Household finance and the role of housing wealth in household financial decision making

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Household Finance and the Role of Housing Wealth in Household Financial Decision Making

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This dissertation consists of three essays on household finance, with a focus on understanding how housing wealth affect household financial decisions.

The first essay uses a novel panel dataset with consumption and income records to study the heterogeneity in house price-consumption sensitivity across and within life-cycle stages. This study finds young homeowners with high income volatility have the largest sensitivity. The influence of income volatility subsumes credit constraint measures such as liquid assets, loan-to-value ratio, and mortgage payment coverage highlighting the precautionary savings nature of this sensitivity. Old unconstrained homeowners with high housing wealth share have significant sensitivity, consistent with the wealth effect. Overall, these two homeowner groups are the largest contributors to aggregate sensitivity while other groups typically have small and insignificant sensitivities.

The second essay develops a stylized life-cycle model on optimal consumption with housing and risky labor income and provides analytical solutions. The study shows that while the consumption of older individuals are affected by house prices only due to a housing wealth effect, the young and middle-aged can be influenced by both the wealth effect and a credit-constraint effect, depending on their levels of wealth. Young homeowners with intermediate level of wealth also exhibit a precautionary saving motive, which is influenced by house prices. This model provides a framework in understanding the empirical findings in the literature.

The last essay uses a novel panel dataset to investigate whether variations in housing wealth affect individuals' stock market entry decision. The study identifies the impact of housing wealth by examining how house price changes predict the stock market entry of homeowners compared to renters, who experience the same economic conditions but the opposite wealth shocks when house prices fluctuate. The study finds rising house prices lead to higher probabilities of stock market entry and larger initial investment of homeowners compared to renters. Falling prices lead to larger bank savings of homeowners than renters, likely due to a heightened precautionary saving motive. In contrast, renters avoid the stock market and save more when house prices increase, suggesting implicit housing costs limit stock market participation.

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Abstract

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The last essay uses a novel panel dataset to investigate whether variations in housing wealth affect individuals' stock market entry decision. The study identifies the impact of housing wealth by examining how house price changes predict the stock market entry of homeowners compared to renters, who experience the same economic conditions but the opposite wealth shocks when house prices fluctuate. The study finds rising house prices lead to higher probabilities of stock market entry and larger initial investment of homeowners compared to renters. Falling prices lead to larger bank savings of homeowners than renters, likely due to a heightened precautionary saving motive. In contrast, renters avoid the stock market and save more when house prices increase, suggesting implicit housing costs limit stock market participation.

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To my beloved mother and father. . .

Chapter 1

Introduction

In this chapter, I provide the background and motivation of the three essays in this thesis. I first introduce household finance as a rising field of study in financial economics. With this backdrop, I discuss my motivation for examining the role of housing wealth in shaping household financial decisions, and define the scope and contributions of the thesis. Lastly, I will provide a review of the existent literature.

1.1 Household Finance: A Rising Field

Household finance has been formally introduced as a field of study in financial economics by John Campbell in his 2006 Presidential Address to the American Finance Association. He defines household finance as studies on how households use financial

instruments to attain their objectives and identifies many special features of the problems in household finance (Campbell, 2006). Prior to this formal introduction, household financial decision making received significantly less attention from academia compared to the traditional fields of financial economics, such as asset pricing and corporate finance. Guiso and Sodini (2012) hypothesize this could be due to the limited need of formal studies on the simple financial matters of individuals in the past, the lack of reliable and proper data, and culture heritage (Tufano, 2009).

However, there has been a growing need for academic studies in household finance in recent years, for a number of reasons. First, the growing complexity of the financial services and products offered to individuals calls for analysis and research. With fast development in technology, individuals can now easily trade shares, ETFs, foreign exchange and derivatives. How well individuals approach this complexity and whether they make correct decisions are not clear to academics nor policy makers. Second, the sheer size of household financial assets (and debts) and their potential impact on the real economy demand our attention. For example, at the end of 2010, the U.S. households hold $48 trillion financial assets, $24 trillion tangible assets (mainly real estate), and $14 trillion debts. These dwindle the $28 trillion assets and $13 trillion debts of the U.S. Corporations (Tufano, 2009). A perfect example of how household financial decisions could affect the financial markets and the real economy is the 2008 financial crisis which was originated in the residential property market. Last but not least, household finance studies face distinct problems that existing theories in asset

pricing and corporate finance cannot easily accommodate, which means some household behavior cannot be understood and explained. To help households make better decisions and improve their welfare, household finance research is called for to better understand household behavior and to provide individuals guidance on decision making.

Since John Campbell's Presidential address, the need for in-depth analysis of household behavior has been increasingly recognized and significant studies on many fronts in household finance have been developed. Joining this growing literature, this thesis presents three essays on household finance with a focus on understanding the role of housing wealth in shaping household financial decisions.

1.2 Motivation

The focus on housing wealth in household portfolio is driven by three main factors. First, housing asset is often the largest asset of a household and the variation in its value can potentially affect a range of household financial decisions. Second, housing asset has special features compared to other financial assets, such as stocks and bonds. A house is both a durable consumption good that provides sheltering service and an investment asset which can be obtained with substantial leverage. Recent developments in the financial market further enable households to access their home equity for consumption and other investments. Lastly, housing asset is highly illiquid and indivisible, which makes traditional asset pricing theories not directly applicable

in most cases. Due to such complexity in nature, the literature has yet to fully understand the impact of housing wealth on household financial decisions. The three essays in this thesis aim to make contributions in this front.

1.3 Aim and Scope

The three essays are *positive* studies in nature, where I attempt to explore how households actually make decisions.[1] In Chapter 2, I examine the impact of variations in housing wealth on household consumption decisions. Chapter 3 develops a stylized life-cycle model to provide theoretical explanations for the findings in Chapter 2 and previous studies. Chapter 4 explores the effect of housing wealth on stock market participation, which sheds light on the link between the housing and stock markets through individual investment choices.

1.4 Contribution of the Study

Chapter 2 provides new empirical evidence on the heterogeneity in the effect of housing wealth on household consumption decisions. In particular, I identify significant impact of income volatility on house-price consumption sensitivity among young homeowners with high income volatility, which provides evidence of the precautionary savings nature of housing assets. In addition, older households also respond to house price variations in their consumption, likely due to a housing wealth effect,

[1] By contrast, *normative* studies attempt to illustrate how households should make decisions.

while the middle-aged tend to have insignificant response. Chapter 3 provides a stylized life-cycle model that explains the findings in Chapter 2 and other studies such as Campbell (2006) and Gan (2010). This model avoids the numerical methods employed in previous studies with an analytical solution that can explain the main mechanisms through which house price variations affect consumption decisions. Chapter 4 identifies the impact of variations in housing wealth on individuals stock market entry decisions using a panel data that follows the same individuals for 15 years. It shows that housing costs limits stock market participation of renters but not homeowners. In addition, households adjust their precautionary savings with variations in housing wealth. Overall, the three essays improve our understanding on how housing wealth shapes household decisions on consumption and investments.

1.5 Literature review

The first Chapter in the thesis belongs to a line of research examining the relationship between housing wealth and household consumption using micro data. Earlier studies, such as Attanasio and Weber (1994), Attanasio and Weber (1995), Skinner (1996), Engelhardt (1996) focus on testing whether housing wealth changes can affect household consumption and saving behavior. Although most studies find that variations in housing wealth do affect household consumption decision in the United States, the specific channels of the link remain largely unidentified and have generally been termed as the 'wealth effect' of housing assets. More recent studies, starting

from Campbell and Cocco (2007), attempt to not only identify the relationship between housing wealth and household consumption, but also test the specific channels of the relationship. Using a pseudo-panel approach with the British Family Expenditure Survey, Campbell and Cocco (2007) find the largest effect of house prices on consumption for older homeowners and te smallest for young renters, consistent with the heterogeneity in the wealth effect. This conclusion, however, has been challenged by the findings in Attanasio, Blow, Hamilton, and Leicester (2009), who use the same dataset but conclude that common omitted factors drive the co-movement between house price and consumption in the United Kingdom. Also casting doubt on the housing wealth effect is the finding from Disney, Gathergood, and Henley (2010), who analyze the British Household Panel Survey and find omitting the measures of household financial expectation biases the marginal propensity to consume out of housing wealth upwards.

The conflicting and often puzzling conclusions are not confined within UK studies. Gan (2010) uses a large credit card panel data from Hong Kong and finds evidence supporting 1) a pure wealth effect as households with multiple properties tend to have much stronger consumption responses to house prices; 2) a credit constraint channel as refinancing increases household consumption sensitivity to house prices; 3) a precautionary saving motive driving most non-refinancing households' response to house prices. However, unlike previous studies where the population tends to be people under the age of 60, most individuals in Gan's study are under the age of 40. Also, although credit card data is accurate, they often fail to catch the full spectrum

of expenditure items of a typical household. These two aspects raise the question of to what extent Gan's findings are comparable to existing studies. Using a Danish household-level panel data, Browning, Gørtz, and Leth-Petersen (2013) find little evidence of a housing wealth effect but support the collateral channel where housing wealth affect consumption through relaxing the credit constraints faced by young households. Most recently, Aladangady (2017) use a geographically linked microdata and regional house price fluctuations in the United States to identify a causal effect of house price changes on consumption. They argue the borrowing constraint is the primary driver of the link between house prices and consumption.

These prior studies tend to suffer from two major data limitations. On the one hand, many household-level panel data does not have measures of consumption and studies such as Skinner (1996), Disney et al. (2010) and Browning et al. (2013) need to infer consumption from savings, introducing noise into the consumption measure. The alternative data source of household expenditure surveys, on the other hand, tend to only follow the same household/individuals for a short period of time, making the comparison overtime of the same individuals and controlling for household heterogeneities and fixed effects impossible. A panel data with detailed consumption records, such as the Health, Income and Labor Dynamics in Australia (HILDA) used in this study can overcome the two limitations faced by most previous studies.

Apart from Gan (2010), most of the existing studies classify households based on age group and test different hypotheses by comparing different age groups' consumption response to housing wealth changes. However, this approach potentially ignores the

heterogeneity within each age group. Calomiris, Longhofer, and Miles (2013) exploit cross-state variations in housing wealth in the United States and find that the impact of housing on consumer spending depends on factors such as the age composition and housing wealth share of the states. Similarly to the state level study, overlooking these heterogeneities within each age group might introduce omitted variable bias and masks the real drivers of the relationship between housing wealth and consumption.

Another important challenge in understanding the various findings from the studies using micro data is the fact that the theoretical literature on this topic is still in development and no well established theory can explain the nuanced relationship between housing wealth and consumption. This is largely due to the complex nature of housing wealth; they are both durable consumption good, investment assets and collateral for borrowing. However, recent theoretical studies do provide insights in understanding the various aspects of the relationship between housing wealth and consumption.

Li and Yao (2007) develops a life-cycle model that incorporates the dual function of housing as both consumption good and investment asset. They conclude that consumption of the young and old homeowners should have much higher sensitivity to house prices changes than that of the middle-aged, and rising house prices only increase the welfare of older homeowners. Campbell and Cocco (2007) uses a calibrated model of consumption and housing choice to evaluate the cohort selection effect on their empirical estimates. Focusing on the collateral role of housing wealth, Iacoviello (2004) develops a two-agent, dynamic general equilibrium model in which housing wealth affects the borrowing capacity and consumption for some households.

In contrast to the calibrated models developed in previous literature, Kraft and Munk (2011) provide analytical solutions to a life-cycle model involving consumption, investment decisions into stock and bond, and the choice between rental and homeownership. However, the costs of providing closed-form solution are the assumption of continuous and costless adjustment of housing consumption and investment, as well as a complete market. More recently, Berger, Guerrieri, Lorenzoni, and Vavra (2018) develops a dynamic and incomplete market model of household consumption and calibrate the model to micro data to explain the large consumption responses to house price movements observed in the micro data. Chapter 3 of the thesis contributes to this line of research by developing a stylized model of household consumption with housing to illustrate the main channels through which house prices can affect consumption decisions of households of different life-cycle stage.

In addition to consumption, existing studies also show that housing wealth can influence a range of other household financial decisions, such as portfolio choice (Flavin and Yamashita, 2002; Cocco, 2005; Yao and Zhang, 2005; Chetty, Sándor, and Szeidl, 2017). Flavin and Yamashita (2002) consider portfolio choice with housing asset in a mean-variance efficiency framework. Cocco (2005) and Yao and Zhang (2005) both build full-fledged life-cycle model to consider portfolio choice with housing and calibrated their model to the Panel Study of Income Dynamics (PSID) data. Chetty et al. (2017) further distinguish the effects between home equity and mortgage debt on portfolio choice. The empirical analysis in those papers focuses on the cross-sectional asset allocation between housing and other assets among households but

does not speak to the question whether exogenous changes in housing wealth have any impact on household investment decisions on other assets. Chapter 4 of this thesis attempts to contribute to this area by studying the impact of variations in housing on individuals' stock market participation.

Chapter 2

How do house prices affect consumption? The role of income volatility, housing wealth share, and age

I use a panel dataset with consumption and income records to study the heterogeneity in house price-consumption sensitivity across and within life-cycle stages. I find young homeowners with high income volatility have the largest sensitivity. The influence of income volatility subsumes credit constraint measures—such as liquid assets, loan-to-value ratio, and mortgage payment coverage—highlighting the precautionary savings nature of this sensitivity. Old unconstrained homeowners with high housing

wealth share have significant sensitivity, consistent with the wealth effect. Overall, these two homeowner groups are the largest contributors to aggregate sensitivity while other groups typically have small and insignificant sensitivities.

2.1 Introduction

Home property is often the most important asset in a household's portfolio.[1] The recent U.S. housing boom and subsequent downturn during the subprime mortgage crisis put a spotlight on risks posed by house price volatility. In the aftermath of the Great Recession, one particular concern of policy makers and academics is the dampening effects of falling house prices on household consumption (Mian and Sufi, 2011; Mian, Rao, and Sufi, 2013; Kaplan, Mitman, and Violante, 2017; Berger, Guerrieri, Lorenzoni, and Vavra, 2017). In order to design effective policies to influence consumption, an important task for policy makers and academics is to understand which households' consumption decisions are affected by house price changes. In an influential study, Campbell and Cocco (2007) find the consumption sensitivity to house prices is largest for older homeowners. Calomiris, Longhofer, and Miles (2013) find that states with more young people, who are more likely to be credit-constrained, and

[1] It is usually the most valuable asset a household owns and the most readily available collateral. In the U.S., for example, housing Ialth accounted for about half the total net worth of households in 2008 (Iacoviello, 2011) and home mortgage debt was equal to about half of the market value of houses in 2007 (Greenspan and Kennedy, 2008).

older homeowners, who are likely to be trading down on their housing stock, experience the largest housing price-consumption sensitivity. They argue that demographic and wealth characteristics cause this effect to vary widely across states.

This study examines heterogeneity in house price-consumption sensitivity among households in the same life-cycle stage. A challenge to identifying such heterogeneity is the lack of a long-term panel data with good measures of consumption, income, and household characteristics.[2] For example, despite reference to precautionary savings motive, most studies do not identify households with high income volatility, who are likely to have stronger need for housing collateral in "hard times". In this paper, I am able to relax several data limitations by using the Household, Income and Labor Dynamics in Australia (HILDA) survey dataset, which follows the same individuals and contains detailed spending records and other household characteristics, such as income, homeownership, tenure and mortgage. The richness of the panel data enables me to measure key variables such as income volatility and control for both unobservable household fixed effects as well as time-varying factors such as household size, income and housing positions, thereby improving identification. I

[2]On one hand, many household panels do not have good measures of household consumption, for example, the Panel of Study of Income Dynamics (PSID) data used in Skinner (1996) and Engelhardt (1996), the British household panel survey (BHPS) in Disney et al. (2010) and the Danish panel dataset of Browning et al. (2013). These studies need to infer consumption from changing wealth and thus provide indirect evidence on how house prices affect consumption. On the other hand, consumer expenditure surveys do not follow the same individuals over time, for example, the British Family Expenditure Survey used in Campbell and Cocco (2007) and Attanasio et al. (2009). Moreover, many important household characteristics, such as income, homeownership and tenure are often missing in different datasets, limiting the controls and in-depth analysis.

am also able to categorize households into three age categories—young, middle- and old-aged—where old-aged include individuals older than 60 years and young include individuals younger than 40 years. In contrast, studies such as Campbell and Cocco (2007) and Gan (2010) classify households into two age categories using a cut-off age of 40, partly because they do not have sufficient data for individuals older than 60. Further, I provide an item level analysis of consumption expenditure. For example, in response to an increase in house prices, young households spend more on "meals eaten out" while old households spend more on "groceries". The identification strategy, enabled by the rich dataset, overcomes many of the limitations faced by previous studies.

With improved identification, I report two main results. First, there are substantial differences in house price-consumption sensitivity within life-cycle stages based on income volatility for young homeowners and housing wealth share (the proportion of housing wealth to total wealth) for old homeowners. Second, other groups of homeowners have insignificant sensitivity. Some groups of middle-aged homeowners even have negative sensitivity. Together, these results indicate that the largest contributors to the aggregate house price-consumption sensitivity are young homeowners with high income volatility and old unconstrained homeowners with high housing wealth shares. Other groups such as middle-aged homeowners contribute to lowering aggregate house price-consumption sensitivity.

This study is not the first to find heterogeneity in house price-consumption sensitivity across households. For example, Campbell and Cocco (2007) find differences across

life-cycle stages. However, they do not have access to time-series data on the same household and are therefore not able to compare across households on dimensions such as income volatility. Gan (2010) examines a credit card panel data from Hong Kong with data on several household characteristics. She concludes that among the majority of households who do not refinance, consumption sensitivity appears to be due to a reduction in precautionary savings based on indirect evidence. For example, she finds that it is stronger among less leveraged households and for younger households. In contrast to this indirect identification by Gan (2010), we directly examine the role of income volatility, which is a fundamental determinant of the precautionary savings motive and is of first-order importance in determining house price-consumption sensitivity. Further, the results suggest that credit constraint measures such as low liquid assets, low net worth or high mortgage payment-to-income ratio do not significantly affect house price-consumption sensitivity for young households that have low income volatility. I also provide new insights to the state level evidence in Calomiris, Longhofer, and Miles (2013) who argue that age composition, wealth distribution, and housing wealth share are important in understanding the relation between house prices and consumption. This study provides micro evidence of heterogeneity in house price consumption sensitivity related to age, income volatility and housing wealth share.

A large literature recognizes reasons why three theoretical channels—wealth effects, borrowing constraints, and precautionary saving motives—may influence household consumption sensitivity to house prices (see e.g. Lustig and Van Nieuwerburgh

(2005), Campbell and Cocco (2007), Li and Yao (2007), Gan (2010), Agarwal and Qian (2014), Aladangady (2017) and Paiella and Pistaferri (2017)). Guided by theoretical insights, we empirically evaluate heterogeneity in the house price-consumption sensitivity across homeowners grouped by characteristics related to age, housing wealth share, borrowing constraints, and precautionary saving motive.

I divide young households into groups based on income volatility. I find that the house price-consumption sensitivity is primarily driven by the high income volatility group. For the low income volatility group, no other sub-category of homeowners has a significant sensitivity. This suggests that income volatility is a relevant and important omitted variable that is likely to influence the results documented in prior studies. The results are consistent with an important precautionary savings motive of young homeowners with high income volatility. These households are more likely to realize low incomes and therefore tend to save more for such times. They benefit from increasing house prices as they can borrow more using their house as collateral, and thereby save less and consume more. It is also possible that households with high income volatility find it hard to obtain credit and therefore are more subject to changes in the value of the housing collateral. While we are not able to pinpoint the exact mechanism, the results control for standard proxies of credit constraints such as liquid assets, loan-to-value ratio, and income-to-mortgage payment ratio. This study is the first to document, to the best of my knowledge, the importance of high income volatility in this context.

Older households typically do not have mortgages or income. Heterogeneity among

older households is more likely to be based on their housing wealth share and likelihood to downsize. Accordingly, we divide older households into groups based on liquid assets, housing wealth share, and likelihood to move (my proxy for downsizing probability). I find that the house price-consumption sensitivity is only significant for those unconstrained households with higher housing wealth share.

I find that middle-aged homeowners on average do not have significant consumption sensitivity to house prices. I also consider subgroups of middle-aged homeowners based on net worth, liquid assets, and likelihood to move. The only subgroup that has significant (negative) sensitivity is the one with low liquid assets and high likelihood to move. This is consistent with the notion that middle-aged households who want to up-size are negatively impacted by rising house prices (see e.g. Li and Yao (2007)).

In summary, two groups of homeowners—young homeowners with high income volatility and older households with higher housing wealth share—are the main drivers of the average sensitivity observed in aggregated data. While we focus mainly on discretionary non-durable consumption of households, this result is robust to using all non-durable consumption items as well as only using staple (non-discretionary) consumption.[3] Although the aggregate marginal propensity to consume (MPC) non-durable goods out of $100 increase in house price is just $0.40 in the sample, there is a wide variation in the MPC across groups of households. The highest MPCs are of

[3]I also report a category-wise breakup of how different categories of homeowners spend a $100 increase in consumption in response to house prices. I find that the maximum increase in consumption expenditure is in the discretionary categories such as "meals eaten out" and "motor fuel", but the staple category of "groceries" is also an important component.

young homeowners with high income volatility at $5.10 and of old homeowners with high housing wealth share at $1.40. In contrast, young homeowners with low income volatility have an MPC of $0.45 and old homeowners with low housing wealth share have an MPC of $0.61. The estimated MPCs are negative for middle aged homeowners, suggesting a need to save in response to increases in house prices. Overall, the evidence suggests that the cross-sectional dispersion in MPC, even within an age-group, is an important feature of the data. This evidence can be used to compare theoretical models based on how they match such heterogeneity in MPCs within life-cycle stages, as well as inform the impact of policy choices on different groups of households.

This study proceeds as follows. In Section 2, we present the econometric model. Section 3 describes the data and variable construction. The empirical analysis is in Section 4, and Section 5 concludes.

2.2 Econometric Design

This paper belongs to a growing empirical literature examining the relation between housing wealth and consumption. This effect is typically estimated by regressing log consumption growth on changes in log house prices:

$$\Delta Log(C_{kt}) = \alpha_j + \beta_{k0}\Delta Log(HP_{kt}) + \beta_{k1}Z_{kt} + u_{kt}, \tag{2.1}$$

where the subscript k denotes a cohort, $\Delta Log(C_{kt})$ is real non-durable consumption growth, and Z_{kt} is a vector of cohort-specific control variables. Differencing log consumption takes care of some issues arising from the omission of unobservable time-invariant variables influencing a cohort's propensity to consumption from housing wealth such as culture and education.

Several studies take a regression like equation 2.1 as a starting point such as Campbell and Cocco (2007) and Calomiris et al. (2013). A challenge to evaluate this sensitivity is the lack of good measures of consumption, income and homeownership in datasets that track the same household over time. Many consumer expenditure surveys follow a household for only a short period of time and therefore are not suitable for household fixed-effects. Studies using such datasets typically require researchers to construct a pseudo-panel of households (based on cohorts). For example, Campbell and Cocco (2007) construct a pseudo-panel from the British FES data and use county-level house price indexes to analyze the relation.

There are a number of problems with estimating regression equation 2.1 and with using pseudo-panel data. First, it is possible that the correlation between house prices and consumption may be driven by an unobserved common macroeconomic factor such as future income prospects. In this case, estimates of β_{k0} will include the influence of future income prospects on consumption (Attanasio et al., 2009).

Second, the decision to become a homeowner is endogenous. Over time, the cohort of renters (for a fixed birth year) is likely to shrink and become more concentrated in the lower-income and lower consumption population. Further, it is possible that lower

house prices increase renters' propensity to buy their first homes. In this case, for a cohort analysis, the mean consumption of homeowners in year t may be lower than in year $t-1$ simply because more renters with lower consumption became homeowners. This may bias estimation results in a cohort analysis as there may be some correlation between changes in house prices and consumption that is simply due to renters becoming homeowners.

Third, a challenge to understanding the source of correlation between household consumption growth and house prices is controlling for unobserved household heterogeneity in consumption growth such as in risk aversion. Accounting for household-specific characteristics is inherently difficult using data at the cohort-, country-, state-, or zip-code-level. In general, household specific time-invariant variables such as risk aversion will influence estimates of β_{k0}. For example, risk aversion influences consumption growth of households and the riskiness of their housing choice (and thereby their expected house price growth). This induces a correlation between a household's average consumption growth and average house price growth. This cross-sectional correlation will influence estimates. Including household fixed effects can avoid this problem, but this requires a dataset that follows the same household over time.

I use a panel regression approach that improves identification on these three issues in regression equation 2.1:

$$\Delta Log(C_{ikt}) = \alpha_i + \beta_0 Z_{it} + \beta_1 \Delta Log(HP_{mt}) + \beta_2 GroupDummy_k * \Delta Log(HP_{mt}) + \beta_3 Z_{mt} + \beta_4 GroupDummy_k * Z_{mt} + \eta_t + \beta_5 \eta_t * GroupDummy_k + u_{it}, \quad (2.2)$$

where $GroupDummy_k$ is a dummy variable indicating whether the household belongs to the group of interest. In this specification, the coefficients β_1 and β_2 are the focus. Here β_2 measures the differential consumption elasticity between household groups such as renters and homeowners. To control for any economy-wide shocks and state-level factors that differentially influence households due to their group membership, I interact the group membership dummy with time fixed effects η_t and all other state-level macroeconomic shocks Z_{mt}.

