The Effect of Homeownership on Households' Financial Portfolio Choices: Evidence from the Panel Study of Income Dynamics

A thesis
submitted by

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Abstract

This paper aims to explore the impact of homeownership on households' financial portfolio choices. Most current theoretical researchers of household finance find that there is a negative effect of housing on the financial assets. However there is no clear conclusion on empirical research. Some research indicates a positive relationship between housing and holdings of financial assets. Others do not find a strong relationship. Chetty and Szeidl (2012) explain possible reasons that lead to this discrepancy. First, since both the home tenure choice and financial investment choice are endogenous, directly regressing portfolio choices on tenure choice and housing value would be strongly biased. Second, it is important to distinguish and isolate the effects of home equity wealth and mortgage debt on portfolio choices, since home equity wealth and mortgage debt play opposite roles and have opposite-signed effects on financial investment choices. Following Chetty and Szeidl's analysis, I conduct an empirical study using data from the Panel Study of Income Dynamics. I develop a two stage least square estimation using two instrumental variables from cross-sectional analysis and a Difference-in-Difference estimation using panel data in 1999-2009. I find that increases in mortgage debt reduce stock holding and raise safe asset holding. On average, a household with 10% increase in mortgage debt has a 3% lower portfolio share of stocks from the least square analysis. However, the DID estimation does not give a significant effect of housing on both stock holding and safe asset holding. This may be caused by the small sample sizes used in estimation.

Keywords: homeownership, households' financial portfolio choices, DID estimation

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1. Introduction

There are two questions that are asked frequently when people study housing and financial portfolio choices. The first question is whether a household would pay a down payment in order to buy a home or directly invest in financial assets such as stocks and bonds. Obviously, when people think about the above question, they would think about the trade-off between investing in the housing market versus investing in the financial market. Buying a home requires a large amount of money to make the down payment and continuous payments to pay for the housing costs and interest on mortgage. However, compared with the high risk of returns to financial assets such as stocks, housing can be treated as an investment with relatively steady growth. In China, most households choose to invest in housing market over the financial market because the financial market is under-developed and housing market is growing rapidly.

The second question that researchers ask is whether the decision to purchase a real estate property has future impact on decisions about financial investment. For example, when a risk averse individual decides to purchase a house and commits to pay off the mortgage loan, property tax, and house insurance, he would rather keep more cash flow in the account and reduce the funds invested in risky assets such as stocks and mutual funds. On the contrary, a less rick averse individual may even invest more money into the financial market if he expects a steady increasing future income and a rapid boom in the housing market, even when he purchases a house and will pay mortgage loan, property tax and insurance for a long time period.

It is interesting to explore whether there are systematic answers to the above two questions. Another important point, which is strongly relevant to the two questions, is that housing often plays a dual role in households' life cycle. Housing, as a durable consumption good, provides households utility in the form of housing services. World wide, housing is the single most important asset for most households. From the U.S Census Bureau, we know that about two-thirds of U.S. households own their primary residential property and on average the home value exceeds 50% of a homeowner's total asset wealth. At the same time, housing, as an investment good, provides homeowners with capital gains. Homeowners often pay attention to movements of current housing prices to evaluate the potential gains of their housing from appreciation.

Due to its dual nature, housing is a very unique investment good compared with other financial assets such as bonds and stocks for several reasons. First, housing is illiquid. It is difficult to realize the value of a house into cash unless selling it. The durable nature of housing and a large amount of transaction costs of buying and selling housing make housing very illiquid. Second, housing is highly leveraged. When an individual purchases a house, it often pays a part of the full purchase price, which is the down payment, and the rest of the cost is met by borrowing. According to the 2010 Survey of Consumer Finance, approximately two-thirds of total U.S. homeowners have an outstanding mortgage debt. Third, the capital gain from housing is not directly comparable with the capital gains from liquid financial assets. Therefore it is incorrect to add housing into the assets portfolio directly or explore the optimization by using a mean-variance efficiency framework (Flavin and Yamashita 2002). For example, a particular house's market value is increased $20,000 from last year to this year, so there is $20,000

of capital gain from the housing. However, the $20,000 capital gain is not directly realized until the owner sells his housing property. On the other hand, if there is $20,000 capital gain in the financial market, the gain can be easily realized by selling the financial assets shares.

In this paper, I aim to study the question of whether a home-purchase decision has a strong impact on a household's financial portfolio choice. In other words, my goal is to estimate the causal effect of housing on households' financial portfolio choices. I use non-IRA stocks such as risky assets and I use bonds, checking and saving accounts as the less risky assets. I estimate how holding housing property would impact the share holding of risky assets (i.e. stocks). However, the decision to purchasing a house and stocks are endogenous to each other. People who hold more stocks are likely to be richer and therefore likely to hold more real estate property (Chetty and Szeidl 2012, Fougere and Poulhes 2012). Therefore, simply using an ordinary least square (OLS) model would potentially bias the results. In this paper, I use the same methodology as follow Chetty and Szeidl (2012) who use a methodology that separates the effects of mortgage debt and home equity. I do so by using two instrumental variables (IVs) to tackle the endogeneity of mortgage debt and home equity. I replicate Chetty and Szeidl's least square analysis by using family-level data from the Panel Study of Income Dynamics (PSID) from 1999-2009. Furthermore, I use a dynamic difference-in-difference (DID) estimation model to estimate the impact on households' portfolio choice after the home purchasing or home selling decisions. The results of my study show that when a household's mortgage debt and home equity increases by 10%, it reduces the share of stocks by 3.1 percentage points. This result is very close to that of Chetty and Szeidl's who find that a 10% increase in

property value leads to a 3 percentage point decrease in stock share holding. However, the DID estimation does not give a significant effect of housing on both stock holding and safe asset holding. This may be caused by the small sample size of treatment groups.

The rest of paper is organized as follows. The next section is the literature review. Section 3 presents the econometric model. Section 4 describes the data. Section 5 presents empirical results. Section 6 concludes.

2. Literature Review

Household tenure choices and wealth portfolios have been a topic of interest for a long time. Henderson and Ioannides (1987) firstly developed an innovative model to examine the tenure choice decision, length of residency, and the consumption level choices by using 1971-1981 PSID panel data. They find that the tenure choices and length of residency are affected by socioeconomic characteristics and demographic factors. For example,being wealthier, getting more family members and getting married significantly increase the probability of a renter becoming an owner. Similarly, richer and more highly educated families move more frequently for both renters and owners. However, renters and owners do not have significant different preference in terms of their housing consumption level. Ioannides and Rosenthal (1994) analyze the consumption and investment demands for housing and their effects on housing tenure status. The paper uses a log likelihood function for an ordered probit model to analyze both investment demand and consumption demand by using 1983's Survey of Consumer Finances (SCF) data. Ioannides and Rosenthal point out that the divergence between investment demand and consumption demand is an important determinant of housing tenure status.

