Household Balance Sheets and Consumption Responses to Income Shocks

Yunho Cho* James Morley† Aarti Singh‡

February 15, 2019

Preliminary and incomplete. Please do not circulate

Abstract

We examine how households with different balance sheet positions respond to unanticipated transitory and permanent income shocks using panel data from the U.S. and Australia. Our main findings are the following. (i) the consumption response of households with higher debt to a transitory income shock is higher relative to households with lower levels of debt in the U.S. This group of households is distinct from households with low liquid wealth who also respond sensitively to transitory income shocks; (ii) the consumption elasticities from house price shocks are higher for households with higher debt in the U.S.; (iii) our time-varying estimates suggest that consumption of households with higher levels of debt exhibited greater sensitivity to transitory income shocks during the Great Recession and during the housing boom in Australia; and (iv) households with higher net wealth and lower debt have more consumption insurance against permanent income shocks. Our results provide new insights into the relationship between household balance sheets and household consumption and how this relationship has changed over the Great Recession period.

Keywords: Household balance sheets; Income risks; Transitory income shocks; Permanent income shocks; Consumption responses; Consumption insurance.

JEL codes: E21; C32; D12; D14.

*Corresponding author: Institute for Economic and Social Research, Jinan University; yunho.cho@outlook.com

†School of Economics, University of Sydney; james.morley@sydney.edu.au

‡School of Economics, University of Sydney; aarti.singh@sydney.edu.au

1 Introduction

There is a growing literature that establishes a link between household balance sheets and consumption. Agarwal, Liu and Souleles (2007); Parker, Souleles, Johnson and McClelland (2013); Kaplan and Violante (2014); Fagereng, Holm and Natvik (2016); and Fuster, Kaplan and Zafar (2018) estimate the marginal propensities to consume (MPCs) from transitory changes in income and find that typically households with lower liquid wealth have higher MPCs. In related literature, Atif Mian and Amir Sufi in a number of papers, e.g. Mian and Sufi (2009); Mian and Sufi (2011); and Mian, Rao and Sufi (2013) find that elevated debt levels and the collapse of housing net worth were the main causes for the fall in consumption during the Great Recession. Others such as Dynan (2012) and Baker (2017) also argue that household debt was an important driver of the slowdown in consumption during the Great Recession.

In this paper, we examine whether there are any discernible patterns in the consumption responses to income shocks across household balance sheets beyond the liquid wealth dimension. We use income, consumption and wealth data from the household surveys in the U.S. and Australia and estimate a panel unobserved components model using the (quasi) maximum likelihood-based approach proposed by Chatterjee, Morley and Singh (2018).[1] We elicit the financial positions of households by stratifying them based on their housing tenure status, and consider the three main subgroups: (1) renters; (2) mortgaged owners; and (3) outright owners.[2] In both datasets, renters have lower debt and wealth, mortgaged owners are wealthy but highly indebted and outright owners have the highest level of wealth with low debt.[3]

[1] See Chatterjee, Morley and Singh (2018) for more details. We also estimated the parameters of our model using the minimum distance estimation with optimally weighted matrices (OMD). The results are quantitatively different but qualitatively unchanged. However, for small sub-sample, such as renters and outright owners, OMD performs very poorly as noted in Altonji and Segal (1996) and Chatterjee et al. (2018). Therefore, we use (Q)MLE for our analysis.

[2] Cloyne and Surico (2017) employ the same classification in their analysis of the impact of income tax changes on consumption using the expenditure survey data from the United Kingdom. Cloyne, Ferreira and Surico (2019) also use the housing tenure status to understand heterogeneous responses to monetary policy shocks for households with different balance sheet positions.

[3] As housing tenure is an endogenous choice, using such information for subgrouping may cause the issues of selection and changes in the share of each group over time. However, this is less of concern as we show later in Figure 2 that the composition of renters, mortgaged owners and outright owners remained relatively stable over our sample periods in both surveys. Furthermore, our results remain qualitatively unchanged, see Tables A–9 and A–10 in the appendix, where we exclude households that changed their housing tenure status from our sample.