In the main tests, I measure sensitivity of household consumption to regional house prices rather than to households' self reported house prices. This is because I do not measure a household's subjective expectations of the macroeconomic environment, which may influence both its house price growth expectations and consumption growth. A household's optimism will show up in both their consumption growth and self-assessed house prices. However, I am interested in understanding how objective house prices influence household consumption growth. To alleviate concerns regarding an omitted variable bias, I use regional house prices, assuming that these are exogenous for households.

The α_i term captures household fixed effects. As discussed earlier, without these fixed effects the cross-sectional correlation of average consumption growth and house price growth will bias estimates. Time-variation in observed household characteristics such as income, household size, and mortgage payments are captured by the term Z_{it}.

2.2.1 Hypothesis of Heterogeneity within Life-cycle Stages

While regression equation 2.2 is very general, it leaves open the question of how to define $GroupDummy_k$? Which groups of households are expected to display differences in house price-consumption sensitivity? This is an important question that can motivate the definition of $GroupDummy_k$ when estimating equation 2.2. I motivate the choice using theoretical insights.

Life-cycle models of household consumption decisions typically recognize the heterogeneity of homeowners across age groups such as the borrowing-constrained young, the saving middle-aged, and the disaving old (Constantinidies, Donaldson, and Mehra, 2002). A key difference across these life-cycle stages of households are that they receive labor income in young-age and middle-age but receive no income in old-age. Further, various studies have noted that young households tend to be more financially constrained than old households (Li and Yao, 2007). However, even within these cohorts, some households are more constrained than others, and the wealth effect will be stronger for some households than others.

In the old-age period, households have already realized their lifetime labor income and know their total wealth. Further, they will consume this wealth, which includes the current value of the house, in a shorter duration. The higher the house value, the larger the wealth of the household, and thereby the larger their non-durable consumption will be: the housing wealth effect (see also Calomiris et al. (2013)). Since they have no future labor income to consume against, old-age households are less influenced by borrowing constraints or precautionary saving motives. A 1% change in

house price typically implies a greater percentage change in wealth for homeowners who have a larger share of wealth tied to house prices. This motivates the following hypothesis:

Hypothesis 1: In the old age, a larger share of housing wealth to total wealth is associated with a greater sensitivity of consumption to house prices due to a wealth effect.

Based on this hypothesis, I estimate a regression like that in equation 2.2 for old homeowners with the variable $GroupDummy = 1$ for the group of old households with high housing wealth share and zero for all other old households.

At the other end of the life-cycle, the housing wealth effect should be smallest for young homeowners due to their long remaining life horizon. In this stage, a substantial portion of lifetime wealth is still tied up in future labor income. Further, due to uninsured labor income risk, both the precautionary saving channel and the borrowing constraint channel are active for young homeowners, who tend to have limited savings and be more liquidity constrained (see also Gan (2010)). This sensitivity should be stronger for young homeowners with higher income volatility as these households are more likely to be constrained in the future. A higher level of income volatility is associated with more uncertainty and the possibility of a more unfavorable income realization. To forearm against this possibility, these households consume less (save more) compared to the case when they know that they have sufficient wealth and will not be borrowing constrained in the future. However, when house prices rise, their ability to borrow and consume in these adverse states increases. Consequently,

they optimally save less and increase current consumption. This motivates the second hypothesis:

Hypothesis 2: Young homeowners who have high income volatility (but are neither borrowing constrained nor have high liquid savings) have a larger consumption sensitivity to house prices due to a stronger precautionary saving motive.

The condition for not being borrowing constrained and not having high liquid savings, such as bonds and equities, is important. On one hand, homeowners who have sufficient liquid savings are unlikely to experience borrowing constraints in the future and therefore do not need much precautionary savings today. On the other hand, homeowners who are already borrowing constrained cannot afford to save for the future. This suggests that young households in the intermediate wealth range are more likely to show heterogeneity based on income volatility.

Based on this hypothesis, I estimate a regression like equation 2.2 for young households with the variable $GroupDummy_k = 1$ for young households with high income volatility. To control for the possibility of unobserved macroeconomic variables that are correlated with income volatility, I also estimate a regression that looks at the difference across homeowners and renters with high levels of income volatility. I also consider groups based on credit constraint measures (net worth, liquid assets, loan-to-value ratio, and mortgage coverage ratio). I note, however, that a constrained household would typically need to refinance before being able to increase consumption. Therefore, credit constrained households who do not refinance are unlikely to increase consumption in response to increasing house prices.

2.3 Data and Variable Construction

I apply the HILDA data for the empirical analysis. HILDA is a national representative longitudinal survey designed to facilitate studies on income, labour market participation, health, and housing issues of Australian households (Summerfield, Freidin, Hahn, Li, Macalalad, Mundy, Watson, Wilkins, and Wooden, 2014). The survey began in 2001 with 7682 households and has been conducted annually following the same families mainly through face-to-face interviews by professional interviewers. In many aspects, HILDA presents an ideal setting to study the relation between household consumption and house prices. First, starting in 2005, HILDA has collected regular household spending on a wide range of non-durable goods and services, which has often been missing in other panel datasets. Second, the panel data structure allows us to compare the same households overtime and control for unobservable household characteristics through household fixed effect. Lastly, HILDA contains detailed housing-related information, such as homeownership, tenure and movements, and a variety of other information, such as income, wealth, and family size, which permits controls for time variation within households.

I use wave 5 (2005) to wave 13 (2013) of the HILDA data. Most questions in the survey, such as income and spending, ask for values of variables covering the prior financial year (1 July to 30 June). Other questions, such as family composition and wealth, give values as of the survey dates, mainly between August and October. Throughout the paper, when I refer to the value of a variable in year t, I mean the value as reported

in the survey taken in the year t. Next, I describe the sample selection procedure and the main variables used in the analysis.

2.3.1 Sample Selection

The basic economic unit in this study is household. As households split and reunite over time, I track a household by identifying and following the head of a household.[4] Specifically, when a household splits I follow the one with the existing head, and when two household heads enter into one household (reunions), both involved households are excluded. This procedure is used as changes in household structure alter the measure of many key economic variables, such as consumption and income. I do not intend to measure the simultaneous effects of changes in consumption and housing due to changes in household structure. I also require that the household head has been interviewed in all subsequent waves because some variables are collected through the Person Questionnaire, which is available only if a person is interviewed. Applying these filters, I obtain a balanced panel of 4620 households with both household and individual information between 2005 and 2013.[5]

I then classify households based on their homeownership status, which fundamentally determines how they should respond to house price changes (Campbell and Cocco, 2007). In the baseline analysis, I consider three types of households: homeowners, renters and those who change between homeowner and renter once during the sample

[4] The household member who has the highest regular income in 2005

[5] The reduction in the number of households is mainly due to natural attrition in responding households. HILDA has retention rates of around 95% in wave 5 and after.

period.[6] I then focus my analysis on 1956 homeowners who did not change their primary residence during the sample period, where I can isolate the impact of house price changes from that of changing housing assets.[7] In addition, the consumption response to house price changes can depend on the whether households up-size or down-size their housing. For example, an up-sizing household might need to save more when house prices rise before they up-size, while a down-sizing household can increase consumption when house prices rise as they have more housing assets than their future demand. As I cannot fully control the various motives of movement, I opt to focus on the cleaner sample of non-moving homeowners.

I further classify the non-moving homeowners into three age groups. I define homeowners as young if the head of a household is younger than or equal to 40 in 2005, and as old if the head is older than 60, with the rest defined as middle-aged. The age of 40 is a common cut-off point in the literature (Campbell and Cocco, 2007; Gan, 2010) and enables me to compare the results with previous studies. Gourinchas and Parker (2002) also show that households tend to behave as buffer-stock savers before 40. Sixty is about the retirement age for household heads in the sample and is therefore applied[8].

[6]These are 3810 households. I omit households who have changed homeownership status more than once during the sample period as I believe that frequent housing transactions could add noise to the estimation. I also exclude a small portion of households who are neither owners or renters, including those living without paying rent and those in a rent-and-buy agreement.

[7]The alternative of including those who moved may introduce bias as the up-sizing and downsizing is an endogenous decision of changing the house assets. This goes against the main purpose of the paper of identifying how exogenous changes in housing wealth affect household consumption decision.

[8]Among those who are aged 60 or above, 84.7% of the individual year observations have employment status as retired and only 4.5% of the individual-year observations worked more than 35 hours

2.3.2 Variables Used

2.3.2.1 Measures of Consumption

HILDA collects household spending on a wide range of non-durable consumption items, which enables us to examine how house price changes affect different types of consumption.[9] I classify these non-durable consumption into discretionary and non-discretionary consumption: the former include all but the three non-discretionary items: groceries, public transport, and utilities (electricity, gas, and other heating fuel)[10]. In Table 2.1, I provide the level and growth rates of the non-durable consumption as well as of the two sub-categories. All consumption measures are deflated to the price level as of June 2005 using the Australia consumer price index (CPI). On average, the non-moving homeowners spend AU$28,706 per year, of which about 60% is for discretionary consumption. The average non-durable consumption growth rate for all homeowners is low at 0.2% per year, but discretionary consumption grow at 2% per annum. Across the life cycle, young and middle-aged homeowners spend

a week. Excluding those full-time working observations do not change the main results in unreported robustness tests

[9]These include spending on groceries, public transport, utilities (electricity, gas, and other heating fuel), alcohol, cigar, meals eaten outside home, clothing, education, motor vehicle fuel, telephone and Internet, health care, child care, private health insurance, other insurance (home, contents, and motor vehicle), and vehicle repair.

[10]Our criteria here is to classify only those absolute necessities as non-discretionary consumption, including groceries, transport and utilities. It can always be argued that some types of expenditures are necessities for certain types of families, such as childcare costs for those with young children. The mitigating factor here is using the measure of all non-durable consumption expenditure lead to consistent results for all the tests as shown in Table 2.7.

more than older homeowners, and the young have the highest consumption growth rate among the age groups.

The main analysis focuses on the discretionary non-durable consumption as by definition, these spending should be more elastic (Gan, 2010). In Table 2.7, I show the main results using the non-durable and non-discretionary consumption measures. Following Campbell and Cocco (2007) and Gan (2010), I do not consider spending on durable goods, as I cannot measure the consumption flows provided by these goods.[11] In Figure 2.1, the plot of both the non-durable consumption (# line) and the discretionary non-durable consumption (Δ line) display hump-shaped life-cycle patterns in the sample and the two consumption measures follow each other closely.

[11] Another reason of not studying durable consumption is HILDA only collects durable consumption between 2005 and 2010. In unreported analysis, I find insignificant response of durable consumption to house price changes. Results are available upon request.

TABLE 2.1: Summary statistics of main variables across homeownership groups

This table presents the summary statistics of the main variables for all non-moving homeowners and across age groups. Non-durable consumption is the sum of spending on non-durable consumption items collected in HILDA (including groceries, public transport, utilities (electricity, gas, and other heating fuel), alcohol, cigar, meals eaten outside home, clothing, education, motor vehicle fuel, telephone and Internet, health care, child care, private health insurance, other insurance (home, contents, and motor vehicle), and vehicle repair). The non-discretionary consumption is the sum of spending on groceries, public transport and utilities, and spending on other items is classified as discretionary non-durable consumption. Total income is annual household disposable income. Mortgage payments are the annual payments for all properties owned by the household. All dollar values are deflated using CPI to 2005 price level. Growth is measured as the first-difference in the logged variables. Head age is the age of the household head in 2005. Household head is the person with the highest regular income in 2005. Household size is the number of household members enumerated each year, including children. Initial liquid assets are the sum of bank savings, and bond and share investments in 2006. Initial net worth is the sum of household total assets minus their debt in 2006. Initial mortgage coverage is the ratio of household annual disposable income over mortgage payments in 2006.The initial LTV (loan to value) ratio is the ratio of mortgage over the property value in 2006. *D.Likely to move* is a dummy variable equal to 1 if a household ever intended to move (This dummy is constructed based on the survey question of how likely a household will move in the next 12 months, with an answer of scale of 1 to 5, where 1 = very unlikely to move, 3 = neutral and 5 = very likely to move. *D.Likely to move* $=$ 1 if a household answer the question with 4 or 5 in any year of the sample.). Wage is wage and salary of the household head and wage volatility is measured as the standard deviation of the growth in wage. House prices are the Residential Property Price Indexes of states and territories in Australia provided by Australian Bureau of Statistics. Local unemployment is the unemployment rate of a household's local area. The age groups thresholds are 40 and 60 years old.

	All			Young ($\leq$40)			Middle-aged (40-60)			Old($>$ 40)		
	Mean	Std	Median	Mean	Std	Median	Mean	Std	Median	Mean	Std	Median
Non-durable consumption growth	0.002	0.321	0.003	0.022	0.289	0.025	-0.003	0.312	-0.002	0.001	0.354	-0.002
Non-durable consumption growth (discretionary)	0.020	0.421	0.019	0.039	0.382	0.040	0.013	0.406	0.013	0.021	0.469	0.016
Non-durable consumption growth (non-discretionary)	-0.019	0.375	-0.018	0.002	0.341	-0.004	-0.025	0.360	-0.022	-0.021	0.420	-0.021
Total income growth	0.013	0.509	0.024	0.027	0.405	0.029	0.014	0.506	0.028	0.004	0.567	0.014
Mortgage payment growth	-0.083	2.547	0.000	0.021	2.602	0.000	-0.147	3.011	0.000	-0.031	1.283	0.000
House price growth	0.021	0.068	0.009	0.022	0.069	0.010	0.020	0.067	0.009	0.021	0.069	0.009
Local unemployment growth	0.089	0.811	-0.100	0.095	0.820	-0.100	0.092	0.799	-0.100	0.079	0.828	-0.100
State gross product growth	-0.001	0.017	-0.004	-0.001	0.017	-0.004	-0.001	0.017	-0.004	-0.001	0.017	-0.004
State income per capita growth	0.020	0.027	0.027	0.020	0.027	0.027	0.019	0.027	0.027	0.020	0.028	0.027
Obs		15648			2752			8296			4600	
Non-durable consumption ($)	28706	17482	25187	35003	18790	31659	31721	17442	28256	19500	12450	17098
Non-durable consumption (discretionary $)	17163	13248	14190	21402	14765	18408	19258	13198	16327	10851	9698	8962
Non-durable consumption (non-discretionary $)	11542	6485	10585	13601	6883	12428	12463	6550	11628	8650	4994	7821
House value ($)	529792	392851	450000	507071	352443	430000	571506	420890	450000	468153	352145	400000
Household size	2.56	1.36	2.00	3.54	1.34	4.00	2.75	1.37	2.00	1.63	0.58	2.00
Obs		17604			3096			9333			5175	
Head age in 2005	53.03	13.52	52.00	34.17	4.89	35.00	49.97	5.68	50.00	69.81	6.16	69.00
Initial liquid assets ($)	115269	320290	21861	60625	278230	7952	100585	301789	19702	174444	364790	47001
Initial net worth ($)	910670	1242486	573100	556426	816916	370000	988358	1238085	674392	982494	1414671	562000
Initial mortgage coverage	18378.41	31060.82	10010.56	8482.05	25770.87	5.04	21376.84	36221.81	9875.46	18891.42	21115.13	13962.67
Initial LTV ratio	0.19	0.28	0.00	0.43	0.31	0.43	0.20	0.28	0.08	0.01	0.07	0.00
Likely to move	0.11	0.32	0.00	0.17	0.37	0.00	0.12	0.32	0.00	0.07	0.25	0.00
Wage volatility	1.44	2.25	0.15	1.42	2.31	0.20	1.69	2.37	0.24	1.00	1.90	0.01
Obs		1956			344			1037			575	

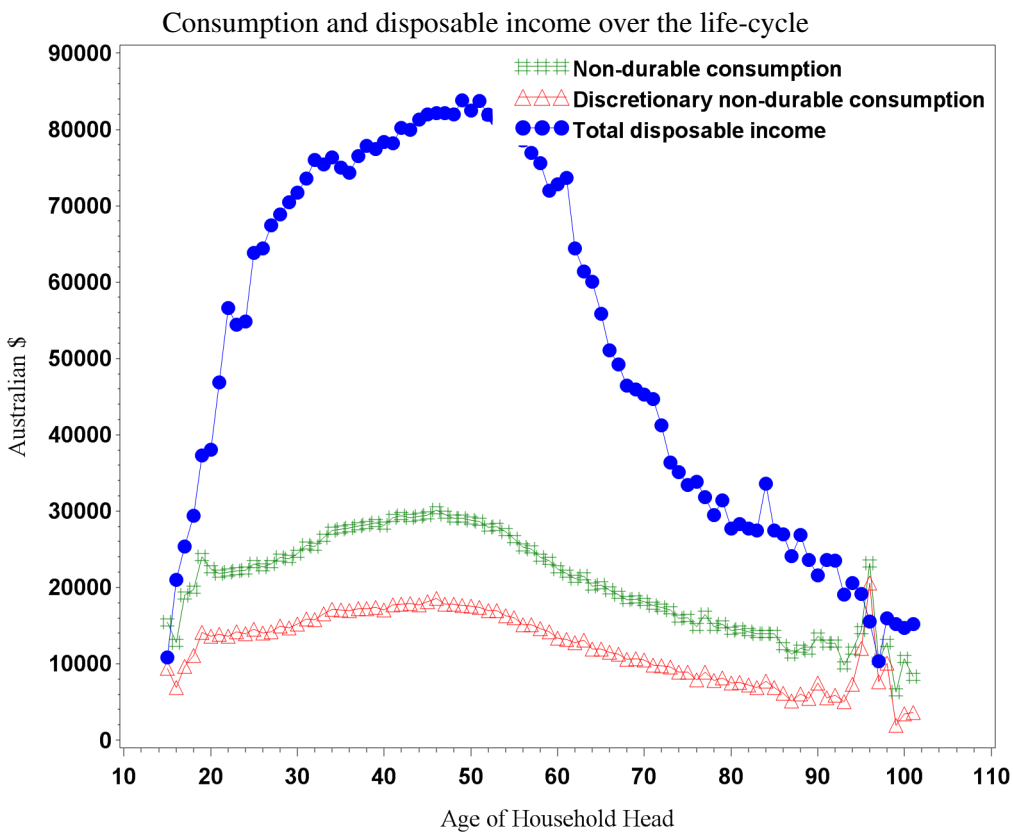

FIGURE 2.1: This figure presents non-durable consumption (# line), discretionary non-durable consumption (Δ line) and total household disposable income (• line) over the life cycle of the households in the sample.

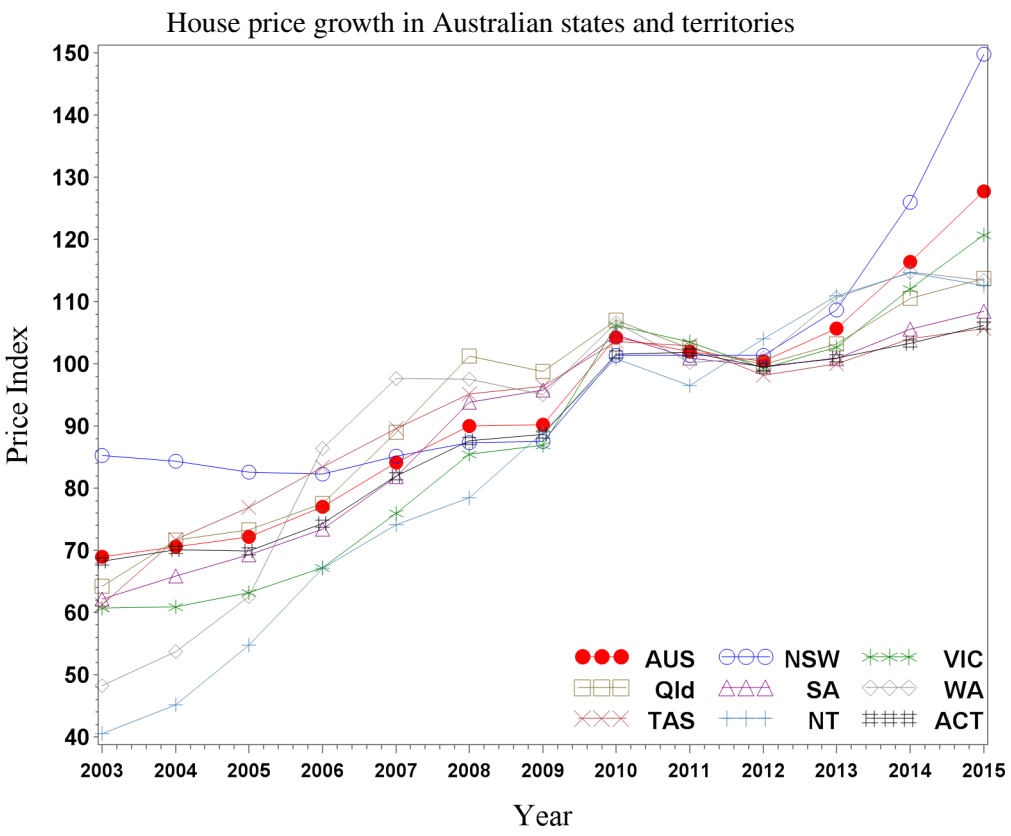

FIGURE 2.2: This figure presents the Residential Property Price Indexes for Australia and its 6 states and 2 territories between 2003 and 2015.

2.3.2.2 House Prices, Income and Other Variables

To measure house prices, I use the Residential Property Price Indexes of the eight capital cities of Australia provided by the Australian Bureau of Statistics (ABS).[12] ABS uses a stratification approach and quarterly sales data to compile these indexes. I similarly deflate house prices using CPI to the 2005 price level. Figure 2.2 plots the house price indexes of the eight states and the weighted average of Australia. Overall, housing markets in Australia have seen strong growth between 2003 and 2015 with some variations across states. Two periods of downturns can be identified: the first one from 2008 to 2009, coinciding with the recent financial crisis, and the second from 2010 to 2012 during the European debt crisis. On average, house prices growth at about 2.1% per annum with a standards deviation of 6.8 % across all states, as shown in Table 2.1[13].

I use the total disposable income in HILDA and deflate it using CPI to the price level in 2005 to measure total household income. Figure 2.1 plots household disposable income (• line) across the life cycle in the sample, where I can also see a hump-shaped pattern with income increasing sharply until middle-age and declining afterwards. Table 2.1 shows that income growth declines with age among homeowners. I also calculate the volatility of wage and salary income growth of the household head, which is used as a proxy of the income volatility faced by a family. The reason

[12] Australia has 6 states and 2 territories, and over 64% of its total population resides within the eight capital cities in 2010 according to ABS population statistics.

[13] The house price growth is calculated at household level to be consistent with other variable reported. The state level house price growths during the sample period are on average 2.7% per annum with a standard deviation of 6.9%.

I use wage and salary income to measure income volatility is that labor income uncertainty is more consistent with the literature of precautionary saving motive (Deaton, 1991; Carroll, 1997). In addition, using the head income excludes the income volatility arising from family structure changes, due to for example marriage and divorce. Lastly, the household head tend to be male and less likely to go on prolonged parental leave, so the measure avoids the income uncertainty due to having children. The average wage volatility is highest for the middle-aged, followed by the young and old homeowners. The high wage volatility of the middle-aged is due to their transitions into retirement and the low wage volatility of the old results from the fact that most of them are retired without wage income.

Every four years (2002, 2006, 2010), HILDA conducts a special wave to collect information on household wealth, such as bank savings, bond and stock investments, and debts. I use the wealth information collected in 2006 (the start of the sample for first-differenced variables) to measure the initial financial positions of a household. The key variables I consider are the level of liquid assets (sum of bank savings and investments in bonds and stocks), total net worth (the value of all assets, including home property and liquid assets, minus debt), the loan to value (LTV) ratio of the home property, and the mortgage coverage ratio (the ratio of disposable income over mortgage payments). Table 2.1 gives the summary statistics of the variables of all homeowners and across the age groups. The middle-aged group has the highest level of liquid assets and net worth, followed by the old and young homeowners. The average LTV ratio decreases with age: 43%, 20% and 1% for the young, middle- and

old-aged homeowners.

One question in HILDA asks households how likely they will move in the next twelve months, and households can choose among five choices, ranging from 1-very unlikely to 5-very likely with 3-neither. I refer to this variable as $Move\ intention_{it}$ and based on it, I construct a dummy variable, $D.Likely\ to\ move$, which is equal to one if a household responds to this question with 4 or 5 during the sample period. The summary statistics in Table 2.1 show that the percentage of households intending to move declines as households age.

2.4 Empirical Analysis

2.4.1 Baseline Results across Homeownership Groups

In this section, I examine whether house price changes affect household consumption decisions. If house prices do not influence household consumption, any correlation between them is likely to be driven by omitted macroeconomic factors, such as future income prospects. To control for the effects of omitted macro factors, I follow the recent literature such as, Campbell and Cocco (2007), Chaney, Sraer, and Thesmar (2012) and Schmalz, Sraer, and Thesmar (2017), and compare homeowners and renters. In this framework, renters in the same region act as a control group as any omitted variables other than those related to the housing should affect homeowners and renters similarly. If housing wealth indeed affects consumption, then I

should expect differential consumption responses to house prices between homeowners and renters. This is because homeowners are "long" in housing assets relative to renters, and higher house prices lead to potential wealth gains and relax borrowing constraints only for homeowners. Renters can be considered "short" in housing and rising house prices typically imply higher future rental liabilities (Sinai and Souleles, 2005). Therefore, the consumption of renters should have an insignificant or even negative response to house price increases.

To test this conjecture, I first examine the sample of homeowners and renters.[14] I estimate Equation 2.2 for different specifications and present the results in columns (1) to (6) of Table 2.2. The standard errors reported in parentheses are clustered by households and the stars indicate levels of significance at conventional levels.[15] In column (1), I find a positive and significant impact of house price changes on consumption growth after controlling for changes in household size, income, rent and mortgage payments, as well as household and year fixed effects. As expected, increases in household size and income both significantly boost household consumption. Also, higher housing costs (rent or mortgage payments) tend to reduce non-housing spending.