Recent research on finance and financial portfolio choices focuses more on how social interactions affect portfolio choices. For example how behavioral motivations affect portfolio choices (Massa and Simonv 2004) and how individual risk attitudes affect financial portfolio choices (Barasinska, Schafer, and Stephan 2011). Ioannides (1992) analyses the determinants of households' choice of assets and how households would restructure their portfolios based on changes in socioeconomic characteristics and labor market status in the years between 1983 and 1986. The paper uses panel data from the 1983 and 1986 SCF to examine the dynamics of the composition of asset portfolios. The main regression model used in the paper are a probit model that examines the significant determinants of portfolio selection, and a poisson model that estimates the number and the type of assets held by households. The empirical results from the paper show that households optimize their asset portfolio with the long-run in mind but they do not restructure the portfolios when their employment status change. In fact, they only restructure their portfolios when non-human wealth changes.

The dual nature of housing makes it play an important role in households' portfolio choices. Meanwhile it cannot be viewed as a normal financial element of household's portfolio. Therefore, most researchers of finance do not consider housing as an exogenous asset. Yao and Zhang (2005) point out that housing, as an investment asset in households' portfolio choices, is not broadly explored because of the difficulties of dealing with various frictions in the housing market such as collateral requirements and liquidation costs.

Since the 1990s, economists started exploring how the presence of housing would impact households' portfolio choices. Grossman and Laroque (1990) established a model to analyze the optimal portfolio choices given the constraint of consumptions. They consider the consumption as an illiquid durable good associated with an adjustment cost such as a house. Grossman and Laroque show that the existence of adjustment costs (such as transaction costs) after purchasing a real estate reduces the proportion of a household's portfolio that is allocated to risky stocks. Ioannides (1989) examines the relationship between the housing and households' wealth portfolios. The author shows that the illiquidity of housing has a significant negative effect on the equity-value ratio and the share of housing equity in household's wealth portfolio. Flavin and Yamashita (2002) employ a mean-variance efficiency framework to analyze the household's optimal portfolio allocation when the owner-occupied housing is added into the portfolio as one of available assets. They find that the optimization of the financial portfolio is constrained by the holding of housing property. Homeowners hold fewer risky assets than those do not own a house. Cocco (2005) estimates the impact of a homeownership decision on a household's financial portfolio choice by using a simulation technique. He shows that the liquidation cost of real estate property reduces the frequency of housing transactions. The illiquidity of a real estate property also increases an individual's risk aversion level and reduces an individual's investment in risky stocks.

Although most theoretical research shows that a home purchasing decision causes reduced demand for risky stock investment, empirical research does not offer a consistent answer for the impact of homeownership on portfolio choices. Heaton and Lucas (2000) use data from the Survey of Consumer Finance (SCF) to explore the impact of

background risks, such as labor and entrepreneurial income, on households' portfolio allocations. Taking housing property into account, Heaton and Lucas even find a positive causal relationship between mortgage debt and stock holdings. Although Cocco (2005) shows that theoretically the illiquidity of housing property and housing price risk reduce the demand for stock holdings, the empirical results also show that higher mortgage leads to higher stock holdings. Yamashita (2003) presents an empirical test of how the house-to-wealth ratio affects a homeowner's portfolio choices. The empirical analysis of the paper implies a non-monotonic relationship: the holding of risky stocks in a household's portfolio has a hump-shaped pattern against the house-to-wealth ratio. It shows that a household holds a large proportion of risky stocks in their portfolio only when housing wealth is either very small or very large against the household's total wealth.

In response to the discrepancy between theoretical and empirical studies, Chetty and Szeidl (2012) explore a framework aimed at reconciling the theory and empirical analysis. The most important innovation of Chetty and Szeidl's study is that they separate the effects of mortgage debt and home equity in order to analyze the effect of housing on a household's portfolio choices. Chetty and Szeidl use an expression for optimal allocation of risky stocks, obtained from a theoretical stylized two-period model. They derive a linear regression model where a household's risky stock share depends on housing property value and home equity. Chetty and Szeidl point out that the endogeneity of the home purchasing decision and the stock investment decision leads to an ordinary least square estimation bias. They therefore design two Instrumental Variables (IVs) to tackle the problem. The two IVs are the average price of houses in the household's state in the year in which portfolios are formed, and the average price of houses in the

household's state in the year in which the house was purchased. They analyze micro panel data for 64,191 households from the Survey of Income and Program Participation (SIPP) panels from 1999-2004, and find that an increase in a household's mortgage debt decreases the household's share holding in stocks significantly, while an increase in a household's home equity increases the household's share holding in stocks. I use the same methodology as Chetty and Szeidl for the least square analysis and also employ a difference-in-difference estimation by using panel data constructed from the PSID.

3. Econometric Models

The main econometric model that I use in the paper was developed by Chetty and Szeidl (2012). An important difference between their model and previous research, such as Heaton and Lucas (2000) and Cocco (2005), is that Chetty and Szeidl isolate the impact of mortgage debt and home equity on the stock holdings to represent the quantitative impacts of housing on portfolio choice. Since the mortgage debt can be obtained by subtracting home equity wealth from housing property value, the effect of property value will be equivalent to the effect of mortgage debt by holding the home equity wealth fixed.

The main linear regression model is the following linear specification for risky stock shares:

$$y_i = \beta_0 + \beta_1 property\ value_i + \beta_2 home\ equity_i + \gamma X_i + \varepsilon_i \qquad (1)$$

where y_i is the percentage of stock shares in a household's financial portfolio. This variable is calculated as the proportion of stock wealth against the total liquid wealth

including risky stocks, bonds, insurance, checking accounts, saving accounts and certificates of deposit. Retirement accounts are excluded from liquid wealth. The variable $property\ value_i$ measures the current market value of household$_i$'s real estate property. The variable $home\ equity_i$ is the equity wealth of the real estate property held by household$_i$. If $mortgage_i$ is denoted as the outstanding mortgage balance in the current year, household$_i$'s home equity$_i$ is designed as follows:

$$home\ equity_i = property\ value_i - mortgage_i.$$

The variable X_i denotes a vector of control variables including family head's age, education level, number of children, household's total annual income, and total illiquid wealth and the state unemployment rate.

