5- or 1- percent level in a two-sided test.

Figure 12: Distribution of Housing Wealth Among Home Owners



Note: The figure reports the cross-sectional distribution of housing wealth. Only home owners are included. The solid line fits a normal distribution to the data.

to 7.3 percentage points, a reduction by 74 percent. Interestingly, a linear and squared term for net worth is unable to fully account for this strong wealth effect (results available upon request).

Column 6 and 7 report the cross-sectional estimate of the home ownership effect while carefully accounting for both wealth and income. These cross-sectional estimates indicate that the effect of home ownership in the Swedish data set is in the range 0.071 to 0.046. This implies that a careful account of net worth and disposable income, in addition to a few other observable characteristics, can explain more than 81 percent of the gap in stock market participation rates between renters and home owners. A noteworthy observation is that although the estimated effect remains positive in all of these "cross-sectional" specifications, there is evidence that at the margin, housing wealth has the effect of a substitute to stock market participation. This is seen in column 7 which includes a linear and squared term of housing wealth. This result is in line with Curcuru, Heaton, Lucas, and Moore (2004), Cocco (2005), Yao and Zhang (2005), Kullmann and Siegel (2005) and Heaton and Lucas (2000) who establish a substitution effect between housing wealth and equity.

Section B.1 in the appendix reports and discusses the results from the same kind of cross-sectional regressions using data from the U.S. Survey of Consumer Finances. The results are very similar to the ones based on the Swedish data set.

B U.S. Data

Table 12 reports sample means for the U.S. households. The classification of holdings is not exactly the same as in the Swedish data. Nevertheless, the qualitative patterns are similar. For instance, the average home owner is much richer than the average renter. Further, the gap in stock market participation rates between home owners and renters as groups is between 21 and 34 percentage points. The size of the gap depends on whether indirect equity holdings are considered in the definition of stock market participation.

B.1 Cross-sectional regressions using U.S. data

Table 13 reports the results of cross-sectional regressions using the 2001, 2004 and 2007 waves of the SCF.[30] The definition of stock market participation is the broadest one, including both direct and indirect equity holdings (see the table above).

Column 1 and 2 report the gap in participation rates when accounting for only time effects and sociodemographic characteristics. Column 3 to 5 then explore the marginal impact of accounting for education (column 3), wage income (column 4), and net worth (column 5). As in the case of the Swedish data set the effect of controlling for net worth is striking. The spline function in net worth completely eliminates the estimated effect of home ownership on stock market

[30]Since the SCF is non-representative, the population weights are used.

Table 11: Cross-Sectional Regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D(HomeOwn$_t$)	0.378***	0.281***	0.274***	0.215***	0.073***	0.046***	0.071***
	(0.0014)	(0.0016)	(0.0016)	(0.0016)	(0.0018)	(0.0017)	(0.0020)
Housing wealth	-	-	-	-	-	-	-0.035***
	-	-	-	-	-	-	(0.0012)
Housing wealth sq.	-	-	-	-	-	-	0.0019***
	-	-	-	-	-	-	(0.0002)
D(No high school)	-	-	-0.089***	-	-	-0.054***	-0.055***
	-	-	(0.0020)	-	-	(0.0019)	(0.0019)
D(College)	-	-	0.061***	-	-	0.024***	0.029***
	-	-	(0.0015)	-	-	(0.0015)	(0.0015)
Constant	0.430***	0.240***	0.245***	0.534***	0.265***	0.554***	0.515***
	(0.0013)	(0.022)	(0.022)	(0.031)	(0.024)	(0.041)	(0.041)
Sociodemographics	No	Yes	Yes	Yes	Yes	Yes	Yes
Spline for disp. income	No	No	No	Yes	No	Yes	Yes
Spline for net worth	No	No	No	No	Yes	Yes	Yes
R^2	0.150	0.155	0.166	0.209	0.237	0.272	0.273

Note: All regressions are OLS and include year dummies. The set of sociodemographic variables include a ten-piece linear spline in age and a dummy for one or two adults in the household. Housing wealth has been normalized to mean zero and unit variance. All regressions include 2,224,419 observations. Standard errors are reported in parenthesis and are based on clustering of error terms at the household level. *, ** and *** indicate significance at the 10-, 5- or 1- percent level in a two-sided test.