Our main findings are as follows. First, the consumption response of households with higher debt to transitory income shocks is higher relative to households with lower levels of debt in the U.S. This might explain why mortgage owners exhibit a significant pass-through of transitory income shocks to their consumption while outright owners do not, even though the demographic characteristics of the two groups are quite similar. One notable difference, however, between the two subgroups is that mortgaged owners in our sample have high levels of debt. Using our estimates of consumption responses, we also compute the consumption elasticities with respect to house price shocks by following a sufficient statistics approach of Berger, Guerrieri, Lorenzoni and Vavra (2017). The consumption elasticity is 0.17 for mortgaged owners and 0.04 for outright owners in the U.S. Using different methods and samples, other studies have also found very similar estimates, see for example Case, Quigley and Shiller (2013).

Households who are highly indebted might respond to transitory income shocks due to larger consumption commitments (Chetty and Szeidl, 2007).[4] Households with debt incur regular expenses such as interest payments which increases their consumption commitments. Faced with a small negative income shock which is transitory, these households will not necessarily change their interest payments on debt, i.e. consumption commitments, but instead reduce spending on other non-durables such as food. To further evaluate the role of debt and other balance sheets of households, we subgroup our sample based on the holdings of debt, net wealth and liquid wealth. Consistent with evidence from subgroups based on housing tenure, households with higher debt respond more significantly to transitory income shocks. Also, as in the existing literature, households with low liquid wealth - Hand to Mouth (HtM) households - also have higher consumption responses. Importantly, households who fall into a high debt group are different from households who are classified into the HtM group.[5] Our results therefore reveal a new group of households which also respond sensitively to transitory income shocks. From our U.S. sample, considering high debt households would increase the number of households who respond to transitory in-

[4] Chetty and Szeidl (2016) also show theoretically that how an increase in consumption commitments can explain excess sensitivity that is commonly found in empirical microeconomic studies.

[5] The percentage of households who are overlapped between high debt and HtM groups is around 29 percent when the cutoff value of 25th percentile is used and is around 11 percent when the cutoff value of 10th percentile is used. These are around 7 and 3 percent of the total sample.

come shocks by at least 50 percent.

Our third result is based on the time-varying estimates of the pass-through of transitory income shocks to consumption. This result reinforces the role of debt for consumption responses before and soon after the Great Recession. The pass-through of transitory income shocks to consumption for the U.S. households increased and peaked during the Great Recession which was also the period when there was a substantial increase in the level of household debt. Convincingly, households in Australia have experienced a continuous rise in the pass-through coefficient which coincides with the rise in their debt holdings during the same period. By computing time-varying consumption elasticities with respect to house price shocks for the U.S mortgage owners, we provide empirical evidence of the rise in consumption elasticities during the housing boom which is consistent with a theoretical prediction by Berger et al. (2017). Consumption elasticities increase during the house price boom because households purchase more housing using debt which in turn increases the consumption responses to transitory income shocks. The consumption elasticity with respect to house price was 0.49 in 2009 for the U.S. mortgage owners, the highest in the U.S. sample, but for Australian mortgage owners, it has continued to increase and it was 0.20 in 2015.

Turning to consumption insurance against permanent income shocks, our fourth result is that households in both countries in our sample have similar levels of consumption insurance, approximately 60 percent. However, there is heterogeneity across households. Households with high net wealth and low debt have more consumption insurance relative to households with low net wealth and high debt. Households with higher net wealth have more consumption insurance due to the ability to access buffer-stock wealth (Carroll, 1997). Faced with income shocks that are large and permanent, they may smooth their consumption plans by adjusting their wealth levels. However, if a household is highly indebted, her wealth is tied up with debt and therefore she would find it difficult to run down her wealth to insure against permanent income shocks.

Related literature. Our paper is related to three broad strands of the literature of consumption. First, our paper contributes to the empirical literature that estimates the MPCs from transitory income shocks (Agarwal et al. (2007), Parker et al. (2013),

Kaplan et al. (2014); Fagereng et al. (2016), and Fuster et al. (2018)) by revealing a positive correlation between the consumption responses to transitory income shocks and the levels of debt holdings. While there is growing consensus in the literature that MPCs are negatively correlated to liquid wealth, this paper provides the first empirical evidence that households with higher debt respond more sensitively to transitory income shocks. Moreover, our time-varying estimates shed lights on how the consumption responses changed throughout the Great Recession. Our result shows that the consumption responses increased sharply right before and during the Great Recession. This is a consistent finding to Gross, Notowidigdo and Wang (2016) which, to our knowledge, is the only empirical paper that examines how MPCs vary over the business cycle. The authors find that the MPC is 20 to 30 percent higher during the Great Recession.