The coefficient β_1 is the effect of property value on the percentage of stock shares by holding home equity wealth fixed. The coefficient β_2 is the effect of home equity wealth on the percentage of stock shares by holding the property value of the real estate property fixed. The main hypothesis of interest is that property value has a negative impact on stock share and home equity wealth has a positive impact on stock share:

$$H_0: \beta_1 = 0\ Vs.\ H_1: \beta_1 < 0;\ H_0: \beta_2 = 0\ Vs.\ H_1: \beta_2 > 0$$

The error term ε_i accounts for omitted variables that may cause a heterogeneity problem (Chetty and Szeidl 2012) such as background risk (Heaton and Lucas 2000), house price risk, and income measurement error (Cocco 2005, Chetty and Szeidl 2012). As Cocco (2005) stresses, the unobservable and unknown future income significantly affects stock holdings and the property value of the house. Specifically, households

expecting higher future incomes will be willing to purchase more expensive houses and therefore such households will likely assume higher mortgage debt. Holding home equity wealth fixed, a higher mortgage also reflects a higher property value. At the same time, a household that expects a high future income will be less risk averse and more likely holds more stock shares. Therefore the omitted future income variable may lead to a positive relationship between mortgage debt and stock share holdings.

In order to resolve the endogeneity problem, Chetty and Szeidl bring two Instrumental Variables (IVs) into the regression. I use the same IVs in my least square analysis. The following section will discuss the validity of the instrumental variables.

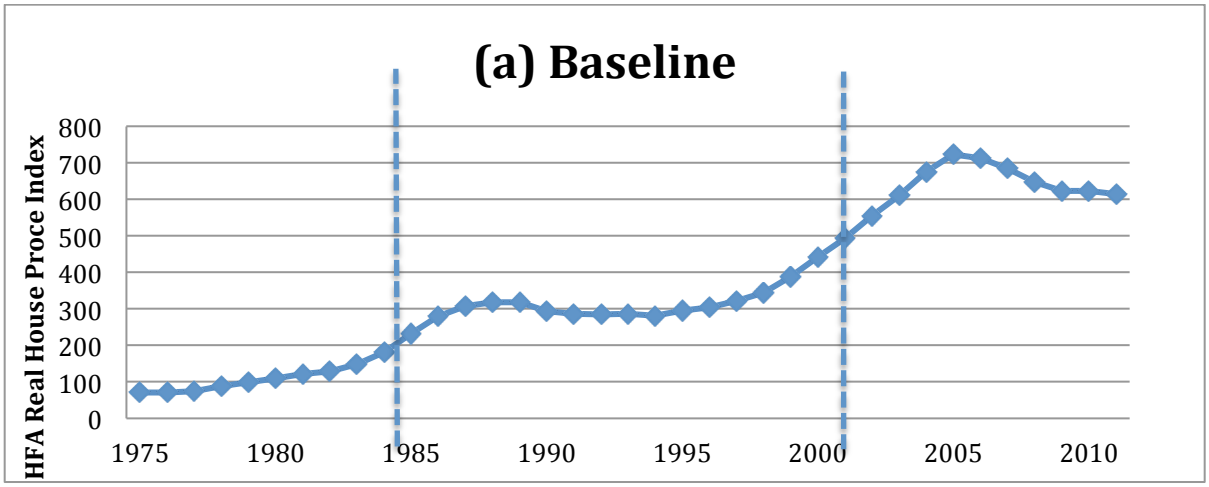
3.1.1 Instrumental Variables

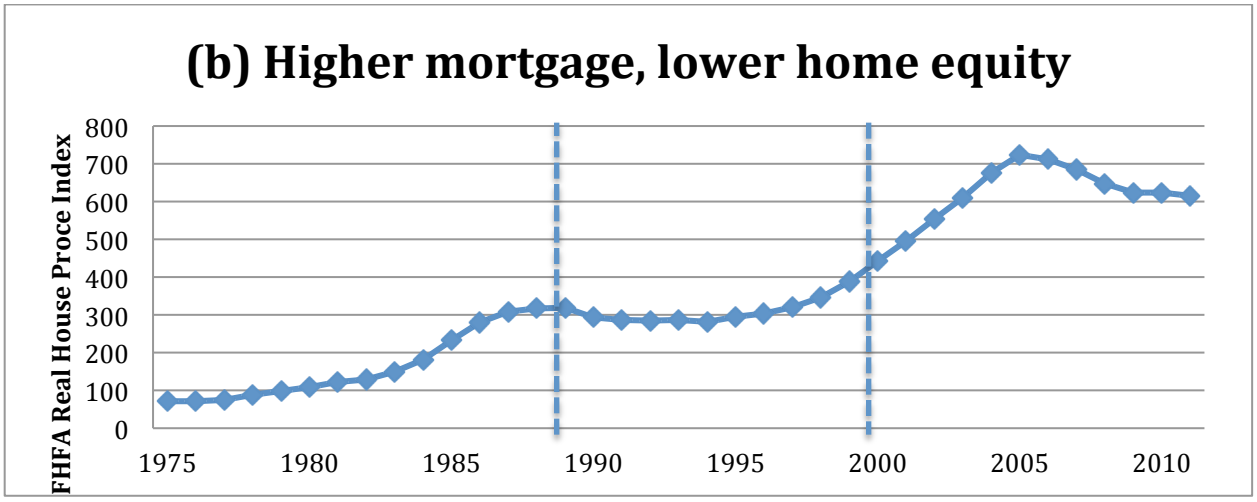
The two instrumental variables that I use in the paper are the average real price of houses in the household's state in the current year in which portfolios are measured and the average real price of houses in the household's state in the year that the house is purchased. The current average state housing price index is a good predictor of the property value of a house. While the average state housing price index is strongly related to the mortgage debt and home equity: a household that buys a house at a higher selling price is more likely to owe a big mortgage debt and therefore hold less home equity wealth.

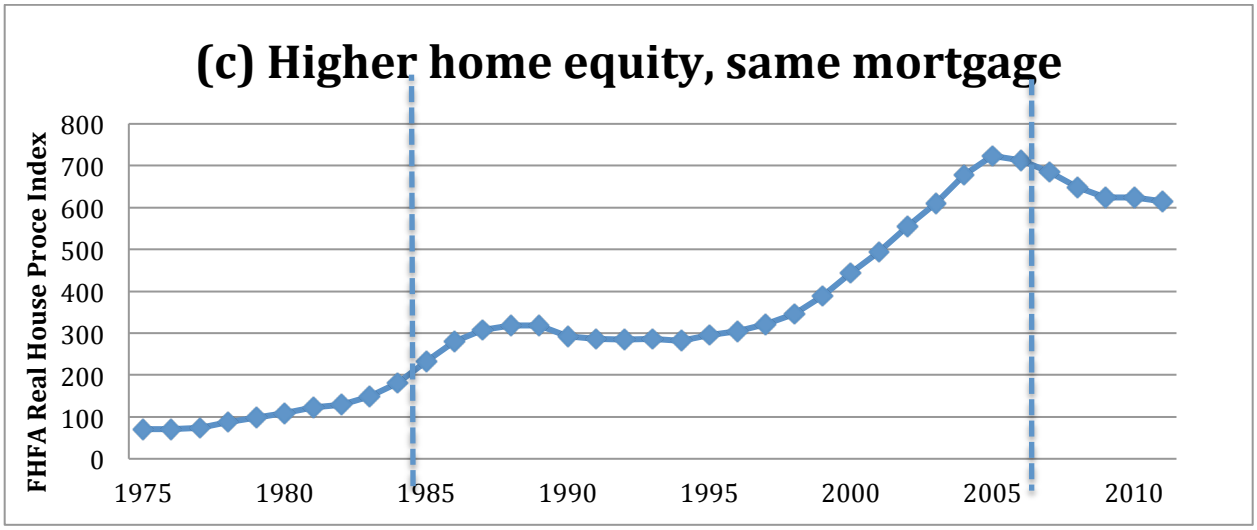
Chetty and Szeidl (2012) construct a hypothetical experiment with a set of households that buy identical houses and pay interest only on the mortgage. The strategt keeps the outstanding mortgage debt constant over time (Chetty and Szeidl 2012). I use