As house prices are measured at the state level, they could be correlated with other state-level economic factors. To alleviate the concern that omitted variables drive consumption and house prices to the same direction, column (2) includes measures

[14] The sample includes long-term homeowners, renters and households who change between homeowners and renters once during the sample period.

[15] Significance level at the 1%, 5% and 10% is indicated by ***,**,and *, respectively.

of state level economic growth: the growth in gross state product and income per capita. Following Campbell and Cocco (2007), I also use changes in the local unemployment rate as proxy for local economic conditions. With these control variables, the estimated coefficient on house price changes decreases in magnitude, but remains significant.

In column (3), I compare homeowners and renters by including an interaction term between house price changes and a dummy variable "$D.Renting$" to indicate if a household is renting. Hence the coefficient on $\Delta Log(HP)$ measures the consumption sensitivity of homeowners, and that of the interaction term measures the incremental sensitivity of those who are renting. I find that while homeowners have a large and significant consumption sensitivity of 0.163. Renters sensitivity is -0.188 lower than homeowners; it is close to zero. Although the coefficient of "$D.Renting$" is not statistically significant, the difference between homeowners and renters is large in magnitude, which seems to suggest differential consumption responses between homeowners and renters.

The main concern of comparing homeowners and renters is homeownership is an endogenous choice, which might bias the estimated consumption sensitivity. For example, if high income households tend to become homeowners and have higher consumption sensitivity to house prices, then omitting income will bias the estimates.

Following Chaney et al. (2012) and Schmalz et al. (2017), I attempt to reduce the potential bias by including variables that may lead to homeownership, including household size and income growth.[16] In addition, the household fixed effect controls for time-invariant factors, such as ability, education, risk attitude, gender and ethnicity. I also interact the renting dummy with both other state-level variables and year dummies to ensure observable macro variables do not bias my results. Lastly, as age is an important determinant of homeownership and can influence house-price consumption sensitivity, I explicitly consider age groups in the following tests.

In columns (4) to (6), I extend the comparison between homeowners and renters to three life-cycle stages: young-, middle-, and old-aged. I find although the differences are present among all age groups, it is mainly driven by the significant difference between young homeowners and renters. Note this result is inconsistent with the argument that future income prospects drive the correlation between house prices and consumption (Attanasio et al., 2009; Disney et al., 2010). As the young will benefit the most from future income growth due to productivity growth, this argument predicts both young homeowners and renters should both have positive consumption sensitivity. The significant differential response between homeowners and renters thus provide evidence that house price changes do affect homeowner consumption decisions.

[16] I do not suffer the self-selection bias of homeownership typically present in studies using cohort analysis, where owner and renter groups within a cohort change endogenously over time (Campbell and Cocco, 2007). With the household-level panel data, I can clearly identify and control for homeownership and household fixed effects.

Next, I focus on non-moving homeowners in columns (7) to (10) to isolate the impact of house price changes from that of the adjustment of housing assets. Column (7) shows non-moving homeowners have a positive and significant consumption sensitivity to house prices, controlling for all the variables I mentioned before. In columns (8) to (10), I split the homeowners into three age groups. I find both young and old homeowners have large and positive consumption sensitivity to house prices, and the middle-aged have an insignificant response.

The life-cycle pattern found in this paper provides new evidence to the debate in the literature. Gan (2010) and Browning et al. (2013) find that house-price consumption sensitivity is positive and significant for the young but not for the old. Note these studies exclude most individuals older than 60 and classify the sample into the young and old groups, with a cut-off age at 40.[17] This means their "old" households correspond to my middle-aged sample. Therefore, my finding that the middle-aged exhibit insignificant consumption sensitivity is consistent with earlier evidence (named "old" households in these studies). However, I also show that homeowners aged 60 and above, which I define as old, have significant house-price consumption sensitivity. This is consistent with a stronger wealth effect for old homeowners in models such as Li and Yao (2007).

Attanasio et al. (2009) categorize their sample similarly into 3 age groups in their cohort analysis using the UK Family Expenditure Survey, and find the magnitude and significance of the sensitivity decrease with age. They conclude that common

[17] Individuals older than 50 and especially 60 are under-represented in the credit card data of Gan (2010) and households with a spouse older than 55 are excluded from Browning et al. (2013).

causality (such as future income prospects) dominate the wealth effect and the collateral channel in driving house-price consumption sensitivity. In contrast to their age cohort analysis where the the composition of homeowners and renters can vary endogenously over time, I carefully control for the homeownership status of the same households.The renter versus homeowner analysis suggests a U-shaped pattern for sensitivities: they are high for young and old, and low for middle-aged homeowners.

This is consistent with the US state level analysis in Calomiris et al. (2013), where the authors find that states with a higher percentage of young and old households experienced the largest housing wealth effect. Next, I use the rich dataset to examine differences across households in the same life-cycle stage using variables that are not available at the zip-code- or state-level.

TABLE 2.2: Baseline results across homeownership groups and the life cycle

This table presents the estimates of consumption sensitivity to house prices across homeownership and life-cycle groups. In columns (1) to (6), the sample include homeowners, renters and those who change between owner and renter once during the sample period, and in columns (7) to (10), the sample includes non-moving homeowners. The dependent variable is discretionary non-durable consumption growth $\Delta Log(C)_t$. $\Delta Log(HP)_t$ is the growth in state house prices. $D.Renting_t$ is a dummy variable equal to 1 if a household is renting in a particular year. $\Delta Log(Income)_t$ is the growth in household disposable income. $\Delta Log(Household\ size)_t$ is the change in number of household members, including children. $\Delta Log(Rent)_t$ is the growth in rent payments, and $\Delta Log(Mortgage\ payment)_t$ is growth in mortgage payments. $\Delta Unemployment_t$ is the change in the local unemployment rate. $\Delta Log(Gross\ state\ product_t)$ is growth in gross state product. $\Delta Log(State\ income)_t$ is the growth in state income per capita. All growth variables are measured in logged differences. I control for household and year fixed effects and report standard errors clustered by households in parentheses. Significance levels at 1%, 5% and 10% are indicated by ***,**,and *, respectively.

	Homeowners and renters						Homeowners			
	All			Young	Middle	Old	All	Young	Middle	Old
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\Delta Log(HP)_t$	0.125**	0.111*	0.163**	0.327**	0.044	0.210	0.131*	0.509***	-0.073	0.241*
	(0.052)	(0.059)	(0.064)	(0.135)	(0.084)	(0.133)	(0.075)	(0.189)	(0.094)	(0.146)
$\Delta Log(HP)_t * D.Renting_t$			-0.188	-0.465*	-0.001	-0.116				
			(0.161)	(0.255)	(0.235)	(0.481)				
$Renting_t$			0.092***	0.087**	0.069	0.037				
			(0.028)	(0.038)	(0.049)	(0.130)				
$\Delta Log(Income)_t$	0.030***	0.030***	0.030***	0.026*	0.034***	0.025*	0.023***	-0.026	0.025**	0.033**
	(0.006)	(0.006)	(0.006)	(0.014)	(0.008)	(0.013)	(0.008)	(0.022)	(0.011)	(0.016)
$\Delta Log(Household\ size)_t$	0.189***	0.189***	0.189***	0.212***	0.156***	0.192***	0.174***	0.230***	0.176***	0.119*
	(0.018)	(0.018)	(0.018)	(0.026)	(0.026)	(0.063)	(0.030)	(0.063)	(0.039)	(0.072)
$\Delta Log(Rent)_t$	-0.009	-0.009	-0.010	-0.010	0.024	-0.147**				
	(0.022)	(0.022)	(0.022)	(0.027)	(0.042)	(0.074)				
$\Delta Log(Mortgage\ payment)_t$	-0.001	-0.001	-0.001	-0.002	-0.001	-0.007	-0.002	-0.005**	-0.002	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.005)	(0.001)	(0.003)	(0.002)	(0.006)
$\Delta Unemployment_t$		-0.001	-0.004	-0.003	-0.002	-0.012	-0.005	-0.005	0.000	-0.014
		(0.005)	(0.005)	(0.009)	(0.007)	(0.012)	(0.007)	(0.014)	(0.009)	(0.013)
$\Delta Log(Gross\ state\ product_t)$		0.219	0.222	-0.138	0.848	-0.570	0.458	-1.648	1.529**	-0.121
		(0.374)	(0.399)	(0.709)	(0.576)	(0.897)	(0.496)	(1.056)	(0.671)	(0.998)
$\Delta Log(State\ income)_t$		-0.086	-0.154	-0.184	-0.401	0.477	-0.193	0.291	-0.292	-0.183
		(0.245)	(0.265)	(0.457)	(0.376)	(0.624)	(0.327)	(0.654)	(0.443)	(0.673)
$\Delta Unemployment_t * Renting_t$			0.014	-0.000	0.007	0.087**				
			(0.012)	(0.017)	(0.019)	(0.038)				
$\Delta Log(Gross\ state\ product_t) * Renting_t$			-0.138	0.413	-1.554	2.310				
			(0.936)	(1.323)	(1.603)	(2.666)				
$\Delta Log(State\ income)_t * Renting_t$			0.241	0.513	-0.086	0.410				
			(0.641)	(0.842)	(1.138)	(1.985)				
Household fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	30480	30480	30480	10152	13656	6672	15648	2752	8296	4600
Adjusted R-squared	0.033	0.032	0.033	0.047	0.032	0.023	0.024	0.040	0.029	0.017

2.4.2 Old Homeowners and the Wealth Effect

In this subsection, I examine consumption sensitivity differences across heterogeneous old homeowners. As discussed in section 2.4, I expect that the larger the housing wealth share (ratio of home equity to total net worth), the larger a household's house price consumption sensitivity. Homeowners with a higher fraction of wealth tied in housing will experience a larger wealth change for the same house price change. If liquid savings are available, these homeowners consume from this increased wealth. In the main tests, I exclude old homeowners who have insufficient liquid savings as they unable to increase consumption in response to house price increases unless they borrow or refinance. I define old homeowners with liquid assets higher than the 25th percentile of beginning-of-sample liquid assets as "unconstrained old homeowners".[18]

In column (1) of Table 2.3, I estimate the consumption sensitivity for old homeowners who have high and low housing wealth shares (indicated by the dummy variable $D.High\ housing\ wealth\ share$). Here I find that those with lower shares tend to have a larger sensitivity, although the coefficients for both groups are insignificant. However, this result does not control for heterogeneity in liquid assets. Among unconstrained old homeowners, I indeed find that those with a high housing wealth share have a

[18]Here I only focus on liquid asset as I believe liquidity constraints are the most relevant factor for old homeowners in this situation. I do not consider mortgage related variables because most old homeowners do not have mortgages. Net worth contains home equity and is substantially correlated with housing wealth share.

larger and more significant consumption sensitivity than those with a smaller share. This finding is consistent with the housing wealth effect and supports Hypothesis 1.

An opposing force to the wealth effect among old homeowners is their bequest motive (Chiuri and Jappelli, 2010). Because such motives can be likened to a longer consumption time frame (tenure) that extends to the next generation, the wealth effect for homeowners with bequest motives can be less significant. To examine the extent such bequest motive influences the wealth effect, I test the impact of the expected tenure of a household. In other words, I test whether the housing wealth effect is still present if a household does not want to downsize and tap into their home equity. Following Sinai and Souleles (2005), I proximate a homeowners' expected tenure with a measure of households' moving probability reported in the survey. I define the dummy variable $D.Likely\ to\ move = 1$ if a household said they were likely to move during the sample period and in columns (4) to (6), I focus on households who are not likely to move during the sample period. Consistent with the wealth effect, among those who are not liquidity constrained, the highest consumption sensitivity is still associated with high housing wealth share. This means even when old homeowners do not want to adjust their housing assets, the wealth effect can still be significant for unconstrained households.

To sum up, the analysis suggests that the unconstrained old homeowners with high housing wealth share are the biggest contributor to this age group's house price consumption sensitivity.

TABLE 2.3: Old homeowners and the wealth effect

This table presents the estimates of consumption sensitivity to house prices for old homeowners. The dependent variable is discretionary non-durable consumption growth $\Delta Log(C)_t$. $\Delta Log(HP)_t$ is the growth in state house prices. *D.High housing wealth share* is a dummy variable equal to 1 if the housing wealth share of a old homeowner is above the median value of the group. Housing wealth share is the ratio of home equity over net worth. Home equity is the value of property minus any outstanding mortgage in 2006. Net worth is the sum of household total assets minus their debt in 2006. *D.Likely to move* is a dummy variable equal to 1 if a household ever intended to move (This dummy is constructed based on the survey question of how likely a household will move in the next 12 months, with an answer of scale of 1 to 5, where 1 = very unlikely to move, 3 = neutral and 5 = very likely to move. $D.Likely\ to\ move = 1$ if a household answer the question with 4 or 5 in any year of the sample.). Other control variables include household total income, size, mortgage payments, local unemployment, state gross products and income per capita but are not reported. I control for household and year fixed effects and report standard errors clustered by households in parentheses. Significance levels at 1%, 5% and 10% are indicated by ***,**,and *, respectively.

	All			*D.Likely to move* = 0		
	All	Liquid constrained		All	Liquid constrained	
		No	Yes		No	Yes
	(1)	(2)	(3)	(4)	(5)	(6)
$Log(HP)_t * D.High\ housing\ wealth\ share = 0$	0.304	0.260	0.066	0.253	0.197	0.074
	(0.186)	(0.205)	(0.469)	(0.192)	(0.212)	(0.467)
$Log(HP)_t * D.High\ housing\ wealth\ share = 1$	0.182	0.644**	-0.436	0.181	0.700**	-0.397
	(0.228)	(0.291)	(0.351)	(0.244)	(0.322)	(0.362)
Household level controls	Yes	Yes	Yes	Yes	Yes	Yes
State level controls	Yes	Yes	Yes	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4600	3456	1144	4280	3216	1064
Adjusted R-squared	0.017	0.022	0.005	0.015	0.021	0.004

2.4.3 Young Homeowners, Borrowing Constraints, and Precautionary Savings

In this subsection, I explore heterogeneity among young homeowners. On the one hand, their large sensitivity is unlikely to be driven by the wealth effect, as young homeowners tend to be "short" in housing. If they want to up-size their houses, then rising house prices can increase their future housing costs, leading to a negative wealth effect. On the other hand, the young are more likely to experience low income realizations compared to middle- and old-aged households. Young renters need to save more to insure against such "hard times". In contrast, young homeowners can reduce their precautionary savings and increase consumption when house prices rise as home equity can be used as collateral for borrowing in "hard times". This suggests that young homeowners' house price-consumption sensitivity is positively impacted by the precautionary savings role of housing collateral. Further, young homeowners with high income volatility are the ones more likely to use housing in this manner. Therefore, I expect young homeowners with high income volatility to have larger sensitivity.

To test the role of income volatility, I equally split young homeowners into those with low and high income growth volatility, indicated by the dummy variable $D.High\ Inc\ Vol$. I interact this dummy variable with house price changes, other state level variables and year dummies. I present the estimated coefficients for these two groups of households separately in Tables 2.4 and 2.5.

For the full sample of young homeowners (column (1) of Table 2.4), I find that those with high income volatility have larger and more significant consumption sensitivity to house prices than those with low income volatility. In columns (2) to (10) of Table 2.4, I split the young homeowner sample into various subgroups based on credit constraint measures (net worth, liquid assets, loan-to-value ratio, and mortgage coverage). Repeating the test for the impact of income volatility using the dummy variable $D.High\ Inc\ Vol$, I consistently find that those with high income volatility have larger and more significant consumption sensitivities to house prices than those with low income volatility. In fact, among households with low income volatility, none of the other sub-groups classified based on measures of credit constraints have significant consumption sensitivity. This finding is consistent with a precautionary saving motive that drives the housing consumption sensitivity of young homeowners. In particular, column (5) shows young homeowners with medium level of liquid savings and high income volatilities have the highest housing-price consumption sensitivity. This result is consistent with Hypothesis 2.

TABLE 2.4: Young homeowner and the precautionary saving motive

This table presents the estimates of consumption sensitivity to house prices of young homeowners with different levels of income volatility. The dependent variable is discretionary non-durable consumption growth $\Delta Log(C)_t$. $\Delta Log(HP)_t$ is the growth in state house prices. *D.High Inc Vol* is dummy variable equal to 1 if the income volatility (the standard deviation of wage and salary growth) of a young homeowner is above the median value. Net worth is the sum of household total assets minus their debt in 2006. Liquid assets are the sum of bank savings, and bond and share investments in 2006. LTV (loan to value) ratio is the ratio of mortgage over the property value in 2006. Mortgage coverage is the ratio of household annual disposable income over mortgage payments in 2006. Other control variables include household total income, size, mortgage payments, local unemployment, state gross products and income per capita but are not reported. The sample splits between high and low is based on the median values of net worth, LTV ratio and mortgage coverage. The three subsamples classified by liquid assets are based on the tercile value of liquid assets. I control for household and year fixed effects and report standard errors clustered by households in parentheses. Significance levels at 1%, 5% and 10% are indicated by ***,**,and *, respectively.

	All	Net worth		Liquid assets			LTV ratio		Mortgage coverage		Income volatility	
		High	Low	High	Medium	Low	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\Delta Log(HP)_t * D.High\ Inc\ Vol = 0$	0.182	-0.231	0.448	-0.235	0.230	0.328	0.150	0.194	-0.011	0.384		
	(0.228)	(0.239)	(0.334)	(0.379)	(0.225)	(0.379)	(0.259)	(0.369)	(0.269)	(0.315)		
$\Delta Log(HP)_t * D.High\ Inc\ Vol = 1$	0.952***	0.689*	1.416***	0.435	1.798***	0.980**	1.400***	0.697*	0.749	1.166***		
	(0.308)	(0.385)	(0.502)	(0.488)	(0.556)	(0.412)	(0.417)	(0.409)	(0.503)	(0.379)		
$\Delta Log(HP) * D.Renting = 0$											0.762**	0.310
											(0.302)	(0.238)
$\Delta Log(HP) * D.Renting = 1$											-0.025	-0.443
											(0.317)	(0.349)
Household level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2752	1368	1384	912	920	1376	1384	1368	1376	1376	3240	2200
Adjusted R-squared	0.042	0.049	0.033	0.061	0.055	0.042	0.035	0.050	0.054	0.032	0.051	0.045

Do households with high income volatility have greater income exposure to some macroeconomic variables that I have not controlled for? If yes, my results could be driven by an omitted macroeconomic variables that also drives house price growth. If omitted variables such as income prospects drive my result, I should find that high income volatility renters also respond strongly to house price changes. In column (11), I test this conjecture by comparing high income volatility homeowners' with high income volatility renters (using the same cutoff for defining high income volatility). I find that these renters have a negative and insignificant sensitivity. This evidence is inconsistent with the omitted variable argument and provides further support to the precautionary savings nature of home equity.

Next I ask: can ignoring income volatility lead to misleading inferences about house price-consumption sensitivity? To examine this, I omit the income volatility dummy and split young homeowners into subsamples based on various measures of borrowing constraints. I evaluate the sensitivity of these subsamples in Table 2.5. Ignoring income volatility, I find that credit constraints measured by the LTV ratio, the mortgage coverage ratio, or net worth are important for all households. These findings mask the results in Table 2.4 where all these credit constraint measures are insignificant for young households with low income volatility. Therefore, omitting controls for income volatility can lead to misleading inferences such as credit constraint measures matter for the house price-consumption sensitivity of all households.

The evidence in this subsection enhances the indirect findings of Gan (2010) and

Agarwal and Qian (2017) who base their inferences on precautionary savings motive proxies such as bank account balance. My contribution here is to provide the first direct evidence on the precautionary saving nature of housing assets by examining a fundamental driver of the precautionary saving motive: income volatility. The analysis suggests that identifying income volatility of households is of first-order importance in understanding their house price-consumption sensitivity.

TABLE 2.5: What if income volatility of young homeowners is ignored?

This table presents estimates of consumption sensitivity to house prices across subsamples of young homeowners. The dependent variable is discretionary non-durable consumption growth $\Delta Log(C)_t$. $\Delta Log(HP)_t$ is the growth in state house prices. Net worth is the sum of household total assets minus their debt in 2006. Liquid assets are the sum of bank savings, and bond and share investments in 2006. LTV (loan to value) ratio is the ratio of mortgage over the property value in 2006. Mortgage coverage is the ratio of household annual disposable income over mortgage payments in 2006. The sample splits between high and low is based on the median values of net worth, LTV ratio and mortgage coverage. The three subsamples classified by liquid assets are based on the tercile values of liquid assets. Other control variables include household total income, size, mortgage payments, local unemployment, state gross products and income per capita but are not reported. I control for household and year fixed effects and report standard errors clustered by households in parentheses. Significance levels at 1%, 5% and 10% are indicated by ***,**,and *, respectively.

	Net worth		Liquid assets			LTV ratio		Mortgage coverage	
	High (1)	Low (2)	High (3)	Medium (4)	Low (5)	High (6)	Low (7)	High (8)	Low (9)
$\Delta Log(HP)_t$	0.296	0.749***	0.279	0.745***	0.436	0.586**	0.426	0.353	0.641**
	(0.254)	(0.284)	(0.369)	(0.253)	(0.353)	(0.250)	(0.275)	(0.297)	(0.254)
Household level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1368	1384	912	920	920	1384	1368	1376	1376
Adjusted R-squared	0.049	0.032	0.060	0.045	0.027	0.031	0.050	0.052	0.029

2.4.4 The Middle-aged Homeowners

In this section, I further examine the house price consumption sensitivity of the middle-aged homeowners. According to Li and Yao (2007), the consumption of the middle-aged homeowners should have the least sensitivity to house prices. This is because, on the one hand, the middle-aged homeowners enjoy less wealth effect compared to the old homeowners as they still have relatively long remaining life horizons. On the other hand, the collateral channel is less important for the middle-aged than for the young, as the middle-aged tend to have accumulated enough wealth to overcome borrowing constraints. The baseline result of the middle-aged homeowners is consistent with this prediction.

I examine whether there are any heterogeneities within the middle-aged group in Table 2.6. I split the sample according to the level of liquid assets (columns (1) and (2)) and net worth (columns (3) and (4)), and find only the group with low liquid assets have negative and significant consumption sensitivity to house prices. One explanation of this negative sensitivity could be that some of these middle-aged households need to up-size their houses for exogenous reasons, such as growing family. As they have limited savings, they have to cut consumption when house prices increase to save for buying a more expensive house. To test this argument, I interact house price changes with the dummy variable *D.Likely to move* in columns (5) and (6). Consistent with my conjecture, only homeowners with low levels of liquid assets and have considered to move have a significant negative incremental consumption sensitivity. To sum up, the negative consumption sensitivity of the middle-aged group is mainly

driven by those who are liquidity constrained (low levels of liquid assets) and have an up-sizing motive [19].

[19] Note, some young homeowners could also have up-sizing motive. I tested the difference in house price consumption sensitivity between young homeowners who are likely and unlikely to motive but find not significant difference between the two groups. In fact, those who are likely to move seem to have higher sensitivity, perhaps because the credit constraints or precautionary savings motive dominate the up-sizing motive among this group.

TABLE 2.6: The middle-aged homeowners

This table presents estimates of consumption sensitivity to house prices of subsamples of the middle-aged homeowners. The dependent variable is discretionary non-durable consumption growth $\Delta Log(C)_t$. $\Delta Log(HP)_t$ is the growth in state house prices. Net worth is the sum of household total assets minus their debt in 2006. Liquid assets are the sum of bank savings, and bond and share investments in 2006. The sample splits between high and low is based on the median values of net worth and liquid assets. *D.Likely to move* is a dummy variable equal to 1 if a household ever intended to move (This dummy is constructed based on the survey question of how likely a household will move in the next 12 months, with an answer of scale of 1 to 5, where 1 = very unlikely to move, 3 = neutral and 5 = very likely to move. $D.Likely\ to\ move\ =\ 1$ if a household answer the question with 4 or 5 in any year of the sample.). Other control variables include household total income, size, mortgage payments, local unemployment, state gross products and income per capita but are not reported. I control for household and year fixed effects and report standard errors clustered by households in parentheses. Significance levels at 1%, 5% and 10% are indicated by ***,**,and *, respectively.

	Liquid assets		Net worth		Liquid assets		Net worth	
	High (1)	Low (2)	Hig (3)	Low (4)	High (5)	Low (6)	High (7)	Low (8)
$\Delta Log(HP)_t$	0.087	-0.214*	-0.100	-0.044	-0.005	-0.131	-0.146	0.014
	(0.140)	(0.126)	(0.127)	(0.140)	(0.136)	(0.133)	(0.127)	(0.144)
$\Delta Log(HP)_t * D.Likely\ to\ move\ =\ 1$					0.888	-0.866*	0.422	-0.505
					(0.592)	(0.473)	(0.577)	(0.566)
Household level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4152	4144	4152	4144	4152	4144	4152	4144
Adjusted R-squared	0.025	0.032	0.028	0.028	0.024	0.033	0.027	0.031

2.4.5 Alternative Measures of Consumption

In the previous sections, I find that there are significant heterogeneities in the house-price consumption sensitivity both across and within age groups. In particular, I find that young homeowners with high income volatility and unconstrained old homeowners with high housing wealth share are the biggest contributors to the house-price consumption sensitivity. In these analysis, I have focused on discretionary non-durable consumption, as I expect this spending is more sensitive to wealth changes than non-discretionary spending.

In this section, I examine these results using alternative consumption measures. I present the results using the non-durable consumption in Panel (a) and the non-discretionary non-durable consumption (groceries, utilities and public transport) in Panel (b) of Table 2.7.