On the theoretical front, our results complement quantitative macroeconomic models of consumption. Carroll, Slacalek, Tokuoka and White (2017) show that households with little wealth have relatively high MPCs, driving up the aggregate MPCs in the economy. Similarly, the work by Kaplan and Violante (2014) argues that there is a subset of households who are wealthy but have little liquid wealth, so called wealthy Hand-to-Mouth, exhibit high MPCs. We complement this literature by providing the empirical evidence which household debt is also an important dimension to better understand the aggregate consumption responses to income shocks.

Second, it is related to a relatively recent literature that tries to understand the relationship between household debt and consumption (Mian et al. (2013), Dynan (2012), Baker (2017), Cloyne and Surico (2017), Cloyne, Ferreira and Surico (2019)). We contribute to this literature by providing empirical evidence from two countries that household debt is indeed an important determinant of the consumption responses. Relative to the previous papers in the literature, our identification of unanticipated income shocks follows a statistical decomposition approach which enables us to examine how consumption responds not just to one particular type of income shocks but in general to any income shocks.

Finally, this paper is also connected to the literature of consumption insurance against permanent income shocks such as Blundell et al. (2008) and Kaplan and Violante (2010). We contribute to this literature by conducting an analysis along differ-

ent household balance sheets and show that net wealth is the most important component that generates significant heterogeneity in consumption insurance.

The rest of this paper is organized as follows: Section 2 describes the data. Section 3 presents an unobserved component model proposed in this paper. Section 4 discusses the main results of this paper including the time-varying analysis, and Section 5 concludes.

2 Data

In this section we describe our two datasets and samples used in our analysis. To ensure comparability between the two datasets, we use similar variables from the two surveys by matching their definitions, except for the cases where the difference in survey design prevents us from doing it. We mention those exceptions throughout this section.

2.1 Panel Survey of Income Dynamics

The PSID is a longitudinal dataset that provides a representative sample of approximately 5,000 U.S. households starting from 1968. Since then, the survey re-interviewed both the original family and their split-offs annually until 1996 and biennially from 1997. Importantly, PSID started to collect information on household expenditure covering roughly 70 percent of consumption categories in the Consumer Expenditure Survey since 1999. Therefore, to obtain measures of income and consumption for each household, we use nine waves of data from 1999 to 2015.

We use the total pre-tax household income as our measure of income. It consists of taxable labor income, transfers and social security. To be consistent with the gross measure from HILDA, which we describe below, we add head and wife's investment income which consists of incomes from housing lease, interest, dividends, trust and alimony. For consumption, we use three broad categories: food, non-durables (excluding food), and housing. Food includes food at home and eaten out. Non-durable consumption includes expenditures on public transport, car fuel and maintenance, utilities, and health care services. While we include the actual amount of rental payment for households who lived in rental housing, we impute rents for homeowners.

Following the literature, we consider the user-cost of owner-occupied housing which takes into account of mortgage interest payments, depreciation and other maintenance costs, and expectation of house price appreciation. Poterba and Sinai (2010) estimate that the user-cost of owner-occupied houses for the U.S. households is 6 percent of the value of dwelling. The annual imputed rent is thus calculated as 6 percent of self-reported housing value from the PSID survey. We deflate each consumption component using the corresponding component from the Consumer Price Index (CPI) obtained from Bureau of Labor Statistics and also deflate income using the headline CPI. The PSID survey also provides information on wealth in every wave. Following Kaplan, Violante and Weidner (2014), we classify wealth into three categories: liquid asset, illiquid asset and debt. The liquid assets consist of cash, bank deposits, bonds and stocks; and the illiquid assets consist of businesses, vehicles, pensions and real-estate properties. Our measure of debt includes mortgages and other debt such as credit card, student loans, medical and legal bills, and borrowings from relatives.

Sample selection. The initial dataset consists of an unbalanced sample of 74,224 head of households. Of those households, we drop households who experienced significant changes in their family composition such as the change of head, divorce of death of partner.[6] We then consider continuously married households where the age of the household head is between 30 to 65. We drop those households who reported zero expenditure or had missing information on key demographics including state of residence, education, employment status and housing tenure status. We also drop those household who did not have information on their income and who reported negative values for liquid or illiquid assets. Households with annual income growth higher than 500 or lower than negative 80 percent, or annual household gross income of less than 100 U.S. dollars are also dropped. The survey distinguishes between Core sample and the Survey of Economic Opportunity (SEO) sample which contains a sample of low income households. We drop those households in the SEO sample. Finally, we drop those households who only appeared in the survey for a single year. In total, our PSID sample consists of 3,213 households with 17,315 observations. See Table 1, columns 2 and 3 for the summary statistics of the PSID variables and Table A–1 in the appendix for more details on sample selection.

