

Household Portfolio Choice Before and After a House Purchase

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Abstract

Using a unique administrative panel data from Denmark, this paper documents the dynamic evolution of households' financial wealth, the equity market participation rate (extensive margin), and the conditional risky asset share of financial wealth (intensive margin) over a 7-year period around a house purchase. We find that households' equity market participation rate falls during the year of house purchase. Conditional on participation, the risky asset share of financial wealth follows a V-shape around the house purchase. It decreases and reaches the lowest point 1 year before a house purchase, but jumps up immediately after. This finding suggests that of the three channels identified in the literature that are related to the risky asset demand after a house purchase, the debt retirement channel and the diversification effect dominate the liquidity concern.

JEL subject classification: D14; G11; G51; R21

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1 Introduction

Housing is the single most important asset for the majority of households. The salient features of housing are that it is difficult to diversify, highly leveraged, and costly to adjust. Prior to buying a house, a household needs to accumulate financial wealth for a down payment.¹ After purchasing a house, a household faces expenditure risk due to committed mortgage payments and house price risk. As a result, households usually plan well ahead before buying a house. These features suggest that a house purchase could be closely linked to the accumulation of financial wealth and the portfolio choice of financial wealth.

Previous studies have presented various theoretical predictions regarding the impact of housing on household portfolio choice of financial wealth. First, Hu (2005) finds that homeownership partially crowds out stockholdings. She argues that homeowners with a mortgage face expenditure risk due to the committed mortgage payments over a long horizon out of an uncertain stream of labor income. Consequently, the risky asset share (the stock share) of financial wealth should decrease after a house purchase because of the concern for liquidity. Second, Becker and Shabani (2010) demonstrate that having a mortgage could diminish the benefits of equity market participation and lead to reduced stock ownership. This is because a mortgage offers a household an alternative risk-free rate (i.e., their mortgage rate). By substituting their individual mortgage rate for the market risk-free rate, households will receive a diminished expected excess return from stock investments. On the other hand, Becker and Shabani (2010) argue that conditional on equity market participation, the risky asset share of financial wealth should increase after buying a house with a mortgage. Households have less incentive to hold safe assets while having a mortgage. This is because they can be better off using their financial wealth to repay their mortgage debt rather than holding safe assets, as retiring mortgage debt offers households a return equal to their mortgage interest rates, which are almost always greater than the return on investing in risk-free assets. Third, Yao and Zhang (2005) show that there is a low correlation between stock returns and housing returns. Therefore, to achieve diversification benefits, investors should hold a higher share of risky assets in their financial wealth portfolios after purchasing a house.²

Other studies have attempted to examine the relationship between housing (mortgage debt and home equity) and household portfolio choice empirically. These studies rely mostly on analyzing cross-sectional data and do not find a systematic relationship between housing and portfolio choice of financial wealth. For example, Cocco (2005) finds that due to housing investment, younger and poorer households have limited financial wealth and

¹Financial wealth in this paper refers to non-pension financial assets. It is defined as the sum of the market value of stocks and risky mutual fund investments, the market value of bonds, and bank deposits. In the literature, some also use the term liquid wealth to refer to the same concept.

²Further details on these theoretical arguments are provided in the following section.

have a low stock market participation. Heaton and Lucas (2000) and Cocco (2005) show that in cross-sectional ordinary least squares (OLS) regressions in which property value is included as a covariate, the risky asset share is positively associated with mortgage debt. On the other hand, Fratantoni (1998) finds that the elasticity of the risky asset share with respect to mortgage debt is negative, and Yamashita (2003) shows that households with a high house-to-net-worth ratio hold a lower proportion in stocks. To account for endogeneity concerns in prior studies, Chetty, Sándor, and Szeidl (2017) build a two-period model and test the model’s predictions empirically using an instrumental variable strategy. They find that for homeowners with CRRA preferences, an increase in mortgage debt reduces the share of financial wealth held in stocks, while an increase in home equity raises the risky asset share of financial wealth.³

In this paper, we provide new evidence on the relationship between housing and household portfolio choice of financial wealth. While the majority of existing studies focus on static and cross-sectional comparisons of portfolio choice outcomes between households with and without housing assets, we instead estimate the dynamic evolution of household portfolio choice around a house purchase with an event study design using administrative panel data. In particular, we study the short-run dynamics of households’ financial wealth, the equity market participation rate (extensive margin), and the conditional risky asset share of financial wealth (intensive margin) from 3 years before to 3 years after a house purchase.

To this end, we exploit a rich administrative panel data set from Denmark that contains the entire Danish population and spans 11 years from 2002 to 2012. Our data includes detailed household demographics, income, as well as asset and debt holdings. Based on these administrative data, we construct our main sample consisting of households that bought houses within the period from 2005 to 2009. We adopt an event study design to plot household portfolio choice trajectories before and after a house purchase event. The event study is implemented by two-way fixed effects regressions, thereby mitigating the potential bias stemming from both observed and unobserved time-invariant household characteristics and the overall calendar-year trends that uniformly impact all households. We explore the portfolio choice variations within households.

We find that households accumulate more financial wealth before a house purchase, which is likely to be driven by the need for a down payment.⁴ On average, households hold about DKK 204,000 (about USD 37,000 or EUR 28,000) in financial wealth 3 years before a house purchase.⁵ This amount peaks at DKK 295,000 (about USD 53,000 or EUR

³A few studies that applied the empirical approaches proposed in Chetty, Sándor, and Szeidl (2017) produced mixed results; see Michielsen, Mocking, and Veldhuizen (2016) and Iwaisako, Ono, Saito, and Tokuda (2022).

⁴In Denmark, there is a tax penalty for withdrawing pension savings before retirement. Thus, it is unlikely that the increase in financial wealth before buying a house is due to withdrawals from pension savings.

⁵This is equivalent to 7.2 times the average monthly household labor income in Denmark after taxes

40,000) 1 year before a house purchase. And in the year of a house purchase, the level of financial wealth falls by about 61%, as households convert most of their financial wealth into home equity. After a house purchase, households' financial wealth remains low for another year and starts to gradually increase after 2 years.

Regarding the extensive margin, we find that the equity market participation rate increases by about 1 percentage point (from 30.4% to 31.3%) from 3 years before to 1 year before a house purchase. In the year of a house purchase, the participation rate decreases by 1.2 percentage points. This represents a 3.8% decline relative to the participation rate 1 year before the house purchase. This finding provides some evidence that housing investments induce households to withdraw funds from the equity market. After the house purchase, the equity market participation rate stays low for another year and starts to increase slightly after that. Overall, the equity market participation around a house purchase follows a similar pattern as the financial wealth accumulation. This result is consistent with the participation cost explanation of equity market participation. If information and/or other types of participation costs (e.g., set-up fees, monitoring costs, etc.) are associated with risky asset investments, there is a positive correlation between equity market participation and financial wealth.⁶

We also examine the intensive margin of risky asset investments. Conditional on equity market participation, the risky asset share of financial wealth follows a V-shape around a house purchase. It decreases in a few years before a house purchase and reaches the lowest point (24.4%) 1 year before the purchase. This finding is consistent with the prediction of Paxson (1990); Grossman and Vila (1992), and Teplá (2000). These studies show that when households face borrowing constraints (e.g., buying a house), they behave in a more risk-averse manner to reduce the likelihood of becoming credit constrained in the near future. Consequently, households rebalance their financial portfolios from risky to safe assets before a house purchase. In the year of the house purchase, the risky asset share jumps up significantly, and it continues to increase in the next 2 years following the house purchase.⁷ As a result, the conditional risky asset share of financial wealth is 3.5 percentage points higher 2 years after the house purchase compared to 1 year before the house purchase, corresponding to a 14.3% increase. This suggests that of the three competing channels mentioned above that are related to the risky asset demands for homeowners, the debt retirement channel and the diversification effect dominate the liquidity concern.

We perform various robustness checks to test how sensitive the estimated patterns of household portfolio choice around a house purchase are to different specifications. We

⁶Equity market participation costs could be one-time or per-period costs. Previous studies by Basak and Cuoco (1998), Vissing-Jorgensen (2002), Haliassos and Michaelides (2003), Gomes and Michaelides (2005), and Alan (2006) suggest that these costs can significantly impact equity market participation.

⁷The increase in the conditional risky asset share in the years immediately after a house purchase is non-monotonic with the largest increase happening in the year of the house purchase.

also explore the variation in these temporal patterns for different types of households. We run a specification where we control for lagged bank loans and net wealth instead of the contemporaneous terms. We run analyses for households with different levels of wealth and in different life cycle stages. We also test the robustness of the estimated temporal patterns for two groups of households in particular: those that had capital gains and those that experienced capital losses in the stock market at 1 year prior to their house purchase year. Finally, we divide the sample periods and carry out analyses for households who bought their houses before and after the 2008 financial crisis, respectively. Overall, our main findings are robust to different specifications and hold largely for different subgroups of the sample.

We aim to document the dynamic correlation between a house purchase and household portfolio choice. Our estimates should not be interpreted as causal. This is because the timing of house purchase is usually not random. Households form expectations years before the actual purchase. Moreover, they likely rebalance their financial portfolios accordingly in anticipation of the house purchase event. While we have included a rich set of control variables in our estimation strategy and controlled for household fixed effects and year fixed effects, concerns persist as to whether the results are driven by other confounders, such as unobserved time-variant household heterogeneity and macroeconomic trends that could affect different households differently. As an attempt to address the endogeneity concerns to some extent, we randomly assign an artificial house purchase year (between 2005—2009) to each household in our sample. We find no systematically significant relationship between household portfolio choice outcomes and the randomly assigned house purchase event.⁸

Our findings in Denmark, an economy with a relatively low minimum down payment requirement,⁹ convenient and low-cost mortgage refinancing and prepayment terms,¹⁰ as

⁸We also carry out a placebo test on an alternative group of households that are subjected to the same sample selection criteria as the main sample, but are renters (i.e., they did not purchase a house during the entire sample period from 2002 to 2012). We randomly assign an artificial house purchase year (between 2005—2009) to each of these households. Again, there is no significant relationship between household portfolio choice outcomes and the randomly assigned house purchase year for this sample of households. We discuss other alternative estimation strategies in Section 4. For instance, we perform matching and subsequently apply the difference-in-difference method on the matched households. We explain why matching does not work well in our particular context. Additionally, we implement the Borusyak, Jaravel, and Spiess (2022) imputation-based estimator as an attempt to address potential biases from heterogeneous treatment effects of a house purchase on portfolio choice outcomes. Please see Section D of the Appendix for further details.

⁹In Denmark, for owner-occupied housing, households can borrow up to 80% of the property value as a mortgage loan according to the Act on Mortgages and Mortgage Bonds by the Danish Financial Supervisory Authority (Finanstilsynet). The remaining 20% can be borrowed as a bank loan from commercial banks. In our sample period, about 92% of home buyers financed their house purchase with a mortgage, as mortgage interest is tax deductible in Denmark (Gruber, Jensen, and Kleven (2021)). During the sample period, there is no legal minimum down payment requirement, although most households make down payments when buying a house. However, since November 1, 2015, most household has been required to have at least a 5% down payment when buying a house.

¹⁰A standard Danish mortgage contract allows households to borrow long-term (up to 30 years) at fixed rates with an option to make a prepayment. The prepayment can be made by either buying back the underlying covered bonds at the market price (i.e., exercise the delivery option) or at par (i.e., exercise

well as a mature stock market, suggest that there could be an even stronger link between house purchases and households' portfolio choice of financial wealth in countries and economies where households face stricter borrowing constraints and more frictions in the mortgage market, and where stock markets are more volatile.

The rest of the paper is organized as follows. In Section 2, we present theoretical predictions on how household portfolio choice should evolve before and after a house purchase. Section 3 describes the data. In Section 4, we explain our empirical strategies, and Section 5 presents the results. Finally, Section 6 concludes the paper.

2 Theoretical Considerations

A significant body of theoretical and empirical literature has studied household portfolio choice along the extensive participation margin (the decision to hold a certain type of financial asset) and the intensive allocation margin (the share of financial wealth held in a given asset); see Guiso, Haliassos, and Jappelli (2002), Campbell (2006), and Guiso and Sodini (2013), among others. Household portfolio choices are found to be associated with various factors, including risk preferences, financial characteristics, demographic characteristics, background risk, information and participation costs, etc.

Most of the previous studies do not consider housing when studying household portfolio choice (Cocco, Gomes, and Maenhout (2005), Gomes and Michaelides (2005), and Fagereng, Gottlieb, and Guiso (2017)). There is a relatively sparse literature examining the effects of housing on household portfolios.¹¹ Nonetheless, it has provided theoretical guidance for our empirical investigation regarding the temporal patterns of household portfolio choice of financial wealth before and after a house purchase.