I find in Panel (b) of Table 2.7 the non-discretionary consumption sensitivities to house prices are not statistically significant for all homeowners (column (1)) or for the three age groups (columns (2),(4) and (6)). The lower sensitivity of non-discretionary consumption lead to lower non-durable consumption sensitivities in Panel (a) of Table 2.7 compared to the results of using only discretionary consumption in the previous sections.

Next, I focus on the two main contributors of the overall consumption sensitivity, namely young homeowners with high income volatility (column (3)) and unconstrained old homeowners with high housing wealth share (column (5)). Consistent

with results in previous subsections, I find even for non-discretionary spending, these two subgroups still have significant and highest house-price consumption sensitivities. This evidence reinforces my conclusion that these two groups are the driving force of the overall house-price consumption sensitivity.

TABLE 2.7: Alternative measures of consumption

This table presents the consumption sensitivity to house prices using alternative measures of consumption for all homeowners and across the age groups. The dependent variable in Panel (a) is the non-durable consumption growth and in Panel (b) is the non-discretionary non-durable consumption growth. $\Delta Log(HP)_t$ is the growth in state house prices. *D.High Inc Vol* is dummy variable equal to 1 if the income volatility (the standard deviation of wage and salary growth) of a young homeowner is above the median value. *D.High housing wealth share* is a dummy variable equal to 1 if the housing wealth share of a old homeowner is above the median value of the group. Housing wealth share is the ratio of home equity over net worth. Home equity is the value of property minus any outstanding mortgage in 2006. Net worth is the sum of household total assets minus their debt in 2006. The age groups thresholds are 40 and 60 years old. Other control variables include household total income, size, mortgage payments, local unemployment, state gross products and income per capita but are not reported. I control for household and year fixed effects and report standard errors clustered by households in parentheses. Significance levels at 1%, 5% and 10% are indicated by ***,**,and *, respectively.

(a) Non-durable consumption

	Homeowner	Young		Old		Middle-aged
				All	Unconstrained	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta Log(HP)_t$	0.074	0.333**		0.121		-0.043
	(0.058)	(0.135)		(0.109)		(0.077)
$\Delta Log(HP)_t * D.High\ Inc\ Vol\ =\ 0$			0.057			
			(0.148)			
$\Delta Log(HP)_t * D.High\ Inc\ Vol\ =\ 1$			0.720***			
			(0.226)			
$Log(HP)_t * D.High\ housing\ wealth\ share\ =\ 0$					0.129	
					(0.162)	
$Log(HP)_t * D.High\ housing\ wealth\ share\ =\ 1$					0.416*	
					(0.215)	
Adjusted R-squared	0.013	0.017	0.021	0.008	0.007	0.020

(b) Non-discretionary non-durable consumption						
	Homeowner	Young		Old		Middle-aged
				All	Unconstrained	
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta Log(HP)_t$	0.009	0.090		-0.002		-0.004
	(0.069)	(0.140)		(0.141)		(0.091)
$\Delta Log(HP)_t * D.High\ Inc\ Vol\ =\ 0$			-0.092			
			(0.177)			
$\Delta Log(HP)_t * D.High\ Inc\ Vol\ =\ 1$			0.358*			
			(0.213)			
$Log(HP)_t * D.High\ housing\ wealth\ share\ =\ 0$					-0.084	
					(0.207)	
$Log(HP)_t * D.High\ housing\ wealth\ share\ =\ 1$					0.361*	
					(0.217)	
Household level controls	Yes	Yes	Yes	Yes	Yes	Yes
State level controls	Yes	Yes	Yes	Yes	Yes	Yes
Household fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	15648	2752	2752	4600	3448	8296
Adjusted R-squared	0.013	0.017	0.023	0.008	0.016	0.020

2.4.6 The Marginal Propensity to Consume (MPC) out of Housing Wealth

An important measure to understand the actual impact of house price changes is the marginal propensity to consume (MPC) out of housing wealth. This measure is obtained by multiplying the house price consumption sensitivity with the ratio of consumption to house value. It tells us how much households actually spend or save out of a $1 increase in housing wealth. Previous micro research report MPC of average households (Disney et al., 2010; Gan, 2010; Browning et al., 2013). Such estimates do not reveal the heterogeneity across households and across consumption items. Taking advantage of the detailed consumption record, I shed some light on this heterogeneity.

In Table 2.8, I present the MPC out of housing wealth using the three consumption measures for all homeowners and for various subgroups. Two salient features are present in Table 2.8.

First, there is significant heterogeneity in the MPC out of housing both across and within the age groups. For all non-durable consumption, the average homeowner has an MPC of $0.41 per $100 change in housing wealth, which consists of a large MPC of $2.45 of young homeowners, $0.52 for the old homeowners, and a negative MPC (a marginal propensity to save) of $0.27 for the middle-aged. Within young homeowners, those with high income volatility have an even larger MPC of $5.15 per $100, while those with low income volatility have an MPC of only $0.45 per $100. Similarly, the MPC of unconstrained old homeowners is higher for those with high

housing wealth share ($1.66 per $100) compared to those with low housing wealth share ($0.61 per $100).

Second, most of the MPC out of housing wealth comes from the discretionary consumption. This is largely due to the higher house-price consumption sensitivity for discretionary spending items. To provide more insight, we decompose the MPC across expenditure items, and present those items with positive MPCs in pie charts in Figure 2.3 to 2.5. As shown in Figure 2.3, most of the homeowners' spending out of increased housing wealth goes to meal eaten outside home, groceries, phones, Internet, and motor fuel. The spending patterns of different age groups also vary significantly, as shown in Figure 2.4 and 2.5. Noticeably, while the young with high income volatility spend most of their increased housing wealth on meals eaten out, groceries, clothing and alcohol, the unconstrained old homeowners with high housing wealth share tend to spend on groceries, phones, Internet, motor fuel and repair.

Note, in Figure 2.3 to 2.5, I only plot the items with positive MPCs. There are some items that have negative consumption sensitivity to house prices, leading to negative MPCs. One item that has the most significant negative consumption sensitivity is the private health insurance expenditure. I interpret this as evidence of the precautionary savings nature of home equity where the increased home equity serves a form of self-insurance and homeowners reduce their private health insurance demand. A closer examination of substitutability between health insurance and home equity is left for future research.

TABLE 2.8: MPC across consumption types and subsample

This table presents the calculation of marginal propensity to consume (MPC) out of housing wealth using different measures of consumption for all homeowners, across homeowner age groups and two subsamples of homeowners. Median consumption are the relevant median values for the particular consumption measure and subsample. House value is the self-assessed house value by households. Consumption sensitivities are the estimated consumption sensitivities to house prices for particular consumption measures and subsamples obtained from Section 4.1 to 4.5.

	All	Young	Middle	Old	Young		Unconstrained Old	
					Income volatility		Housing wealth share	
					High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Non-durable								
Median Consumption (C $)	25186.5	31658.5	28256	17098	33598	31793	16002	20114
Median house value (H $)	450000	430000	450000	400000	470000	400000	400000	425000
C/H	0.056	0.074	0.063	0.043	0.071	0.079	0.040	0.047
Coefficients	0.074	0.333	-0.043	0.121	0.720	0.057	0.416	0.129
MPC (of $100)	0.41	2.45	-0.27	0.52	5.15	0.45	1.66	0.61
Discretionary non-durable								
Median Consumption (C $)	14189.5	18407.5	16327	8962	20406.5	18283.5	8242	11324
Median house value (H $)	450000	430000	450000	400000	470000	400000	400000	425000
C/H	0.0315	0.0428	0.0363	0.0224	0.0434	0.0457	0.0206	0.0266
Coefficients	0.013	0.509	-0.073	0.241	0.952	0.182	0.644	0.260
MPC	0.04	2.18	-0.26	0.54	4.13	0.83	1.327	0.69
Non-discretionary non-durable								
Median Consumption (C $)	10585	12428	11628	7821	12828	12428	7403	8424
Median house value (H $)	450000	430000	450000	400000	470000	400000	400000	425000
C/H	0.0235	0.0289	0.0258	0.0196	0.0273	0.0311	0.0185	0.0198
Coefficients	0.009	0.09	-0.004	-0.002	0.358	-0.092	0.361	-0.084
MPC	0.02	0.26	-0.01	0.00	0.98	-0.29	0.67	-0.17

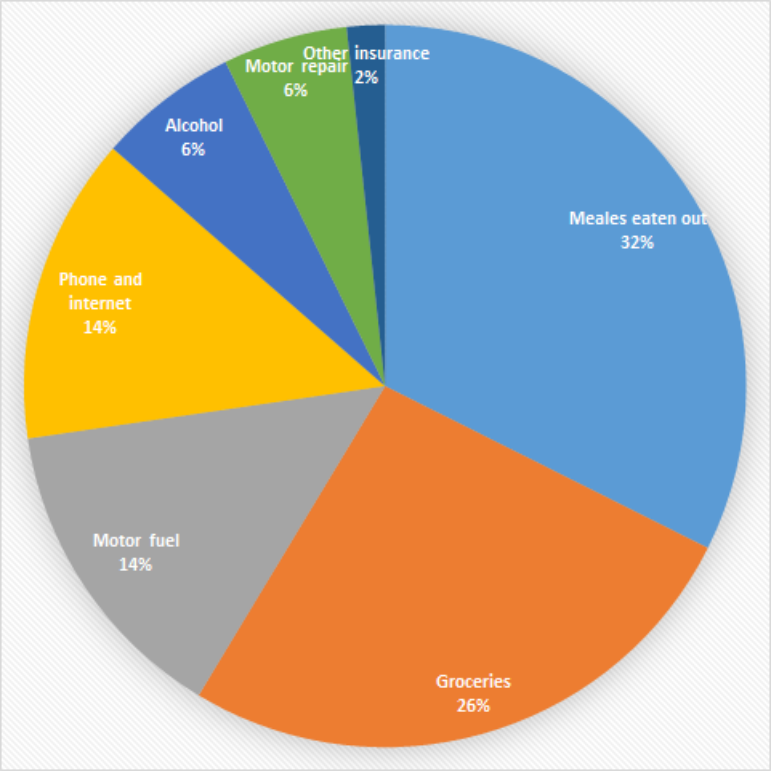

FIGURE 2.3: The marginal propensity to consume (MPC) out of housing wealth for each consumption item for all homeowners.

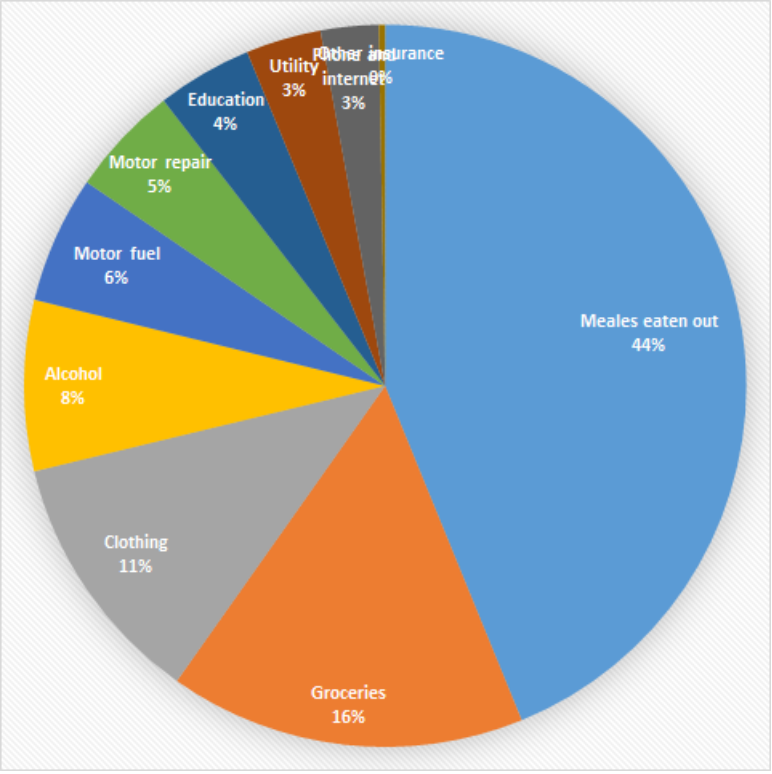

FIGURE 2.4: The marginal propensity to consume (MPC) out of housing wealth for each consumption item for young homeowners with high income volatility.

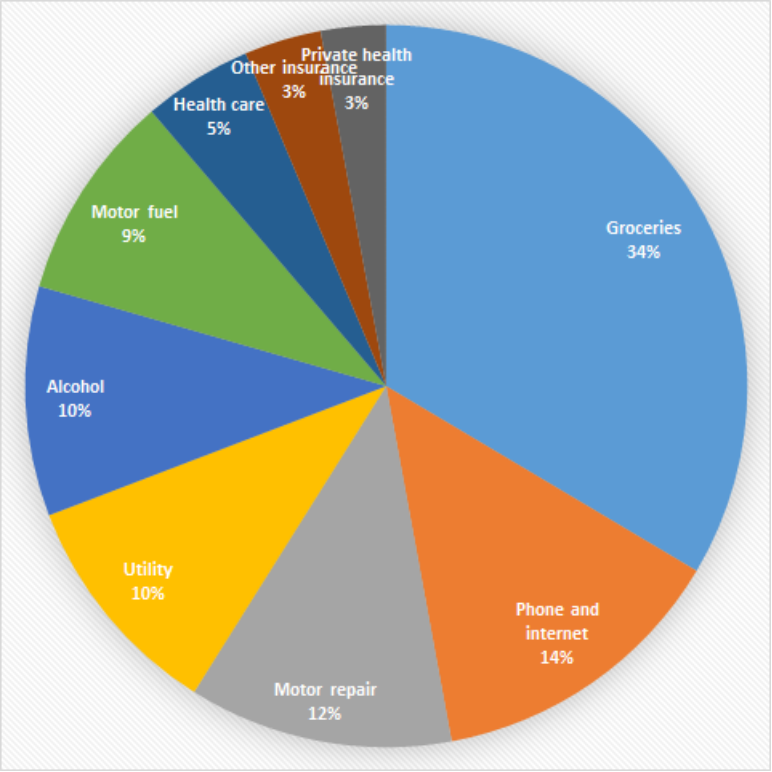

FIGURE 2.5: The marginal propensity to consume (MPC) out of housing wealth for each consumption item for unconstrained old homeowners with high housing wealth share.

2.5 Conclusion

In this paper, I use a rich panel data of households with consumption records to study the factors that influence house price-consumption sensitivity. I find significant heterogeneity in the sensitivity across the age groups: both young and old-aged homeowners have positive and significant consumption sensitivities to house price changes, while the middle-aged homeowners have insignificant sensitivity. This heterogeneity also leads to large variations in the MPCs out of housing wealth across the age groups.

Among young homeowners, I find income volatility is the predominant driver of the house-price consumption sensitivity and only those with high income volatility have significant consumption sensitivity. Importantly, the effect of income volatility subsumes that of other common used measures of credit constraints, such as liquid savings, net worth, LTV ratio and mortgage payment coverage. This evidence highlights the precautionary savings nature of housing assets. Consistent with the housing wealth effect, I find that unconstrained old homeowners with high housing wealth share have stronger consumption sensitivity than those with low housing wealth share. Overall, the results suggest that young homeowners with high income volatility and unconstrained old homeowners with high housing wealth share are the biggest contributors to the aggregate house-price consumption sensitivity.

In the aftermath of the Great Recession, regulators and economists in the US are

highly concerned about the dampening effect of lower house value on household consumption. This study shows that this shock has distinct implications for households of different age and demographic characteristics. A housing market crash means a substantial destruction of wealth for older homeowners, especially those with large shares of total wealth tired in housing. This can have severe impact on their welfare in retirement. Young homeowners with high income volatility are adversely affected mainly because their housing collateral has declined in value, forcing them to save more as buffers against future income shocks. In contrast, middle-aged homeowners who plan to up-size could actually benefit from falling house prices, which makes their next home more affordable. Policy makers are likely to benefit from this evidence when developing targeted policies.

Chapter 3

How do house prices affect household consumption over the life cycle? A stylized model

I develop a stylized life-cycle model on optimal consumption decision with housing and risky labor income and provide analytical solutions. I show that house prices affect individuals' consumption decisions through different channels across life-cycle stages. While old individuals are affected only by a housing wealth effect, the consumption of the young and middle-aged can be influenced by both the wealth effect and a credit constraint effect, depending on their levels of wealth. In addition, the young with intermediate level of wealth exhibit precautionary saving motive, which

is also influenced by house prices. The model provides a simple framework to understand the empirical findings in the literature.

3.1 Introduction

A house is the single most important asset in a typical household's portfolio. It is often the most valuable asset a household owns and the most readily available collateral for borrowing.[1] Because house prices can experience large swings, as evidenced in the recent U.S. housing market turmoil during the subprime mortgage crisis, house price variations can potentially affect many household decisions (Mian, Rao, and Sufi, 2013). In particular, an important strand of literature finds a significant correlation between changes in house price and household consumption (Campbell and Cocco, 2007; Gan, 2010; Browning et al., 2013; Berger et al., 2017).

This literature however debates heavily on the channels through which house prices affect household consumption decisions. For example, Campbell and Cocco (2007) argue for both a housing wealth effect and credit constraints channel and Gan (2010) further provides evidence for a precautionary saving channel. By contrast, Attanasio et al. (2009) provide evidence that co-movement is driven by omitted variables such future income prospect. Along with the empirical evidence, theoretical studies such as Li and Yao (2007), Kraft and Munk (2011) and Berger et al. (2017) attempt to

[1] In the U.S., for example, housing wealth accounted for about half of the total net worth of households in 2008 (Iacoviello, 2011) and home mortgage debt was equal to about half of the market value of houses in 2007 (Greenspan and Kennedy, 2008).

incorporate the features of housing and risky labor labor income in full-fledged life-cycle models to provide explanations of the evidence. However, most of the existing theoretical studies rely on simulation and numerical methods for solutions and it is not easy to understand the underlying rationales of the various channels through which house prices can affect house prices.

The objective in this paper is to build a stylized life-cycle model and provide closed-form solutions to demonstrate the different mechanisms of the house price- consumption sensitivity across the life-cycle age groups. The main insights of the model are as follows. Old homeowners are affected by house price changes due to a housing wealth effect: higher house prices increase the total wealth of the household and thus their consumption. The unconstrained middle-aged and young households can also be affected by the housing wealth effect but to a lesser extent as the housing is of a smaller proportion of their total life-time wealth (including future labor income) compared to the old households. In addition, the constrained middle-aged and young are affected by the credit constraint channel where higher house prices allow them to borrow more for current consumption. Lastly, the young households with intermediate level of wealth are influenced by a precautionary savings motive in their consumption decision as higher housing wealth can help them hedge low income realization in the future. They can therefore optimally reduce precautionary savings and increase their consumption in the current period.

These results stem from some of the key features of the model. I assume that each household live for three periods $t = 0, 1, 2$, which could be considered three life-cycle

stages: young, middle and old. Households are endowed with one unit of housing asset at $t = 0$ and has a time-additive quadratic utility function of non-durable consumption. This housing asset can be used as collateral for borrowing and is subject to price risks.[2]. Further, I assume that a household can earn a deterministic labor income y_0 at $t = 0$, stochastic incomes y_t at $t = 1$ and $t = 2$. The households know the realization of y_1 and y_2 at the beginning of $t = 1$ and at the end of $t = 1$ respectively, and households are therefore subject to future income risk at $t = 0$ and $t = 1$. This risk introduces both credit constraints and precautionary saving motive for the young household.

Based on these assumptions, the model generates the following specific predictions. In an unconstrained economy where households can borrow against their future labor income as well as their housing wealth, each period households consume a fixed share of their expected life-time resource due to the certainty equivalent property of the quadratic utility function (Hall, 1978).

In a constrained economy, households can only borrow against their housing wealth but not their future labor income. In the last period, the household will pay off their debt and consume all of their wealth. House prices affect household consumption

[2]Admittedly, this is a simplifying assumption. I effectively assume that households prefer to become homeowners and there is no adjustment of housing consumption. This assumption is made to isolate the effect of house price changes on consumption without the complication of housing choice, as well as ensuring a closed-form solution. I do not consider the homeownership choice in this study and studies such as Agarwal and Qian (2017) provide detailed analysis. To alleviate the concern of this assumption, in the extended model, I assume households need to up-size during middle age and incur transaction costs.

only through a wealth effect. In the middle-aged period, the optimal consumption depends on the realization of their labor income plus the wealth/debt they bring forward from the previous period. On the one hand, if this wealth on hand is high enough, their consumption will not be constrained and they consume half of their remaining expected total wealth. House prices again affect consumption through a wealth effect. On the other hand, if their wealth is low, the household is constrained and will borrow the maximum amount against their housing wealth for consumption. In this case, house prices affect consumption through the credit constraint channel.

The optimal decision of the young is similar to that of the middle-age with one additional case due to the uncertainty of future labor income. If the initial wealth of the household is high enough, the household will not be constrained and they will consume one third of their expected life-time wealth. The housing wealth effect arises in this case. By contrast, if the household has very low initial wealth, they are constrained and they have to borrow the maximum amount against their housing wealth, which leads to a credit constraint effect. In addition, if the household have intermediate level of wealth, they will not be constrained in the current period but may be constrained in the middle-aged period if low income realizes. In this case, the prospect of being constrained in the next period will lead the household to save more and deviate from the consumption level in the unconstrained case. This is the precautionary saving motive due to income and consumption uncertainty(Carroll, 1997; Deaton, 1991).Rising housing wealth will reduce the precautionary saving motive because household can borrow against their housing wealth if low y_1 realizes.

In addition, the higher the income uncertainty, the stronger the precautionary saving motive.

Complementing the full-fledged life-cycle models, such as Li and Yao (2007) and Kraft and Munk (2011), the three-period model focuses on some of the essential elements for understanding the impact of house price changes on household consumption decisions. For example, I incorporate housing as both a vehicle for wealth accumulation and borrowing collateral and explicitly consider the labor income risks.The analytical solutions derived from the model intuitively demonstrate the how various channels affect household consumption decisions over the life-cycle and provide a simple and unified framework to understand the highly-debated empirical results. In particular, the model provides a framework for understanding the precautionary savings motive documented in recent empirical studies such as Gan (2010).

However, to achieve simplicity, the model does have important omissions. Most importantly, homeownership decision is outside the model. I do not consider this as other studies such as Agarwal, Hu, and Huang (2015) have conducted detail analysis on this topic and this omission allows me to focus on the impact of changing house prices. I however briefly discuss the impact of of moving houses after the main model. Also, the model is not intended to generate statistics that can match the observed patterns in the data, as that inevitably requires more realistic features and recent studies such as Berger et al. (2017) have provided an excellent analysis on this front.

The paper proceeds as follows. In the next section, I present the model and discuss its implications. Section 3 discusses the impact of moving on the model and Section 4 concludes.

3.2 The Baseline Model

To illustrate how house prices can affect household consumption over the life cycle, I consider a simple model in which homeowners maximize their lifetime utility by optimizing over nondurable consumption and debt/saving, given a distribution of future labor income.

3.2.1 Model Setup

3.2.1.1 Preferences

I model the consumption, and debt/savings choices of homeowners who live for three periods ($t = 0, 1, 2$). In each period t, the household optimizes per-capita nondurable consumption c_t, and their debt/savings b_t.[3]

[3]Because I focus on the consumption sensitivity of homeowners over the life cycle, I implicitly assume that house price expectations are such that owning a home dominates renting, and those that can afford homeownership in the first two periods of their life will purchase a home as soon as their borrowing capacity allows. In the last period, I assume that households will sell their house and consume all their terminal wealth. A household's optimal timing of home sale or purchase is not considered here but in studies such as Agarwal et al. (2015).

Individuals derive utility from nondurable goods for each period before period T. The time between any two periods in the model corresponds to about 20 years in a households life. They consume all their wealth w_T in the last period. Each period, households invest/borrow in bonds and consume from current income, expected future income, and housing wealth.

I assume that the utility function is linear-quadratic in nondurable consumption, $U(c) = c + \frac{\theta}{2}c^2$. $\theta < 0$ is the risk-aversion parameter. Homeowners maximize their lifetime utility:

$$U(c_0, c_1, c_2) = \sum_{i=0}^{2} E\left[\beta^i \left(c_i + \frac{\theta}{2} c_i^2\right)\right]; \tag{3.1}$$

where $E[]$ represents expectation, and β is a discount factor, which also determines the riskless rate $r_f = \frac{1}{\beta}$. An important advantage of this utility specification is that optimal consumption exhibits the certainty equivalence property in the absence of borrowing constraints. That is, optimal consumption depends only on the expected future income and expected present value of wealth (financial and housing). The variance and higher moments of income and wealth do not affect optimal consumption in the absence of borrowing constraints. This feature of linear-quadratic utility helps isolate the housing wealth effect from the effect of borrowing constraints and precautionary saving (Dow Jr and Olson, 1991).

3.2.1.2 Housing

House prices in the model are exogenously specified and have the following dynamics:[4]

$$p_t = p_{t-1} + (\bar{p} - p_{t-1})v + \varepsilon_{p,t}; \tag{3.2}$$

where $\bar{p}$ is the long-run average level of house prices and $\bar{h} = \bar{p} * s$ is the long-run average level of house value of a house with scale s.For convenience, I normalize $s = 1$ and assume that $\varepsilon_p * s$ is equally likely to be either $+\delta_h$ or $-\delta_h$, with $0 < \delta_h < \bar{h}$.

The parameter $v \in [0, 1]$ and can accommodate different house price processes. When $v = 1$ house prices follow a constant value of $\bar{p}$ plus some variations each period and current house prices do not affect expectation of future house prices. When $v = 0$, house prices follows a martingale process. When v is in between 0 and 1, house prices follow a mean-reverting process. This is consistent with empirical evidence where house prices tend to have short-term momentum but long-run mean-reversion (Piazzesi and Schneider, 2016).