Figure 1 to illustrate the intuition of the instruments. Firstly, suppose household A buys a house in 1985 and its financial portfolio is measured in year 2000. Then, consider household B that buys a house in 1990 and its financial portfolio is also observed in 2000. Comparing households A and B, it is obvious that they have the same property value but actually face different mortgage debts and home equity wealth because of the different house purchasing prices in 1985 and 1990. Secondly consider household C that buys a house in 1985 and its financial portfolio is measured in year 2005. Comparing households A and C, it is obvious that they purchased at the same price therefore they have the same mortgage debts under the assumption that households pay interest only on the mortgage. However, households A and C do not the have same property value because of the different market selling prices of housing in 2000 and 2005. Therefore households A and C have different home equity wealth. Therefore the combination of average state housing price index in current year and the house purchase year help to separately identify the impacts of mortgage debts and home equity on portfolio choices.

Figure 1







3.1.2 Least Square Analysis and Sample Selection Model

The two instrumental variables are designed to isolate the causal effects of mortgage debt and home equity wealth. However, the housing markets across the country are very different. Economic growth, average education level of the population, industry distribution in each state and many other factors make each state unique. Therefore, I

control for aggregate shocks and differences across housing markets by including state and year fixed effects. The identification will be based on the differential within-state variation. Chetty and Szeidl also use this fixed effect methodology. The least square analysis will be conducted using the 2 Stage Least Square (2SLS) method with state fixed effects.

However, the 2SLS method ignores the fact that a large percentage of households do not hold any stock. The 1999-2009 PSID data show that approximately 70% of households do not own stock. Therefore, stock share is a limited dependent variable and 2SLS may cause bias. To account for this, I used Heckman's (1979) sample selection correction model.

The general Heckman's sample selection model is constructed by the following:

$$y_i^* = X_i'\beta + \epsilon_{1i}, \qquad (2)$$

$$d_i^* = Z_i'\alpha + \epsilon_{2i}, \qquad (3)$$

where y_i^* is the dependent variable representing the percentage of stock share holding by a household, X_i is a vector of control variables and Z_i is a vector of variables that determine d_i^*, the selection variable. The variable d is defined as follows:

$$d = \begin{cases} 1, & if\ Z_i'\ \alpha + \epsilon_{2i} > 0; \\ 0, & otherwise; \end{cases} \qquad (4)$$

Therefore d is defined by a latent variable model; it is a binary variable that describes whether the household owns stock shares. Then a sample selection rule follows in the form:

$$y_i = \begin{cases} y_i^*, & if\ d_i^* > 0; \\ 0, & otherwise; \end{cases} \qquad (5)$$

Assume that $\{\in_{1i}, \in_{2i}\}$ are i.i.d. and drawn from a bivariate normal distribution with a mean vector zero and covariance matrix $\begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{12} & 1 \end{bmatrix}$

The conditional mean of y_i when $d_i > 0$ is given by Heckman (1979)

$$E[y|X, d = 1] = X'\beta + \sigma_{12}\lambda, \qquad \lambda = \frac{\emptyset(Z_i^{'}\ \alpha)}{\phi(Z_i^{'}\ \alpha)}, \qquad (6)$$

where λ is the inverse Mill's ratio, $\emptyset$ and ϕ denote the standard normal probability density function and the standard normal cumulative distribution function. Given the conditional mean function of (6), the regression function becomes:

$$y_i = X_i^{'}\beta + \sigma_{12}\lambda_i + \mu_i, \qquad (7)$$

where $E[y|X, \lambda, d = 1] = 0$.

Heckman's (1979) two-step estimation procedure is used as follows. In the first step, an estimate of α is obtained by running a probit regression. Then, I generate

$\widehat{\lambda\imath} = \frac{\emptyset(Z_i^{'}\ \widehat{\alpha})}{\phi(Z_i^{'}\ \widehat{\alpha})}$ by using $\hat{\alpha}$. Finally, causal effect β is estimated by the linear regression function:

$$y_i = X_i'\beta + \sigma_{12}\hat{\lambda}_i + \mu_i$$

3.2 Difference-in-Difference Estimation

3.2.1 First Difference Estimation

In order to answer the question "Do households that buy larger houses reduce their stockholdings by a larger amount in the year after home purchases?" Chetty and Szeidl (2012) explore a first difference method to estimate the casual effect of selection. Chetty and Szeidl use a panel sample from SIPP. The data allow them to observe a home purchase within the panel. They can observe portfolio shares both before and after home purchase. They define $\Delta x_i = x_{i,t+1} - x_{i,t-1}$ for a household i that buys a new house in year t. Then they estimate equation (1) in first differences:

$$\Delta stock\ share_i = \alpha + \beta_1 \Delta property\ value_i + \beta_2 \Delta total\ illiquid\ wealth_i + \gamma \Delta X_i + \Delta\varepsilon_i \quad (8)$$

I used the same first difference estimation model as Chetty and Szeidl do to analyze the portfolio change around home purchase by directly addressing the home purchase decision. The model deals with unobserved fixed effects that are common to a family across the time before and after the home purchase. While Chetty and Szeidl's data allows them to observe portfolio shares both before and after home purchase, my data does not allow this level of observation. This is because the PSID data are collected every

other year started from 1997 and the information about a household's financial portfolio is collected starting in 1999. Therefore, it is impossible to observe every household's portfolio in the year before and after home purchase, because the even years are missing from the data. Therefore for households that buy a house in an odd year, I do not observe the corresponding data from the year before and after. In this paper, I try to mitigate the problem by choosing the closest year before and after they purchase a house.