Table 12: Sample Means - U.S. Data

	All	**Renters**	**Home owners**	**No high school**	**High school**	**College**
Checking accounts	4.57	1.96	5.78	1.95	3.06	6.19
Direct bond holdings	9.28	0.83	13.2	0.93	1.11	16.4
Direct equity holdings	57.6	8.62	80.2	5.52	14.4	97.4
Total equity holdings	107.5	16.2	149.6	10.0	31.5	179.1
Partic., direct equity	27.0%	12.3%	33.8%	6.1%	17.3%	38.4%
Partic., total equity	51.3%	27.8%	62.1%	16.4%	41.5%	66.5%
Total financial assets	202.4	37.2	278.5	34.6	75.6	323.2
Value of primary residence	168.2	0	245.6	73.7	108.4	229.3
Total non financal wealth	345.2	35.0	488.0	116.1	185.7	501.9
Total assets	547.6	72.2	766.5	150.7	261.3	825.1
Home equity, primary resid.	110.1	0	160.8	57.2	70.9	147.7
Total debt	77.5	11.8	107.8	23.1	49.6	108.9
Net worth	470.1	60.4	658.8	127.6	211.8	716.2
Age of HH head	49.5	41.9	53.0	55.5	49.6	47.9
Normal income	72.1	37.0	88.2	28.5	47.5	98.5
Wage income	50.5	27.5	61.0	16.1	33.4	69.9
Number of children	0.82	0.78	0.84	0.82	0.85	0.80
Marriage rate	41.0%	60.6%	32.0%	46.5%	41.9%	39.0%
No. of observations	66,895	18,210	48,685	7,329	16,948	42,618

Note: Data from the Survey of Consumer Finances 2001, 2004 and 2007. In each wave all the five implications are used. Sample statistics adjusted with the population weights. Asset values in terms of 1000's of U.S. dollars (deflated to year 2004).

Table 13: Cross-Sectional Regressions (U.S. Data)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D(HomeOwn$_t$)	0.343***	0.272***	0.235***	0.185***	-0.034**	-0.030**	-0.027**
	(0.0097)	(0.011)	(0.011)	(0.011)	(0.014)	(0.014)	(0.014)
Housing wealth	-	-	-	-	-	-	-0.008*
	-	-	-	-	-	-	(0.004)
Housing wealth sq.	-	-	-	-	-	-	0.00005
	-	-	-	-	-	-	(0.00004)
D(No high school)	-	-	-0.169***	-	-	-0.080***	-0.080***
	-	-	(0.013)	-	-	(0.012)	(0.012)
D(College)	-	-	0.206***	-	-	0.091***	0.092***
	-	-	(0.011)	-	-	(0.010)	(0.010)
Constant	0.291***	-0.221**	-0.228***	-0.412***	-0.884***	-0.594***	-0.577***
	(0.010)	(0.087)	(0.085)	(0.086)	(0.282)	(0.216)	(0.216)
Sociodemographics	No	Yes	Yes	Yes	Yes	Yes	Yes
Spline for wage income	No	No	No	Yes	No	Yes	Yes
Spline for net worth	No	No	No	No	Yes	Yes	Yes
R^2	0.102	0.186	0.254	0.274	0.334	0.383	0.383

Note: All regressions are OLS and include year dummies. The set of sociodemographic variables includes a linear spline in age and dummies for family structure and race. Stock market participation is defined as holdings of any kind of equity (direct or indirect). Housing wealth has been normalized to mean zero and unit variance using the population moments. In total, there are 66,895 observations observations from the 2001, 2004 and 2007 waves of the Survey of Consumer Finances. The population weights are used and the standard errors reported in parenthesis are based on clustering of error terms across the five implications of each wave. *, ** and *** indicate significance at the 10-, 5- or 1- percent level in a two-sided test.

participation and in fact even reverses the sign of the effect from positive to negative. A linear and a squared term in net worth are unable to accomplish the same thing, just as in the Swedish data set (results available upon request). The estimated effect remains slightly negative also in the richest specifications (column 6 and 7). These results are indicative that home ownership is a substitute to stock market participation, and stronger so than what the cross-sectional regressions on the Sweden data set indicate.

C Model details

C.1 Cash-flows for a stayer

The stayer's budget constraint at $t+1$ can be rearranged as follows:

$$\begin{aligned} c_{t+1} + A_{t+1} + (\chi + \delta - \phi) P^h_{t+1} h_t &\leq A_t R_f + A_t \alpha_t (R_{t+1} - R_f) + Y_{t+1} \\ &\quad + P^h_t h_t ((1-\phi) R^h_{t+1} - (1-\delta) R_f) \\ c_{t+1} + A_{t+1} + \chi P^h_{t+1} h_t &\leq A_t R_f + A_t \alpha_t (R_{t+1} - R_f) + Y_{t+1} \\ &\quad + (1-\delta) P^h_t h_t \left[R^h_{t+1} - R_f \right] \end{aligned}$$

The inequality constraint tells that at $t+1$, the stayer is maintaining the house at the cost $\chi P^h_{t+1} h_t$. The household also services the old mortgage, pays back the principal and takes out a new mortgage with value $(1-\delta) P^h_{t+1} h_t$.

C.2 The renter's problem

The renter's problem is given by:

$$V_t^r(X_t, z_t, P_t^h, I_{t-1}) = \max_{c_t, A_t, \alpha_t} \left\{ \left((c_t^{1-\omega} h_t^{\omega})^{1-\rho} + \beta \mathcal{R}_t(V_{t+1})\right)^{\frac{1}{1-\rho}} \right\}$$
$$s.t.(4) - (12), (14), (17)$$

Note that since for the renter the housing good is not part of cash in hand in period $t+1$ the household faces a static problem regarding how much to allocate to c_t and h_t, respectively. The Cobb-Douglas specification implies that a fraction ω out of total consumption expenditure today will be allocated to h_t, so $h_t = (\omega/((1-\omega)P_t^h))c_t$.