3.2.1.3 Borrowing constraint

I denote the level of savings for future consumption (net of any mortgages or borrowing for current consumption) as b_t, where a negative number represents borrowing. The household could save/borrow b_t at the risk-free rate, r_f. The level of borrowing

[4]I could introduce rent in the model as the determinant of house prices. However, as long as the rental yield is constant, there would be a deterministic relation between rent and house prices, and their distinction would not be meaningful for the optimization problem.

is restricted by the house value such that:

$$b_t \geq -\phi h_t, \tag{3.3}$$

where ϕ determines that maximum proportion of house value that households can borrow. I assume that $\frac{1}{2} \leq \phi \leq 1$ to ensure that households can borrow a substantial proportion and are not constrained to sell their house in order to consume their housing wealth. In the model, the borrowing constraint only binds due to low labor income realizations or high levels of debt endowment such as from a mortgage.

3.2.1.4 Labor income

I assume that households receive deterministic labor income in young-age, and stochastic income at the start and end of the middle-age. Once the labor income level is realized at the end of the middle-age, the old age households face no further labor income uncertainty.[5] I do not consider the labor-leisure decision and assume the income process is exogenous and independent. More formally, a homeowner earns labor income y_t for $t = 0,1,2$. For $t = 0$, I assume the income in the period 0 (y_0) is known at the start of the period.[6] For $t = 1,2$, I assume the labor income to be either high income, $y_u = \bar{y} + \delta_y$, with probability of p, or low income, $y_d = \bar{y} - \delta_y$, with probability $(1-p)$. Therefore I have $E_0[y_1] = E_1[y_2] = \bar{y} + (2p-1)\delta_y$.

[5] Old households can receive income from both government pension and personal retirement savings, but I assume that this level is known by the end of middle-age.

[6] The simplifying assumption that the income of the young ($t = 0$) is deterministic may be relaxed to allow this income to be stochastic without meaningfully changing the solution of the model.

These stylized assumptions are meant to capture two key aspects of reality in a parsimonious way. First, the major future income uncertainty is faced by the young and middle-aged households. Second, both the young and middle-aged would like to borrow against future income, and the old will not borrow as they do not have future income.

3.2.1.5 Budget constraint

I calculate w_t (the net liquid cash on hand or net debt liability) by adding period t financial (nonhousing) wealth $r_f b_{t-1}$ to labor income y_t. That is $w_t = r_f b_{t-1} + y_t$. I assume $w_0 = y_0$. Here y_0 can also be interpreted as the starting income plus wealth inherited by the young household minus the value of any mortgage. The budget constraints are:

$$
\begin{aligned}
b_0 &= w_0 - c_0 \\
b_1 &= w_1 - c_1 = r_f b_0 + y_1 - c_1, \\
w_2 &= c_2 = r_f b_1 + y_2 + h_2,
\end{aligned}
\tag{3.4}
$$

where the value of a house at period t (net of transaction costs on sale, τ) is denoted as $h_t = p_t(1-\tau)$.

3.2.2 Optimization problem

Households maximize lifetime utility 3.1, subject to the constraints 3.2.1.3 and 3.2.1.5. For simplicity and algebraic convenience, I assume that interest rate is zero so that $r_f = \frac{1}{\beta} = 1$. I now solve the model recursively from the last period with the typical dynamic programming technique.

3.2.2.1 Optimal consumption in the unconstrained borrowing case

In this world, households can borrow against their future labor income and the only constraint is that life-time consumption should not exceed life-time resources. It is well known that optimal consumption is certainty equivalent ($c_t = E_t[c_{t+1}]$) when utility is quadratic and only the life-time resource budget constraint is binding (Hall(1978)). Each period, households consume an equal share of their total life-time wealth:

$$c_0 = E_0[c_1] = E_0[c_2] = \frac{1}{3}(w_0 + E_0[y_1] + E_0[y_2] + E_0[h_2]), \tag{3.5}$$

This equation says that, during the young period, households consume one-third of their expected life-time wealth (over three periods).

$$c_1 = E_1[c_2] = \frac{1}{2}(w_1 + E_1[y_2] + E_1[h_2]), \tag{3.6}$$

At the beginning of the middle-aged period, the household know whether they will receive high or low income in period $t = 1$. Therefore, the household consume half of their expected wealth and income, and invest the rest for their old age period.

$$c_2 = w_2 \tag{3.7}$$

In the old age, they know whether they will sell their house at a high or low price. Based on this, households consume their savings, and the realized value of their house in the final period. Notice that in the young and middle-aged periods, consumption is also sensitive to the expected housing wealth in the final period, but the housing wealth effect increase with age due to diminishing remaining life horizon.

Consumption growth is given by:

$$c_2 - c_1 = c_2 - E_1[c_2] = (y_2 - E_1[y_2] + h_2 - E_1[h_2]) \tag{3.8}$$

$$c_1 - c_0 = c_1 - E_0[c_1] = \frac{1}{2}(y_1 - E_0[y_1] + E_1[y_2] - E_0[y_2] + E_1[h_2] - E_0[h_2]) \tag{3.9}$$

Consumption growth in the final period equals to the difference between the realized values of y_2 and h_2 and the household's expectations at $t = 1$. Similarly, between the young and middle-aged period, the consumption growth depends on the difference

between realized income y_1 and the expected value at $t = 0$, as well as the change in expected housing wealth in the final period h_2 and the income y_2.

3.2.2.2 Optimization problem with constrained borrowing

In the borrowing constrained case, households can only borrow against their housing wealth but not future labor income. These assumptions mirror the financial frictions faced by households in reality. To find the optimal consumption, I solve the model recursively from the last period using standard dynamic programming techniques.

$$V_t(w_t) = \max_{c_t} \left(c_t + \frac{\theta}{2} c_t^2 \right) + E_t[V_{t+1}(w_{t+1})] \tag{3.10}$$

For simplicity and algebraic convenience, I assume that interest rate is zero so that $r_f = \frac{1}{\beta} = 1$.

In the final period, the household sells its house and consumes the realized value of its house (net of transaction costs) along with all its savings so that: $c_2^* = w_2$. This result demonstrates the housing wealth effect where higher house value increases the total resource for consumption for the household in the last period.

Because $c_2^* = w_2$, $V_2(w_2) = U(c_2)$. I therefore have $E_1[V_2'(w_2)] = 1 + \theta(w_1 - c_1 + E_1[y_2] + E_1[h_2])$, where $'$ represents the first derivative with respect to w_2.

In period-1:

$$V_1(w_1) = \max_{c_1} \left(c_1 + \frac{\theta}{2} c_1^2 \right) + E_1[V_2(w_2)] + \lambda_1(w_1 + \phi h_1 - c_1). \tag{3.11}$$

where $c_1 \leq w_1 + \phi h_1$ is the budget constraint. A household can only spend their wealth on hand and the borrowing against their home equity. The first order conditions for maximization are:

$$1 + \theta c_1 - E_1[V_2'(w_2)] - \lambda_1 = 0 \tag{3.12}$$

$$\lambda_1(w_1 + \phi h_1 - c_1) = 0$$

$$\lambda_1 \geq 0, w_1 + \phi h_1 - c_1 \geq 0$$

These can be solved for the optimal c_1 to obtain

$$c_1^* = \begin{cases} \frac{1}{2}(w_1 + E_1[y_2] + E_1[h_2]), & \text{if } w_1 \geq E_1[y_2] + E_1[h_2] - 2 * \phi h_1 \\ w_1 + \phi h_1, & \text{otherwise} \end{cases} \tag{3.13}$$

The optimal consumption decision for middle-aged homeowners depends on w_1: the savings/debt they bring from last period and the realized labor income in that period y_1. Note that w_1 excludes expected future labor income and housing wealth. While the households with high w_1 are not constrained and consume half of their total expected lifetime wealth, those with lower w_1 are constrained and have to borrow the maximum amount against their home equity for consumption.

For the unconstrained middle-aged households, their consumption is affected by house prices because of the housing wealth effect, as higher house value increases their total life-time resources. By contrast, for the constrained households, house prices affect

their consumption through the credit constraints channel where higher house value allows the household to relax their borrowing constraints and thus increase consumption.

The threshold w_1 at which borrowing constraints become binding is $w_1 < E_1[y_2] + E_1[h_2] - 2 * \phi h_1$. In the borrowing constrained case, households can only borrow against their housing wealth but not future labor income. Therefore, households that expect to have larger future labor income are more likely to be constrained to consume against that future labor income. Also lower house prices (h_1) or lower ability to borrow against the house prices (ϕ) are also associated with a higher threshold for w_1 and thereby a higher likelihood for being constrained.

In period-0, these homeowners solve

$$V_0(w_0) = \max_{c_0} \left(c_0 + \frac{\theta}{2} c_0^2 \right) + E_0[V_1(w_1)] + \lambda_0(w_0 + \phi h_0 - c_0). \tag{3.14}$$

Before deriving the optimal period-0 consumption, I introduce two thresholds of w_0 that are relevant for the results: (i) I define w_u as the level above which the consumer's optimal consumption is not constrained in both period-0 and period-1 and (ii) I define w_d as the level below which the consumer's optimal consumption is constrained in period-0.

I first derive w_u. From Equation 3.13, we see that whether the household is constrained in period-1 depends on how much savings/debt it has accumulated and the realized income of y_1. Therefore, period-0 financial wealth determines not only

whether c_0^* is constrained, but also whether c_1^* will be constrained. That is, if the consumer's initial wealth is high enough ($w_0 \geq w_u$), then c_0^* and c_1^* are not constrained even if the household receives low income $y_1 = \bar{y} - \delta_y$ in period-1. Note: c_1^* is unconstrained if $w_1 > E_1[y_2] + E_1[h_2] - 2 * \phi h_1$. With the optimal unconstrained $c_0^* = \frac{1}{3}(w_0 + E_0[y_1] + E_0[y_2] + E_0[h_2])$ and eliminating c_0^*, we obtain the expression for $w_u = \bar{y} + (5p-1)\delta_y + \frac{1}{2}E_0[h_2] + \frac{3}{2}E_1[h_2] - 3\phi h_1$. Assuming $h_1 = h_0 + (\bar{h} - h_0)v - \delta_h$ and substituting in $E_0[h_2]$ and $E_1[h_2]$, we have [7]

$$w_u = \bar{y} + (5p-1)\delta_y + [2(1-v)^2 - 3(1-v)\phi]h_0 + [(4-3\phi)v - 2v^2]\bar{h} - [\frac{3}{2}(1-v) - 3\phi]\delta_h. \tag{3.15}$$

Next I derive the threshold w_d. If w_0 is below w_d then the consumer's optimal consumption is constrained in period-0 and $c_0^* = w_0 + \phi h_0$. In this case, $w_1 = -\phi h_0 + y_1$ and whether c_1 is constrained depends on income and house prices in period-1. I assume that liquidity constraints arise only due to low income in period-1.[8] Specifically, I assume c_1 is constrained if $y_1 = \bar{y} - \delta_y$ and is unconstrained if $y_1 = \bar{y} + \delta_y$.

The first order condition for Equation 3.14 is

$$u_0'(w_0) = E_0[V_1'(w_1)] + \lambda_0. \tag{3.16}$$

[7] Here we have assumed that $\phi > \frac{1-v}{2}$ so that the lower realization of house price y_1 will give a larger value of the upper boundary.

[8] This is true if c_1 is constrained with a low realization of y_1 and high realization of h_1, and unconstrained with a high realization of y_1 and a low realization of h_1. After simplification, I obtain two conditions: $p\delta_y > \phi h_1 - \frac{1}{2}(E_1[h_2] + \phi h_0)$ and $(1-p)\delta_y \geq \frac{1}{2}(E_1[h_2] + \phi h_0) - \phi h_1$. This basically requires that the variation of income realization to be large enough relative to that of house prices.

Using Equations 3.12 and 3.13, and applying the envelope theorem, I obtain: $V_1'(w_1) = E_1[V_2'(w_2)] + \lambda_1$. Substituting for V_2' and λ_1 gives

$$V_1'(w_1) = \begin{cases} \alpha + \frac{\theta}{2}(w_1 + E_1[y_2] + E_1[h_2]), & \text{if } w_1 \geq E_1[y_2] + E_1[h_2] - 2 * \phi h_1 \\ \alpha + \theta(w_1 + \phi h_1), & \text{otherwise.} \end{cases} \tag{3.17}$$

Substituting Equation 3.17 in Equation 3.16 I obtain:

$$\frac{\lambda_0}{\theta} = w_0 - \frac{p}{2}(-\phi h_0 + y_u + E_0[y_2] + E_0[h_2]) - (1-p)(-\phi h_0 + y_d + \phi E_0[h_1]) \leq 0. \tag{3.18}$$

Substituting in the expectation of housing wealth, I obtain the expression

$$w_d = \bar{y} + (p^2 + p - 1)\delta_y + [\frac{1}{2}(1-v)A - \phi(1 - \frac{p}{2})]h_0 + \frac{1}{2}v(p+A)\bar{h}, \tag{3.19}$$

where $A = p(1-v) + 2(1-p)\phi$.

In between these two extremes, $w_d < w_o < w_u$, c_0^* is unconstrained but c_1^* may be constrained if low income is realized in period-1. From Equation 3.16, the first order condition is $u_0'(c_0) = E_0[V_1'(w_1)] + \lambda_0$, which yields the following expression for c_0:

$$c_0 - \frac{p}{2}(w_0 - c_0 + \bar{y} + \delta_y + E_0[y_2] + E_0[h_2]) - (1-p)(w_0 - c_0 + \bar{y} - \delta_y + \phi E_0[h_1]) = 0. \tag{3.20}$$

Solving this equation, I obtain the optimal consumption rule for the young homeowners:

$$c_0^* = \begin{cases} \frac{1}{3}(w_0 + E_0[y_1] + E_1[y_2] + E_0[h_2]), & \text{if } w_0 \geq w_u \\ \frac{1}{4-p}\{(2-p)w_0 + 2\bar{y} + 2(p^2+p-1)\delta_y + v(p+A)\bar{h} + (1-v)Ah_0\}, & \text{if } w_d < w_o < w_u \\ w_0 + \phi h_0, & \text{if } w_0 \leq w_d \end{cases} \tag{3.21}$$

The young homeowners with high w_0 are unconstrained and consume one-third of their expected total wealth in each period. In this case, house value affect consumption through the wealth effect. Those with low w_0 are constrained and need to borrow the maximum amount against their home for consumption and house prices affect consumption through the credit constraints channel.

For young households with intermediate levels of w_0, their consumption differs from that of both the high wealth and constrained households. This is because although they are not constrained in the period $t = 0$, they might be constrained in the next period if the low level of income realizes. Such prospect of being constrained in the future cause them to save more (and consume less) in the current period and this is a precautionary saving motive. This precautionary saving motive is affected by house prices because higher house prices enable a household to borrow more in the middled-aged period if low income realizes, thus relaxing their borrowing constraints.

This feature of model illustrates why house prices can affect household consumption through a precautionary savings motive (Gan, 2010). More important, I identify the

driver of this precautionary saving motive: the uncertainty of future income. Future empirical studies should therefore test the importance of the income uncertainty.

3.2.3 Model implied house price-consumption sensitivity

Recall the house price process specified in Equation 3.2 and for $v < 0$, the effect of v is purely quantitative. Qualitatively, the mechanisms influencing consumption elasticity remain the same. To improve exposition, I present the sensitivities for the case of $v = 0$.

In the final period $t = 2$,

$$E_{h_2} = \frac{\partial c_2^*}{\partial h_2} * \frac{h_2}{c_2} = \frac{h_2}{w_2}. \tag{3.22}$$

The consumption elasticity therefore depends on the ratio of housing wealth to the total wealth of the household w_2. This is an intuitive result as the more wealth of a household is tied up in housing, the more sensitive they should be to house price variations in their consumption.

In the period $t = 1$, I have

$$E_{h_1} = \frac{\partial c_1^*}{\partial h_1} * \frac{h_1}{c_1} = \begin{cases} \frac{h_1}{w_1 + E_1[y_2] + h_1}, & \text{if } w_1 \geq E_1[y_2] + E_1[h_2] - 2 * \phi h_1 \\ \frac{\phi h_1}{w_1 + \phi h_1}, & \text{otherwise.} \end{cases} \tag{3.23}$$

For the unconstrained middle-aged homeowners, the house price consumption sensitivity depends on the ratio of house value relative to w_1 plus expected labor income

and the house value. For the constrained, the sensitivity equals to their ability to borrow against their house value relative to this borrowing plus w_1.

In the period $t = 0$, I have

$$E_{h_0} = \frac{\partial c_0^*}{\partial h_0} * \frac{h_0}{c_0} = \begin{cases} \frac{h_0}{w_0 + E_0[y_1] + E_0[y_2] + h_0}, & \text{if } w_0 \geq w_u \\ \frac{[p + 2(1-p)\phi]h_0}{(2-p)(w_0) + E_0[y_1] + E_0[y_2] - \sqrt{p(1-p)}\sigma_y + [p + 2(1-p)\phi]h_0}, & \text{if } w_d < w_o < w_u \\ \frac{\phi h_0}{w_0 + \phi h_0}, & \text{if } w_0 \leq w_d. \end{cases} \tag{3.24}$$

where $\sigma_y = \sqrt{4p(1-p)\delta_y^2}$ is the standard deviation of income growth. The elasticity of the wealthy and poor young homeowners are of similar forms of those of the middle-aged. For the intermediate-wealth range, the elasticity also depends on the volatility of income growth measured by σ_y: the higher the volatility, the higher the elasticity.[9]

Similar to the middle-aged households, the wealthy ($w_0 \geq w_u$) young households have house-price consumption sensitivity equal to the ratio of house value relative to w_0 plus expected labor income and the house value, and the constrained ($w_0 \leq w_d$) have a sensitivity equal to their ability to borrow against their house value relative to this borrowing plus w_0.

[9] Note that $E_0[y_1] + E_0[y_2] - \sqrt{p(1-p)}\sigma_y = 2\bar{y} + 2(p^2 + p - 1)\delta_y$. Solving $p^2 + p - 1 < 0$, I can find as long as $p < 0.618$, the larger the δ_y, the higher the consumption elasticity.

For young households with intermediate levels of wealth, their house price-consumption sensitivity is influenced by the characteristics of their future income. First, when $p < \frac{2}{3}$, the larger the δ_y (range of income variation), the stronger the house price consumption-sensitivity. This means that if the young household is not very certain about a high realization of future income and the variation in income is large, their consumption will be more sensitive to the house prices. Second, the higher the income volatility σ_y, the higher the consumption sensitivity. Overall, the model shows that the precautionary savings effect related to housing wealth can be significantly influenced by the income uncertainty of a household.

3.2.3.1 The cross-section implications

So far the model has demonstrated channels through which house price changes can affect a homeowner's consumption decision. In the cross-section of households, the various channels might differ in strength due to the common life-cycle patterns of income and wealth accumulation. Here I discuss some of the important factors that may influence the cross-sectional patterns of house price-consumption sensitivity and the implications for empirical studies.

On the one hand, it has been well documented that young households should be more credit constrained than middle-aged and old households due to lower financial wealth and high future labor income (Gourinchas and Parker, 2002). This suggests that the strength of credit constraint channel should decrease with age. On the other hand, the wealth effect of house price change should increase with age as households get

closer to the point of liquidating their housing wealth. If we take into account of a discount factor (a feature omitted in the model for simplicity), the wealth effect should diminish exponentially for young and middle-aged households. In addition, young people tend to have high income uncertainty due to the lack of experience compared to the middle-aged. All together, those aspects would imply a dominate role of credit constraints and precautionary savings for the young households and a wealth effect for the old households. The middle-age households are affected less by credit constraints compared to the young and do not enjoy as much wealth effect as the old.

These general patterns can vary depending on the proportions of individuals being constrained in the population. It is therefore important to systematically examine these channels with empirical studies. Nonetheless, the theoretical channels demonstrated in this paper give guidance on understanding future empirical results.

3.3 The impact of moving on household consumption sensitivity

In the main analysis above, homeowners do not move for exogenous reasons. This decision may be modeled as an endogenous outcome in a more general setting. For example, three features can be incorporated into the model. First, I can consider a utility maximization problem that depends on nondurable consumption and housing consumption:

$$U(c_0, c_1, c_2, s_0, s_1, s_2) = \sum_{i=0}^{2} E\left[\beta^i \left(c_i + \frac{\theta}{2} c_i^2 + s_i + \frac{\omega}{2} s_i^2\right)\right]; \tag{3.25}$$

where ω is a parameter that governs the substitution between nondurable consumption and housing consumption. s_i is a housing scale parameter that also determines house value $h_t = p_t * s_t$ for a given level of house price level p_t. This parameter measures the size, location, and quality of the house providing utility to households.

Second, an important feature of housing that makes it different from liquid financial assets is its indivisibility. Following Cocco (2005), I can assume a minimum scale for housing, $\bar{s}_{min}$, so that:

$$s_t \geq \bar{s}_{min}, \forall t. \tag{3.26}$$

Third, an important feature of housing are substantial transaction costs associated with buying and selling houses. This feature influences the budget constraints. For households who are purchasing a house in period t, the constraint is $b_t = w_t - c_t - p_t s_t(1+\tau)$, where the scale of the house that the household purchases at the start of period is given by s_t and the proportional transaction costs incurred in the purchase are given by τ. Incorporating these features in the model implies, that in period $t = 1$, there are now at least two possibilities: the household will either choose to change its house scale or there will be no intermediate housing sale and purchase. The budget

constraints for these two cases are given by:

$$b_1 = \begin{cases} w_1 - c_1, & \text{if no housing transaction} \\ w_1 - c_1 - p_1 \Delta s_1 (1+\tau) - 2\tau p_1 s_0, & \text{if housing transaction} \end{cases} \tag{3.27}$$

where τ represents the transaction costs associated with buying or selling property.

What are the implications of moving for the house-price consumption sensitivity of households with these three features? When a housing transaction occurs, the budget constraint (Eq. 3.27) implies a loss of wealth in terms of transaction costs and the difference between the value of the new and current house, which is determined by the change in scale of the house. Consider the case of constrained middle-aged households who cannot borrow to consume. The level of consumption simplifies in this case to all of liquid wealth minus transaction costs of purchasing the house:

$$c_1 = \quad w_1 - p_1 \Delta s_1 (1+\tau) - 2\tau p_1 s_0, \tag{3.28}$$

$$E_{h_1} = \quad -\frac{h_1}{c_1} \left(\frac{\Delta s_1}{s_0} (1+\tau) + 2\tau \right). \tag{3.29}$$

In Eq. 3.29, we see that up-sizing (or down-sizing) influences decreases (or increases) the consumption sensitivity of these households. This reflects the constraint that a middle-aged household that is up-sizing and constrained will need to reduce consumption to accommodate the additional payment for the house and transaction costs associated with selling one house and buying another one.

The empirical analysis in Chapter 2 supports our predictions. Figure 3.1 illustrates

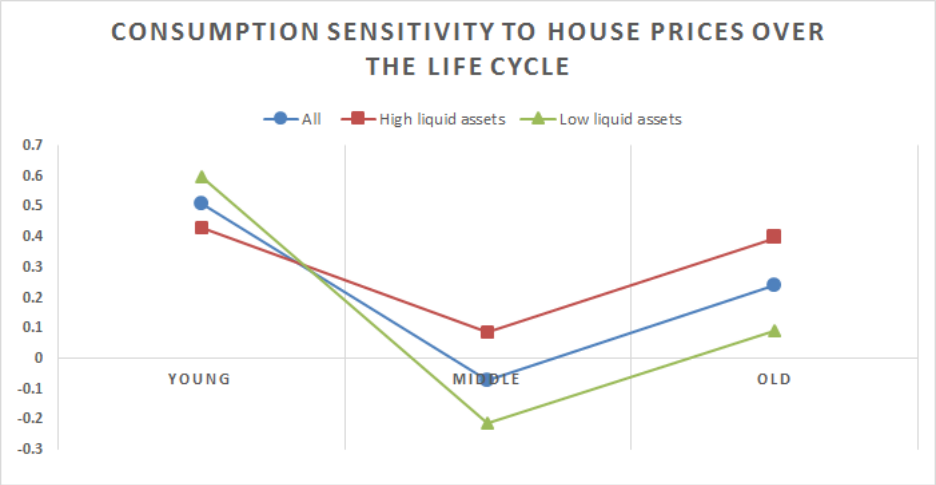

FIGURE 3.1: The house-price consumption sensitivity of three age groups estimated using the HILDA data in Chapter 2 of the thesis.

the consumption sensitivity to house price changes of the three life-cycle groups. Overall, we can see that the young and old homeowners have positive and much higher consumption sensitivity to house prices than the middle-aged, which could be due to the up-sizing motive among the middle-aged homeowners. More importantly, when we further classify the three groups by their levels of liquid assets (a measure of liquidity constraints), we find that the constrained young and unconstrained old homeowners have higher consumption sensitivity to house prices than their counterparties of the same age groups. This is consistent with the model prediction that credit constraints and precautionary saving motive drive the young homeowners' sensitivity while the wealth effect drives the old homeowners' consumption sensitivity.

3.4 Conclusion

The recent subprime mortgage crisis and the ensuing economic downturn in the US highlight the importance of housing assets to household welfare. How house prices affect household consumption is an important question for both academics and policy-maker and subject to heavy debate. This paper presents a stylized model to illustrate the channels through which house prices can affect household consumption decisions.