3.2.2 Difference-in-Difference Estimation with multiple time periods

Using the 1999-2009 panel data, it is helpful to analyze how households' portfolio choices change over time because of the decision to purchase/sell. A Difference-in-Difference (DID) estimation can help explore the above question. In this paper, I use a multi-periods DID model with time-varying intensity of treatment effects.

The reason that I use a multi-periods DID model with time varying intensity of treatment effects is that I am interested in how the decision of home purchase or home selling would impact a households' portfolio choices over time. We can imagine that the impact of a change in home tenure status might take years to be fully realized. One household might not remove or add investment into the financial market immediately after the purchase/sale, but their portfolio choice might change over time. This multi-period DID model solves this problem and examines the change of the treatment effect over time.

I basically constructed two DID models, one in which home purchase is a treatment, and the other in which home selling is a treatment. Obviously, people do buy

one house and sell another at same time; therefore, another important point in this generalized DID model is that the treatment does not apply in the same time period for each household in the treatment group. That is, D_{ijt} “turn on” or "turn off" at different points of time. This DID model allows for the different time periods to apply the treatment The property value and home equity wealth are two main indicators of the real estate property status. Therefore, I view property value and home equity wealth as the intensity of treatment. In each time period, property value and home equity wealth are viewed as the intensity in that level.

The generalized model is defined as following:

Define $D_i = \begin{cases} 1, if\ household\ is\ in\ the\ treatment\ group; \\ 0, if\ household\ is\ in\ the\ control\ group. \end{cases}$

Assume there are J levels of the treatment and the intensity for level j is d_j.

A permanent treatment effect can be defined as follows:

$$D_{ijt} = \begin{cases} d_j, & \text{for members of the treatment group receiving} \\ & \text{the } j^{th} \text{ treatment level for } t \geq t_a; \\ 0, & otherwise. \end{cases}$$

, where the treatment is administrated in time t_a.

A generalized DID model can be expressed by the following:

$$y_{it} = \beta_0 + \beta_1 T_t + \beta_2 D_i + \tau D_{ijt} + X'_{it}\beta_3 + c_i + u_{it}, t = 1,2,..,6 \qquad (11)$$

where T_t is a time dummy, X_{it} is a vector of other controls, c_i is unobserved fixed effects that are common to a family at all periods of time. The individual fixed effect estimation controls these unobserved effects. The variable D_i =1 if household is in the treatment group and D_i =0 otherwise. The variable u_{it} is the idiosyncratic errors. The coefficients τ is the treatment effect.

4. Data

The main dataset that I am using is the Panel Study of Income Dynamics (PSID). The PSID begins in 1968 and tracks more than 5,000 households living cross the United States. Data are collected annually from 1968-1997, at which point, data collection becomes biannual. The datasets can be downloaded separately for each interview year and aggregated across years. However, the study does not provide datasets in the standard panel data format. The most recent published data is in 2009. The study collects detailed information on households' income, jobs, assets and demographics. The information on assets is collected in each wave since 1999. This information is helpful in analyzing the changes in portfolios. The main reasons for using PSID rather than the Survey of Consumer Finances (SCF) are that the PSID provides clear geographic information of households and very detailed information about households' income.

The supplemental data set I use is from the Federal Housing Finance Agency (FHFA). The FHFA produces a quarterly house price index (HPI) from 1975-2009 that is based on repeat sales transactions on single-family homes. The mortgages for these homes have been purchased or securitized by Fannie Mae or Freddie Mac since January 1975. I use the HPI in the year that the house was purchased and in the year that the

portfolio is analyzed (current year). These two price indices are the instrumental variables used in the econometric model.

I use the 1999-2009 family level panel data for the analysis because households' financial information is collected since 1999. Over 1999-2009, there are six waves of interviews in total that contain more than 9,000 households, producing 18,273 observations. 8,064 out of 18,273 observations are homeowners. Since there are six waves of interviews conducted from 1999-2009, the maximum observation for a family is 6 and the minimum is 1. Within 9566 households, there are 2400 households who have 6 observations, 3965 households with 5 observations, 4048 households who have 4 observations, 3036 households who are observed 3 times, 2160 households who have 2 observations, and 2664 households who are observed only once. In order to perform the instrumental variable analysis, the HPI data have to be merged with PSID data. This requires the year the home is purchased in PSID data. Since the PSID does not provide information about which year the homeowners purchased the house, I use the year the first mortgage, which is the original mortgage debt, was obtained to estimate the year of home purchase. The remaining sample contains 10,186 observations. In addition, I excluded 157 households whose liquid wealth by the calculation is zero (Chetty and Szeidl 2012). After excluding all the observations that are cleaned, I obtain a sample with 10,029 observations for the least square analysis and 17,445 observations for the DID analysis.

TABLE 1

Summary Statistics for the PSID Panel Data from 1999-2009 (Full Sample)

	Mean	Median	Standard Deviation
Demographics			
Age	42.51	42.00	13.71
Years of education	13.14	13.00	2.54
Number of children	0.93	0.00	1.20
Household Income ($)	47,647	34,017	112,153
Housing			
Property Value ($)	125,884	52,468	97,461
Mortgage	61,681	0	94,124
Wealth			
Total wealth ($)	179,199	35,004	798,014
Liquid wealth ($)	43,146	2,334	193,027
Home equity ($)	64,203	5,493	145,456
Equity in other real estate ($)	24,111	0	192,029
Retirement accounts ($)	22,638	0	99,250
Portfolio Allocation			
Percentage of households holding stocks	17.30%	0.00%	X
Stock Share (% of liquid wealth)	9.79%	0.00%	26.15%
Safe assets share (% of liquid wealth)	65.61%	99.00%	44.10%
Number of observations		17,445	

Notes: All monetary values are in real 2009 dollars.

Table 1 reports summary statistics for the panel data with the full sample. In the full sample, which is used in the DID estimation, both homeowners and renters are included. In the sample, the average households' property value (the worth of households' house) is approximately $125,883 in 2009 U.S. dollars. The average household's home equity is $64,203 with average current outstanding mortgages debts of

$61,681. The average household head is 43 years old. The medians of variables that are related to housing equity are small because there is significant proportion of households who do not own a housing property. For example, the median of mortgage is $0.00, the median of property value is $52,468.29 and the median of home equity value is $5492.50.

The household income is defined as a sum of labor income, family business income, and all incomes in other forms including the bonus of head, the rental income of head, dividend income, interest income, trust funds income of head, transfer income, SSI of head, other welfare income of head and annuities income of head. In the PSID, the amount of salary corresponds to the payment period of the salary. Therefore, I computed the annual salary through the multiplication of salary amount in each pay period and the number of payments within a year. The average annual salary is about $32,000. The total business income is calculated as the sum of the profit/loss of all businesses. However, the distribution of family income is extremely skewed. Summing up all the income variables, the average household income is $47,647; the median of the household income is only $34,017.