Earlier studies show that when facing a borrowing constraint (e.g., buying a house), households behave in a more risk-averse manner in anticipation of the possibility that the constraint might be binding in the near future (Paxson (1990), Grossman and Vila (1992), and Teplá (2000)). Thus, before a house purchase, we expect that households are likely to rebalance their financial wealth portfolios from risky to safe assets due to a reduced willingness to take on risk. Given that buying a house is the most important

the call option). Borrowers typically exercise the delivery option if the underlying bond is priced below par (when the interest rate increases) and are charged a trading fee of 0.10%-0.30% depending on the size of the loan. Borrowers can refinance their mortgages to reduce the interest rate if there is a decline in interest rates and extend the loan's maturity without cashing out, even when the borrowers have negative home equity. In addition, deregulation and mortgage banks' adoption of new technologies in the 1990s gave rise to a wide range of loan types for borrowers to choose from. For more details on the supply side of Danish mortgages, see the Danish Mortgage Banks' Federation, Frankel, Gyntelberg, Kjeldsen, and Persson (2004), Willemann and Svenstrup (2006), and Rasmussen, Madsen, and Poulsen (2014).

¹¹For example, Grossman and Laroque (1990) and Flavin and Yamashita (2002) show that housing increases a household's exposure to risk and illiquidity. Cocco (2005) studies household portfolio choice in the presence of housing using simulation (i.e., all model households own a house). He finds that house price risk crowds out stockholdings.

financial decision for the majority of households, we also anticipate that households form expectations about their upcoming house purchase and accumulate more financial wealth for a down payment. If participation costs are associated with risky asset investments, the equity market participation rate will likely increase before a house purchase when households accumulate more financial wealth.

When buying a house, it is likely that households will convert most of their financial wealth into down payments. Immediately after a house purchase, they have less financial wealth to invest in risky assets and benefit less from equity market participation. Here, a few theoretical papers from the literature on housing and portfolio choice are most relevant for our study. These papers identify three channels that provide different incentives for households to rebalance their financial wealth toward riskier or safer positions.

First, Hu (2005) studies the interaction of housing investment and portfolio choice in a life-cycle model. In addition to the house price risk, the model incorporates another type of uncertainty associated with housing investment: the committed expenditure risk. The expenditure risk arises due to committed mortgage payments over a long horizon with an uncertain stream of labor income. Hu (2005) shows that buying a house partially crowds out stock market participation. Moreover, due to liquidity concerns stemming from the committed expenditure risk, buying a house has a negative impact on the risky asset share. The risky asset share of financial wealth decreases after a house purchase, while the share of bond holdings increases as bonds provide liquidity to make mortgage payments in case of income shortfalls.¹² Considering the nature of the expenditure risk, we expect that long after a house purchase, liquidity concern could become less of an issue if households accumulate more financial wealth over time. In that case, households' capacity for risk taking could gradually recover in the future as households accumulate more financial wealth. However, in the short-term (i.e., in the few years immediately after a house purchase) the risk asset share of financial wealth should decrease due to the liquidity concern.

Second, Becker and Shabani (2010) consider a simple portfolio choice model, in which households face the decision of how to allocate their wealth between stocks, bonds (safe assets), and repayment of mortgage debt. They investigate how the presence of mortgage debt and the mortgage interest rate influence households' financial portfolios through a debt retirement channel. By substituting individual mortgage rates for the market risk-free rate of return and obtaining a diminished expected excess return, the theoretical framework predicts that buying a house and having a mortgage should decrease the probability of equity market participation. This is because households have less wealth available for investing in risky assets and earn less on each dollar invested in the risky assets after buying a house with a mortgage. Therefore, these households will be less likely to own stocks.

¹²Fratantoni (2001) also finds that committed expenditure risk associated with homeownership results in much lower predicted risk asset shares.

Becker and Shabani (2010) also argue that conditional on equity market participation, buying a house and having a mortgage should increase the equity share of financial wealth through a debt retirement channel. After a house purchase with a mortgage, households have less incentive to hold safe assets if they participate in the equity market. This is because households can be better off using their financial wealth to pay back their mortgage debt, as retiring mortgage debt offers households a return equal to the mortgage interest rate, which is almost always greater than the return on investing in safe assets. The debt retirement channel will always be in effect as long as the mortgage has not been paid off entirely. Thus, we expect the conditional risky asset share of financial wealth will remain high in the few years immediately after a house purchase.

Third, Yao and Zhang (2005) study how households optimally choose their portfolios when they also decide whether to rent or own a house using a life-cycle model. When households are indifferent between owning and renting, the authors show that investors choose substantially different portfolio compositions when they own a house compared to when they rent a house. When owning a house, investors reduce the stock share in their total wealth (i.e., the sum of bonds, stocks, and home equity), reflecting the substitution effect of home equity for risky stocks. However, investors hold a higher risky asset share in their financial wealth portfolios (i.e., bonds and stocks) after owning a house, reflecting the diversification effect. The diversification effect is stemming from the low correlation between stock returns and housing returns. We also expect that this diversification effect will continue to be relevant for homeowners in the years immediately following a house purchase. Yao and Zhang (2005) do not factor in a fixed cost for entering the equity market, thus their model does not address stock market participation directly.¹³ Households possess considerably lower financial wealth after a house purchase. If stock investment involves participation costs, the equity market participation rate is likely to decline immediately after a house purchase. And as households accumulate more financial wealth over time after a house purchase, the equity market participation rate could gradually increase.

Based on the discussions above, we expect that the equity market participation rate will decrease immediately after a house purchase and remain at a lower level for a certain period. As households build up their financial wealth over time, we can expect the equity market participation rate to gradually rise. Regarding the risk asset share of financial wealth, the liquidity channel suggests a decline in the conditional risky asset share of financial wealth in the few years after a house purchase, whereas the debt retirement channel and the diversification effect present arguments for the opposite trend.

To summarize, to the extent that households anticipate an upcoming house purchase, we expect that they accumulate more financial wealth to facilitate the need for a down

¹³A fixed cost to equity market participation is a common feature used in the literature to address limited stock market participation; see Vissing-Jorgensen (2002), Cocco (2005), Gomes and Michaelides (2005), and Fagereng, Gottlieb, and Guiso (2017).

payment. If participation costs are associated with risky asset investments, the equity market participation rate is likely to increase before a house purchase as financial wealth accumulates. Prior to a house purchase, the risk asset share of financial wealth is likely to fall as households behave in a more risk-averse manner. Following a house purchase, financial wealth tends to be reduced due to the investment in housing. We expect that the equity market participation rate will fall immediately after a house purchase and remain low for a certain period. As households build up financial wealth over time after a house purchase, we expect a gradual increase in the equity market participation rate. Regarding the conditional risky asset share of financial wealth in the years immediately after a house purchase, economic theory offers three channels that are related to the demand for risky assets. However, the net impact is ambiguous. Consequently, it is an empirical question to investigate which channel dominates and what is the overall net impact.

3 Data

We exploit administrative panel data from Statistics Denmark that contains the entire Danish population for 11 calendar years over the period 2002—2012. For each individual, we have access to their demographics, income, as well as asset and debt holdings, which include information on housing. All these variables are available on an annual basis. We then aggregate all the financial variables into “household” level using the family identifier provided by Statistics Denmark. We use the household head’s age, marital status, and highest educational attainment as the household characteristics. We choose the “household” instead of the “individual” as the research unit because purchasing a house and the associated housing investment often entail a collective household decision-making.

We select a number of demographics and financial characteristics as control variables, drawing insights from portfolio choice theories (Haliassos and Bertaut (1995); Guiso, Haliassos, and Jappelli (2002); Christiansen, Joensen, and Rangvid (2008)). These include variables such as age, age-squared, marital status, number of children, the highest education attained, labor income after taxes and deductions, compulsory pension savings, bank loans,¹⁴ net wealth, and profits and losses from stock investments.¹⁵ Our goal is to estimate the temporal patterns of household portfolio choices of financial wealth around a house purchase. In particular, the outcome variables we are interested in are the level of financial wealth, the equity market participation rate, and the risky asset share of financial wealth. Our dataset begins with a total of 47,847,174 individual-level observations

¹⁴Bank loans include consumer loans and the proportion of a loan for buying a house that is not covered by a mortgage. The maximum lending limits for Danish mortgages are set up for each type of property. For owner-occupied homes, cooperative homes, and housing projects, mortgage loans can account for up to 80% of the property value. The remaining 20% can be secured from a commercial bank at a rate that is typically higher than the mortgage rate and lower than the consumer loan rate.

¹⁵A complete list of variable definitions can be found in the Appendix, Table A.

spanning the period from 2002 to 2012.

We restrict the sample based on several criteria: (i) We keep only households with heads aged between 28 and 59 years in the year of the house purchase to avoid the effect of early retirement or being in full-time education on household portfolio choice. We focus on the purchases of owner-occupied housing. i.e., purchases of holiday housing, private rentals, and cooperative housing are excluded from the analysis. The year of the house purchase is defined as the first instance when the “taxable property value” appears greater than zero. (ii) We require the “house purchase” events to occur during the period 2005 to 2009 to ensure that we have household information for at least 3 years before and 3 years after the house purchase. (iii) For households that purchased homes during the period 2005—2009, we further impose a strict requirement that these households must not have owned a house within the three years preceding the year of the house purchase.

After applying these sample selection criteria, the panel is then balanced based on the list of covariates and outcome variables. This gives us 44,970 distinct households, corresponding to 463,523 observations.¹⁶ These households purchased a house between 2005 and 2009, and all information on the portfolio outcomes and the control variables is available for a span of at least 7 years around the house purchase (from 3 years before to 3 years after).¹⁷ Our main sample consists of these 44,970 households.

Our dataset offers a number of advantages. First, using register-based data for the entire population eliminates the concern of attrition bias usually present in survey data, and ensures that our results do not suffer from sampling error. Second, the large sample size increases the external validity of our results and allows us to perform various sub-sample tests while having sufficient observations in each specification to yield robust inferences. The availability of detailed information also gives us a broad spectrum of controls that capture the background risk to a large extent. Finally, the panel data structure allows us to account for time-invariant unobserved household heterogeneity which is a pervasive problem in cross-sectional analyses.

[Table 1 is here]

Table 1 presents the summary statistics for the main sample in the representative year 2010. The average household head in the main sample during 2010 is 41 years old and has 12-14 years of education. The average household has a labor income of DKK 529,842, has bank loans amounting to DKK 389,831, possesses a household net wealth of DKK 22,918, registers a profit of DKK 2,259 from stock investments, and owns financial wealth of DKK 194,961, of which DKK 31,870 is allocated to risky assets. The riskiness of household portfolio is measured by the ratio of the market value of stocks and the risky mutual fund

¹⁶Table B in the Appendix Section B shows the number of observations after each selection criteria.

¹⁷The numbers of households that bought a house are: 12,495 in 2005, 9,834 in 2006, 9,171 in 2007, 7,332 in 2008, and 6,138 in 2009.

investments at year end to the total financial wealth. This measure is often referred to as the risky asset share or stock share. In 2010, 32.12% of the households in our sample are stockholders. Among those who participate in the stock market, on average, 26.32% of their financial wealth is invested in risky assets.

4 Empirical Strategy

In our empirical analysis, we estimate the temporal patterns of households' financial wealth accumulation and investments in risky assets over a 7-year period around a house purchase. We use two empirical strategies to address this issue.

4.1 The Main Empirical Strategy

We implement an event study design to plot the dynamics of household portfolio choice before and after a house purchase.¹⁸ Our empirical strategy is illustrated by the following specification:

$$Y_{it} = \sum_{k \geq -3}^{k \leq 3} \delta_k D_{it}^k + \beta X_{it} + \eta_i + \gamma_t + \varepsilon_{it}. \quad (1)$$

where the dependent variable Y_{it} is a portfolio choice outcome for a household i in year t . The outcomes we focus on in this paper are the level of financial wealth, the equity market participation rate, and the share of risky assets in financial wealth. To capture the dynamic effect of portfolio choice around a house purchase, Equation 1 includes a set of "lags" and "leads" dummies spanning 7 relative years around the year of the house purchase: $D_{it}^k = \{D_{it}^{-3}, D_{it}^{-2}, D_{it}^{-1}, D_{it}^0, D_{it}^1, D_{it}^2, D_{it}^3\}$, where the relative year zero corresponds to the house purchase year.¹⁹ Let $D_{it}^k = 1$ if year t is k years relative to a house purchase year.²⁰ δ_k are our parameters of interest, which describe the short-term dynamics of the portfolio choice outcomes from 3 years before to 3 years after a house purchase. X_{it} contains a broad spectrum of controls on households' demographics and financial characteristics: household head's age, age-squared, marital status, the highest education attainment, number of children, household's total labor income after taxes and deductions, compulsory pension

¹⁸Event study designs were originated from the finance literature, see, for example, Dolley (1933) and MacKinlay (1997). Nowadays, event study designs are widely adopted in applied economics. To list a few, see Dobkin, Finkelstein, Kluender, and Notowidigdo (2018), Fuest, Peichl, and Siegloch (2018), and Guidolin and La Ferrara (2007).

¹⁹The dataset spans 11 years from 2002 to 2012. We observe all sample households at least 3 years prior to and 3 years after a house purchase. The house purchase events are restricted to occur between 2005 and 2009. The dataset includes observations up to 7 years before a house purchase if the purchase event occurred in 2009, and up to 7 years after a house purchase if it took place in 2005.