C.3 The buyer's problem

The buyer's problem is given by:

$$V_t^b(X_t, z_t, P_t^h, I_{t-1}) = \max_{c_t, A_t, \alpha_t, h_t} \left\{ \left((c_t^{1-\omega} h_t^{\omega})^{1-\rho} + \beta \mathcal{R}_t(V_{t+1})\right)^{\frac{1}{1-\rho}} \right\}$$
$$s.t.(4) - (13), (15), (18)$$

Note that when choosing to buy a new home the household's decision regarding how much to allocate to c_t and h_t is not static as in the case of the renter. The household must trade off its current need of housing relative to its need of c_t *and* relative to its future housing need conditional on life-cycle considerations such a future labor income. This intertemporal trade-off is captured by the Euler equation for h_t:

$$\begin{aligned} \frac{\omega c_t}{(1-\omega)P_t^h h_t} &= (\chi + \delta + \phi_b) \\ &\quad - E_t \left[SDF_{t+1} \left[(R_{t+1}^h - (1-\delta)R_f) + \frac{\omega c_{t+1}}{(1-\omega)P_t^h h_{t+1}} - (\chi+\delta)R_{t+1}^h \right] \right] \end{aligned} \tag{23}$$

where the stochastic discount factor SDF_{t+1} equals[31]

$$SDF_{t+1} = \beta \left(\frac{C_{t+1}}{C_t}\right)^{-\rho} \left(\frac{c_{t+1}}{c_t}\right)^{-\omega} \left(\frac{h_{t+1}}{h_t}\right)^{\omega} \left(\frac{V_{t+1}}{\mathcal{R}_t(V_{t+1})}\right)^{\rho-\gamma}$$

Equation (23) trades off the marginal utilities of each good with the current costs of a home purchase minus the discounted future capital and consumption gains from home ownership. Yogo (2006) studies a version of this intertemporal trade-off in the context of durable goods.

The home buyer must also take into account the ratio of permanent income to cash in hand. The higher the ratio, the more credit constrained is the household at the present and the lower is the value of the optimal home to be purchased.

C.4 The stayer's problem

Finally, the stayer's problem is given by:

$$V_t^s(X_t, D_{t-1}^o h_{t-1}, z_t, P_t^h, I_{t-1}) = \max_{c_t, A_t, \alpha_t} \left\{ \left((c_t^{1-\omega} h_t^{\omega})^{1-\rho} + \beta \mathcal{R}_t(V_{t+1})\right)^{\frac{1}{1-\rho}} \right\}$$
$$s.t.(4) - (13), (16), (18)$$

A household that owns a home since before and stays in that same home chooses how much to save in financial assets and how much to consume today. The stayer also chooses the fraction to invest into stocks and bonds. All of these decisions is influenced by how much housing wealth the household owns relative to its cash-in-hand and permanent income. If housing is large relative to cash-in-hand and to permanent income the household bears a lot of financial risk in the sense that it owns

[31] Analogous to Piazzesi, Schneider, and Tuzel (2007), it is possible to simplify the expression for SDF_{t+1} further if the trade-off between c_t and h_t is static, as in the case of the renter's problem.

Table 14: Calibration of the Stochastic Processes

Parameter	Value
r_f	0.01
μ	0.04
μ_h	0.01
σ_ε	0.17
σ_η	0.0989
σ_ε^h	0.015
σ_ν	0.1283
σ_ε^o	0.013
σ_η^o	0.0166
σ_ω	0
λ	0.65
$\underline{Y}$	SEK 60,000
$\bar{Y}$	SEK 506,000

Note: Annual counterparts are reported for all parameters that govern first or second moments.

Table 15: Maintenance

Obs.	Mean	Std	P5	P10	P25	P50	P75	P90	P95
712	2.98%	6.73%	0	0.11%	0.81%	1.49%	3.2%	5.6%	8.6%

Note: The LINDA wave for 2003 was merged with the Household Budget Survey for 2003. Households whose heads have high school education were kept if they had a positive amount of housing wealth in LINDA and if they had reported to be home owners in the survey.

a poorly diversified portfolio. This may however be optimal if the household's hedging motive is large (see the discussions in Sinai and Souleles (2005) and Han (2010)). Due to the frictions in equation (15)-(16) and (18) the ratio of housing wealth to cash-in-hand and the ratio of housing wealth to disposable income may vary significantly over time and across households.