Liquid wealth is defined as the summation of assets held in stocks, bonds, insurance, checking accounts, saving accounts, and certificate deposits (Chetty and Szeidl (2012)). Retirement accounts are excluded from the liquid wealth. The average amount of liquid wealth is $43,146 and the median amount is $2,334. The distribution of liquid wealth is skewed. A small fraction of the liquid wealth is held in taxable stock form. Approximately, households hold 10% of the liquid wealth in a form of stocks and 90% of

the liquid wealth in a form of riskless safe assets such as bonds, insurance, checking and saving accounts and certificated deposits.

Illiquid wealth is defined as the summation of home equity, equity in other real estate and the amount in retirement accounts. Home equity is equal to the property value minus the remaining mortgage debt value. I use the amount invested in an IRA/Annuity account as the amount in retirement account. Total wealth is calculated as the sum of liquid wealth and illiquid wealth. The approximate average amount of total wealth is $179,199 with a median of $52,468.

TABLE 2

Summary Statistics for the PSID Panel Data from 1999-2009 (Home-owners Only)

	Mean	Median	Standard Deviation
Demographics			
Age	45.00	45.00	12.12
Years of education	13.69	14.00	2.44
Number of children	0.97	1.00	1.16
Household Income ($)	71,476	51,779	152,758
Housing			
Property Value ($)	239,909	200,000	242,517
Mortgage	127,393	170,000	110,352
Home Tenure (years)	4.18	3.00	4.29
Wealth			
Total wealth ($)	294,734	110,000	1,473,389
Liquid wealth ($)	60,246	7,562	240,160
Home equity ($)	112,518	62,084	180,445
Equity in other real estate ($)	49,291	0	1,067,347
Retirement accounts ($)	33,301	0	180,445
Portfolio Allocation			
Percentage of households holding stock	25.40%	0.00%	X
Stock Share (% of liquid wealth)	13.97%	0.00%	29.07%

Safe assets share (% of liquid wealth)	75.13%	100.00%	38.12%
Housing Price Index			
HPI for home purchase year	3,343.96	300.37	126.61
HPI for year 2009	340.56	319.26	98.39
Number of observations		10,029	

Notes: All monetary values are in real 2009 dollars.

Table 2 reports the summary statistics of the 1999-2009 panel data for the sample of homeowners. Comparing the main statistics from the full sample panel data, it is easy to see that the average and median values of main variables are higher in the sample that is restricted to homeowners. For example, the average total annual income is $71,476, the average household's property value is $239,909, and the average total wealth is $294.734, all of which are higher than in the non-homeowners sample. The increase of the average values and median values in the homeowner's panel data is expected since normally, homeowners are richer than renters. Therefore, restricting the sample to homeowners increases the household's average income, property wealth and wealth level. Also, the stock share holding increases in the restricted data as well. The summary statistics are consistent with the reality that households who hold more real estate property or buy more expensive houses are likely to be richer and therefore tend to hold more risky stocks.

5. Empirical Results

5.1 Least Square Estimation Analysis and Heckman's Sample Selection

TABLE 3

OLS, 2SLS and Sample Selection and Probit Estimation

Dependent Variable	Stock Share (%)				Stock Holder
	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS with positive stockshare	2SLS & Sample Selection	Probit
Property Value (log)	5.58	-16.02	-22.32	-17.04	-0.065
	(9.56)**	(7.97)**	(2.15)*	(0.68)	(2.70)**
Home Equity Value (log)	-4.21	-0.58	4.47	3.32	0.008
	(4.40)**	(0.57)	(0.56)	(0.29)	(0.55)
Home Tenure	0.12	-0.44	-0.56	-0.10	-0.006
	(1.60)	(5.05)**	(1.29)	(0.05)	(4.29)**
Age	-0.27	1.97	1.08	0.84	-0.005
	(1.95)	(16.19)**	(2.00)*	(0.99)	(2.40)*
Age_sq	0.00	-0.31	-0.02	0.01	0.0005
	(2.93)**	(2.23)*	(0.05)	(0.02)	(2.37)*
Education	1.65	0.01	0.00	0.00	0.038
	(13.11)**	(3.33)**	(0.72)	(0.78)	(19.27)**
Kids	-0.91	-0.75	0.29	1.17	-0.018
	(3.56)**	(2.95)**	(0.38)	(0.36)	(4.39)**
Total Annual Income (log)	0.88	1.13	1.26	-0.87	0.026
	(4.32)**	(5.63)**	(1.42)	(0.11)	(6.51)**
Total Illiquid Wealth (log)	2.90	4.57	6.37	0.93	0.095
	(9.82)**	(18.77)**	(1.27)	(0.06)	(22.14)**
Lambda				-17.84	
				(0.29)	
Constant	-69.57	128.90	173.90	229.91	
	(6.11)**	(3.94)**	(2.39)*	(1.34)	
Observation	10,029	10,029	2,460	2,460	10,029

* p<0.05; ** p<0.01

Notes: Absolute values of t-statistics are in parentheses. Specification (1) is an OLS estimation. Specification (2) is a 2SLS estimation where property value and home equity value are instrumented by the housing price index in the year of home purchasing and the year of portfolio measured. Specification (3) is a 2SLS regression conditioning on the positive stock shares. Specification (4) is a 2SLS and Heckman's sample selection estimation. The dependent variable in specification (5) is an indicator for stock holders that is estimated by using Probit. All specifications include state and year fixed effects.

Specification (1) in Table 3 reports the ordinary least square (OLS) regression result. The regression shows that the property value and percentage of stock shares are significantly positively related. When the property value increases by 1%, the stock share is increased by 0.40% in the financial portfolio, on average. This is an economically significant impact. This positive relationship is consistent with most other research. I interpret this result as follows: households with higher property values are more likely to be richer and tend to hold more housing property as well as stock shares. This positive effect is potentially biased because of the endegeneity problem previously discussed. The OLS regression also show several common-sense relationships, such as an increase in total annual income and total illiquid wealth leads an increase in stock share; and higher educated households tend to hold more risky stock shares.

Column (2) in Table 3 gives the result of 2 Stage Least Square regression estimations with 2 IVs. The regression shows that 1% increase in the property value leads to 1.4% decrease in stock holdings, on average, ceteris paribus. In other word, holding the home equity wealth fixed, a household reduces its stock share by 1.4% in its portfolio when it faces a 1% increase in the mortgage debt. This result is not very different from Chetty and Szeidl's results. Their empirical study show that a household with 10% more property value has a lower portfolio share of stocks by 3 percentage points. In terms of the elastic effect, the property value has an elasticity -1.48, which indicates a strong negative impact of change in property values on the decision to hold stock share.