I show that while the consumption of old households can only be affected by house prices through a wealth effect, the consumption of middle-aged can be influenced through both a wealth effect and a credit constraint effect, depending on the level of wealth of the households. Similar to the middle-aged, young households will be affected by a wealth effect or a credit constraint effect if their initial wealth is very high or very low. With intermediate level of wealth, young households exhibit precautionary saving motive, the strength of which is also influenced by house prices. The extended model with up-sizing and transaction costs indicates that the wealth effect can become very small or even negative for the middle-aged households.

The model provides a simple but unified framework to understand the often conflicting empirical findings in the literature. It also generates testable implications for future empirical analysis. Most importantly, the model indicates that life-cycle stage is a key determinant of the house price-consumption sensitivity. Within each life-cycle, the sensitivity can also vary significantly depending on the constraints faced

by the households. In particular, the model identifies the precautionary saving motive channel of house price-consumption sensitivity and its key determinant, future income volatility. These implications call for further empirical studies with household level micro data.

Chapter 4

Housing Wealth and Stock Market Participation

Using a novel panel dataset, this paper investigates whether variations in housing wealth affect individuals' stock market entry decision. I identify the impact of housing wealth by examining how house price changes predict the stock market entry of homeowners compared to renters, who experience the same economic conditions but the opposite wealth shocks when house prices fluctuate. I find that rising house prices lead to higher probabilities of stock market entry and larger initial investment of homeowners compared to renters. Falling prices lead to larger bank savings of homeowners than renters, likely due to a heightened precautionary saving motive. In contrast, renters avoid the stock market and save more when house prices increase, suggesting implicit housing costs limit stock market participation.

4.1 Introduction

Owner occupied housing is often the most important asset of a household and variations in housing wealth can influence a range of household decisions. In particular, there is a growing recognition of the important role of housing in household portfolio choice. Theoretical studies, such as Flavin and Yamashita (2002), Cocco (2005), Yao and Zhang (2005), Kraft and Munk (2011), Chetty et al. (2017) give rich insight into understanding the optimal portfolio choice with housing. Many of the theoretical predictions have been tested with empirical analysis that focuses on the cross-sectional patterns of household asset allocation between housing and other investments. However, as pointed out by Cocco (2005) and Chetty et al. (2017), one cannot identify the impact of housing on portfolio choice using cross-sectional variations among households, as both housing and portfolio choices could be driven by unobservable factors such as individual preference and expectations.

In this paper, I examine the impact of time-varying housing wealth on individuals' stock investment decisions. Specifically, using an Australian household panel dataset that tracks the same individuals between 2001 and 2015, I examine whether variations in housing wealth influence the stock market entry decision of individuals. I use local house price variations as exogenous shocks to housing wealth and control for changing economic conditions by comparing homeowners and renters who experience the opposite wealth shocks when house prices rise. I find strong evidence that exogenous changes in housing wealth affect individuals' decisions in stock market participation and asset allocation between stocks and bank savings.

This study differs from and complements existing empirical analysis in two aspects. First, I examine how time-varying housing wealth of the same individual affects their investment decisions. The panel structure of the data and the wide range of variables available allow me to control for factors that might otherwise drive the cross-sectional asset allocation decisions, such as individuals' ability and risk attitude. Second, I focus on individuals' stock market entry decisions. Non-participation in stock market has long been a puzzle in the household finance literature (Campbell, 2006). As Guiso and Sodini (2012) point out, an important agenda in solving the puzzle is to examine the stock market entry and exit decisions in a dynamic framework using panel data, such as in Nagel (2008) and Kaustia and Torstila (2011). To the best of my knowledge, this study is the first to examine the role of housing wealth in stock market participation by examining how housing wealth affects an individual's decision on entering the stock market over time.

I use local house price changes to identify exogenous variations in housing wealth. The main challenges of identification are that house price changes are correlated with other factors, such as local labor market conditions, and affect the investment opportunities in other asset classes. To overcome these challenges, I compare the participation decisions of homeowners to renters in the same state in response to house price changes, while controlling for a myriad of individual, region, state and country level factors. This strategy is akin to the generalized difference-in-difference framework in Chaney et al. (2012) and Schmalz et al. (2017) and rests on the assumption that when house prices rise, homeowners gain from increased housing wealth, while

renters lose as their future housing costs increase (Sinai and Souleles, 2005; Campbell and Cocco, 2007). In this setting, renters in the same state serve as a useful "control" group as they face the same changing investment opportunities due to housing market dynamics as homeowners.

The central finding of this paper is that homeowners are significantly more likely to enter the stock market than renters following increases in house prices. This differential effect is economically large: a one-standard-deviation increase in house prices (8.2%) raises the probability of stock market participation of homeowners, relative to renters in the same state, by 0.39%. Given the unconditional annual entry rate during the sample period is 1.7%, this represents a 23% increase in the probability of entering the stock market. This result is robust to different estimation specifications that control for a range of individual and state level variables, year, region, and individual fixed effects. The initial investments of homeowners also tend to be larger than that of renters in states with greater house price growth. These results provide strong evidence that changes in housing wealth (or implicitly housing costs) have significant impact on individuals' stock market participation decisions.

Decomposing the house price changes into price growth and falls provides further insights. First, it is primarily house price growth that spurs stock market participation of homeowners but hinders renters, driving the significant wedge in the participation response between the two groups. Second, renters tend to avoid the stock market and save more in the bank (approximated by their interest income) in response to rising house prices compared to homeowners in the same states. This is consistent with

the view that unlike homeowners, renters cannot hedge against house price risks and need to accumulate more safe assets to buffer against rising housing costs or save for larger home down payment (Sinai and Souleles, 2005). Lastly, house price falls drive homeowners to save more in the bank relative to renters, consistent with the view that reduced housing wealth (and thus housing collateral) heightens the precautionary saving motive of homeowners(Gan, 2010; Konark and Wang, 2018).

Across the life cycle, the differential participation between homeowners and renters is mainly driven by the unconstrained individuals, namely the middle-aged non-retired individuals. As the middle-aged tend to have accumulated certain levels of wealth and are less liquidity constrained than the young, this result suggests that the impact of housing on stock market participation is unlikely due to housing wealth reducing the liquidity constraints of individuals(Constantinidies et al., 2002).[1] Rather, given the changes in bank savings following house price changes, it seems that households adjust their asset allocation between safe assets and stock investments in response to variations in housing wealth.

This empirical study is motivated by the growing theoretical literature on portfolio choice with housing. Cocco (2005) considers housing consumption and a house price process that is correlated with risky labor income in a life-cycle model. He concludes that housing investment leaves limited financial wealth for younger and poorer individuals to invest in stocks. Similarly, in a full-fledged life-cycle model, Yao and Zhang (2005) study the choice between owning and renting a property, and show that

[1] In unreported results, I find mortgage refinance among homeowners do not have significant impact on stock market participation

this housing choice can have significant impact on the investors' portfolio choice. Both studies find supporting evidence from the cross-sections of household asset allocation using the Panel Study of Income Dynamics (PSID) data. More recently, Chetty et al. (2017) distinguish between home equity and mortgage debt and show that only the exogenous increases in home equity raise stock holdings. The authors test their theoretical predictions by applying a cross-sectional instrumental variables strategy with the Survey of Income and Program Participation data and identifying exogenous variations in house prices driven by local housing supply constraints.

This paper contributes new empirical evidence to this literature on portfolio choice with housing. Complementing existing evidence on cross-sectional asset allocation with housing, this study identifies the impact of time-varying housing wealth on individuals' stock market entry and asset allocation decisions. Utilizing the panel structure of the data, I am able to control a range of observable and unobservable individual factors that are difficult to control in a cross-sectional study. My identification strategy of comparing homeowners and renters further controls for factors that might drive the co-movement between house prices and stock market investments, such as economic conditions and expectations of future economic growth, thus improves the identification. The evidence in this paper suggests time-varying housing wealth affects individual asset allocation between risky and safe assets.

This study also contributes to the literature of stock market participation. I join the literature that attempts to explain the limited participation with issues related to housing, such as homeownership (Beaubrun-Diant and Maury, 2016) and mortgage debt

(Becker and Shabani, 2010). This paper shows that rising house prices can lead to stock market participation of individuals with sufficient bank savings but limit stock market entry of renters, thus providing direct evidence that homeownership goal is an important factor limiting stock market participation. In addition, I provide evidence on the stock market entry decision, an area we only have limited understanding (Nagel, 2008; Kaustia and Knpfer, 2012).

Lastly this study relates to the growing area of household finance (Campbell, 2006) and in particular the literature on understanding the role of housing assets in shaping household decisions. The findings show that changing housing wealth not only affect household decisions on consumption (Campbell and Cocco, 2007; Gan, 2010; Konark and Wang, 2018) and entrepreneurship (Adelino, Schoar, and Severino, 2015; Corradin and Popov, 2015; Schmalz et al., 2017), but also individuals' decisions on stock market participation and asset allocation. The results provide evidence of a link between the housing and financial markets through individuals' portfolio choice.

The paper proceeds as follows. In the next section, I present the data and main variables. Section 3 discusses the empirical model and the identification strategy. Empirical analysis is in Section 4, and Section 5 concludes.

4.2 Data and variable construction

4.2.1 Sample selection

This study applies the HILDA survey data. HILDA is a national representative longitudinal survey designed to facilitate studies on income, labor market participation, health, and housing issues of Australian households.[2] The survey began in 2001 with 7,682 households and more than 10,000 individuals and has been conducted annually following the same individuals mainly through face-to-face interviews by professional interviewers.

In many respects, HILDA presents a unique setting to study the long-term dynamic relationship between individual stock market participation decision and housing wealth. First, the panel data structure allows me to examine the participation behavior of the same individuals over time and to apply individual fixed effects to control for unobservable individual characteristics that might jointly determine housing and other investments. Second, HILDA contains detailed housing-related information, such as homeownership status, tenure and movements, mortgages, which allows me to conduct clean econometric tests based on the housing position of a household. Third, the variety of other information collected by HILDA, such as income, wealth, and demographics, permits controls for household heterogeneity and other factors that may influence portfolio choice.

[2]For details of the survey, refer to the User Manual prepared by Summerfield, Freidin, Hahn, Li, Macalalad, Mundy, Watson, Wilkins, and Wooden (2014).

I use wave 1 (2001) to wave 15 (2015) of the HILDA data, the longest range at the time of the study. The basic unit in my study is an individual and I require an individual to be interviewed at least for the first 3 years to be included in the sample.[3] Some individuals might miss some years of the interview but come back into the data in later years. For those individuals, I only keep them in the sample until they first drop out in order to track their stock market participation. To examine the impact of housing wealth on stock market participation decision, I further control the homeownership status of individuals by excluding about 10% of the individuals whose homeownership types involves those other than owning or renting a property.[4] These procedures lead to an unbalanced panel of individuals with 9,539 individuals in 2001 and 5,527 in 2015. Out of the 9,539 individuals in 2001, 5925 are long-term owners throughout the sample period, 1162 are long-term renters and 2,452 changes between homeowners and renters.

4.2.2 Main variables

Most questions in the survey, such as income, ask for the value of variables covering the prior financial year (1st of July to 30th of June 30). Other questions, such as family composition and wealth, give values as of the survey dates.[5] Throughout the

[3] Similar to other survey data, some individuals drop out of the data over time, although HILDA has relatively high retention rates ranging from 86.9% in wave 2 to around 95% in wave 5 and after.

[4] There are two other types: living without rent and rent-and-buy agreement

[5] The data collection starts in August each year, and the bulk of the families are interviewed between August and October.

paper, when I refer to the value of a variable in year t, I mean the value as reported in the survey taken in the year t. Next, I describe the main variables used in the analysis.

4.2.2.1 Measure of stock market participation

As HILDA collects detailed individual income each year, we measure the stock market participation using the dividend income of an individual. Although this measure cannot capture the participation through non-dividend paying stocks, the high market concentration in blue-chip stocks and the high dividend payout ratio in Australia mitigate this concern to a large extent.[6] Further, as long as the choice between dividend paying and non-dividend paying stocks is not systematically correlated with the impact of housing wealth on stock market participation, the fact that we have fewer observations of market entry should work against me finding any significant results[7].

The benefit of this measure is that I can then track the stock market entry decision of individuals over a 15 year period. Specifically, I define participation as the first year when an individual receives dividend income and classify an individual as shareholder if he/she receives dividend income in a particular year. In Table 4.1, the

[6] As of December 1, 2017, the largest 20 stocks account for 50% and the largest 50 accounts for 70% of market capitalization of the All Ordinary Index of Australia. According to the statistics provided by Reserve Bank of Australia, Australia has an average payout ratio between 2005 and 2015 of 67%, which is the highest among United Kingdom, Japan, Europe, Canada and United State (Bergmann, 2016)

[7] One limitation of the study is that I can only capture the direct stock investment. It is possible that individuals can obtain exposure to stocks through other investment channels, such as through the superannuation savings (the compulsory retirement saving scheme in Australia). Therefore, the results of this study should be interpreted in the context of direct stock market investment.

columns labeled “Participate” give the yearly frequencies of the participation measure and the percentage of the new participants out of shareholders. Note in the first year 2001, the participation and shareholders coincide and I cannot determine whether these individuals participated in 2001 or earlier. I therefore only consider the participation between 2002 and 2015.

In Table 4.1, the number of new participants in the stock market declines over time. This is due to the natural attrition of the sample and the definition of our measure as we only count the first time an individual enters the stock market during the 15 year sample period. We capture this declining average participation rate with year fixed effects in our analysis. Comparing the participation between homeowners and renters, we can see although there are more new participants among homeowners each year, the percentage of new participants out of shareholders is actually higher for renters. As summarized in Table 4.2, The average participation rate between 2002 and 2015 is 1.7% per annum among the population and each year about 28 percent of the individuals are shareholders.

TABLE 4.1: Summary statistics of the stock market participation measure

This table presents the annual frequency of stock market participation (Participate), shareholder (SH) and the percentage of new participants among shareholders (% of SH). Stock market participation is a dummy variable equal to 1 if it is the first year an individual receives dividend income and a shareholder is dummy equal to 1 if an individual receives dividend income in a particular year.

	All			Homeowners			Renters		
Year	Participate	SH	% of SH	Participate	SH	% of SH	Participate	SH	% of SH
2001	2953	2953	100.0%	2659	2659	100.0%	294	294	100.0%
2002	587	2821	20.8%	504	2540	19.8%	83	281	29.5%
2003	280	2732	10.2%	243	2479	9.8%	37	253	14.6%
2004	146	2458	5.9%	124	2249	5.5%	22	209	10.5%
2005	128	2341	5.5%	105	2133	4.9%	23	208	11.1%
2006	107	2232	4.8%	84	2030	4.1%	23	202	11.4%
2007	110	2189	5.0%	80	2006	4.0%	30	183	16.4%
2008	75	1948	3.9%	57	1794	3.2%	18	154	11.7%
2009	75	1838	4.1%	64	1701	3.8%	11	137	8.0%
2010	62	1779	3.5%	51	1657	3.1%	11	122	9.0%
2011	34	1730	2.0%	29	1618	1.8%	5	112	4.5%
2012	35	1641	2.1%	29	1537	1.9%	6	104	5.8%
2013	25	1573	1.6%	20	1465	1.4%	5	108	4.6%
2014	31	1530	2.0%	25	1432	1.7%	6	98	6.1%
2015	18	1423	1.3%	15	1332	1.1%	3	91	3.3%

Other concerns with this measure of participation are some individuals might hold non-dividend paying stocks and later switch to dividend paying stocks or the companies they hold start to pay dividends. In these cases, the participation measure actually captures the switching decision or company's decision to pay dividend. Although these cases are unlikely to be systematically different between homeowners and renters, as well as correlating with house prices changes, I create an alternative measure of stock market participation to mitigate these concerns.

Every 4 years (2002, 2006, 2010, 2014), HILDA conducts a special wealth wave to collect detailed household wealth information, including whether a household holds stocks. Based on this information, I exclude those participation observations if 1) the household an individual belongs to hold stocks before his/her participation and 2) no other household members interviewed in the survey participated in the stock market before the wealth wave. For example, assume one person participates in 2007 but her/his household holds stocks in 2006. I would exclude this observation if no other household members participate in the stock market in or prior to 2006. Note, this is a stringent definition that is likely to exclude some genuine active participations.[8] In Table 4.2, the adjusted participation rate reduces to 1.4% per annum between 2002 and 2015. In the robustness test, the alternative measure of participation gives consistent and significant results.

[8]For example, the household stock holding could be from a household member who is not interviewed in that year. Or a household could have received non-dividend paying stocks through employment, government de-mutulization or inheritance, but later decide to buy dividend paying stocks.

Another way to test the appropriateness of the measure is to examine its persistence. In other words, whether those who participated in the stock market continue to receive dividends later on. To measure this, I calculate the ratio of the years between participation and last dividend income: year-to-last-div and the years between the participation and the end of the sample period of an individual: year-to-end-sample. Then the persistent can be measured as the ratio of the two: $\frac{year-to-last-div}{year-to-end-sample}$. The mean value of this measure is 0.92 with the 25th percentile being 1. This indicates a very high persistence of the dividend measure and supports its validity as measure of participation[9].

4.2.2.2 Other variables

Table 4.2 provides the summary statistics of other main variables of the study. The house price index is from CoreLogic RP data for the eight states and territories of Australia. The annual house price growth is 5.1% with a standard deviation of 8.2% and an inter-quartile range of 11.3% in our sample period.

In terms of demographics, the average age of the sample individuals in 2001 is 44.3 years old, 46.1% of the individuals are male, 66.2% are married, 79.1% are home-owners and the proportion of individuals belonging to young (<40), middle (40-60) and old (>60) age groups in 2001 are 43.9%, 38.7% and 17.9% respectively. 46.3%

[9]This high persistence also mitigates the concern that some individuals might bought and sold their stocks before the beginning of the sample period, which means our measure of participation could not capture their initial stock market participation. This high persistence suggests such omission should be of very small number as most individuals seems to continue to hold their stocks after participating.

of the sample received less than 12 years of education, 30.6% have a Diploma and 23.1% have a degree or above. On average, 10% individuals receive business income during the sample period.

Based on a question of risk taking behavior in HILDA, I construct measures of risk attitude and a dummy of being liquidity constraint.[10] Most individuals have high risk aversion: 41.1% and 39.2% have either very high or high risk aversions. 11.2% of the individuals are liquidity constrained during the sample period.

The wage growth rate is negative at 3.2% per annum while bank savings grow at 6.9% each year.[11] This is due to the relative high average age of the sample and the aging and retirement during the sample period. Both mortgage and rental payments decline over time.

[10]The question is "Which of the following statements comes closest to describing the amount of financial risk that you are willing to take with your spare cash? That is, cash used for savings or investment." The individual can choose between 5 choice: 1-3 correspond to taking on substantial, above-average, average risks respectively, 4 is not willing to take on financial risks and 5 is never has any spare cash. Correspondingly, I code 4 types of risk aversion and one dummy variable for liquidity constraint.

[11]The bank savings is constructed based on household wealth information collected every four years. For year without the wealth wave, I assume the value to be the same as in the previous wealth wave.

TABLE 4.2: Summary statistics of the main variables

This table presents the summary statistics of the main variables between 2002 and 2015. D.Participation is a dummy equal to 1 if an individual receive dividend income for the first time during the sample period. D.Participation - Adj is constructed based on D.Participation but excludes the cases where the household an individual belongs to have held stocks before the participation and no other household members interviewed in the survey has participated before. Please see Section 4.2.2.2 for more details. D.Shareholder is a dummy equal to 1 if an individual receives dividend income in a particular year. First dividend is the value of the dividend income when D.Participate = 1. First dividend Adj is the value of the dividend income when D.Participate - Adj = 1. Interest income is the individual's income from annual interest payments received. Dividend income is the individual's annual income from dividends. The age groups thresholds are 40 and 60 years old based on the individual's age in 2001. D.Liquidity constrained and dummies of risk aversion are constructed based a survey question on individual risk taking (see section 4.2.2.2). Wage is the individual income from wage and salary. Bank savings are at the household level constructed based on the special wealth waves. Mortgage and rent payment are measured at annual frequency. House price the state and territory residential property house price indexes from CoreLogic RP data. Local unemployment is the local unemployment rate. State GDP is the gross state product. State consumption is the total consumption of a state. State income is the state income per capita. All growth variables are measured in logged differences except for that of unemployment rate which are measured as simple difference.)

	Mean	SD	p(10)	p(25)	p(50)	p(75)	p(90)	Obs.
Individual level variables								
D.Participation	0.017	0.129	0.000	0.000	0.000	0.000	0.000	100687
D.Participation - Adj	0.014	0.116	0.000	0.000	0.000	0.000	0.000	100687
D.Shareholder	0.280	0.449	0.000	0.000	0.000	1.000	1.000	100687
Log(First dividend)	0.084	0.740	0.000	0.000	0.000	0.000	0.000	100687
Log(First dividend - Adj)	0.067	0.659	0.000	0.000	0.000	0.000	0.000	100687
Log(Interest income)	2.223	3.310	0.000	0.000	0.000	5.525	7.601	100687
Log(Dividend income)	1.665	3.037	0.000	0.000	0.000	3.045	6.909	100687
D.Male	0.461	0.498	0.000	0.000	0.000	1.000	1.000	100687
Age in 2001	44.300	15.936	23.000	33.000	43.000	56.000	67.000	100687
D.Young	0.439	0.496	0.000	0.000	0.000	1.000	1.000	100687
D.Middle-aged	0.387	0.487	0.000	0.000	0.000	1.000	1.000	100687
D.Old	0.174	0.379	0.000	0.000	0.000	0.000	1.000	100687
D.Owner	0.791	0.406	0.000	1.000	1.000	1.000	1.000	100687
D.married	0.662	0.473	0.000	0.000	1.000	1.000	1.000	100687
D.Education - Year 12 or less	0.463	0.499	0.000	0.000	0.000	1.000	1.000	100687
D.Education - Diploma	0.306	0.461	0.000	0.000	0.000	1.000	1.000	100687
D.Education - Degree and above	0.231	0.422	0.000	0.000	0.000	0.000	1.000	100687
D.Business owner	0.100	0.300	0.000	0.000	0.000	0.000	1.000	100687
D.Liquidity constrained	0.112	0.315	0.000	0.000	0.000	0.000	1.000	100687
D.Risk aversion - low	0.125	0.331	0.000	0.000	0.000	0.000	1.000	100687
D.Risk aversion - medium	0.071	0.258	0.000	0.000	0.000	0.000	0.000	100687
D.Risk aversion - high	0.392	0.488	0.000	0.000	0.000	1.000	1.000	100687
D.Risk aversion - very high	0.411	0.492	0.000	0.000	0.000	1.000	1.000	100687
Wage growth	-0.032	2.722	-0.386	-0.025	0.000	0.070	0.445	100687
Bank saving growth	0.069	1.001	0.000	0.000	0.000	0.000	0.300	100687
Mortgage payment growth	-0.015	0.720	-0.051	-0.017	0.000	0.000	0.011	100687
Rent payment growth	-0.006	0.452	-0.023	0.000	0.000	0.000	0.000	100687
Macro variables								
House price growth	0.051	0.082	-0.045	-0.006	0.029	0.107	0.176	100687
Local unemployment growth	0.002	0.034	-0.012	-0.006	-0.002	0.004	0.011	100687
State GDP growth	0.003	0.019	-0.018	-0.010	0.000	0.013	0.033	100687
State consumption growth	-0.008	0.018	-0.033	-0.018	-0.009	0.004	0.013	100687
State income growth	0.022	0.028	-0.013	0.000	0.019	0.039	0.060	100687

4.3 Empirical design

4.3.1 Empirical model

This study examines the impact of time-varying housing wealth on individuals' stock market participation and asset allocation decision. I use local house price changes as exogenous variations to housing wealth and control for a range of individual and state level variables, as well as individual, year and region fixed effects. Let i indexes an individual, t the year of interview, k the state, and j the region.[12].

The baseline predictive model is

$$Participate_{i,t+1} = \alpha_i + \beta_1 \Delta HP_{k,t} + \boldsymbol{\beta_2 Z_{i,t}} + \boldsymbol{\beta_3 S_{k,t}} + \eta_t + \gamma_j + u_{i,t+1}, \quad (4.1)$$

where the dependent variable $Participate_{i,t+1}$ is a dummy variable equal to one if an individual i living in state k, participates in the stock market in year $t+1$. In other tests, the dependent variable can be the level of dividend income or the interest income received by individual i in year t. $\Delta HP_{k,t}$ is the annual house price growth of state k in year t. The vector $\mathbf{Z_{i,t}}$ contains time-varying individual level controls, including changes in wage income, bank savings, mortgage and rent payments, marital status, risk aversion, liquidity constraint and changes in local unemployment rate.

[12]A region is a sub-area within a state. For 5 states, there are two regions within each state: the capital city region and the rest of the state. For one state (Tasmania) and the 2 territories of Australia, there are no regions.

The vector $\mathbf{S_{k,t}}$ contains other state level control variables, including state gross product growth, consumption per capital growth and income per capita growth. α_i is the individual fixed effect which controls for the time-invariant variables such as gender, education, ability etc. η_t is the time fixed effect that controls for country level factors, such as changes in interest rate and market risk premium. γ_k is the region fixed effect that controls for region specific factors. $u_{i,t+1}$ are residuals. Note age and age squared are not included as their effect is indistinguishable from year fixed effect (Deaton, 1992).

In this baseline model, β_1 measures the impact of house price changes on future stock market participation of an individual. A positive value of the coefficient may indicate a wealth spillover effect from the real estate to the stock market while a negative value may be due to a crowding out effect of the housing market on the stock market.