²⁰For example, when $k = -2$, $D_{it}^{-2} = 1$ means that year t is 2 years before a household i bought a house. Similarly, when $k = 3$, $D_{it}^3 = 1$ indicates that year t is 3 years after a household i purchased a house.

savings, bank loans, net wealth, and realized profits and losses from stock investments within a calendar year. η_i are household fixed effects that allow for different baseline outcomes across households. γ_t are calendar-year fixed effects that capture overall trends in portfolio choice outcomes. ε_{it} is an idiosyncratic error term. The observations are assumed to be independent across households but not necessarily across time.

This event study is implemented by two-way fixed effect regressions.²¹ This is to ensure that time-invariant household heterogeneity and aggregate calendar-year variations that uniformly impact all households (e.g., macroeconomic conditions, such as the interest rates, and mortgage regulations), which may potentially affect the timing of the house purchase and household portfolio choice decisions, will not bias the results. We allow households' behaviors to be correlated across time and report cluster-robust standard errors, clustering at the household level. The regressions are estimated using only within-household variations, and therefore should be interpreted as the evolution of household decisions over time rather than differences in decisions across households.

4.2 Random Assignment of An Artificial House Purchase Year

We aim to document the dynamic correlation between a house purchase and household portfolio choice. Our estimates should not be interpreted as causal. This is because the timing of house purchase is usually not random. Households form expectations years before the actual purchase. And often times, they also rebalance their financial portfolios accordingly in anticipation of the house purchase event. Although we have included a rich set of control variables in our main estimation strategy and controlled for household fixed effects and year fixed effects, concerns remain on the potential influence of other confounding factors, such as unobserved time-variant household heterogeneity (e.g., risk preference, investment horizon, tax treatment, etc.) and macroeconomic trends that might affect different households differently.

As an attempt to address the omitted variables concerns to some extent, we develop another empirical strategy, where we randomly assign an artificial house purchase year (between 2005 and 2009) to each household in our sample, and then repeat the analysis (i.e., running two-way fixed effects regressions as specified in Equation 1).²² If an unobservable/omitted shock occurs during the sample period, it should still reside in the testing framework, and thus have the potential to influence our results. We do not expect any systematic patterns of household portfolio choice around these randomly assigned house purchase years, and it would raise concerns if such patterns were to emerge.²³

²¹In a previous version, we study the equity market participation decision using a fixed effects Logit model controlling for household fixed effects and calendar year fixed effects. The resulting portfolio choice dynamics around a house purchase were consistent with the findings from this specification.

²²A similar approach has been adopted in the corporate finance literature (e.g., Cornaggia, Mao, Tian, and Wolfe (2015)).

²³Another intuitive way of doing this analysis is to first construct a matching sample of "control"

5 Results

In this section, we first report the findings of the two empirical strategies outlined in Section 4. We then perform various robustness checks to test how sensitive the estimated patterns of household portfolio choice around a house purchase are to different specifications. Lastly, we explore the variations in these temporal patterns across different subgroups of the population.

5.1 Results from the Main Empirical Strategy

We estimate the short-run dynamic evolution of financial wealth, the equity market participation rate, and the risky asset share of financial wealth around a house purchase. Table 2 reports the regression coefficients estimated using Equation 1. The corresponding predicted outcomes in each relative year around the house purchase from these regressions are shown in Table 3.²⁴

[Table 2 and 3 are here]

We find that households accumulate more financial wealth before a house purchase. Figure 1 shows that Danish households, on average, hold DKK 204,304 (about USD 37,000 or EUR 28,000) in financial wealth 3 years prior to purchasing a house (T represents the year of the house purchase in the figure). Financial wealth continues to rise and reaches its peak at DKK 294,707 (about USD 53,000 or EUR 40,000) 1 year before the house purchase. Thereafter, there is a sharp decline in financial wealth in the year of the house purchase, likely attributed to households allocating funds towards down payments and

households that have similar characteristics as the “treated” households, and subsequently implement the difference-in-difference method on the two more comparable samples. We did try the propensity score matching approach. But the resulting matching quality is poor. Certain areas within the common support interval only contains treated observations. Many treated households fall off the common support (mostly the observations that have high propensity scores). If we drop the observations that are off common support and run the event study for "treated" and "control" samples, this raises a serious concern of whether the estimated effects on the remaining households are representative. This approach could potentially introduce another selection bias. We suspect that the reason why matching does not work well in our study is that the conditional independence assumption does not hold in our context. Additionally, we implement a imputation-based estimator developed by Borusyak, Jaravel, and Spiess (2022) as an attempt to address potential biases from heterogeneous treatment effects in our study. We choose this method because this framework focuses on event study designs with staggered treatment adoption and heterogeneous treatment effects that fit our setting very well, i.e., households purchase their home in different years (staggered roll-out), and the magnitude and direction of the effects of house purchase on portfolio choice outcomes vary across different households (heterogeneity of treatment effects). This estimator is shown to provide robust and efficient estimator under these circumstances. The resulting household portfolio choice dynamics around house purchases obtained from this estimator align closely with the patterns found in our main results (see Section D Figures 7, 8 and 9 in the Appendix). Section D in the Appendix also provides a more detailed discussion on the matching approach and the Borusyak, Jaravel, and Spiess (2022) estimator.

²⁴Table 3 contains the underlying estimates for financial wealth in Figure 1, the equity market participation rate in Figure 2, and the risky asset share in Figure 3 below.

transforming a portion of their financial wealth into home equity. The magnitude of the decline amounts to DKK 180,526 (about USD 32,000 or EUR 24,000), representing 61.26% of the financial wealth documented 1 year before the house purchase. Financial wealth remains at a lower level for another year following the house purchase and starts to increase after that. By the end of the third year following the house purchase, the financial wealth has risen by DKK 18,564 in comparison to the value recorded at the end of the house purchase year, corresponding to a 16.26% increase.

[Figure 1 is here]

5.1.1 The Extensive Margin

Figure 2 illustrates the temporal pattern of equity market participation before and after a house purchase. The evolution of equity market participation closely mirrors the trajectory of financial wealth accumulation. Before a house purchase, the participation rate increases by about 1 percentage point over the 2 years period from $T - 3$ to $T - 1$. In the year of house purchase, the participation rate undergoes a decrease of 1.20 percentage points, marking a 3.83% decline relative to the participation rate observed 1 year prior to the house purchase. Our finding that the equity market participation rate decreases in the year of a house purchase provides some evidence that housing investments induce households to withdraw funds from the equity market.

[Figure 2 is here]

After the house purchase, the equity market participation rate stays low for another year and starts to increase slightly after that. Overall, the equity market participation rate observed in the years following the house purchase remains beneath the level immediately before the house purchase. This is likely because households have low levels of financial wealth in the few years after a house purchase. Given the existence of fixed participation costs associated with stock investments, individuals who have recently become homeowners may find the potential benefits from risky investments limited and decide not to participate in the short term.

5.1.2 The Intensive Margin

Regarding the intensive margin, Figure 3 reports the dynamic evolution of risky asset share of financial wealth before and after a house purchase. Households rebalance their financial portfolios from risky to safe assets before a house purchase. This is consistent with the theoretical prediction that investors behave in a more risk-averse manner when they face borrowing constraints (see, for example, Paxson (1990); Grossman and Vila (1992) and Teplá (2000)). Conditional on participation (the left panel of Figure 3), the risky asset

share falls by 2.09 percentage points over the period from 3 years before (26.49%) to 1 year before a house purchase (24.40%), which corresponds to a 7.89% decline.

[Figure 3 is here]

Regarding the risky asset share of financial wealth after a house purchase, there are three competing theoretical channels: the liquidity concern (Hu (2005)), the debt retirement channel (Becker and Shabani (2010)), and the diversification effect (Yao and Zhang (2005)). While the liquidity concern predicts that the conditional risky asset share should decrease immediately following a house purchase, the latter two suggest that the share should increase.²⁵ Although we cannot separately identify the effects of each channel, our results suggest that the debt retirement channel and the diversification effect dominate the liquidity concern, as the conditional risky asset share jumps up significantly after a house purchase. The conditional risky asset share rises from 24.40% 1 year before the house purchase to 26.25% in the year of the house purchase. And it continues to increase during the next 2 years following the house purchase. We note that the increase in the conditional risky asset share is non-monotonic with the largest increase observed in the year of the house purchase. As a result, the conditional risky asset share is 3.5 percentage points higher 2 years post-purchase in comparison to 1 year pre-purchase, corresponding to a 14.34% increase. Overall, we find that the conditional risky asset share of financial wealth follows a V-shape around a house purchase.

5.2 Results for the Randomly Assigned Artificial House Purchase Year

In this section, we report the results from the second empirical strategy, in which we randomly assign an artificial house purchase year to each household in our sample. By comparing the temporal patterns of portfolio choice outcomes around the actual house purchase and around the randomly assigned purchase, we attempt to address concerns of omitted variables that could potentially influence our results.²⁶

As shown in Figure 4, households from our sample accumulate more financial wealth before the actual house purchase. They allocate a significant portion of their financial wealth to cover down payments and then gradually rebuild capital post-purchase. However, we do not observe any notable change in financial wealth for the same households before and after the randomly assigned house purchase year. Their financial wealth stabilizes around DKK 175,000 (about USD 32,000 or EUR 23,000 euro) throughout the entire sample period.

²⁵Please find a more detailed discussion on the dynamic effects of these three channels in Section 2.

²⁶Panel A of Table C in the Appendix reports the regression coefficients estimated using Equation 1 for this exercise. Panel B of Table C reports the underlying estimates for the randomly assigned purchase concerning the financial wealth outcome in Figure 4, the equity market participation rate outcome in Figure 5, and the risky asset share outcome in Figure 6.

[Figure 4 is here]

5.2.1 The Extensive Margin

Figure 5 shows the temporal patterns of the equity market participation for the same households around the actual house purchase and around the randomly assigned purchase. Equity market participation declines in the year of the actual house purchase and remains at a low level in the years immediately following the purchase. Here again, we do not find any systematic pattern for equity market participation before and after the artificially assigned house purchase year. The participation rate hovers around 30.6% during the entire sample period.

[Figure 5 is here]

5.2.2 The Intensive Margin

Figure 6 reports the dynamic evolution of the risky asset share around the actual versus the artificially assigned house purchase for the same households. On average, the evolution of risky asset share of financial wealth displays a V-shaped pattern around an actual house purchase. However, as expected, we do not observe any significant pattern in the risky asset share before and after a randomly assigned house purchase. The unconditional risky asset share is flat, about 8.4% during the sample period. Conditional on equity market participation, the risky asset share stabilizes at approximately 27.0% both before and after the artificial house purchase.

[Figure 6 is here]

Overall, we demonstrate that clear patterns of household portfolio choice exist around the actual house purchase, whereas there is no systematic evidence of households rebalancing their risky asset holdings around the randomly assigned artificial house purchase. This suggests that the portfolio choice dynamics we found around a house purchase are unlikely to be driven by unobserved confounders and/or macroeconomic trends.

5.3 Heterogeneity and Robustness

In this section, we perform robustness checks and heterogeneity tests for the main empirical strategy. We run a specification where we control for lagged bank loans and net wealth instead of their contemporaneous terms. We run analyses for households with different levels of wealth (i.e., more financially constrained households versus wealthier households), and in different life cycle stages.²⁷ Moreover, we explore the temporal patterns for two

²⁷We also explore heterogeneity for households with different levels of labor income, and for households from different regions. Overall, the patterns in each subgroup are similar to what we find in the main results. The results are reported in Section E of the Appendix. Figures 25, 26, and 27 show the results by income groups, while Figures 28, 29, and 30 report the results by regions.

types of households in particular: those that experienced capital gains and those that experienced capital losses in the stock market 1 year prior to their house purchase. Finally, we divide the sample period into two segments and conduct analyses for households that purchased their houses before and after the 2008 financial crisis, respectively. The main findings are robust to different specifications and hold broadly across different subgroups of the sample.

5.3.1 Using Lagged Control Variables

Some of the control variables in the main empirical strategy, such as bank loans and net wealth, could be endogenous to the house purchases and portfolio choice decisions. To address this concern, we replace the contemporaneous terms with the lagged ($t - 1$) terms. In particular, we estimate Equation 1 using lagged bank loans and net wealth as controls, instead of their corresponding contemporaneous terms.

Similar to the main findings reported above, households accumulate more financial wealth before the house purchase, and financial wealth peaks at 1 year before the house purchase. Financial wealth falls after a house purchase. However, households draw down a smaller fraction of their financial wealth in the year of house purchase compared to the main results. After the purchase, households continue to tap into their financial wealth for a few years. On average, financial wealth is DKK 115,000 lower from 1 year before to 3 years after the purchase. With respect to equity market participation and risky asset shares decision, we find that both the dynamic patterns and the magnitude of the results are similar to our main findings.²⁸ Our finding is robust to this alternative specification, suggesting that this particular source of endogeneity is unlikely to be the driving factor behind our results.