Column (3) in Table 3 presents the results from a 2SLS estimation where the sample is restricted to positive stock shares. Since there are significant amount of zeros in

the percentage of stock shares, I restrict my sample into the ones with positive stock shares. A bigger effect is shown in the conditional 2SLS estimation. The result shows that on average, a 10% increase in property value causes a 3.06 percentage point decrease in stock shares holding of a liquid portfolio holding with other factors fixed. The estimated elasticity is -1.59, which suggests a strong negative relationship between the increase in mortgage debt and stock share holding.

Specification (4) in Table 3 reports the regression results from Heckman's Sample Selection model. Since the large amount of zero of stock shares is taken into account, the regression results are much better than the previous 2SLS estimation. The regression shows a larger elastic effect, which is -1.21, compared with the 2SLS estimation without sample selection. However, the result is not statistically significant. Since the sample is restricted on households who hold positive stock shares, the marginal and elastic effect tend to be larger; however, since only about 25% of the full sample is selected, the selected size is relatively small. This might cause the result to be insignificant.

Column (5) in Table 3 gives the results form a probit estimation where the dependent variable is a binary indicator that represents whether a household participates in the stock market. The regression result shows that a 10% increase in the mortgage debt would decrease the likelihood for a household to participate in the stock market by 6.5 percentage point. Differently from the 2SLS-based estimates that analyze the impact of mortgage debts on the amount of stock share holdings, the regression estimations suggest that the extensive margin of whether participating in the stock market is more sensitive than the intensive margin of how much to invest in the stock market. In other words, a

household that holds a large amount of mortgage debt would be much less likely to start participating in the stock market than one that holds low mortgage debt. I interpret this as follows: a household that does not participate in the stock market is probably poorer. Therefore when the household faces debt, it is even less likely to start investing in the stock market with a large outstanding mortgage debt, holding income and illiquid wealth fixed.

5.2 First Difference Estimation

TABLE 4

First Difference Estimation

Dependent Variable	Δ Stock Share (%)	
	(1)	(2)
	Full sample	Sample selection
Δ Property Value	17.51	32.64
	(4.42)**	(2.04)*
Δ Annual Income	0.56	2.54
	(0.94)	(0.74)
Δ Total Illiquid Wealth	-1.32	-12.31
	(1.18)	(1.94)
Δ Age	-0.48	-12.02
	(0.14)	(1.23)
Δ Kids	-7.51	-4.13
	(2.82)**	-1.52
Δ Education	-1.84	-1.15
	(2.74)**	-1.19
Constant	-31.17	-66.58
	(4.77)**	(2.47)*
Observations	714	152

* p<0.05; **p<0.01

Notes: Absolute value of t-statistic in parentheses. Specification (1) - (2) report the first difference estimation and measures the effects of changes in property value and total illiquid wealth on the change of stock share holdings. Column (1) uses the full sample that 1428 households buy a house within 1999-2009. Column (2) uses the Heckman's sample selection and first difference estimation that restrict the sample in households who hold positive stockshare. Δ Property Value is instrumneted by the house price index in the year of home purchase and the total wealth in the year of portfolio measured. Both specifications included the state fixed effect.

Table 4 reports the First Difference estimation using data from 1999-2009. Specification (1) includes the whole sample. I only observe 1428 households that purchase a house during 1999-2009. Therefore, when I take the first difference, the observation drops to 714. From the regression result: the change in property value before and after the home purchase has a positive effect on stock shares holding. On average, an increase of 10% in the property value increases the stock share holding by 2.4 percentage point with an elasticity of 1.75. This elasticity shows a strong positive relationship between the change of property value and the change of stock shares holding. Since the property value is 0 before the home purchase, the $\Delta property\ value_i$ is the market value of the house. Therefore, the bigger delta property value means a household that purchased a house at a higher price. Consider that a household that purchases a house at a higher price is likely to hold more financial assets even before the home purchase. Specification (2) limits the sample to households with positive stock holdings. This reduces the observations to only 152. The result suggests a larger positive effect of property value change on the change of stock share holding. The regression shows that a 10% increase in property value would increase a 4.49 percentage point of stock shares holding in a household liquid wealth portfolio. The elasticity effect is further raised to 3.2.

5.3 Difference-in-Difference Estimation

TABLE 5

Difference-in-Difference Estimation

Dependent Variable	Stock Share (%)		Dependent Variable	Stock Share (%)	
	(1)	(2)		(3)	(4)
Property Value_buy (log)	-2.63	-1.42	Property Value_sell (log)	11.73	9.74
	(0.36)	(0.10)		(0.27)	(0.19)
Homeequity_buy (log)	3.28	2.31	Homeequity_sell (log)	-22.65	-10.57
	(0.36)	(0.10)		(0.30)	(0.16)
Hometenure	-0.03	0.03	Hometenure	0.51	0.17
	(0.31)	(0.02)		(0.34)	(0.11)
Age	1.13	4.19	Age	1.44	5.05
	(1.53)	(1.15)		(0.91)	(0.94)
Age_sq	-0.01	-0.01	Age_sq	-0.01	-0.01
	(1.84)	(0.14)		(1.25)	(0.57)
Kids	-0.23	-0.34	Kids	0.20	1.65
	(0.60)	(0.03)		(0.18)	(0.23)
Education	1.89	-32.99	Education	5.22	-38.28
	(1.15)	(0.75)		(0.50)	(1.70)
Annual Income (log)	-0.13	-2.63	Annual Income (log)	-0.19	-5.99
	(1.04)	(0.10)		(1.31)	(0.52)
Total Illiquid Wealth (log)	-0.19	-4.21	Total Illiquid Wealth (log)	0.31	-9.53
	(0.22)	(0.09)		(0.45)	(0.52)
Lambda		-30.89	Lambda		-83.50
		(0.07)			(0.47)
Y1	X	X	Y1	X	X
Y2	X	X	Y2	X	X
Y3	X	X	Y3	X	X
Y4	X	X	Y4	X	X
Y5	X	X	Y5	X	X
Constant	X	X	Constant	X	X
Observations	17,445	3,020	Observations	17,445	3,020
	* p<0.05; ** p<0.01			* p<0.05; ** p<0.01	

Notes: Absolute value of t-statistic in parentheses. All specifications include individual fixed effects and time fixed effects. In column (1) and (2), the treatment is the home purchase. In column (3) and (4), the treatment is the home selling. Column (1) and (3) use the full sample DID estimation. Column (2) and (4) use Heckman's sample selection method and DID estimation, which eliminates the large amount of zero in the dependent variable. Property Value_buy, Homeequity_buy, Property Value_sell and Homeequity_sell are instrumented by house price index in the year of home purchasing/sell and the year of portfolio measured.