[6]This follows a sample selection strategy in Blundell, Pistaferri and Preston (2008) and Blundell, Pistaferri and Saporta-Eksten (2016).

2.2 Household Income and Labour Dynamics Australia

The HILDA is a longitudinal survey that contains a nationally representative sample of Australian households since 2001. A total of 7,682 households, consisting of 19,914 individuals participated in Wave 1.[7] The members of these households form the basis of the panel in subsequent waves as they, including new adult members who are older than age 15, are re-interviewed. The re-interview rates are high, ranging from 87 percent in Wave 2 to 97 percent in Wave 15. The survey contains detailed information on income, expenditure, wealth and other demographic and socioeconomic factors that are standard in a typical household survey.

While the survey contains many income measures, we use the gross total income which includes pre-tax incomes from labor, investment, business, pension and transfers. Since 2006, the HILDA survey started collecting a rich set of expenditure information. As in PSID, we use three broad categories of expenditure including food (groceries and meals eaten out), non-durables (public transport, motor vehicle fuel and maintenance, utilities and health care services) and housing (rent and imputed rent). The imputed rent for homeowners is approximated to 4.2 percent of the self-reported housing value from HILDA in which the 4.2 percent represents the user-cost of owner-occupied housing estimated by Fox and Tulip (2014).

The survey has incorporated wealth modules every fourth year starting in 2002. Using this information, for each household we compute its holdings of liquid asset, illiquid asset and debt. Liquid assets include cash in bank accounts, shares and bonds. Illiquid assets include real estates, life insurance and superannuation. The survey specifically asks respondents to report their total debt holdings including mortgages, credit card debt, student loans, business debt, overdue bills and other personal debt. We deflate each component of consumption using the corresponding component in Consumer Price Index (CPI) obtained from the Australian Bureau of Statistics. The income is deflated using the headline CPI.

While we apply the same sample selection procedure as that in PSID, a few exceptions arise due to the difference in the survey structure. First, we do not drop households who experienced significant changes in their family composition as such information is not available in HILDA. Second, HILDA does not make a distinction

[7] From Wave 11 onwards, additional 2,153 households have been added to the survey.

between Core Sample and SEO households like PSID does. Third, the head of household is not directly observed in HILDA. We define the head as a male worker within the family unit who is not a child. In our HILDA sample, we exclude other members of family such as the grandfather or uncle. Finally, there were observations for mortgage paying households who do not report their mortgage payment and we drop those households. In total, our sample of HILDA consists of 4,165 households with 24,825 observations. Table 1, columns 4 and 5 for the summary statistics of the HILDA variables and Table A–2 in the appendix for more details on sample selection.

3 Empirical model

We first isolate the idiosyncratic (residual) income and consumption by regressing log of household income and consumption on a vector of regressors and fixed effect of year, cohort and state.[8] The specification of the regression equation is given by

$$\log Y_{i,t} = \beta_t' X_{i,t} + y_{i,t} \tag{1}$$

$$\log C_{i,t} = \alpha_t' X_{i,t} + c_{i,t} \tag{2}$$

where $Y_{i,t}$ and $C_{i,t}$ denote income and consumption for household i in year t, respectively. $X_{i,t}$ is a vector of control variables. The last terms $y_{i,t}$ and $c_{i,t}$ are the residuals of the regressions.

Therefore, our reduced form panel unobserved components model decomposes idiosyncratic income and consumption for household i (measured as residuals from regressions of household income and consumption on common observed factors) into permanent components and transitory deviations from the permanent components:

$$y_{i,t} = \tau_{i,t} + (y_{i,t} - \tau_{i,t}), \tag{3}$$

$$c_{i,t} = \gamma_\eta \tau_{i,t} + \kappa_{i,t} + (c_{i,t} - \gamma_\eta \tau_{i,t} - \kappa_{i,t}). \tag{4}$$

[8]The list of control variables is as follows. In HILDA, we consider education, number of dependent children, family size, and a set of dummies including marital status, employment status, native English speaker, big city, working family members other than head and partner, kids living out of family. We also consider a set of interaction terms using education, state, native English speaker and employment, all interacted with year. While we keep the same regression specification for our PSID sample, we use race instead of native English and do not consider the big city dummy in the regressions.