5.3.2 By Wealth

To compare the dynamic portfolio choice decisions made by households with varying levels of financial resources, we split the sample into two subgroups based on the median value of households' net wealth. We then estimated the two-way fixed effects model on these two sub-samples respectively.²⁹

Households in both groups accumulate more financial wealth before a house purchase. At 1 year before the house purchase, the level of financial wealth peaks at around DKK 470,000 for wealthier households, and around DKK 86,500 for the more financially constrained households. Households in both groups tap into their financial wealth at the house purchase year. Financial wealth drops 61.70% for wealthier households, and 20.23% for the more constrained households. Although the overall dynamic evolution of financial

²⁸Figures 10, 11 and 12 in the Appendix report the temporal patterns of financial wealth, the extensive and intensive margins of risky asset investments around a house purchase using lagged controls.

²⁹Figures 13, 14 and 15 in the Appendix show the results.

wealth around the house purchase exhibits similarities between the two groups, there is one notable difference. For the more financially constrained households, their financial wealth continues to decline in the year following the house purchase. In contrast, wealthier households experience a gradual increase in financial wealth immediately after the purchase. This suggests that liquidity concerns have a more pronounced impact on the more financially constrained households after buying a house, which in turn influences the extensive and intensive margins of stock investments.

Wealthier households maintain a relatively stable equity market participation rate before a house purchase, with a decline of 5.85 percentage points occurring in the year of the house purchase. Conversely, the more financially constrained households exhibit a slight increase in equity market participation before a house purchase, followed by a further increase in the year of the house purchase. This suggests that on average the more financially constrained households are taking on higher levels of risk by investing in risky assets immediately before and at the time of a house purchase. This behavior could be driven by the aim to achieve high returns from the stock market and relax their borrowing constraints. This trend might reflect a channel proposed by Chetty and Szeidl (2007) that commitments affect risk preferences by creating a motive to take large-payoff gambles.³⁰ For some financially constrained households, the commitment to homeownership creates an incentive to engage in stock market speculation. The analysis also provides evidence for the findings in Figure 2, suggesting that the drop in the overall participation rate during the house purchase year is primarily driven by wealthier (i.e., above median wealth) households.

The dynamic pattern of the conditional risky asset share around a house purchase for wealthier households is similar to our main result reported in Figure 3. In particular, it follows a V-shape and the risky asset share increases in the house purchase year. For the more financially constrained households, the conditional risky asset share of financial wealth drops in the few year before the house purchase, and it continues to decrease in the year of the purchase. This may suggest that the liquidity demand is indeed a bigger concern for these households, resulting in lower investments in risky assets for these households, as proposed by Hu (2005).

5.3.3 By Age

Households at different stage of their life cycle may have different risk preferences and make different portfolio choice, see, e.g., Cocco, Gomes, and Maenhout (2005). To compare household portfolio choice dynamics around a house purchase across different life-cycle stages, we split the sample into three age groups: households aged from 28 to 38, from 39

³⁰Another plausible explanation could be that the decision to purchase a house is influenced by experiencing a higher income/wealth growth, which simultaneously drives up their financial wealth and stock market participation. In an additional robustness check (not reported in this paper), we control for income and wealth growth, and still find an increase in equity market participation prior to a house purchase.

to 48, and from 49 to 59. The dataset contains 238,519 observations in the youngest age group, 122,661 observations in the middle age group, and 63,057 observations in the elder age group.

Elder households have higher levels of financial wealth compared to the other two groups. Nevertheless, the portfolio choice dynamics outlined in our main findings are consistent across households at different life-cycle stages.³¹

5.3.4 Capital Gains and Losses

Households' risky asset returns may be associated with their house purchase and portfolio choice decisions. In particular, households that have gained from capital appreciation in the stock market may be able to buy a house ahead of plans and/or use their capital gains to finance down payments. Conversely, households that have incurred capital losses may have to delay their house purchases and seek to decrease their exposure to risky assets. We examine two groups of households that either achieved capital gains or suffered capital losses in the stock market 1 year before buying a house.³²

For both of these households, we find comparable trends in financial wealth accumulation and risky asset share dynamics, which are also consistent with our main findings. However, the dynamic patterns of equity market participation diverge between these two groups. For households that realized capital gains, the participation rate declines at the house purchase year and continues to decrease in the 3 years following the purchase. In contrast, for households who suffered capital losses, the participation falls from $T - 3$ to $T - 1$. And then, it increases in the house purchase year, and continues to increase by about 1 percentage point in the few years after the purchase. This increase may be driven by the aspiration to recover their losses in the stock market.

5.3.5 The Impact of the 2008 Financial Crisis

We further address potential biases stemming from the economic environment during the sample period. Approximately 70% of the house purchases in our sample occurred during the mid-2000s housing and stock market boom (i.e., 2005, 2006 and 2007). During the subsequent years 2008 and 2009, the global financial crisis led to a significant downturn in the Danish real estate and stock markets. Given the potential influence of these economic conditions on household behavior, we split our sample into two groups: households who bought their houses during the economic expansion (2005 - 2007), and those who bought their houses during the global financial crisis (2008 - 2009). We then carry out analyses for the two groups of households separately.

We find that the dynamic evolution of household portfolio choice decisions for these two groups of households are consistent with the dynamic patterns estimated in our main

³¹See Figures 16, 17 and 18 in the Appendix for more details.

³²Figures 19, 20 and 21 in the Appendix report the results.

findings, along both the extensive and the intensive margins.³³ In particular, conditional on equity market participation, the risky asset share of financial wealth follows a V-shaped trajectory. This entails a decline in risky asset holdings to their lowest level 1 year prior to a house purchase, succeeded by an upswing in the year of the purchase.

6 Conclusions

Housing is the single most important asset for the majority of households. Many theoretical studies have shown that housing has a great influence on households' saving decisions and portfolio choices. The purpose of this paper is to document the short-run dynamic evolution of household portfolio choice of financial wealth before and after a house purchase.

Using a unique administrative panel data from Denmark that spans 11 years from 2002 to 2012, we show that households accumulate more financial wealth in the years leading up to a house purchase, and subsequently financial wealth falls by 61% on average in the year of a house purchase. The equity market participation rate also decreases in the year of a house purchase, suggesting that housing investments induce households to withdraw funds from the stock market. Interestingly, we find that the equity market participation rate increases slightly before a house purchase for the more financially constrained households (the bottom 50% by net worth), indicating that some of these households might be taking on high levels of risk in the pursuit of higher returns to facilitate house purchase. Conditional on equity market participation, the risky asset share of financial wealth follows a V-shaped trajectory, with a decline in risky asset holdings to their lowest level 1 year prior to a house purchase, succeeded by a surge in the year of the purchase. This pattern is robust across various robustness checks, and the 2008 global financial crisis does not seem to significantly affect our findings. The literature has identified three channels that could be related to the conditional risky asset share following a house purchase. Our results suggest that the debt retirement channel and the diversification effect have a dominant effect over the liquidity concern.

Our analysis provides new evidence on the relationship between a house purchase and household portfolio choice of financial wealth. There seems to be a clear link between the housing market and the stock market. The reduction in demand for risky assets due to house purchases could contribute to the volatility in stock prices. It is also important to bear in mind that our results stem from an economy with a relatively low minimum down payment requirement, convenient and low-cost mortgage refinancing and prepayment terms, as well as a mature stock market. In countries where households face stricter borrowing constraints and where stock markets are more volatile, there could be an even stronger link between house purchase and households' portfolio choice of financial wealth.

³³See Figures 22, 23, and 24 in the Appendix

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Table 1: Summary Statistics – The Main Sample

	Year 2010
Demographics:	
Age	40.99 (8.35)
Married	55% (50%)
Education	5.75 (2.34)
Number of children	1.13 (1.12)
Income and Debt:	
Compulsory pension contribution	11,630.72 (43416.0)
Labor income	529,842.10 (342381.5)
Bank loans	389,831.10 (766759.2)
Net wealth	22,918.08 (1372024.0)
Stock income	2,259.46 (77079.53)
Outcomes:	
Financial wealth	194,961.10 (507155.2)
Risky assets	31,870.21 (180025.2)
Safe assets	163,090.90 (425158.9)
Stock shares (unconditional)	8.58% (20.01%)
Stock shares (conditional)	26.32% (27.58%)
Stock market participation rate	32.12% (46.69%)

Note: This table reports summary statistics (mean value) in the year 2010 based on our main sample of 44,970 unique households (463,523 observations). Education is defined in categories (see Table A in Appendix). Where applicable, values are in Danish Kroner (DKK) and measured at the end of each year. Standard deviation in parentheses.

Table 2: Main Result – Coefficients

VARIABLES	(1) Financial Wealth (in DKK)	(2) Risky Asset Shares Conditional on Par- ticipation (in %)	(3) Unconditional Risky Asset Shares (in %)	(4) Equity Market Participation
T-3	32,208*** (10,198)	-0.456* (0.257)	-0.0494 (0.0929)	0.00413*** (0.00150)
T-2	58,465*** (16,979)	-0.933*** (0.307)	-0.0767 (0.114)	0.00767*** (0.00156)
T-1	122,611*** (27,511)	-2.544*** (0.342)	-0.482*** (0.128)	0.0122*** (0.00159)
T	-57,915** (27,130)	-0.700** (0.350)	-0.193 (0.131)	0.00236 (0.00159)
T+1	-59,299*** (20,390)	0.767** (0.327)	0.303** (0.123)	0.00485*** (0.00150)
T+2	-57,006*** (17,563)	0.956*** (0.283)	0.392*** (0.106)	0.00460*** (0.00139)
T+3	-39,350*** (11,697)	0.461** (0.230)	0.198** (0.0861)	0.00360*** (0.00120)
Controls	X	X	X	X
Household FE	X	X	X	X
Calendar Year FE	X	X	X	X
Observations	463,523	141,465	455,335	463,523
R-Squared	0.705	0.630	0.623	0.609
Number of Distinct Households	44,970	19,514	44,970	44,970

Notes: This table reports regression estimates for the short-run dynamics of household portfolio choices around the time of a house purchase. The coefficients are estimated using panel data fixed effects model, controlling for household fixed effect and calendar year fixed effect. Column 1-4 reports the dynamic evolution of (1) financial wealth (2) conditional risky asset shares (3) unconditional risky asset shares (4) equity market participation from 3 years before to 3 years after a house purchase, respectively. T denotes the house purchase year. T-3 denotes 3 years before the house purchase and T+3 denotes 3 years after the house purchase. Controls included in all regressions are household head's age, age-squared, marital status, highest education attainment, number of children, household's total labor income after tax and deductions, compulsory pension savings, bank loans, net wealth and realized profit and losses from stock investments. Cluster-robust standard errors in parentheses, clustering at household level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3: Main Result – Predicted Outcomes

VARIABLES	(1) Financial Wealth (in DKK)	(2) Risky Asset Shares Conditional on Par- ticipation (in %)	(3) Unconditional Risky Asset Shares (in %)	(4) Equity Market Participation
T-3	204,304*** (14,712)	26.49*** (0.184)	8.190*** (0.0651)	0.304*** (0.00112)
T-2	230,560*** (21,480)	26.01*** (0.176)	8.163*** (0.0638)	0.309*** (0.00111)
T-1	294,707*** (32,006)	24.40*** (0.183)	7.758*** (0.0672)	0.313*** (0.00121)
T	114,181*** (22,418)	26.25*** (0.183)	8.046*** (0.0665)	0.301*** (0.00113)
T+1	112,796*** (15,665)	27.71*** (0.178)	8.542*** (0.0657)	0.300*** (0.00105)
T+2	115,090*** (12,886)	27.90*** (0.169)	8.631*** (0.0635)	0.301*** (0.00102)
T+3	132,745*** (7,107)	27.41*** (0.177)	8.437*** (0.0645)	0.301*** (0.00110)
Controls	X	X	X	X
Household FE	X	X	X	X
Calendar Year FE	X	X	X	X
Observations	463,523	141,465	455,335	463,523

Notes: This table reports predicted outcomes for the short-run dynamics of household portfolio choices around the time of a house purchase. These predictions are calculated based on estimates from panel data fixed effects model from Table 2. Column 1-4 reports the dynamic evolution of (1) financial wealth (2) conditional risky asset shares (3) unconditional risky asset shares (4) equity market participation from 3 years before to 3 years after a house purchase, respectively. T denotes the house purchase year. T-3 denotes 3 years before the house purchase and T+3 denotes 3 years after the house purchase. Controls are household head's age, age-squared, marital status, highest education attainment, number of children, household's total labor income after tax and deductions, compulsory pension savings, bank loans, net wealth and realized profit and losses from stock investments. Cluster-robust standard errors in parentheses, clustering at household level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Figure 1: Financial Wealth