Table 6 reports the Difference-in-Difference estimation using 1999-2009 panel data. The estimation includes individual fixed effects and instruments for the property value and home equity. When I first look at the impact of home purchasing, the variable "property value_buy" is calculated to be the property value of a house in and after the years of home purchase, 0 before the years of home purchase. In general, property values go from 0 to positive for households in the treatment group, and remains 0 for households in the control group. When I explore the impact of home selling, the variable "property value_sell" is calculated as the property value of a house before the years of home selling, 0 in and after the years of home selling. Therefore, the property values turn from positive to 0 for households in the treatment group where the treatment is home selling, and remains 0 for households in the control group.

Columns (1) and (2) provide the estimates of the treatment effect of home purchase. Specification (1) includes the whole sample and (2) uses a Heckman's sample selection so that the sample is restricted into households whom hold positive stock shares. The property value of home purchasing treatment gives an elasticity -0.263 and the home equity wealth of home purchasing gives elasticity 0.328. The property value of home selling gives elasticity 1.173 and the home equity wealth of home selling gives elasticity -2.265. The specification (3) and (4) estimates the treatment effect of home selling. Specification (3) includes the whole sample and (4) uses a Heckman's selection model that restricts the sample on households whom have positive stock shares. The Heckman's selection estimation limits the sample to positive stock share holdings. Property value and home equity wealth in both the home-purchasing group and the home-selling group report elasticity estimates that are close to the ones with the elasticity in specification (1)

and (3). From the regression results, we can see that property value has a negative effect on stock share holdings from a home purchasing decision; it has a positive effect on stock share holdings from a home selling decision conditional on a fixed home equity wealth. On the contrary, home equity wealth has a positive effect on stock share holdings from home purchasing decision and a negative effect on stock share holdings from home selling decision conditional on a fixed property value. However, these effects are statistically insignificant.

Regarding to the above results, I think a large concern is the small sizes of the treatment group. There are only about 697 out of 9000 households who purchase a house in 1999-2009 and there are only 380 out of 9000 households that sell a house in 1999-2009. It makes only 1516 out of 17,445 observations in the treatment group that has a home purchasing decision and only 753 out of 17,445 observations in the second treatment group that has a home selling decision. The sample of treatment group is very small relative to the control group. This may cause the problem that no significant causal effect is found.

5. Conclusion

This paper examines the causal impact of housing on households' portfolio choices. I employ the main econometric model from Chetty and Szeidl (2012). The importance of the model is to help isolate the effect of mortgage debt and home equity on financial portfolio choices especially on stock share holding. Two instrumental variables used to reconcile the endogeneity problem are the average real price index of houses in the household's state in the year in which portfolios are observed and the average real

price index of houses in the household's state in the year of home purchase. Heckman's sample selection model is used to resolve the problem of limited dependent variable. Finally, a Difference-in-Difference estimation is designed to explore the impact of house purchasing and house selling decision on portfolio choices over time. A cross-sectional estimation analysis results show that there is a negative relationship between the property value and the stock share when the home equity wealth is held fixed. Conditioning on fixed home equity wealth, an increase in mortgage debt generally reduces the demand of risky stocks. Furthermore, the home purchasing decision reduces the stock share holding and the home selling decision increases the demand for stocks. However, the DID estimation does not find a significant relationship between property value or home equity wealth and portfolio choices. This insignificant result may be caused by a small sample size of treatment groups.

References

Berkoves, J. and Fullerton, D. (1990), "A General Equilibrium Model of Housing, Taxes, and Portfolio Choices*," Journal of Political Economy: 100(2), 390-429*

Barasinska, N., Schafer, D., and Stephan, A. (2011), " Individual Risk Attitudes and the Composition of Financial Portfolios: Evidence from German Household Portfolios," *The Quarterly Review of Economics and Finance: 52(1), 1-14*

Chetty, R. and Szeidl, A. (2012), "The Effect of Housing on Portfolio Choice," *National Bureau of Economics Research, Working paper No.15998*

Campbell, J. Y. and Cocco, J. F. (2003), "Household Risk Management and Optimal Mortgage Choices," *Quarterly Journal of Economics 118:1449-1494.*

Campbell, J. Y. and Cocco, J. F. (2007), "How Do House Prices Affect Consumption? Evidence from Micro Data," *Journal of Monetary Economics 54:591-621*

Cox, D. and Jappelli, T. (1993), "The Effect of Borrowing Constraints on Consumer Liabilities," *Journal of Money, Credit and Banking, 25(2): 197-214*

Cocco, J.F. (2005), "Portfolio Choice in the Presence of Housing," *Review of Financial Studies 18,535-567*

Dusanky, R., Koc. C., and Onur, I. (2010), " Household Housing Demand: Empirical and Theoretical Reconciliation," *The Journal of Real Estate Finance and Economics, 44(4): 429-445*

Flavin, M. and Yamashita, T. (2002), "Owner-Occupied Housing and the Composition of the Household Portfolio," *American Economic Review, 92(1): 345-362*

Fratantoni, M. C. (1998), "Homeownership and Investment in Risky Assets," *Journal of Urban Economics, 44(1): 27-42*

Fratantoni, M. C. (2001), "Homeownership, Committed Expenditure Risk, and the Stockholding Puzzle," *Oxford Economic Papers, 53(2): 241-259*

Grossman, S. J. and Laroque, G. (1998), "Asset Pricing and Optimal Portfolio Choice in the Presence of Illiquid Durable Consumption Goods," *Econometrica 58,25-51*

Henderson, J. V. and Ioannides, Y. M. (1989), "Dynamic Aspects of Consumer Decisions in Housing Markets," *Journal of Urban Economics 26: 212-230*

Heaton, J. and Lucas, D. J. (2000), "Portfolio Choice in the Presence of Background Risk," *Economic Journal 110(460):1-26*

Hu, X. (2005), "Portfolio Choices for Homeowners," *Journal of Urban Economics 58(1): 114-136*

Ioannides, Y. M. (1992), "Dynamics of the Composition of Household Asset Portfolios and the Life Cycle," *Applied Financial Economics, 2, 3: 145-159*

Ioannides, Y. M. (1989), "Housing, Other Real Estate, and Wealth Portfolios: An Empirical Investigation Based on The 1983 Survey of Consumer Finances," *Regional Science and Urban Economics, 19: 259-280*

Ioannides, Y. M. and Rosenthal, S. (1994), "Estimating the Consumption and Investment Demands for Housing and Their Effect on Housing Tenure Status," *The Review of Economics and Statistics, 76(1), 127-140*

Yamashita, T. (2003), "Owner-Occupied Housing and Investment in Stocks: An Empirical Test, "*Journal of Urban Economics, 53(2): 220-237*

Yao, R. and Zhang, H. (2005), "Optimal Consumption and Portfolio Choices with Risky Housing and Borrowing Constraints," *Review of Financial Studies, 18(1), 197-239*