4.3.2 Identification strategy

One concern with the baseline predictive model is that house price variations might correlate with the investment opportunities in other asset classes, such as stock market. For example, rising house prices might contribute to an overall booming economy, where the stock market becomes more attractive to investors. To mitigate the concern that omitted unobservable factors drive the results estimated in the baseline model, I follow the strategy employed in recent studies such as Chaney et al. (2012) and Schmalz et al. (2017). I compare the difference in the stock market participation between homeowners and renters, who are subject to the same macroeconomic

shocks but are differentially affected by house price changes. This strategy is akin to a generalized difference-in-difference strategy, where the "treated group" are homeowners and the "control group" are the renters in the same state. The (continuous) "treatment" is the house-price growth as rising house prices generally lead to wealth gains for homeowners but losses for renters (Sinai and Souleles, 2005).

To implement this strategy, I interact the house prices changes in the baseline model with a dummy variable $Owner_{i,t}$, which equals to one if the individual is a homeowner in year t. The modified predictive model is

$$P_{i,t+1} = \alpha_i + \beta_0 \Delta HP_{k,t} + \beta_1 \Delta HP_{k,t} * Owner_{i,t} + \beta_2 \mathbf{Z_{i,t}} + \beta_3 \mathbf{S_{k,t}} + \eta_t + \gamma_j + u_{i,t}, \quad (4.2)$$

The coefficients of interest in this equation are β_0 and β_1, where the former measures the response of participation decision of renters and the latter the incremental propensity of participation of homeowners. This identification strategy uses both cross-sectional and time series variations in house prices to identify β_1. First, in a given year, some states experience larger house price growth than others, so β_1 is identified by comparing the difference in stock market participation between homeowners and renters across states with different levels of house price growth. Second, within a give state, β_1 is also identified by the difference in stock market participation between homeowners and renters as house price growth evolves. The null hypothesis is that $\beta_1 = 0$, which would indicate that changing housing wealth do not affect individual's stock market participation decision. A positive β_1 would indicate that

homeowners are more likely to participate in the stock market than renters in regions with higher house price growth. This means that housing wealth changes do affect individuals' stock market participation decision.

4.4 Empirical analysis

4.4.1 Baseline results

In this section, I provide the baseline results on how house price changes affect an individual's stock market participation decision. I estimate various specifications of Equation 4.2 with linear probability model and present the baseline results in Table 4.3. The sample period is between 2002 and 2015.[13] The standard errors are clustered at the individual level. Specifications (1) to (4), (6) and (8) do not include individual fixed effects and specifications (5), (7) and (9) do. All specifications control for year and region fixed effects.

In specification (1), I do not distinguish between homeowners and renters, and the overall effect of house price growth on the stock market participation decision is positive but not significant. This indicates the aggregate impact of housing wealth on

[13]The predictive model effectively exclude the 2001 and 2002 participation events. As 2001 is the first year of the sample and I cannot determine whether an individual enters the stock market in 2001 or earlier, 2001 is excluded. To guard against the possibilities that some individuals missed the question on dividend income question in the first year of the survey (2001), but started to answer the question only from the second year (2002), the predictive model effectively excludes 2002. This is prudent given the high initial participation rates in 2001 and 2002 of the sample.

stock market participation is limited but potentially masks the differential impact of house prices on homeowners and renters. In column (2), I add the interaction of house price growth and the dummy variable *Owner* into the specification to test the differential response between homeowners and renters. In this setting, the coefficient of house price growth measures renters' stock market participation response to house price growth and the coefficient on the interaction term between house price growth and *Owner* captures the incremental propensity of participation of homeowners. We can see renters have a significant negative response to house price changes. More importantly, the coefficient on the interaction term is positive and significant, which means homeowners are significantly more likely to enter into the stock market than renters in response to rising house prices. This result is consistent with the argument that homeowners on average benefit from growing housing wealth while renters tend to incur high housing costs when house prices rise. The significant differential response between homeowners and renters supports the hypothesis that time-varying housing wealth affect individuals' stock market participation decision.

In column (3), I add other individual level control variables, including their wage growth, bank savings growth, mortgage and rent payment growth which could affect the wealth and cash flows of an individual. To account for the possibility that variations in wealth leads to changes in individuals risk attitude, I control for the risk aversion of an individual (Nagel, 2008). Further, I control for individuals' marital status, gender, age group, education levels and whether an individual is liquidity constrained. Among the control variables, increases in bank savings, increase of risk aversion from

the very low level, and having a diploma significantly increase the probability of stock market participation. By contrast, liquidity constraints significantly limit stock market participation. I also include other state level variables including gross product, total consumption, income per capita, and local unemployment changes to control for local economic conditions. With all these control variables, the coefficients on house price growth and its interaction with the owner dummy are almost unchanged from the those in column (2). This indicates that the differential impact of house price changes on stock market participation is not driven by those other factors.

One concern of the identification strategy of comparing homeowners with renters in the same state is that renters may not be the perfect control group. After all, homeowners and renters are different in many aspects, such as age and income. To address this concern, I follow Schmalz et al. (2017) and interact the owner dummy with all individual characteristics. The idea behind this method is that if these characteristics are correlated with own-versus-rent decision and with the individuals' elasticity of stock market participation to house-price growth, then we can directly control the impact of these characteristics. As shown in column (4), where I add the interactions of all individual characteristics with *Owner*, the results on house-price growth remain almost the same as in column (3). Therefore, the difference between homeowners and renters seem to have limited impact on the estimation results.[14].

[14]One might consider there are differences in the saving behaviour between homeowners with mortgage and those without mortgage as well as renters, as paying off mortgage would represent a better risk-free alternative than bank deposit for those with mortgage. However, this should lead to less divergence between homeowners and renters saving response to house prices if homeowners with mortgage do not adjust their bank savings. This should in fact reduce the probability of finding a significant

To further mitigate the concern of systematic differences between homeowners and renters, in column (5), I control for individual fixed effects. The fixed effect controls for time-invariant factors such as individual's ability, IQ, financial literacy, trust, habit and preferences that have been shown important for both homeownership and stock market participation (Guiso and Jappelli, 2005; Guiso, Sapienza, and Zingales, 2008; Nagel, 2008; Kaustia and Torstila, 2011; Van Rooij, Lusardi, and Alessie, 2011; Grinblatt, Keloharju, and Linnainmaa, 2012; Changwony, Campbell, and Tabner, 2014). In this case, some time-invariant variables drop out of the estimation. The results remain almost unchanged and it seems unlikely the results are driven by factors other than the differential housing position between homeowners and renters. However, as in Chaney et al. (2012) and Schmalz et al. (2017), I lack a perfect instrument for homeownership. This is one limitation of this study. To mitigate the concerns, I will in later sections explore the various dimensions of the cross-sectional heterogeneity to show that the results are most likely driven by the difference in housing wealth but not other omitted factors.

Overall, the consistent differential response between homeowners and renters to house price variations observed in columns (2) to (5) give strong evidence that time-varying housing wealth matters for stock market participation decisions of individuals. The magnitude of the differential effect of housing wealth changes on stock market participation is also large. A one-standard-deviation increase in house-price growth (8.2%)

difference between homeowners and renters. The fact that the results suggest otherwise reinforces my conclusion.

lead to a 0.39% (0.082*0.047) increase in the probability of stock market participation of owners relative to renters in the same state. With an unconditional probability of stock market participation of 1.7% in the sample period, this corresponds to a significant 23% increase in the probability of participation. Therefore, the changing housing wealth drives a large wedge in the stock market participation behavior between homeowners and renters.

Also it is important to note the significant negative response of renters' participation in the stock market to house-price growth. As pointed out by Sinai and Souleles (2005), renters are short in housing assets and cannot hedge against rent risks. Rising house prices will therefore increase the future housing costs of renters, especially when renters intend to achieve homeownership, as they need to save more for the down-payment. This implicit housing wealth losses due to rising house prices seem to have significant impact on renters' stock market participation decisions. This finding suggests that homeownership goal or the need to hedge housing cousts may be a factor limiting stock market participation.

TABLE 4.3: Housing wealth and stock market participation

This table presents the baseline results of the predictive regression models. The dependent variable in specifications (1) to (5) is $D.Participation_{t+1}$, a dummy variable equal to one if an individual receives dividend income for the first time during the sample period in year $t+1$. The dependent variable in specifications (6) and (7) is $Log(First\ dividend)_{t+1}$, the value of the first dividend if $D.Participation_{t+1} = 1$ and otherwise zero. The dependent variable in specifications (8) and (9) is $Log(Interest\ income)_{t+1}$, the value of an individual's interest income. $D.Owner_t$ is a dummy variable equal to 1 if an individual is homeowner in year t. Other variables are defined in the notes of Table 4.2 and measured in year t. Columns (4), (6) and (8) include individual level control variables interacted with D.Owner and columns (5), (7), and (9) include individual fixed effects. All specifications include year and region fixed effects. Standard errors clustered by individual are reported in parentheses. Significance levels at 1%, 5% and 10% are indicated by ***, **, and *, respectively.

Dependent variable	$D.Participation_{t+1}$					$Log(First\ dividend)_{t+1}$		$Log(Interest\ income)_{t+1}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$House\ price\ growth_t$	0.004	-0.032***	-0.033***	-0.033***	-0.032**	-0.100	-0.089	0.724**	0.539**
	(0.008)	(0.011)	(0.012)	(0.012)	(0.012)	(0.067)	(0.069)	(0.283)	(0.253)
$House\ price\ growth_t$*$D.Owner_t$		0.046***	0.046***	0.045***	0.047***	0.181***	0.181***	-1.120***	-0.600**
		(0.011)	(0.011)	(0.011)	(0.012)	(0.063)	(0.066)	(0.277)	(0.243)
$D.Owner_t$		0.001	0.000	0.003	-0.004	0.028*	-0.015	0.320**	-0.761***
		(0.001)	(0.001)	(0.003)	(0.002)	(0.016)	(0.014)	(0.131)	(0.066)
Wage growth			0.000	0.000**	0.000	0.002*	0.001	-0.007	-0.008***
			(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.005)	(0.003)
Bank savings growth			0.001**	0.001**	0.001**	0.006*	0.005**	0.130***	0.115***
			(0.000)	(0.001)	(0.000)	(0.003)	(0.002)	(0.014)	(0.008)
Mortgage payment growth			-0.000	-0.000	-0.000	-0.000	0.001	-0.020	-0.038***
			(0.001)	(0.001)	(0.001)	(0.004)	(0.004)	(0.013)	(0.012)
Rent payment growth			0.001	0.001	0.000	0.008	0.005	0.184***	-0.057**
			(0.001)	(0.001)	(0.001)	(0.006)	(0.007)	(0.023)	(0.022)
D.Married			-0.001	-0.002	-0.000	-0.009	-0.003	-0.011	-0.160***
			(0.001)	(0.001)	(0.002)	(0.009)	(0.011)	(0.073)	(0.056)
D.Middle-aged			-0.000	0.000		0.011		0.573***	
			(0.001)	(0.002)		(0.010)		(0.097)	
D.Old			0.000	0.000		0.008		1.415***	
			(0.001)	(0.002)		(0.013)		(0.172)	
D.Female			0.001	-0.001		-0.004		0.005	
			(0.001)	(0.001)		(0.008)		(0.079)	

Table continued...	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
D.Education - Diploma			0.002**	0.004**	0.008***	0.024**	0.046***	0.127	0.094
			(0.001)	(0.002)	(0.003)	(0.010)	(0.015)	(0.083)	(0.077)
D.Education - Degree and above			0.001	0.004*	0.003	0.021*	0.039	0.875***	0.447***
			(0.001)	(0.002)	(0.006)	(0.012)	(0.027)	(0.116)	(0.144)
D.Business owner			0.001	0.000	-0.001	0.007	0.002	0.105	0.113**
			(0.001)	(0.003)	(0.002)	(0.021)	(0.012)	(0.119)	(0.050)
D.Liquidity constrained			-0.006***	-0.005***	-0.003**	-0.022**	-0.023***	-0.799***	-0.164***
			(0.001)	(0.002)	(0.001)	(0.009)	(0.009)	(0.053)	(0.028)
D.Risk aversion - medium			0.004**	0.013***	0.002	0.086***	0.029	1.258***	0.160***
			(0.002)	(0.005)	(0.003)	(0.030)	(0.020)	(0.159)	(0.054)
D.Risk aversion - high			0.001	0.004*	0.000	0.031**	0.001	1.207***	0.213***
			(0.001)	(0.002)	(0.002)	(0.014)	(0.012)	(0.092)	(0.040)
D.Risk aversion - very high			-0.001	-0.001	-0.002	-0.007	-0.017	0.073	0.102**
			(0.001)	(0.002)	(0.002)	(0.009)	(0.013)	(0.063)	(0.041)
Local unemployment growth			0.056	0.058	0.069	0.365	0.457	0.272	1.038
			(0.055)	(0.055)	(0.055)	(0.328)	(0.332)	(1.061)	(1.001)
State GDP growth			0.067*	0.067*	0.052	0.385	0.320	2.102**	1.434
			(0.040)	(0.040)	(0.041)	(0.278)	(0.282)	(1.017)	(0.935)
State consumption growth			0.019	0.019	0.024	0.233	0.202	0.507	0.559
			(0.042)	(0.042)	(0.042)	(0.245)	(0.247)	(0.825)	(0.772)
State income growth			-0.043*	-0.043*	-0.036	-0.176	-0.127	-0.719	-0.489
			(0.026)	(0.026)	(0.026)	(0.150)	(0.152)	(0.581)	(0.539)
Wage growth*D.Owner				-0.000*		-0.002		-0.010	
				(0.000)		(0.002)		(0.006)	
Bank savings growth*D.Owner				-0.001		-0.002		-0.020	
				(0.001)		(0.005)		(0.019)	

Table continued...	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
D.Married*D.Owner				0.001		0.003		-0.274***	
				(0.002)		(0.010)		(0.095)	
D.Middle-aged*D.Owner				-0.000		-0.005		0.886***	
				(0.002)		(0.012)		(0.112)	
D.Old*D.Owner				0.000		0.008		1.848***	
				(0.002)		(0.015)		(0.189)	
D.Female*D.Owner				0.002		0.006		0.222**	
				(0.002)		(0.010)		(0.096)	
D.Education - Diploma*D.Owner				-0.003		-0.016		-0.103	
				(0.002)		(0.011)		(0.105)	
D.Education - Degree and above*D.Owner				-0.004*		-0.017		-0.782***	
				(0.002)		(0.014)		(0.135)	
D.Business owner * D.Owner				0.001		-0.004		0.314**	
				(0.003)		(0.022)		(0.142)	
D.Liquidity constrained*D.Owner				-0.001		-0.012		-0.506***	
				(0.002)		(0.012)		(0.074)	
D.Risk aversion-medium*D.Owner				-0.011**		-0.062*		-0.131	
				(0.005)		(0.034)		(0.186)	
D.Risk aversion-high*D.Owner				-0.005		-0.036**		-0.083	
				(0.003)		(0.017)		(0.117)	
D.Risk aversion-very high*D.Owner				-0.001		-0.008		0.022	
				(0.002)		(0.013)		(0.093)	
Individual fixed effect	No	No	No	No	Yes	No	Yes	No	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	91134	91134	91134	91134	91134	91134	91134	91134	91134
Adjusted R-squared	0.004	0.005	0.005	0.005	0.005	0.003	0.003	0.183	0.030

Next, I examine the intensive margin of the impact of housing wealth changes on stock market participation. I use the value of the first dividend an individual receives as a proxy for the value of stock market investment. Specifically, I replace the dummy variable $Participate_{i,t+1}$ in Equation 4.2 with the $Log(First\ dividend)_{i,t+1}$ that measures the value of the first dividend payment. The identification strategy is the same as before, where the "treated group" and "control group" are homeowners and renters in the same state and the continuous treatments are the various levels of house-price growth individuals experience.

Column (6) presents the estimation with individual level control variables interacted with the owner dummy and column (7) include individual fixed effect. In both specifications, I find significant differences in the amount of amount of initial stock market investments between homeowners and renters in response to house-price growth. The size of the impact is significant. A one-standard-deviation increase in house prices (8.2%) increases the size of initial dividends of homeowners by 0.015 (0.082*0.181) compared to renters. Given the average logged initial dividends over the sample period is 0.084, this represents an 18% increases in the size of initial investment of homeowners relative to renters. This result indicates that house-price growth not only drives a wedge in the probability of stock market participation, but also leads to a divergence in the size of the initial investments between homeowners and renters.

If housing wealth affects the stock market participation decisions of individuals, where does the investment fund come from? Apart from labor income, one possible source of fund is the individuals' savings in bank deposit and other interest bearing

investments. To investigate this question, I examine the impact of variations in housing wealth on the level of bank savings of an individual, which is approximated by the level of interest income received by the individual.[15] Specifically, I replace the dummy variable $Participate_{i,t+1}$ in Equation 4.2 with the $Log(Interest\ income)_{i,t+1}$ which measures the value of the interest income of an individual and present the estimations in columns (8) and (9).

Column (8) presents the estimation with individual level controls interacted with the owner dummy and column (9) includes individual fixed effect. In both specifications, rising housing prices significantly increase the safe savings of renters but not homeowners, and the difference between the two groups is significant. These results indicate that homeowners and renters adjust their bank savings in response to house price changes in exactly the opposite directions to their stock market participation decision in response to house price changes.

Combining the results on stock market participation and bank savings, it seems that house price variations affect the asset allocation decisions of individuals. Renters tend to save more safe asset in response to rising house prices and avoid the stock market. In contrast, homeowners can not only hedge against rising housing costs (do not need to save more) but also enjoy a wealth spillover from the increased housing

[15] Interest income can also vary due to change in interest rate. However, two factors mitigate this concern. First, I include year fixed effect which controls for the differences in interest rates across different years. Second, I compare the interest income of homeowners and renters and it is unlikely the interest rate on bank savings are systematically different for the two groups.

wealth and participate in the stock market. These results shed new light on the role of housing asset in household portfolio choice[16].

4.4.2 Asymmetric house price changes and asset allocation

In this section, I decompose the house price changes into house price growth and falls and examine their respective impact on individual stock market participation and asset allocation decisions. This exercise provides insights into the link between housing and stock markets under different market conditions. Also by examining individuals' response to house price growth and falls separately, we can better understand the mechanisms underpinning the link between house price changes and stock market participation.

Table 4.4 presents the estimated impact of house price growth and falls on stock market participation (columns (1) and (2)), the value of first dividend income (columns (3) and (4)) and interest income (columns (5) and (6)). Specifications (1), (3) and (5) control for individuals level variables interacted with the dummy *Owner*, and (2), (4) and (6) include individual fixed effects. The control variables are the same as in corresponding specifications in Table 3. The main variable "house price up" is equal to positive house price growth or zero if house prices fall, and "house price down" is equal to negative house price growth or zero if house prices rise.

[16] I also conduct robustness tests where I scale the dollar value dividend and interest income by the total financial assets of a household in 2002 (beginning of the sample period). The results of dividend income remain significant but those of the interest income become insignificant.

In columns (1) and (2), we can see that the difference in stock market participation sensitivity between homeowners and renters is mainly driven by house price growth. In terms of the first dividend income, results in columns (3) and (4) suggest both house price growth and falls are both marginally important. For the interest income, columns (6) with individual fixed effect provides interesting results: house price growth drives higher bank savings of renters while falls lead to higher banking savings of homeowners.

Combing the results on both stock market participation and bank savings, two consistent findings emerge. First, rising house prices significantly limit the stock market entry of renters (columns (1) and (2)) and cause renters to save more in safe assets (column (6)). This again confirms the argument that renters need to hedge against rising housing costs with more safe assets. Second, higher house prices raise the stock market participation of homeowners significantly relative to renters but price falls increase their bank savings compared to renters. The stock market participation is consistent with the rising housing wealth of homeowners when rising house prices. The increase in bank savings in response to house price falls seems to be consistent the argument that housing wealth affects the precautionary saving motive of homeowners (Gan, 2010). Lower house value reduces the ability of homeowners to borrow in "hard times" and they therefore need to save more in the bank.

The results in this section also suggest that booming housing market can lead to a significant wedge between homeowners and renters in their the stock market participation decisions. As stock market participation has significant impact on long-term

wealth growth and accumulation, this study raises the concern of a divergent welfare effect of sustained house price growth in countries like Australia and China.

TABLE 4.4: Asymmetric house price changes and stock market participation

This table estimates the asymmetric impact of house price growth and falls in year t on stock market participation (columns (1) and (2) with dependent variable $D.Participation_{t+1}$), the value of first dividend (columns (3) and (4) with dependent variable $Log(First\ dividend)_{t+1}$), and the value of interest income (columns (5)-(6) with dependent variable $Log(Interest\ income)_{t+1}$) in year $t+1$. $House\ price\ up_t$ is equal to the $house\ price\ growth_t$ if the growth is positive and otherwise zero. $House\ price\ down_t$ is equal to $house\ price\ growth_t$ if the growth is negative and otherwise zero. Columns (1), (3) and (5) include individual level control variables interacted with the dummy $D.Owner_t$, and columns (2), (4), and (6) include individual fixed effects. The control variables are the same as in Table 4.3 and not reported. Standard errors clustered by individual are reported in parentheses. Significance levels at 1%, 5% and 10% are indicated by ***, **, and *, respectively.

Dependent variable :	$D.Participation_{t+1}$		$Log(First\ dividend)_{t+1}$		$Log(Interest\ income)_{t+1}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$House\ price\ up_t$	-0.036**	-0.035**	-0.099	-0.078	0.501	0.460*
	(0.015)	(0.016)	(0.081)	(0.085)	(0.317)	(0.277)
$House\ price\ up_t * D.Owner_t$	0.045***	0.046***	0.152*	0.146	-0.735**	-0.371
	(0.015)	(0.016)	(0.085)	(0.090)	(0.333)	(0.287)
$House\ price\ down_t$	-0.004	-0.009	-0.050	-0.090	1.579*	0.783
	(0.037)	(0.038)	(0.207)	(0.214)	(0.924)	(0.790)
$House\ price\ down_t * D.Owner_t$	0.044	0.048	0.316	0.344*	-2.944***	-1.905**
	(0.035)	(0.036)	(0.193)	(0.201)	(0.956)	(0.791)
$D.Owner_t$	0.003	-0.003	0.031*	-0.011	0.280**	-0.790***
	(0.003)	(0.003)	(0.017)	(0.015)	(0.132)	(0.068)
Individual fixed effect	No	Yes	No	Yes	No	Yes
Individual level controls	Yes	Yes	Yes	Yes	Yes	Yes
State level controls	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	91134	91134	91134	91134	91134	91134
Adjusted R-squared	0.005	0.005	0.003	0.003	0.183	0.032

4.4.3 Subsample tests

To provide further insight into the relationship between housing wealth and individuals stock market participation decision, I examine the cross-sectional heterogeneity of this relationship through subsample analysis in this section. First, I examine the life-cycle patterns of this relationship. This exercise improves our understanding of the life-cycle behavior of individuals and mitigates the concern that life-cycle difference between homeowners and owners bias our results (Gourinchas and Parker, 2002; Cocco, Gomes, and Maenhout, 2005; Kraft and Munk, 2011). I classify individuals into 3 life-cycle group based on their employment status and age at the beginning of the sample period: retired and non-retired, with the second group further classified into young and middle-aged based on the medium age of the group at 42. Here the retired group corresponds to the older individuals. I use the employment status to categorize individuals because the existing literature has shown employment status and labor income risks can affect individuals' stock market participation decisions (Guiso, Jappelli, and Terlizzese, 1996; Angerer and LAM, 2009; Betermier, Jansson, Parlour, and Walden, 2012). Table 4.5 presents the estimated impact of house price changes on stock market participation (columns (1) to (4)) and bank savings (columns (5) to (8)) with individual fixed effects.

For stock market participation, the significant difference between homeowners and renters are mainly driven by the non-retired individuals (column (1) and (4)). The insignificant results of the retired sample is unsurprising given life-cycle theories predict reduced exposure to risky assets in the advanced age. Among the non-retired, the

middle-aged group have larger and more significant differences in stock market participation propensity than the young. As the young tend to be more credit constrained than the middle-aged, this results seem to suggest that credit constraints are not the main driver of the results (Iacoviello, 2004; Lustig and Van Nieuwerburgh, 2005; Gan, 2010; Adelino et al., 2015; Schmalz et al., 2017) Rather, as the middle-aged tend to have accumulated certain wealth, their strong response to housing wealth is likely to be consistent with a precautionary saving channel. High house prices significantly raise middle-aged renters' propensity to save if they are closer to buying a first property but reduces the precautionary savings of homeowners as the increases in house value provide a larger collateral to borrow against in "hard time".

Similar results can be found for the level of bank savings where the differential response between homeowners and renters are mainly driven by the non-retired middle-aged group. This result is consistent with my conjecture that middle-aged individual adjust their bankings and stock market investment in response to house price changes. Interestingly, the retired renters seem to be particularly sensitive in their bank savings to house price changes perhaps due to the heightened cautiousness with growing age.

TABLE 4.5: The housing wealth effect across the life cycle

This table presents the estimated impact of house price changes in year t on future stock market participation (columns (1) to (4) with dependent variable $D.Participation_{t+1}$) and the value of interest income (columns (5) to (8) with dependent variable $Log(Interest\ Income)_{t+1}$) across employment status and life-cycle in year $t+1$. All variables are as defined in the notes of Table 4.2. The young and middle-age age group of the non-retired individuals are classified by the median age of the non-retired at 42 years old. All specifications include individual, year and region fixed effects. Standard errors clustered by individual are reported in parentheses. Significance levels at 1%, 5% and 10% are indicated by ***, **, and *, respectively.