D Calibration

D.1 Parameter values for the stochastic processes

Table 14 reports the parameter values that govern the stochastic processes. Note that transitory income risk (σ_ω), which can be viewed as short-term cash flow risk, is shut down. Several studies, including Wachter and Yogo (2009) and Gomes and Michaelides (2005) have argued that transitory risk does not matter much for portfolio choice. The replacement rules for pension and the income floor are set to broadly match the Swedish welfare systems.

Figure 13 displays the house price growth and the return on the MSCI World index, converted to SEK.

D.2 Consumption expenditure shares

D.3 Simulation: Initial Conditions and Shocks

Table 18 reports the initial conditions used in the simulation. These conditions are an approximation of the joint distribution observed among households whose heads have a high school education and are 25 years old. In the simulation each realization of the aggregate shocks is set to its mean so that the asset distributions in the simulation best match the micro data set. See page 548 in Cocco (2005) for a discussion of this point.

Table 16: Leverage Ratio and Implied Down-Payment Requirement

Age	25	35	45	55	65
Median leverage	0.738	0.842	0.752	0.622	0.331
Implied down-payment	0.262	0.158	0.248	0.378	0.669

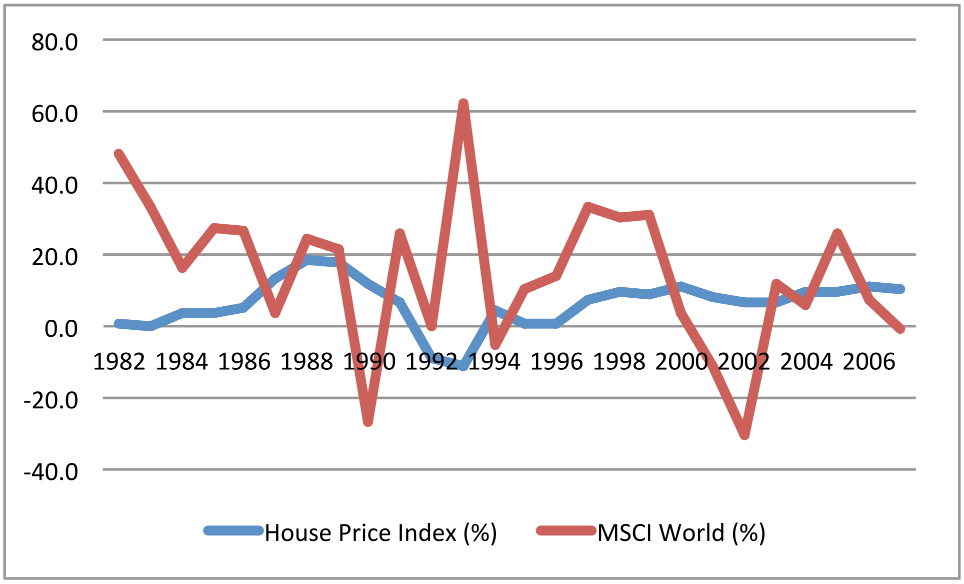
Note: The first and second row of the table report leverage and implied down-payments among recent home purchasers who used to rent ($t = 2$ according to the terminology introduced in section 5).

Table 17: Housing Expenditure Shares for Renters

	Disposable Income					
	1st	2nd	3rd	4th	5th	
2003	33.0	32.2	30.9	26.6	25.7	
2004	41.4	33.8	33.4	26.9	23.2	
2005	38.9	31.8	34.8	23.3	23.8	
	Net Worth					
	1st	2nd	3rd	4th	5th	
2003	30.8	29.0	33.4	31.3	27.2	
2004	31.8	37.3	32.1	35.4	29.4	
2005	28.6	29.0	25.9	35.5	36.4	
	Age					
	21-30	31-40	41-50	51-60	61-70	71+
2003	23.7	30.1	32.0	30.3	35.6	38.9
2004	30.0	30.7	31.6	33.2	33.1	39.9
2005	23.9	28.3	29.9	40.2	30.7	44.5
	Household Size					
	1	2	3	4	5	
2003	29.5	31.2	28.1	27.0	25.9	
2004	33.9	31.5	27.5	28.3	25.3	
2005	31.5	30.8	29.1	29.7	25.7	
	Education					
	No HS	HS	College			
2003	34.5	39.0	28.8			
2004	30.0	30.0	31.5			
2005	26.5	29.6	27.2			

Note: Expenditure shares are defined as total expenditure on rent divided by total consumption expenditure. The sample is restricted to households that rent their home. The source is the Swedish Consumption Expenditure Survey for years 2003-2005. Similar statistics for the entire U.S. population are reported in Appendix A of Piazzesi, Schneider, and Tuzel (2007).

Figure 13: House Price Growth and the Return on MSCI World



Note: The figure displays house price growth in Sweden and the return on the MSCI World portfolio, converted to SEK.

E Estimation of the Income Process

The estimation of the income process is largely standard and follows, e.g. Carroll and Samwick (1997), Gourinchas and Parker (2002), Storesletten, Telmer, and Yaron (2004) and Domeij and Flodén (2008).