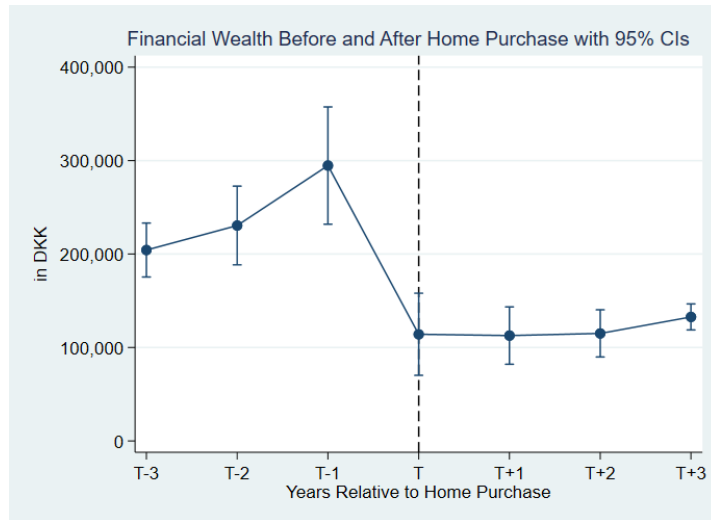


Figure 2: Equity Market Participation Rate

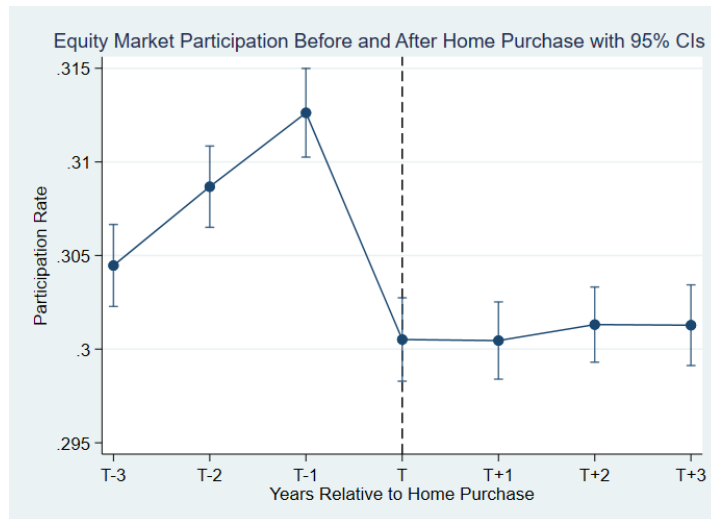


Figure 3: Risky Asset Shares – Conditional vs. Unconditional on Participation

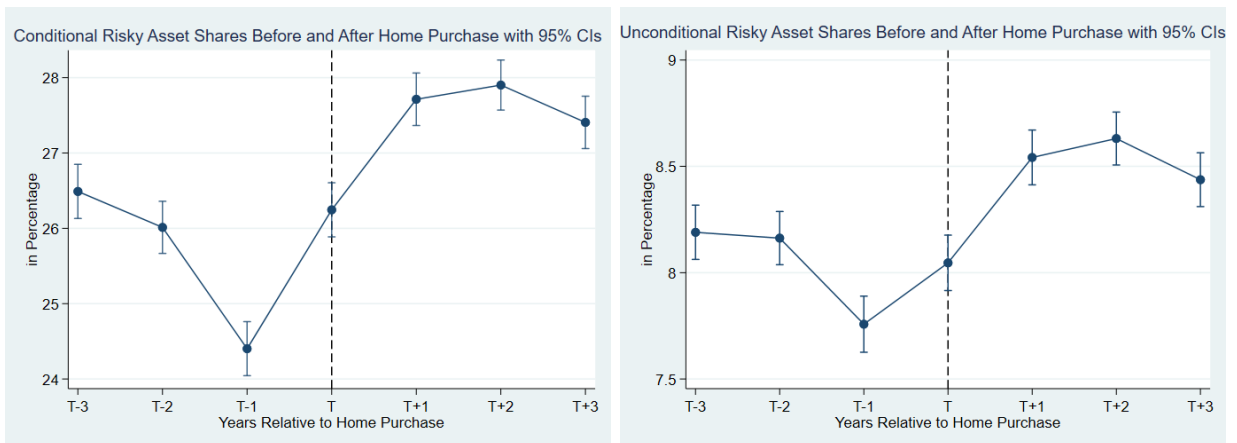


Figure 4: Financial Wealth

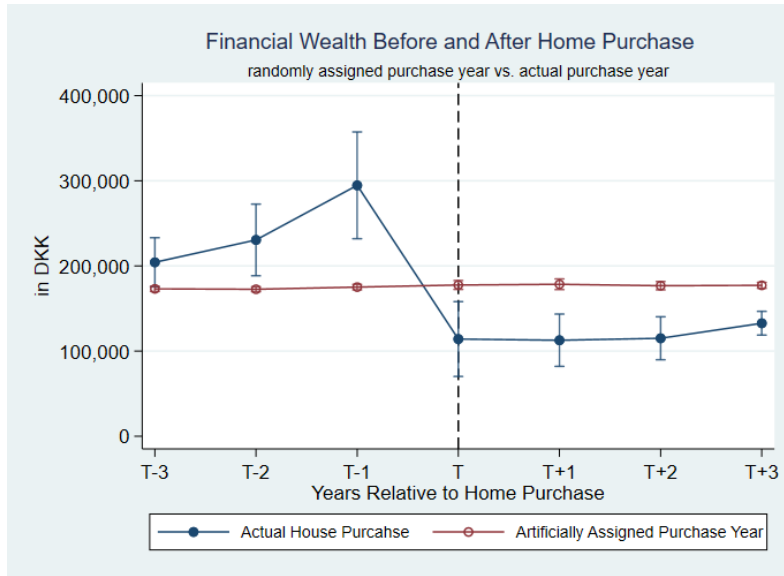


Figure 5: Equity Market Participation Rate

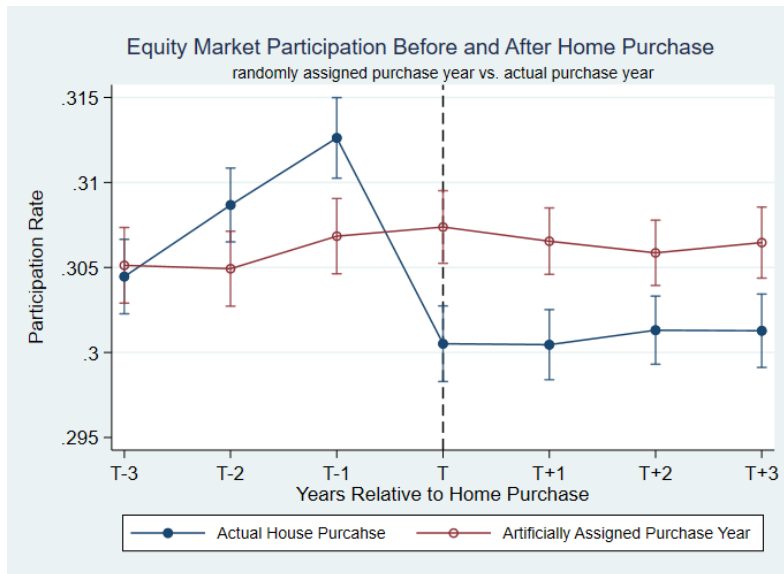
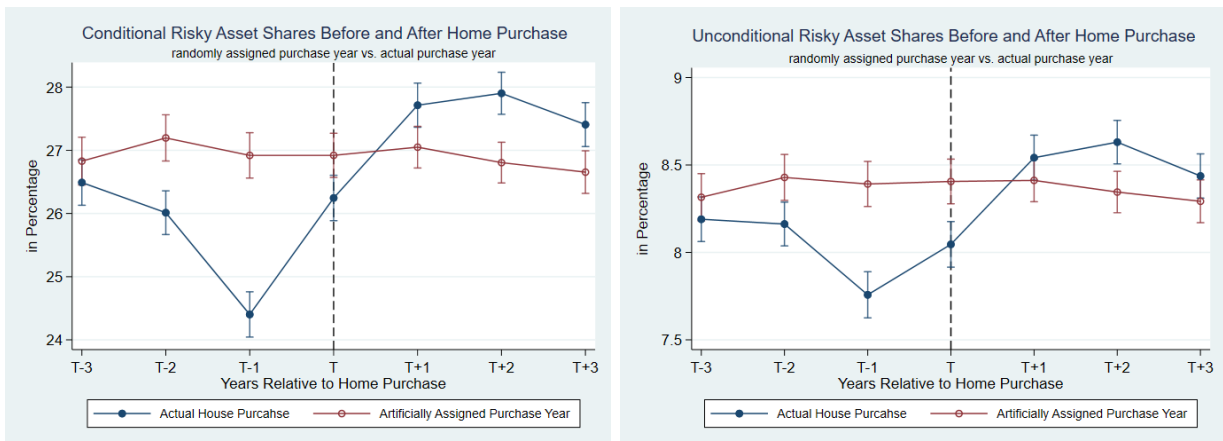


Figure 6: Risky Asset Shares – Conditional vs. Unconditional on Participation



Appendix

A. Variable Definition

Table A provides the definitions of variables used in the paper.

Table A: Variable Definition

Variable Name	Definition	Unit	Level
Age	Household head's age on 1st January of a specific year	-	Household head
Marital Status	Married = 1 when the household head is married (including separated but still legally married couples) or involved in registered partnership. Otherwise, Married = 0	-	Household head
Education	Education is defined in categories: 1 denotes lower than primary education; 2 denotes primary education, 9 years of schooling; 3 denotes preparatory courses, 10 years of schooling; 4 denotes upper secondary education, 11 years of schooling; 5 denotes high school and apprenticeship education, 12 years of schooling; 6 denotes shorter cycle higher education, 14 years of schooling; 7 denotes vocational bachelors education, 15 years of schooling; 8 denotes a bachelor's degree, 16 years of schooling; 9 denotes a master's degree, 18 years of schooling; 10 denotes a PhD, 20 years of schooling.	-	Household head
Number of children	Children include all people under 25 who is the child of at least one other person in the household. Furthermore, the person is only counted as a child in the household, if he/she does not have children of his/her own and have never been part of a couple in a marriage or registered partnership.	-	Household
Compulsory pension contribution	National and early retirement pension (taxable) incl. supplementary pension, retirement pension and tax-free supplement to early retirees + Special pension contribution	in 10,000 DKK	Household
Labor income	Taxable salary including benefits, tax-free pay, annual bonus and the value of stock options	in millions DKK	Household
Bank loans	Bank loans include consumer loans and the proportion of a loan for buying a house which is not covered by mortgage. Maximum lending limits for Danish mortgage are set up for each type of properties and documented in the Act on mortgages and mortgage bonds § 5. For owner-occupied homes, cooperative homes and housing projects, mortgage loans can represent up to 80 percent of the property value. The remaining 20 percent can be borrowed from a commercial bank with a rate that is typically higher than the mortgage rate and lower than the consumer loan rate.	in 10,000 DKK	Household
Net wealth	Net wealth includes property value, bank deposits, stocks, bonds, debt in different financial institutions including mortgage and consumer debt. This measure doesn't include pension wealth, value of cars, boats, cash, value of inventory, private debt and undocumented corporate bond value.	in millions DKK	Household
Stock income	Realized capital gains or losses	in DKK	Household
Financial wealth	Deposits in banks etc., market value of bonds and mortgage deeds in deposit measured on 31 December (excluding childcare, self-retirement and index contracts) + Market value of stocks and investments in risky mutual fund measured on 31st December	in DKK	Household
Risky asset	Market value of stocks and investments in risky mutual fund measured on 31st December. Do not have information on each stock in investor's portfolio	in DKK	Household
Safe asset	Deposits in banks etc., market value of bonds and mortgage deeds in deposit measured on 31 December (excluding childcare, self-retirement and index contracts)	in DKK	Household
Stock share	Risky asset/financial wealth, measured on 31st December	in percentage	Household

Note: where applicable, financial variables are in nominal term, not adjusted by CPI. Data Source: Statistics Denmark

B. Sample Selection

Table B shows the main sample used in the paper.

Table B: Sample Selection

Selection criteria for main sample	Number of observations	Number of distinct households
Initial sample	47,847,174	–
Drop individuals aged less than 25	42,458,008	–
Keep only household head (1 observation per household per year)	27,783,510	–
Drop duplicates by family identifier and year	26,998,570	4,428,829
(i) require the event of “house purchase” to occur during the period 2005 to 2009	2,495,209	478,693
(ii) keep only households with household’s head aged between 28 to 59 at the year of house purchase	1,719,343	324,172
(iii) By the end of step (ii), we have an unbalanced panel. In this step, we select those with complete information on portfolio choice and background information from 3 years before to 3 years after a house purchase. We also require households not to own a house in the 3 years leading up to the house purchase year.	463,523	44,970
Final main sample	463,523	44,970

C. Regression Results for the Randomly Assigned House Purchase Year

Table C Panel A: Randomly Assigned Purchase Year – Coefficients

VARIABLES	(1) Financial Wealth (in DKK)	(2) Risky Asset Shares Conditional on Participation (in %)	(3) Unconditional Risky Asset Shares (in %)	(4) Equity Market Participation
T-3	-315.6 (1,913)	0.128 (0.254)	0.00290 (0.0930)	0.000162 (0.00176)
T-2	-760.6 (2,692)	0.495 (0.305)	0.116 (0.113)	-3.65e-05 (0.00215)
T-1	1,740 (3,493)	0.219 (0.337)	0.0787 (0.125)	0.00188 (0.00236)
T	4,231 (4,639)	0.220 (0.338)	0.0931 (0.126)	0.00242 (0.00237)
T+1	5,049 (5,134)	0.349 (0.316)	0.0992 (0.119)	0.00158 (0.00218)
T+2	3,407 (4,268)	0.105 (0.275)	0.0325 (0.103)	0.000897 (0.00190)
T+3	3,831 (3,261)	-0.0457 (0.227)	-0.0202 (0.0846)	0.00150 (0.00153)
Controls	X	X	X	X
Household FE	X	X	X	X
Calendar Year FE	X	X	X	X
Observations	463,523	141,465	455,335	463,523
R-Squared	0.600	0.609	0.603	0.600
Number of distinct households	44,970	19,514	44,970	44,970

Notes: This table reports regression estimates for the short-run dynamics of household portfolio choices around an artificially-assigned house purchase year. The coefficients are estimated using panel data fixed effects model, controlling for household fixed effect and calendar year fixed effect. Column 1-4 reports the dynamic evolution of (1) financial wealth (2) conditional risky asset shares (3) unconditional risky asset shares (4) equity market participation from 3 years before to 3 years after a fake house purchase, respectively. T denotes the artificially-assigned house purchase year. T-3 denotes 3 years before the artificially-assigned house purchase year and T+3 denotes 3 years after the artificially-assigned house purchase year. Controls included in all regressions are household head's age, age-squared, marital status, highest education attainment, number of children, household's total labor income after tax and deductions, compulsory pension savings, bank loans, net wealth and realized profit and losses from stock investments. Cluster-robust standard errors in parentheses, clustering at household level, *** p<0.01, ** p<0.05, *p<0.1.