Dependent variable :	$D.Participation_{t+1}$				$Log(Interest\ Income)_{t+1}$			
	Non retired			Retired	Non retired			Retired
	All	Young	Middle-aged	All	All	Young	Middle-aged	All
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
House price growth$_t$	-0.031**	-0.026	-0.055**	-0.019	0.542*	0.240	0.996	1.017*
	(0.014)	(0.017)	(0.025)	(0.027)	(0.282)	(0.315)	(0.647)	(0.557)
House price growth$_t$ * D.Owner	0.047***	0.030*	0.086***	0.027	-0.775***	-0.325	-1.370**	-0.565
	(0.013)	(0.016)	(0.025)	(0.028)	(0.269)	(0.296)	(0.623)	(0.547)
D.Owner$_t$	-0.003	-0.002	-0.008	-0.012	-0.782***	-0.797***	-0.726***	-0.433
	(0.003)	(0.003)	(0.005)	(0.012)	(0.067)	(0.072)	(0.173)	(0.317)
Wage growth	0.000	0.000	0.000	-0.000	-0.007**	-0.003	-0.011**	-0.014
	(0.000)	(0.000)	(0.000)	(0.001)	(0.003)	(0.003)	(0.005)	(0.011)
Bank savings growth	0.001**	0.001**	0.001	-0.001	0.117***	0.123***	0.106***	0.087***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.009)	(0.010)	(0.017)	(0.022)
Mortgage payment growth	-0.000	-0.000	-0.000	-0.002	-0.038***	-0.047***	-0.027	-0.041
	(0.001)	(0.001)	(0.001)	(0.002)	(0.012)	(0.016)	(0.019)	(0.044)
Rent payment growth	0.001	0.001	-0.001	-0.004	-0.066***	-0.082***	0.021	0.050
	(0.001)	(0.001)	(0.003)	(0.006)	(0.023)	(0.025)	(0.058)	(0.095)
D.Married	-0.001	-0.000	-0.006	0.002	-0.177***	-0.163**	-0.169	-0.298*
	(0.002)	(0.002)	(0.005)	(0.006)	(0.060)	(0.064)	(0.163)	(0.157)
D.Education - Diploma	0.007**	0.008**	0.002	0.017***	0.045	0.066	0.089	-0.122
	(0.003)	(0.003)	(0.007)	(0.004)	(0.077)	(0.080)	(0.206)	(1.770)
D.Education - Degree and above	0.002	0.003	-0.023	0.028***	0.361**	0.508***	-0.739	-4.981***
	(0.006)	(0.006)	(0.023)	(0.005)	(0.144)	(0.148)	(0.644)	(0.075)
D.Business owner	-0.001	-0.004*	0.003	0.009	0.109**	0.125**	0.110	0.255
	(0.002)	(0.002)	(0.003)	(0.012)	(0.051)	(0.064)	(0.084)	(0.223)
D.Liquidity constrained	-0.005***	-0.005**	-0.004	0.000	-0.157***	-0.138***	-0.198***	-0.200***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.030)	(0.034)	(0.058)	(0.067)
D.Risk aversion - medium	0.001	0.002	-0.002	0.014	0.173***	0.095	0.359***	-0.005
	(0.003)	(0.004)	(0.005)	(0.011)	(0.056)	(0.065)	(0.108)	(0.218)
D.Risk aversion - high	-0.001	-0.003	0.003	0.010*	0.211***	0.161***	0.327***	0.215*
	(0.002)	(0.003)	(0.004)	(0.006)	(0.042)	(0.048)	(0.083)	(0.121)
D.Risk aversion - very high	-0.005*	-0.007**	0.001	0.010	0.091**	0.058	0.169*	0.157
	(0.002)	(0.003)	(0.004)	(0.006)	(0.044)	(0.049)	(0.087)	(0.122)
Local unemployment growth	0.115*	0.015	0.263***	-0.109	1.986*	1.685	2.581	-3.511
	(0.063)	(0.081)	(0.101)	(0.115)	(1.086)	(1.310)	(1.895)	(2.497)
State GDP growth	0.095**	0.098	0.096	-0.151*	1.415	2.186*	0.162	2.328
	(0.046)	(0.061)	(0.067)	(0.090)	(1.015)	(1.196)	(1.806)	(2.392)
State consumption growth	0.043	0.033	0.061	-0.072	0.316	0.274	0.744	1.220
	(0.047)	(0.060)	(0.076)	(0.094)	(0.847)	(0.970)	(1.594)	(1.873)
State income growth	-0.043	-0.056	-0.025	0.007	-0.382	-0.409	-0.457	-0.779
	(0.029)	(0.036)	(0.049)	(0.060)	(0.589)	(0.703)	(1.029)	(1.339)
Individual fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	72304	44462	27842	18830	72304	44462	27842	18830
Adjusted R-squared	0.004	0.003	0.006	0.008	0.038	0.040	0.040	0.015

Next, to further examine whether the precautionary motive drives the individuals' stock market participation response to house price changes, I test the impact of labor income volatility. Individuals with high income volatility should have stronger precautionary savings motive and if this group's participation is more responsive to house price changes, then it is more likely that the precautionary savings motive play an important role. I therefore divided the sample into those with high and low wage volatility and present the estimations for both groups in Table 4.6. Note all specifications are with individual fixed effects. As we can see from the table, both participation and the level of bank savings, the results are only significant for the group with high income volatility. This result gives strong evidence of a precautionary savings motive that drive individuals' strong market entry and saving decision in response to house price changes.

TABLE 4.6: The housing wealth effect and income volatility - a precautionary savings motive?

This table presents the estimated impact of house price changes in year t on future stock market participation (columns (1) to (2) with dependent variable $D.Participation_{t+1}$) and the value of interest income (columns (3) and (4) with dependent variable $Log(Interest\ Income)_{t+1}$) across individuals with different high or low levels of labour income. All variables are as defined in the notes of Table 4.2. All specifications include individual, year and region fixed effects. Standard errors clustered by individual are reported in parentheses. Significance levels at 1%, 5% and 10% are indicated by ***, **, and *, respectively.

Dependent variable :	$D.Participation_{t+1}$		$Log(Interest\ Income)_{t+1}$	
	Labour Income Volaility			
	High	Low	High	Low
	(1)	(2)	(3)	(4)
$House\ price\ growth_t$	-0.033**	-0.028	0.419	0.570
	(0.016)	(0.020)	(0.317)	(0.389)
$House\ price\ growth_t * D.Owner$	0.059***	0.030	-0.528*	-0.587
	(0.015)	(0.020)	(0.307)	(0.369)
$D.Owner$	-0.003	-0.004	-0.647***	-0.868***
	(0.003)	(0.004)	(0.079)	(0.108)
Wage growth	0.000	-0.001	-0.007***	-0.064*
	(0.000)	(0.002)	(0.003)	(0.038)
Bank savings growth	0.001*	0.001	0.107***	0.111***
	(0.001)	(0.000)	(0.011)	(0.012)
Mortgage payment growth	-0.000	-0.000	-0.030*	-0.045***
	(0.001)	(0.001)	(0.016)	(0.016)
Rent payment growth	-0.002	0.004**	-0.020	-0.096***
	(0.002)	(0.002)	(0.028)	(0.034)
D.Married	0.000	-0.000	-0.170**	-0.153*
	(0.002)	(0.003)	(0.071)	(0.083)
D.Education - Diploma	0.009**	0.004	0.075	0.063
	(0.004)	(0.004)	(0.091)	(0.131)
D.Education - Degree and above	0.003	-0.001	0.500***	0.149
	(0.007)	(0.012)	(0.164)	(0.262)
D.Business owner	0.001	-0.006*	0.084	0.206**
	(0.002)	(0.004)	(0.055)	(0.103)
D.Liquidity constrained	-0.003	-0.004*	-0.142***	-0.171***
	(0.002)	(0.002)	(0.037)	(0.039)
D.Risk aversion - medium	0.003	0.002	0.122*	0.212***
	(0.004)	(0.004)	(0.069)	(0.081)
D.Risk aversion - high	-0.002	0.003	0.181***	0.253***
	(0.003)	(0.003)	(0.051)	(0.059)
D.Risk aversion - very high	-0.006*	0.002	0.082	0.131**
	(0.003)	(0.003)	(0.054)	(0.060)
Local unemployment growth	0.127*	-0.005	2.291*	-0.595
	(0.075)	(0.081)	(1.349)	(1.395)
State GDP growth	0.108*	-0.011	2.674**	-0.095
	(0.062)	(0.052)	(1.241)	(1.304)
State consumption growth	0.079	-0.033	0.421	0.648
	(0.059)	(0.061)	(1.063)	(1.055)
State income growth	-0.080**	0.008	-1.828**	0.933
	(0.037)	(0.037)	(0.731)	(0.738)
Individual fixed effect	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes
Observations	45972	45162	45972	45162
Adjusted R-squared	0.004	0.006	0.032	0.025

Lastly, I examine whether the impact of housing wealth differs with the levels of housing assets of an individuals. If is the housing wealth between homeowners and renters that drives their divergent response to house price changes, then we would expect individuals who have more than one properties to potentially enjoy a larger housing wealth growth when house prices rise. I further categorize owners into those with one property (home property) and those with two or more properties and interact the categorical variable with house-price growth (as well as house price up and down). In these specifications, the coefficient on house price growth (up and down) measures the sensitivity of renters and the coefficients on the interactions with the categorical variable measure the incremental sensitivity of those with one property or more than one properties. The specifications applied in these tests have individual, year and region fixed effects as well as all the individual and state level controls applied before. The estimation results are presented in Table 4.7

In column (1) of Table 4.7, we can see both homeowners with and without other properties are significantly more likely to participate in the stock market in response to rising house prices compared to renters in the same state, but the those with more than one properties have a larger incremental propensity. In column (3), those with only 1 property have slightly larger initial stock market investment in response to house price growth than those with more than one property. Column (5) indicates that those with more than one property adjust their bank savings much more strongly than both renters and those with only one property.

Examining the house price up and downs separately in columns (2), (4) and (6) gives

similar results. It seems the impact of house price variations on stock market participation are not significantly different for those with one or more properties. By contrast, the level of housing wealth significantly affect the individuals bank savings behavior in response to house price changes. This seems to suggest that individuals with more housing asset exhibit stronger precautionary savings motive.

TABLE 4.7: The effect of multiple property and the housing wealth effect

This table estimates the impact of house price changes in year t on stock market participation (columns (1) and (2) with dependent variable $D.Participation_{t+1}$), the value of first dividend (columns (3) and (4) with dependent variable $Log(First\ dividend)_{t+1}$), and the value of interest income (columns (5)-(6) with dependent variable $Log(Interest\ income)_{t+1}$) in year $t+1$ of individuals who own zero, one and two or more properties. $House\ price\ up_t$ is equal to the $house\ price\ growth_t$ if the growth is positive and otherwise zero. $House\ price\ down_t$ is equal to $house\ price\ growth_t$ if the growth is negative and otherwise zero. $No.\ of\ property_t$ is a categorical variable equal to 0 if an individual is a renter, 1 if an individual is a homeowner but does not own any other property, and 2 if an individual owns two or more properties in year t. Other control variables are the same as in Table 4.5. All specifications include individual, year and region fixed effects. Standard errors clustered by individual are reported in parentheses. Significance levels at 1%, 5% and 10% are indicated by ***, **, and *, respectively.

Dependent variable:	$D.Participation_{t+1}$		$Log(First\ dividend)_{t+1}$		$Log(Interest\ income)_{t+1}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$House\ price\ growth_t$	-0.032**		-0.089		0.575**	
	(0.012)		(0.069)		(0.253)	
$House\ price\ growth_t * No.\ of\ property = 1$	0.045***		0.183***		-0.535**	
	(0.012)		(0.069)		(0.250)	
$House\ price\ growth * No.\ of\ property \geq 2$	0.054***		0.178*		-1.044***	
	(0.016)		(0.092)		(0.368)	
$House\ price\ up_t$		-0.035**		-0.079		0.466*
		(0.016)		(0.085)		(0.277)
$House\ price\ up_t * No.\ of\ property = 1$		0.045***		0.145		-0.258
		(0.017)		(0.094)		(0.296)
$House\ price\ up * No.\ of\ property \geq 2$		0.051**		0.150		-0.788*
		(0.023)		(0.126)		(0.440)
$House\ price\ down_t$		-0.009		-0.090		0.780
		(0.038)		(0.214)		(0.789)
$House\ price\ down_t * No.\ of\ property = 1$		0.043		0.356*		-1.804**
		(0.037)		(0.206)		(0.814)
$House\ price\ down * No.\ of\ property \geq 2$		0.063		0.305		-2.205*
		(0.045)		(0.288)		(1.181)
No. of Property = 1	-0.003	-0.003	-0.015	-0.010	-0.785***	-0.816***
	(0.003)	(0.003)	(0.015)	(0.017)	(0.073)	(0.075)
No. of Property $\geq$ 2	-0.006	-0.006	-0.018	-0.015	-0.656***	-0.686***
	(0.005)	(0.005)	(0.026)	(0.027)	(0.119)	(0.122)
Individual fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Individual level controls	Yes	Yes	Yes	Yes	Yes	Yes
State level controls	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	91134	91134	91134	91134	91134	91134
Adjusted R-squared	0.005	0.005	0.003	0.003	0.032	0.032

4.4.4 Robustness tests

In this section, I test the robustness of the findings on the impact of time-varying housing wealth on stock market participation.

First, I conduct a survival analysis treating the stock market entry as the ”failure” event and those who did not participate at the end of the sample period as right censored. To structure the data as a panel and take into consideration of time-varying co-variate, I delete the observations of an individual after the participation. This procedure has reduced the sample size from 91134 to 48957. In Panel a of Table 4.8, I re-run the simple OLS and obtain consistent results as before with the coefficients of slightly larger magnitude. Note, as the events are not repeated for each individual, I cannot put in individual fixed-effects here. I also conduct a logistic analysis with maximum likelihood estimation following Allison (2010) and present the results in Panel b of Table 4.8. Again, the coefficients are of consistent sign and statistical significance.

TABLE 4.8: Robustness test: survival analysis

This table presents the robustness tests using survival analysis. Panel a presents the results using OLS analysis and Panel b presents the results using logistic analysis. The control variables are the same as in Table 4.3 and not reported. Standard errors clustered by individual are reported in parentheses in Panel a. Significance levels at 1%, 5% and 10% are indicated by ***, **, and *, respectively.

Panel a: OLS regression

	(1)	(2)	(3)	(4)
House price growth	-0.000	-0.046***	-0.052***	-0.054***
	(0.014)	(0.016)	(0.016)	(0.016)
House price growth*D.Owner		0.065***	0.066***	0.068***
		(0.015)	(0.015)	(0.016)
D.Owner		0.010***	0.005***	-0.003
		(0.001)	(0.002)	(0.004)
Individual level controls	No	No	Yes	Yes
State level controls	No	No	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes
Observations	48957	48957	48957	48957
Adjusted R-squared	0.005	0.007	0.013	0.013

Panel b: Logistic procedure with maximum likelyhood estimates

	Estimate	Standard Error	Wald Chi-Square	Pr>ChiSq
House price growth	-1.5507	0.9733	2.5384	0.1111
House price growth*D.Owner	2.4785	0.9435	6.9004	0.0086
D.Owner	0.5666	1.1533	0.2413	0.6233

Next, I test the robustness of the main results with an alternative measure of the stock participation. The original definition of participation relies on whether an individual receives dividend income to identify the entry into the stock market. However, some individuals might hold non-dividend paying stocks and later switch to dividend paying stocks or the companies they hold start to pay dividends. In these cases, the participation measure actually captures the switching decision or company's decision to pay dividend. To mitigate these concerns, I create an alternative measure of stock market participation.

Every 4 years (2002, 2006, 2010, 2014), HILDA conducts a special wealth wave to collect detailed household wealth information, including whether a household holds stocks. Based on this information, I exclude those participation observations if 1) the household a individual belongs to hold stocks before he/she participation and 2) no other household members participated in the stock market before a particular wealth wave. For example, assume one person participates in 2007 but her/his household holds stocks in 2006. I would exclude this observation if no other household members interviewed in the survey participate in the stock market in or prior to 2006.[17]

Columns (1) and (2) of Table 4.9 present the estimated coefficients with column (1) including individual level controls interacted with the owner dummy and column (2) including individual fixed effect. As we can see, even with this stringent definition of

[17]Note, this is a stringent definition that is likely to exclude some genuine active participations. For example, the household stock holding could be from a household member who is not interviewed in that year. Or a household could have received non-dividend paying stocks through employment, government de-mutulization or inheritance, but later decide to buy dividend paying stocks.

stock market participation, there is still a significant difference between homeowners and renters in their response to house price changes.

Another concern of the results is whether it is driven by the high participation rates during the starting years of the survey. As discussed before, the predictive model already excludes the sample in 2001 and 2002. Here I further exclude the participation in 2003 and presents the estimates in columns (3) and (4) in Table 4.9. Again, column (3) includes individual level controls interacted with the Owner dummy and column (4) includes individual fixed effect. In both specifications, the significant difference between homeowners and renters remains.

In columns (5) and (6), I examine the impact of house price changes over the past two years on the stock market participation decision. There remains statistically significant difference between homeowners and renters. The magnitude of the coefficients reduces compared to the baseline results in columns (4) and (5) in Table 4.3. However, as the average house price growth over two years is 10% with a standard deviation of 13.9%, a one-standard deviation increase in house-price growth increase the probability of stock market participation by 0.33% of homeowners relative to renters, an impact similar to the one year house price changes (0.39%). This evidence suggests house price changes can have lasting impact on stock market participation behavior.

Another concern of the main results might be that an industry effect can lead to similar result. For example, if house price dynamics in a certain state are mainly driven a particular industry, such as the case of Western Australian where the housing market

is largely driven by the mining industry, the differential response between homeowners and renters might be due to systematic differences in their job industries. In this case, not controlling for the job industry effect might bias the results. In columns (7) and (8), I therefore further control for the interactions between the job industry dummies with house price growth. As we can see, the results remain unchanged. This indicates that the differential stock market participation response between homeowners and renters is unlikely to be driven by the job industries of the individuals.

Overall, the robustness tests show that there are persistent significant difference between homeowners and renters in their stock market participation in response to house price changes, providing evidence that time-varying housing wealth can influence stock market participation decision.

TABLE 4.9: Other robustness tests

This table presents the robustness tests. Columns (1) and (2) present the impact of house price changes on stock market participation using the alternative measure of participation, $D.Participation - Adj_{t+1}$. $D.Participation - Adj_{t+1}$ is constructed based on $D.Participation_{t+1}$ but excludes the cases where the household an individual belongs to have held stocks before the participation and no other household members interviewed in the survey has participated before. Please see Section 4.2.2.2 for more details. Columns (3) and (4) presents the results excluding 2003 participants. The dependent variable is $D.Participation_{t+1}$. Columns (5) and (6) estimate the impact of 2 year house price changes in year t and $t-1$ on stock market participation in year $t+1$, $D.Participation_{t+1}$. Column (7) and (8) control for the job industry of the individuals with the job industry dummies interacted with the house price growth. Columns (1), (3), (5) and (7) include individual level control variables interacted with $D.Owner_t$ and columns (2), (4), (6) and (8) include individual fixed effects. The control variables are the same as in Table 4.3 and not reported. Standard errors clustered by individual are reported in parentheses. Significance levels at 1%, 5% and 10% are indicated by ***, **, and *, respectively.

	Alternative Participation		No 2002		2 year house price		Job Industry	
Dependent variable :	$D.Participation - Adj_{t+1}$		$D.Participation_{t+1}$					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$House\ price\ growth_t$	-0.019*	-0.015	-0.017	-0.022*			-0.037***	-0.030**
	(0.010)	(0.011)	(0.012)	(0.013)			(0.012)	(0.013)
$House\ price\ growth_t * D.Owner_t$	0.028***	0.027***	0.025**	0.031**			0.043***	0.046***
	(0.009)	(0.010)	(0.012)	(0.012)			(0.011)	(0.012)
$2\ year\ house\ price\ growth_t$					-0.011	-0.012		
					(0.007)	(0.007)		
$2\ year\ house\ price\ growth_t * D.Owner_t$					0.022***	0.024***		
					(0.006)	(0.007)		
$D.Owner_t$	0.002	-0.002	0.004	-0.003	0.002	-0.003	0.002	-0.003
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)
$House\ price\ growth * Job\ Industry$							Yes	
Individual fixed effect	No	Yes	No	Yes	No	Yes	No	Yes
Individual level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State level controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	91134	91134	81581	81581	91134	91134	91134	91134
Adjusted R-squared	0.003	0.002	0.003	0.002	0.005	0.005	0.006	0.005

4.5 Conclusion

This study utilizes the HILDA survey data, which tracks the same individuals over a 15 year period, to examine whether time-varying housing wealth affects individuals' stock market participation and asset allocation decisions. Using variations in state level house prices as exogenous changes in housing wealth and by comparing homeowners and renters, I find that rising housing wealth significant increases the probability of stock market participation and the value of initial stock market investment, but decreases the bank savings of homeowners relative to renters.

Decomposing the house price changes into growth and falls, I find it is mainly house price growth that drives the difference in stock market participation between homeowners and renters. By contrast, while rising housing prices lead to more bank savings of renters, falling prices lead homeowners to save more in the bank. These evidence suggest rising house prices significantly limit the stock market participation of renters, reflecting renters' need to hedge against higher housing costs or save more for down-payment. By contrast, homeowners benefits from rising housing wealth and can start to investment in the stock market. In housing market downturns, homeowners, particularly the middle-aged, become more cautious and save more in the bank, consistent with the argument that housing wealth affects the precautionary saving motive of individuals.

This paper complements the studies on household portfolio choice with housing by identifying the impact of time-varying housing assets on individuals' stock market

participation decisions. In addition, I provide new evidence to understanding the limited stock market participation puzzle by examining the stock market entry decisions in a dynamic setting. Overall, this paper highlights the important role of housing assets in shaping individuals' financial decisions.

The evidence in this paper demonstrates a link between the housing and financial markets through individuals' portfolio choice. In countries with high homeownership, we might expect to see heightened stock market investments during housing market booms due to the housing wealth spillover effect. In housing market downturns, our study suggests that homeowners tend to save more in the bank and limit the stock market investments due to heightened precautionary savings motive.

Another implication of this study is that sustained house price growth observed in many countries such as Australia and China can create a wedge in stock market participation and long-term wealth accumulation between homeowners and renters. Whether this wedge can lead to economic inequality between homeowners and renters warrants further research. Nonetheless, the design of housing policies should recognize such impact of housing on individuals' stock market investments and long-term welfare.

Chapter 5

Conclusion

In Chapter 2, I use a rich panel data of households with consumption records to study the factors that influence house price-consumption sensitivity. I find significant heterogeneity in the sensitivity across the age groups: both young and old-aged homeowners have positive and significant consumption sensitivities to house price changes, while the middle-aged homeowners have insignificant sensitivity. Among young homeowners, I find income volatility is the predominant driver of the house-price consumption sensitivity and only those with high income volatility have significant consumption sensitivity, which highlights the precautionary savings nature of housing assets. Consistent with the housing wealth effect, I find that unconstrained old homeowners with high housing wealth share have stronger consumption sensitivity than those with low housing wealth share.

In the aftermath of the Great Recession, regulators and economists in the US are

highly concerned about the dampening effect of lower house value on household consumption. This study shows that this shock has distinct implications for households of different age and demographic characteristics. A housing market crash means a substantial destruction of wealth for older homeowners, especially those with large shares of total wealth tired in housing. This can have severe impact on their welfare in retirement. Young homeowners with high income volatility are adversely affected mainly because their housing collateral has declined in value, forcing them to save more as buffers against future income shocks. In contrast, middle-aged homeowners who plan to up-size could actually benefit from falling house prices, which makes their next home more affordable. Policy makers are likely to benefit from this evidence when developing targeted policies.

Chapter 3 presents a stylized model to illustrate the channels through which house prices can affect household consumption decisions. I show that while the consumption of old households can only be affected by house prices through a wealth effect, the consumption of middle-aged can be influenced through both a wealth effect and a credit constraint effect, depending on the level of wealth of the households. Similar to the middle-aged, young households will be affected by a wealth effect or a credit constraint effect if their initial wealth is very high or very low. With intermediate level of wealth, young households exhibit precautionary saving motive, the strength of which is also influenced by house prices. The extended model with up-sizing and transaction costs indicates that the wealth effect can become very small or even negative for the middle-aged households.

The model provides a simple but unified framework to understand the often conflicting empirical findings in the literature and generates testable implications for future empirical analysis. More importantly, the model indicates that life-cycle stage is a key determinant of the house price-consumption sensitivity. Within each life-cycle, the sensitivity can also vary significantly depending on the constraints faced by the households.

Chapter 4 utilizes the HILDA survey data, which tracks the same individuals over a 15 year period, to examine whether time-varying housing wealth affects individuals' stock market participation and asset allocation decisions. Using variations in state level house prices as exogenous changes in housing wealth and by comparing homeowners and renters, I find that rising housing wealth significant increases the probability of stock market participation and the value of initial stock market investment, but decreases the bank savings of homeowners relative to renters. These evidence suggest rising house prices significantly limit the stock market participation of renters, reflecting renters' need to hedge against higher housing costs or save more for down-payment.

This study complements the studies on household portfolio choice with housing by identifying the impact of time-varying housing assets on individuals' stock market participation decisions. In addition, I provide new evidence to understanding the limited stock market participation puzzle by examining the stock market entry decisions in a dynamic setting. Overall, this paper highlights the important role of housing assets in shaping individuals' financial decisions.

The evidence in this paper demonstrates a link between the housing and financial markets through individuals' portfolio choice. The sustained house price growth observed in many countries such as Australia and China can create a wedge in stock market participation and long-term wealth accumulation between homeowners and renters. Whether this wedge can lead to economic inequality between homeowners and renters warrants further research. Nonetheless, the design of housing policies should recognize such impact of housing on individuals' stock market investments and long-term welfare.

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