E.1 Sample Selection

The definition of income is disposable income (it is called 'cdisp' in LINDA), summed over the household members (summed within the household identifier 'bidnrf'). The household head is defined by, in order, education, age, and gender. If these criteria are not sufficient to identify the head of the household I am choosing the head randomly. The household composition is controlled for by excluding income growth rates for a household if the household head changes between those years. One could also exclude households that undergo other types of changes, such as a changing number of adults or, in the case married spouses, divorce. However, since I have an additional exogenous moving shock in the model the income process ought to be consistent with such events.

E.2 Estimation

The identification strategy relies on the assumption of age-independent permanent income risk. This assumption implies that the cross-sectional variance of income growth (net of any predictable component) increases linearly with the time-interval over which the income growth is measured. The time interval varies from one to x years. Following the notation in Carroll and Samwick (1997) the time interval can be denoted by d. Cross-sectional variances of income growth rates (over different time intervals) are computed by age and by cohort. This is the dependent variable, denoted by s^2. Income risk is estimated with OLS with the following regression:

$$s^2 = constant + \beta_d \cdot d + \varepsilon$$

Carroll and Samwick (1997) show that in order to have an estimation procedure that is robust to autocorrelations up to order MA(2) the inclusion of income growth rates should be restricted to income growth rates over three years or more. In the three regressions reported in table 19 the minimum time period varies from one to three years.

Table 18: Initial Conditions in the Simulation

Fraction	D_0^o	I_0	Y_0	A_0	$P_0^h h_o$
8.25%	0	0	64.1	2.06	0
8.25%	0	0	64.1	52.3	0
8.25%	0	0	133	6.27	0
8.25%	0	0	133	49.3	0
8.25%	0	0	171	9.55	0
8.25%	0	0	171	66.5	0
8.25%	0	0	265	16.2	0
8.25%	0	0	265	127	0
8.50%	1	0	144	8.9	454
8.50%	1	0	144	92.6	571
8.50%	1	0	313	26.3	716
8.50%	1	0	313	260	1153

Note: Approximation of the joint distribution observed among households whose heads have a high school education and are 25 years old. Values in 1000's of Swedish kronor (SEK).

Table 19: Estimates of Income Risk

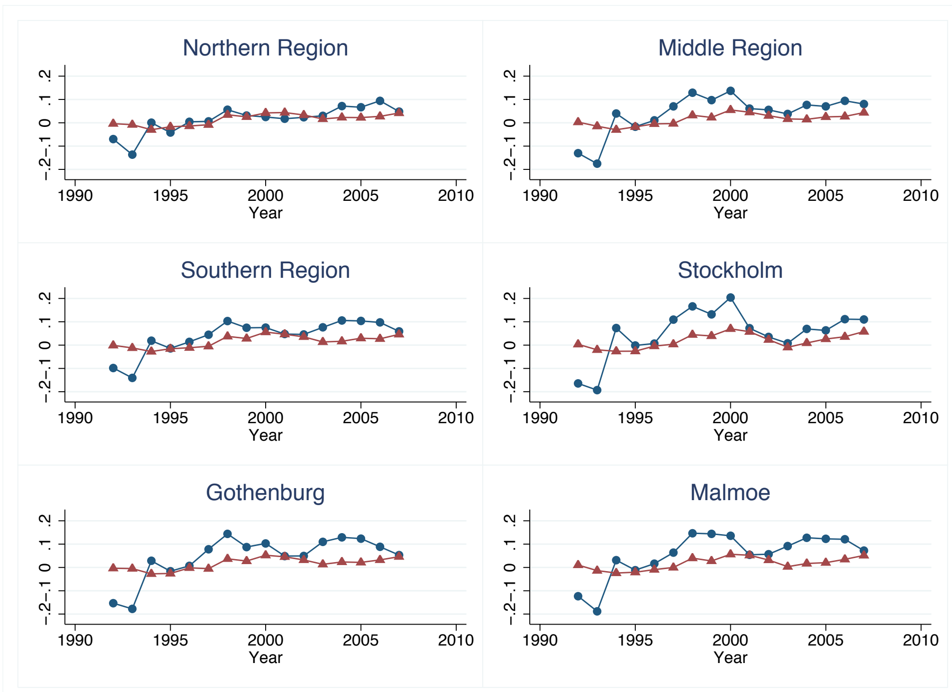
Regression	$d \geq 1$	$d \geq 2$	$d \geq 3$
Constant $(2 \cdot (\sigma_\omega)^2)$	0.16 (0.009)	0.21 (0.017)	0.23 (0.033)
β_d $((\sigma_v^o)^2)$	0.0256 (0.0034)	0.0122(0.005)	0.0056 (0.009)
Adjusted R^2	0.089	0.0108	−0.0026

Cohort and time dummies could have been included in the regressions. Alternatively, age and cohort dummies or age and time dummies could be included, as in Storesletten, Telmer, and Yaron (2004), in order to estimate age-varying transitory risk. In another set of regressions age and cohort dummies were included (not reported). However, neither the set of cohort or age dummies were significant.