Table C Panel B: Randomly Assigned Purchase Year – Predicted Outcomes

VARIABLES	(1) Financial Wealth (in DKK)	(2) Risky Asset Shares Conditional on Participation (in %)	(3) Unconditional Risky Asset Shares (in %)	(4) Equity Market Participation
T-3	173,133*** (1,522)	26.83*** (0.193)	8.316*** (0.0688)	0.305*** (0.00113)
T-2	172,688*** (1,488)	27.20*** (0.187)	8.429*** (0.0670)	0.305*** (0.00112)
T-1	175,188*** (1,640)	26.92*** (0.183)	8.392*** (0.0658)	0.307*** (0.00113)
T	177,679*** (2,648)	26.92*** (0.178)	8.406*** (0.0652)	0.307*** (0.00109)
T+1	178,497*** (3,208)	27.05*** (0.168)	8.412*** (0.0623)	0.307*** (0.000998)
T+2	176,855*** (2,475)	26.81*** (0.164)	8.345*** (0.0604)	0.306*** (0.000978)
T+3	177,280*** (1,811)	26.65*** (0.172)	8.293*** (0.0624)	0.306*** (0.00107)
Controls	X	X	X	X
Household FE	X	X	X	X
Calendar Year FE	X	X	X	X
Observations	463,523	141,465	455,335	463,523

Notes: This table reports predicted outcomes for the short-run dynamics of household portfolio choices around an artificially-assigned house purchase year. These predictions are calculated based on estimates from panel data fixed effects model from Table C Panel A. Column 1-4 reports the dynamic evolution of (1) financial wealth (2) conditional risky asset shares (3) unconditional risky asset shares (4) equity market participation from 3 years before to 3 years after a fake house purchase, respectively. T denotes the artificially-assigned house purchase year. T-3 denotes 3 years before the artificially-assigned house purchase and T+3 denotes 3 years after the artificially-assigned house purchase. Controls are household head's age, age-squared, marital status, highest education attainment, number of children, household's total labor income after tax and deductions, compulsory pension savings, bank loans, net wealth and realized profit and losses from stock investments. Cluster-robust standard errors in parentheses, clustering at household level, *** p<0.01, ** p<0.05, *p<0.1.

D. Borusyak, Jaravel, and Spiess (2022) Imputation-Based Estimator

Matching was an approach we initially considered. To evaluate the relationship between a house purchase and household portfolio choice dynamics, we would like to know the difference between the portfolio choice outcomes at each year for households with and without housing. Clearly, we cannot observe both outcomes for the same household at the same time. The “treated” (new home buyers) and “untreated” households (renters) differ even in the absence of treatment. Matching is indeed one possible solution to address this selection bias. Assume the underlying identifying assumption holds (selection on observables or conditional independence and overlap), we tried propensity score matching (PSM) approach. We used probit model to estimate the propensity score, i.e., the probability of buying a house during 2005 to 2009 given the observed socioeconomic characteristics, such as age, marital status, education, number of children, income, etc. We applied kernel matching algorithm for observations with common support to select the matching partners and construct the counterfactual outcome of a treated household (because both nearest neighbor and caliper matching algorithms find only a few observations to form the control group). We then check the overlap and the region of common support between treatment and control groups by plotting the density distribution of the propensity score in both groups. There are areas within the common support interval where only treated observations can be found. Many treated households fall off the common support (mostly the observations that have high propensity scores). We further evaluate the match quality using t-test (check balance on covariates), and compare pseudo- R^2 for matched and unmatched sample. After matching there should be no systematic differences in the distribution of covariates between treatment and control groups, therefore the pseudo- R^2 should be low, and t-test should come back insignificant among covariates. But this is not the case for our matched sample, indicating a poor match quality. If we drop the observations off common support and run the event study for treatment and control groups as in Figure 4 – 6, there is a serious concern whether the estimated effects on the remaining households are representative. We might introduce another selection bias this way.

We suspect that the reason matching does not work well in our study is that the conditional independence assumption does not hold in our setting. The conditional independence assumption assumes that given a set of observable characteristics which are not affected by the treatment, i.e., the probability of buying a house during 2005 and 2009, potential portfolio choice outcomes are independent of treatment assignment. This implies that all variables that influence treatment assignment and potential outcomes have to be simultaneously observed by the researcher. This is a very strong assumption in our application. For example, we do not observe households’ risk preference, investment horizon, and tax treatment.

Instead, we implement the new imputation-based estimator developed by Borusyak, Jaravel, and Spiess (2022) as an attempt to address potential biases from heterogeneous treatment effects in our study. We choose this method because this framework focuses on event study designs with staggered treatment adoption and heterogeneous treatment effect that fits our setting very well, i.e., households purchase their home in different years (staggered rollout), and the magnitude and direction of the effects of house purchase on portfolio choice outcomes vary across different households (heterogeneity of treatment effects). This estimator is shown to provide robust and efficient estimator under these circumstances.

The average treatment effect for a household i in year t can be written as $Y_{it}(1) - Y_{it}(0)$. Problem arises because we can only observe one of the potential outcomes for each household at each year. The key of evaluating the treatment effect is to impute the counterfactual outcome. Borusyak, Jaravel, and Spiess (2022) first estimate a model for $Y_{it}(0)$ using untreated/not-yet-treated observations. In this step, they back out the unit and period fixed effects using untreated observations only. Then, these fixed effects are used to impute $Y_{it}(0)$ for the treated observations $\hat{Y}_{it}(0)$. This is the counterfactual outcome for the treated households had they not been treated. Finally, the difference between treated and imputed outcomes $Y_{it}(1) - \hat{Y}_{it}(0)$ serves as an estimate for the treatment effect for household i in year t . These are then averaged to form average treatment effects for groups of (i, t) in the event study. We apply this method, controlling for two-way fixed effect (household fixed effect and calendar year fixed effect) with cluster standard errors, clustering at household level. The resulting household portfolio choice dynamics around house purchases from this estimator (see below) shows a similar pattern compared to the ones found in our main results.

Figure 7: Financial Wealth

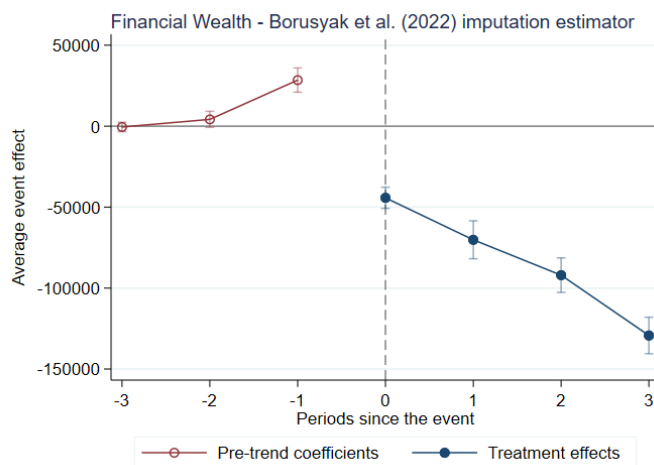


Figure 8: The Equity Market Participation Rate

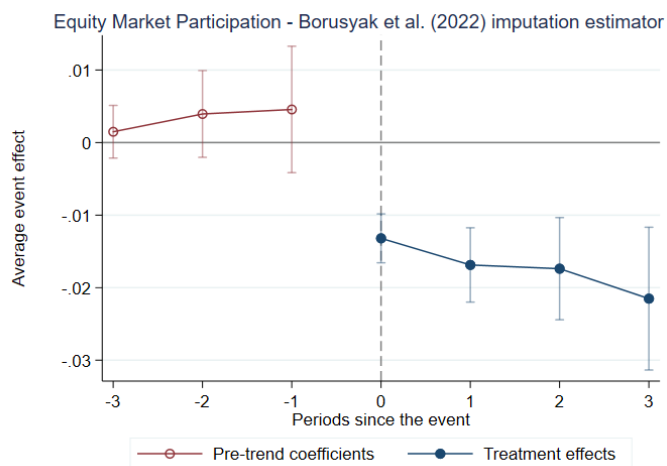
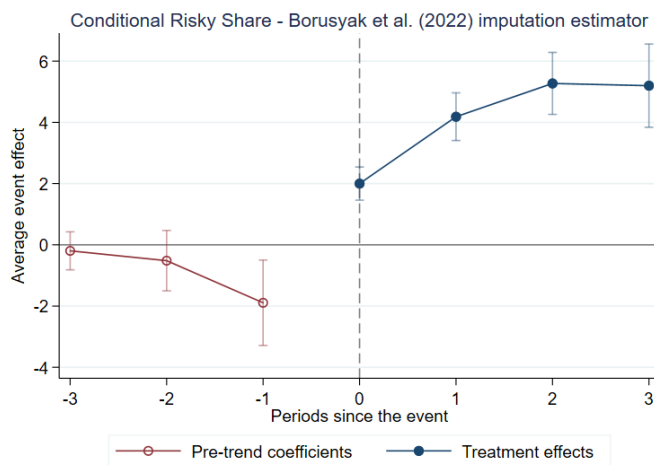


Figure 9: The Risky Asset Share Conditional on Participation



E. Heterogeneity and Robustness

(1) Control for lagged wealth and bank loans instead of the corresponding contemporaneous terms

Figure 10: Financial Wealth - lagged control variables

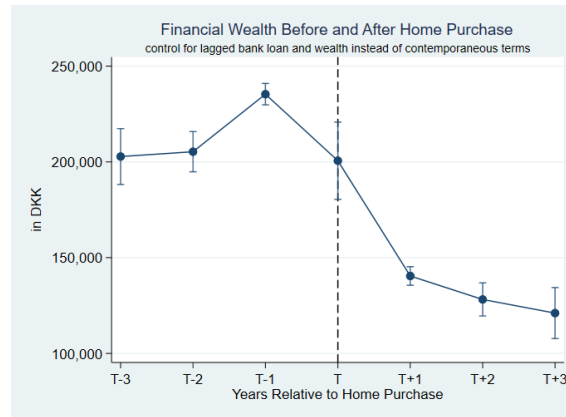


Figure 11: Equity Market Participation - lagged control variables

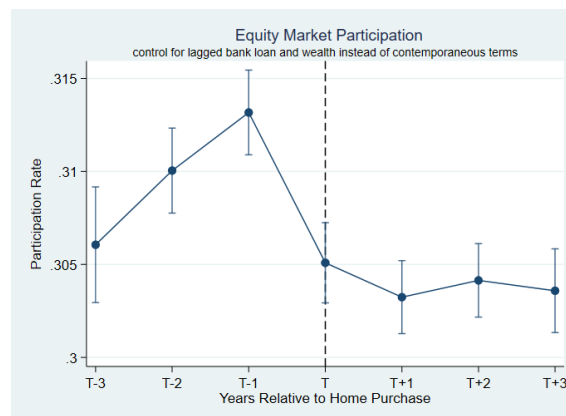
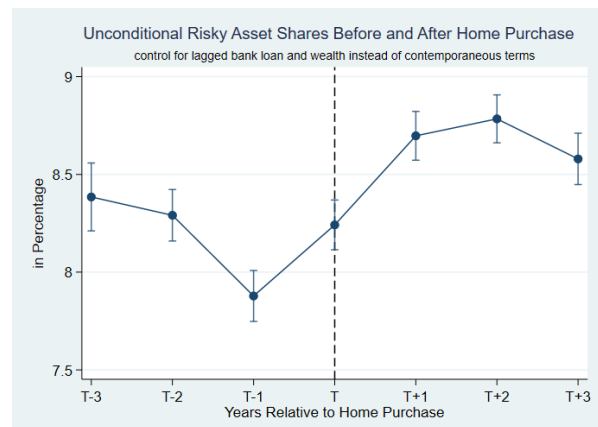
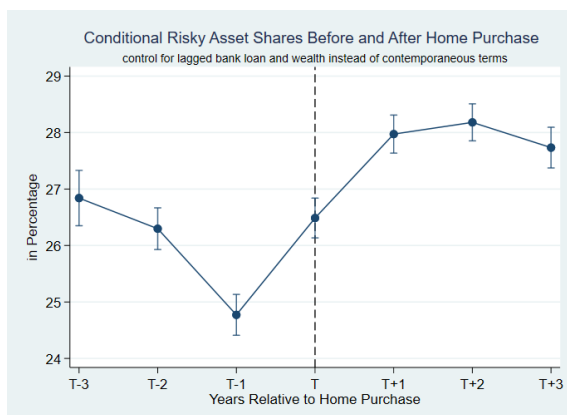