E.2.1 Regional innovations

Figure 14 shows the innovations of earnings and house prices at a regional level.

Figure 14: Innovations to Regional House Prices and Regional Household Earnings



F Additional Model Implications

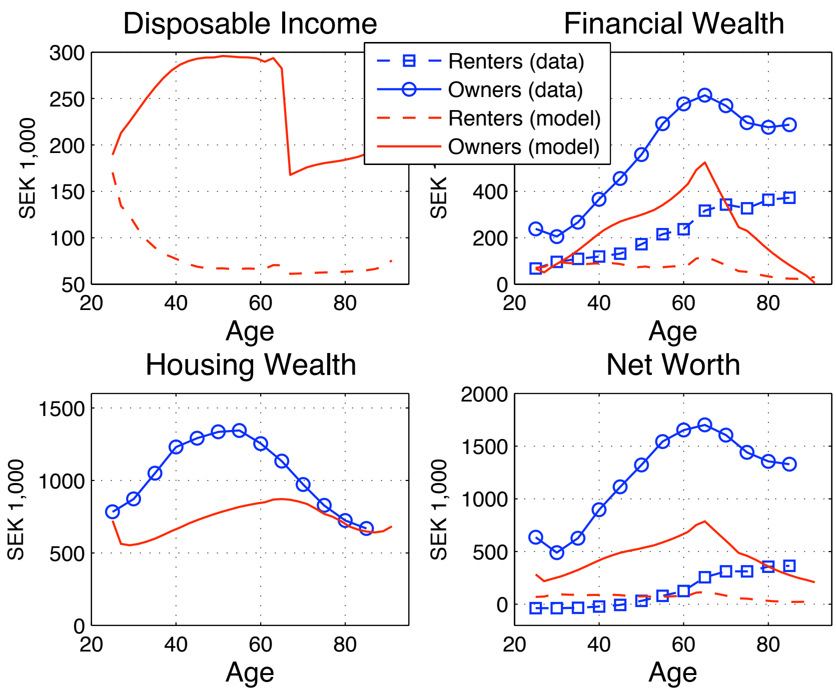
F.1 Asset holdings for renters and home owners

F.2 Equity Shares for Renters and Home Owners

Figure 16 displays the mean equity share conditional on stock market participation. Although the relative risk aversion is fairly high ($\gamma = 5$), the equity shares are too aggressive on average. This is particularly the case for the group of participating renters. Further, in the data there is essentially no life cycle pattern, while home owners in the model choose less aggressive financial portfolios over the course of life.

F.3 Comparative Statics

Figure 15: Mean Assets for Renters and Home Owners



Note: The figure displays cross-sectional mean of earnings, financial assets, housing wealth and net worth separately for renters and home owners. Data from year 2000 and the baseline calibration.

Figure 16: Equity Share Conditional on Stock Market Participation

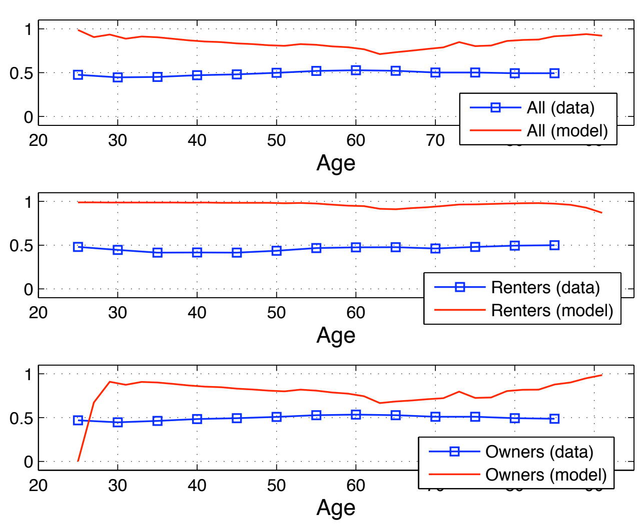
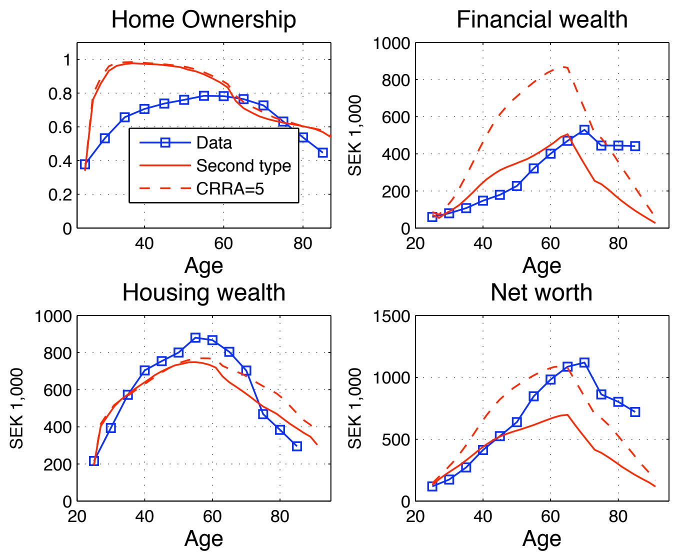
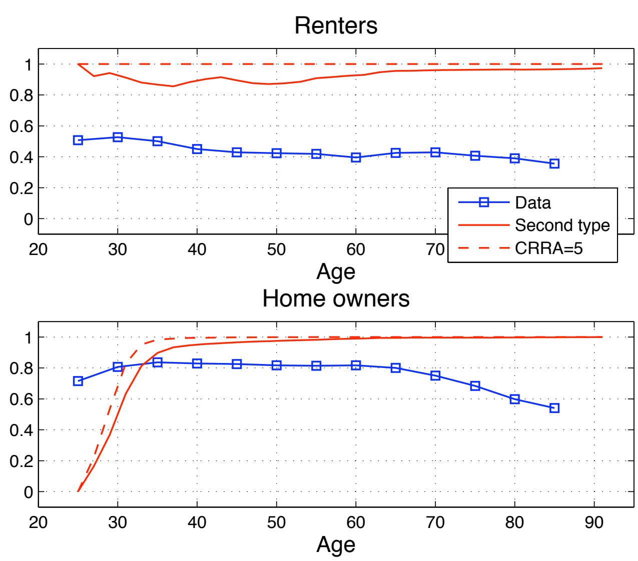