Figure 12: Risky Asset Shares – Conditional vs. Unconditional on Participation - lagged control variables



(2) By Net Wealth Levels

Figure 13: Financial Wealth by Net Wealth Levels

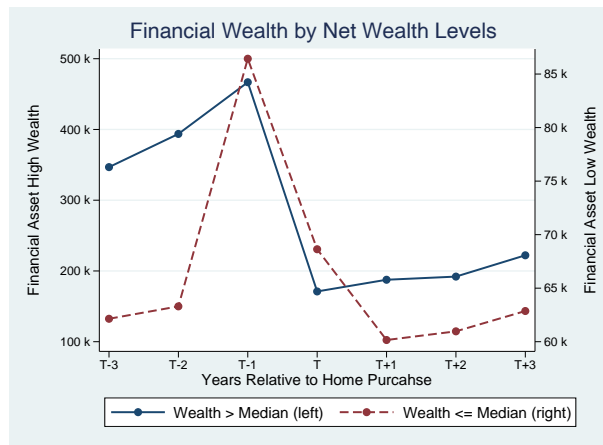


Figure 14: Equity Market Participation by Net Wealth Levels

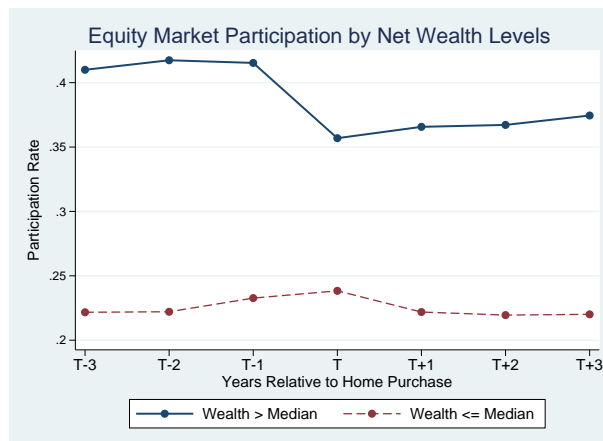
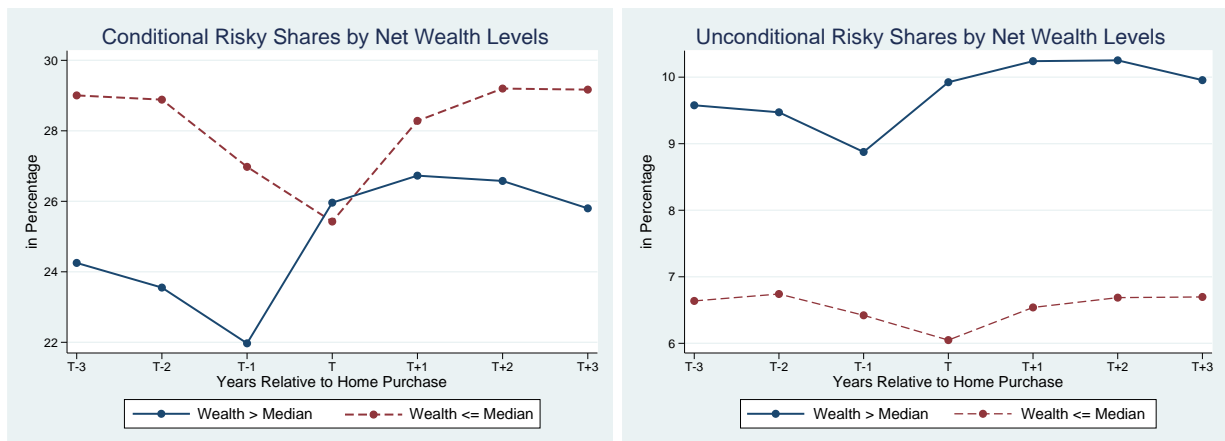


Figure 15: Risky Asset Shares – Conditional vs. Unconditional on Participation by Net Wealth Levels



(3) By Age

Figure 16: Financial Wealth by Age

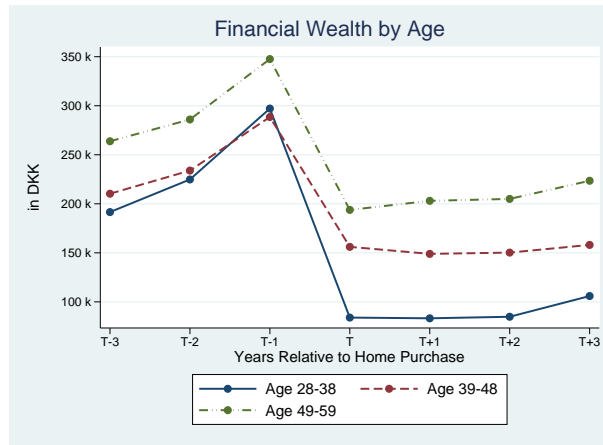


Figure 17: Equity Market Participation by Age

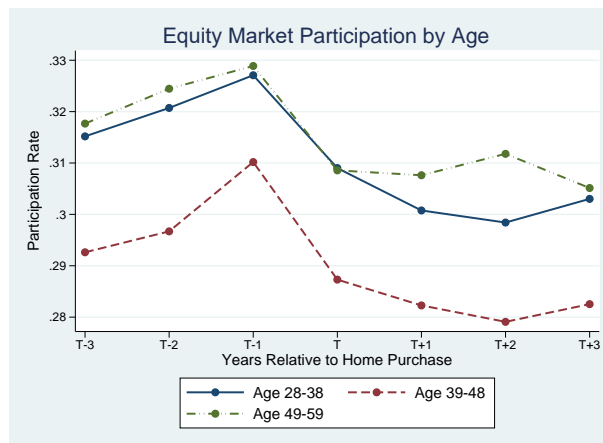
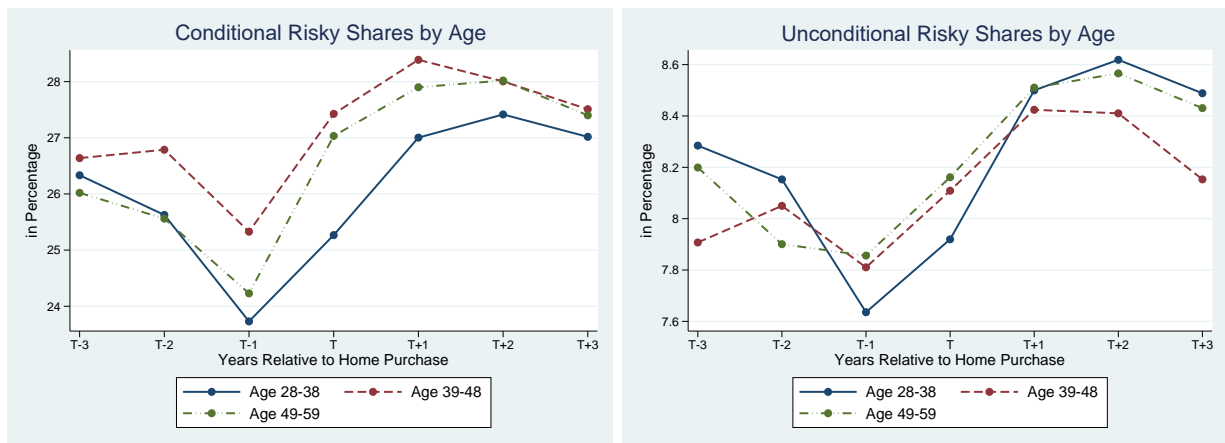


Figure 18: Risky Asset Shares – Conditional vs. Unconditional on Participation by Age



(4) Households who have experienced capital gains or capital losses at the year before the home purchase

Figure 19: Financial Wealth for Two Types of Households

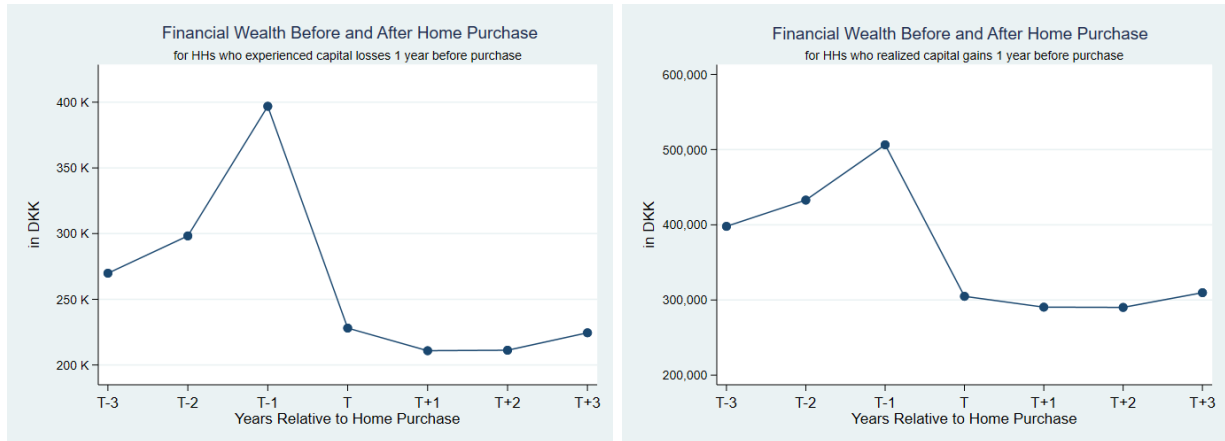


Figure 20: Equity Market Participation for Two Types of Households

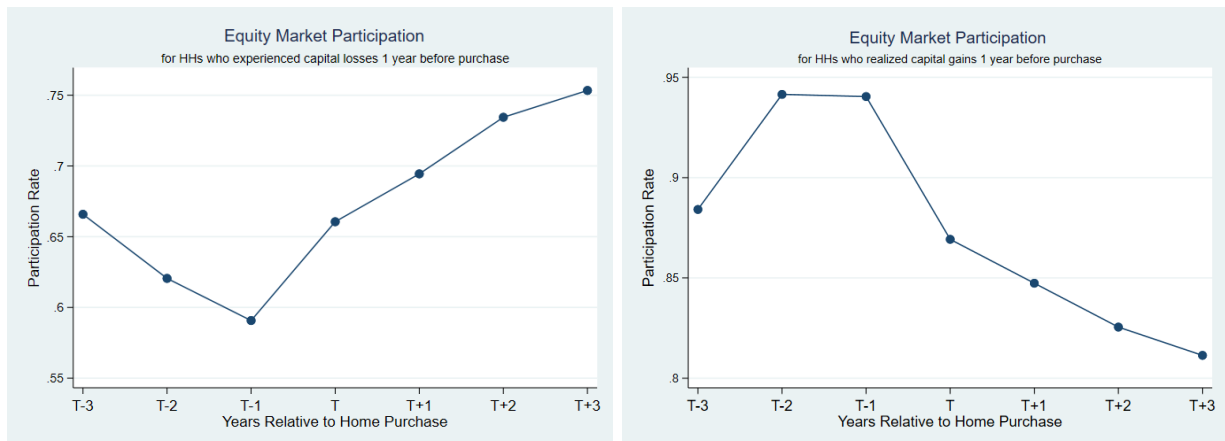
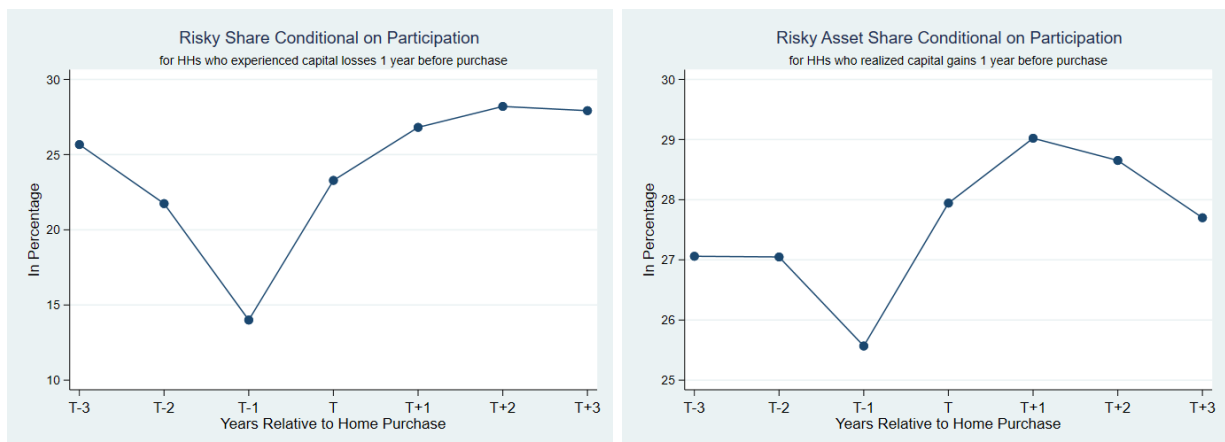


Figure 21: Risky Asset Shares – Conditional on Participation for Two Types of Households



(5) Impact of the 2008 financial crisis

Figure 22: Financial Wealth Before and After the Financial Crisis

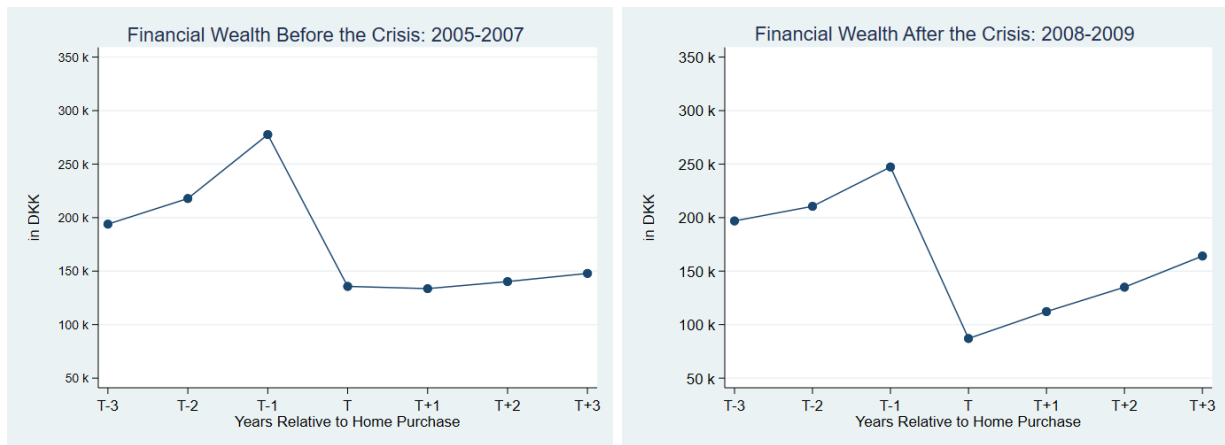


Figure 23: Equity Market Participation Before and After the Financial Crisis

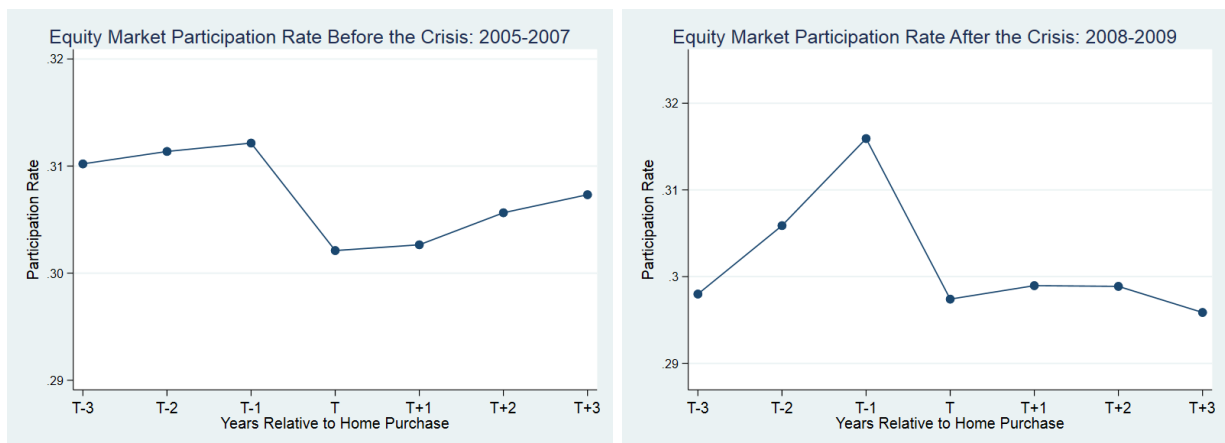


Figure 24: Risky Asset Shares – Conditional on Participation Before and After the Financial Crisis



(6) By Income

After buying a house, households are subject to committed housing expenditure risk. Liquidity demand may be a concern for homeowners. As income is closely linked to liquidity, we compare the time path of portfolio choice outcomes around a house purchase among different income groups. The main sample is divided into four sub-groups by income quartile. Figure 25 shows the wealth around the year of a house purchase by income group, while Figure 26 and Figure 27 show the equity market participation rate and the risky asset share, respectively. The patterns are similar to what we find for the main sample.

Figure 25: Financial Wealth by Income

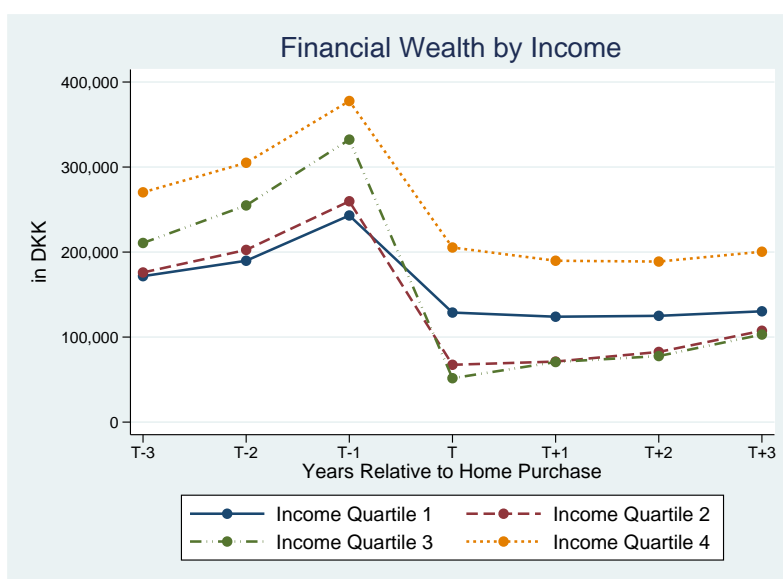


Figure 26: Equity Market Participation by Income

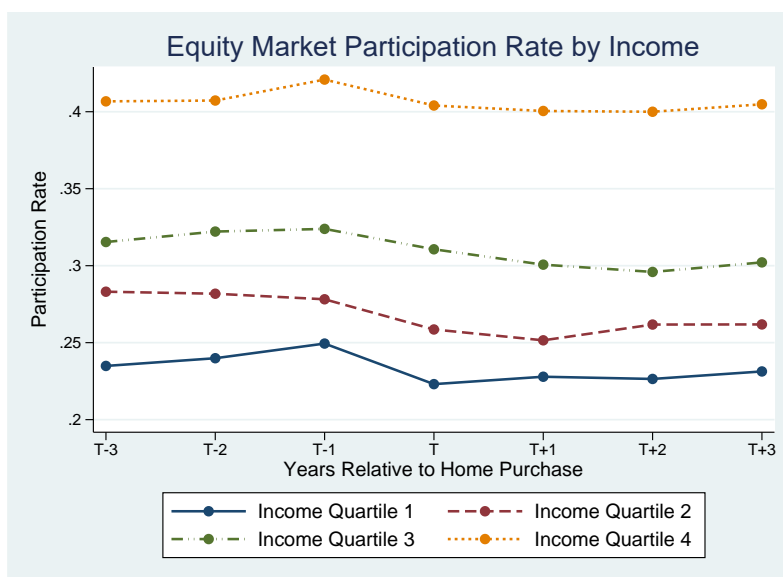
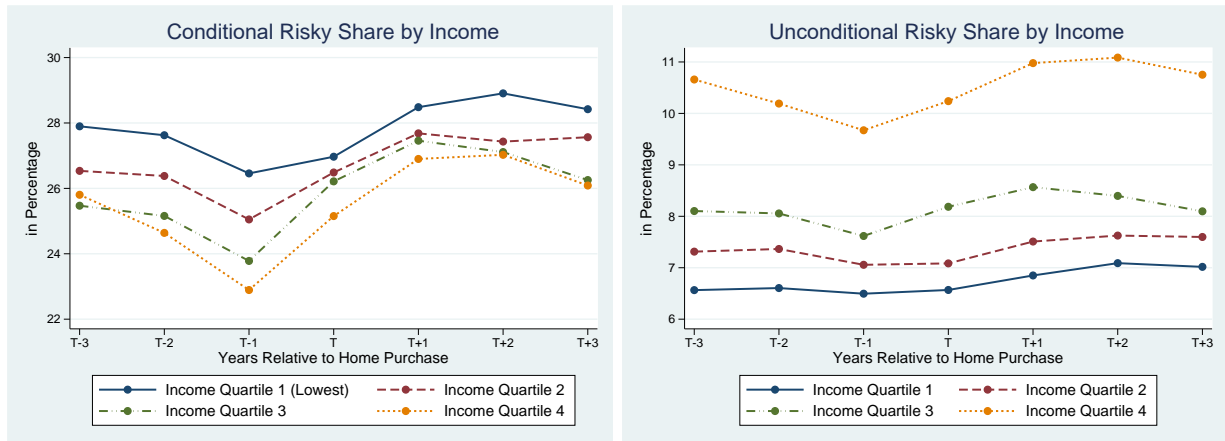


Figure 27: Risky Asset Shares – Conditional vs. Unconditional on Participation by Income



(7) By Region

We compare the development of the household portfolio outcomes among different regions, as demographic and socioeconomic environment in each region may influence households' portfolio choice of financial wealth and house purchase decisions. Figures 28, 29, and 30 show the temporal patterns for financial wealth, the equity market participation rate, and the risky asset share of financial wealth by region, respectively. The patterns for each region are similar to the patterns we report in the main results.

Figure 28: Financial Wealth by Region

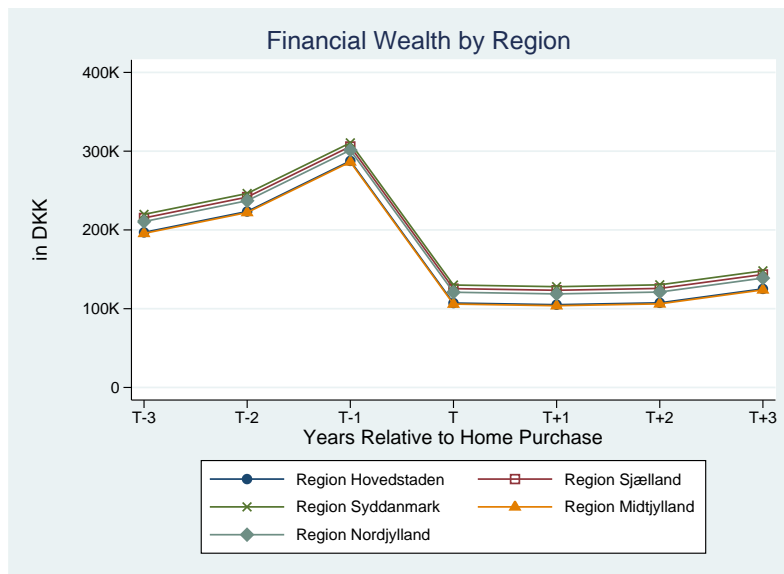


Figure 29: Equity Market Participation by Region

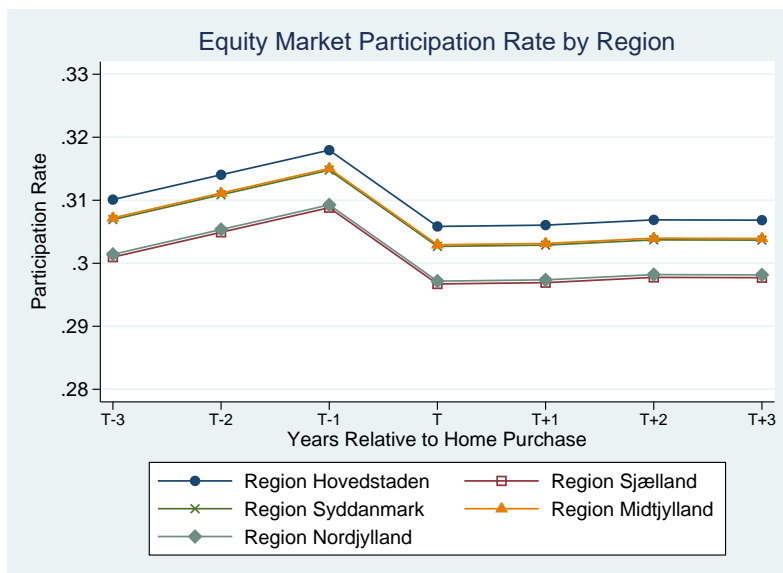


Figure 30: Risky Asset Shares – Conditional vs. Unconditional on Participation by Region