Figure 17: Home Ownership and Assets - Second Type CRRA 5



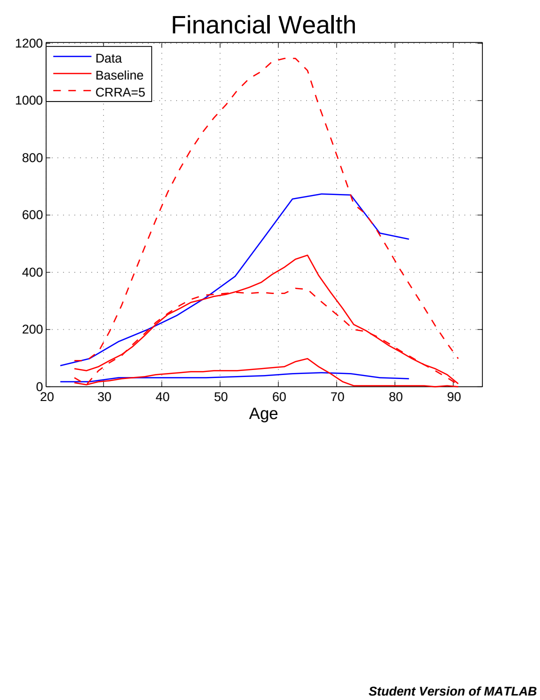
Note: The figure displays the home ownership rate and the cross-sectional means of financial assets, housing wealth and net worth for the second type household in the baseline calibration ($\gamma = 5$, $\rho = 3$) compared to a household with CRRA preferences such that $\gamma = \rho = 5$. Data from year 2000.

Figure 18: Stock Market Participation - Second Type CRRA 5



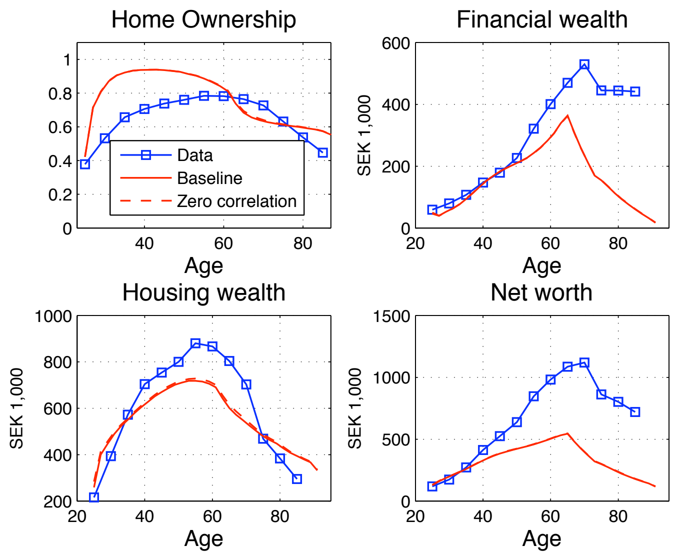
Note: The figure displays the stock market participation rates for the second type household in the baseline calibration ($\gamma = 5$, $\rho = 3$) compared to a household with CRRA preferences such that $\gamma = \rho = 5$. Data from year 2000.

Figure 19: Interquartile Range for Financial Wealth (P25-P75) - Second Type CRRA 5



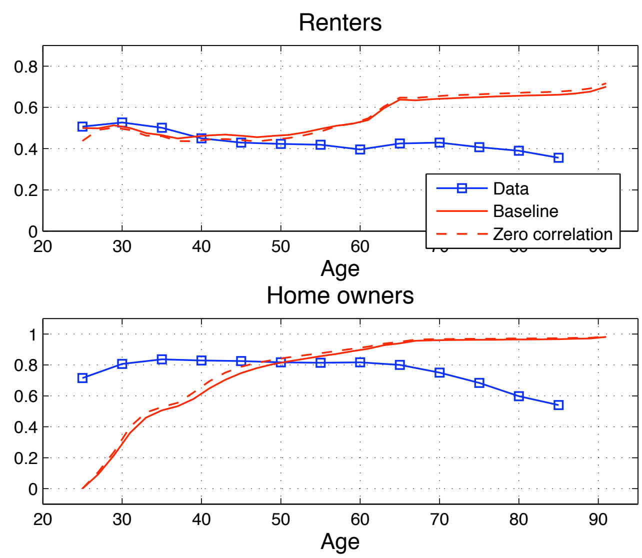
Note: The figure displays the interquartile range for financial wealth for the baseline calibration (i.e. a 50-50 weight of the first and the second household type) and an alternative calibration that includes the first household type from the baseline calibration but where the second type (which has $\gamma = 5$, $\rho = 3$) is replaced by a household with CRRA preferences such that $\gamma = \rho = 5$. Data from year 2000.

Figure 20: Home Ownership and Assets - Zero Correlation Between Housing and Stocks



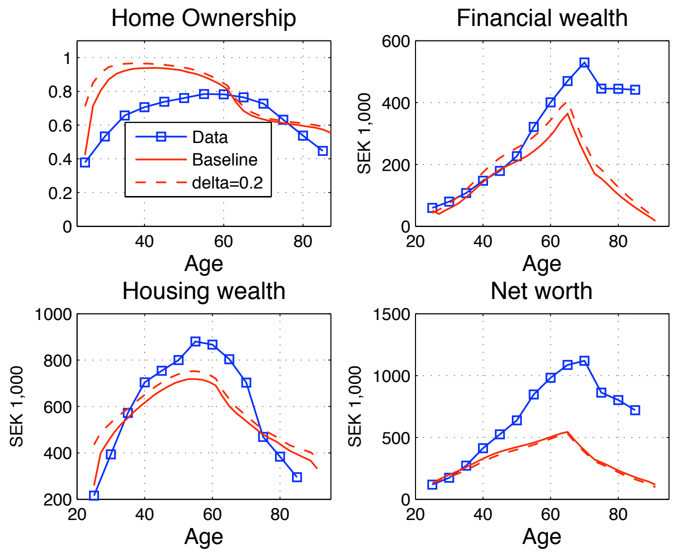
Note: The figure displays the home ownership rate and the cross-sectional means of financial assets, housing wealth and net worth in the baseline calibration and in a calibration that sets the correlation between house price growth and the stock market return to zero. Data from year 2000.

Figure 21: Stock Market Participation - Zero Correlation Between Housing and Stocks



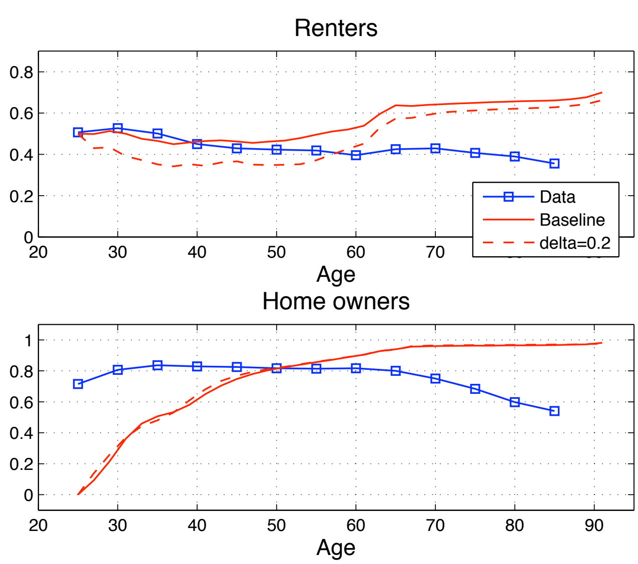
Note: The figure displays the stock market participation rates for renters and home owners in the baseline calibration and in a calibration that sets the correlation between house price growth and the stock market return to zero. Data from year 2000.

Figure 22: Home Ownership and Assets - Lower Down-Payment Requirement



Note: The figure displays the home ownership rate and the cross-sectional means of financial assets, housing wealth and net worth in the baseline calibration and in a calibration that sets the down-payment requirement to 20 percent ($\delta = 0.20$). Data from year 2000.

Figure 23: Stock Market Participation - Lower Down-Payment Requirement



Note: The figure displays the stock market participation rates for renters and home owners in the baseline calibration and in a calibration that sets the down-payment requirement to 20 percent ($\delta = 0.20$). Data from year 2000.