Table 1: Summary statistics

	United States		Australia	
Variable	mean	median	mean	median
(Real) Total household income	93,249	72,040	141,310	120,050
(Real) Consumption				
Total	32,220	22,909	51,395	46,841
Food at home (grocery)	5,340	4,875	11,952	10,965
Meals eaten out	2,250	1,554	3,207	2,589
Gasoline	1,299	1,040	3,115	2,451
Utilities	3,227	2,983	4,334	3,784
Motor vehicle repair	1,272	0	1,187	939
Public transport	213	0	498	0
Health services	1,141	593	1,756	1,057
Rent	7,901	7,028	17,554	16,807
Imputed rent	18,783	9,330	26,402	22,047
Assets				
Total	624,801	263,000	1,009,208	742,145
Liquid assets	98,000	10,000	88,739	16,000
Illiquid assets	526,800	235,000	920,468	697,598
Debt	113,891	79,000	248,906	135,000
Net wealth	510,910	142,000	896,250	577,418
Demographics				
Age	47.59	47	47.42	47
Family size	3.38	3	3.45	3
No. of children	1.08	1	1.25	1
No. of working households	-	-	1.87	2
Working members other than head/wife	0.27	0	-	-
High school dropouts	0.10		0.18	
High school graduates	0.24		0.08	
College (TAFE) or higher	0.66		0.74	
Employed	0.88		0.87	
Native English speaker	-		0.88	
White	0.84		-	
Number of households	3,213		4,165	
Number of observations	17,315		24,825	

Notes: Data for the United States and Australia are from PSID and HILDA. All monetary values are reported in USD for the United States sample and AUD for the Australian sample. Each consumption component is deflated using the corresponding component from the CPI. The income is deflated using the headline CPI.

The permanent components are specified as random walks with possible drift:

$$\tau_{i,t} = \mu_{\tau,i} + \tau_{i,t-1} + \eta_{i,t}, \qquad \eta_{i,t} \sim i.i.d.N(0, \sigma_\eta), \tag{5}$$

$$\kappa_{i,t} = \mu_{\kappa,i} + \kappa_{i,t-1} + \gamma_\epsilon \epsilon_{i,t} + u_{i,t}, \qquad u_{i,t} \sim i.i.d.N(0, \sigma_u), \tag{6}$$

where for household i, the common stochastic trend of income and consumption is $\tau_{i,t}$ and $\kappa_{i,t}$ is the additional trend of consumption. In our specification, γ_ϵ and γ_η capture the impact of permanent and transitory income shocks on permanent consumption, respectively.

The transitory components are specified as white noise:

$$y_{i,t} - \tau_{i,t} = \epsilon_{i,t} + \theta_y \epsilon_{i,t-1} \tag{7}$$

$$c_{i,t} - \gamma_\eta \tau_{i,t} - \kappa_{i,t} = v_{i,t}. \tag{8}$$

The permanent income shock, $\eta_{i,t}$, can be interpreted as reflecting shocks to health, promotion, or other idiosyncratic factors that result in an idiosyncratic change in permanent income. Other permanent shocks to consumption, $u_{i,t}$, beyond permanent shocks to income could be taste and preference shocks or other shocks to non-labor income, such as wealth shocks. The transitory income shock is $\epsilon_{i,t} \sim i.i.d.N(0, \sigma_\epsilon)$ while the transitory consumption shock is $v_{i,t} \sim i.i.d.N(0, \sigma_v)$, where the latter could capture measurement error. We also allow transitory income shocks to impact the transitory consumption with a coefficient λ_ϵ. We note that the model assumes time-invariant volatilities of shocks, although it is relatively easy to test for and allow structural breaks in these parameters.

Solving for consumption growth for household i we get:

$$\Delta c_{i,t} = \gamma_\eta \eta_{i,t} + u_{i,t} + \lambda_\epsilon \epsilon_{i,t} + v_{i,t} - v_{i,t-1}. \tag{9}$$

Based on our model, a change in consumption at date t due to a change in transitory income shock and permanent income shock is γ_ϵ and γ_η respectively.[9] We therefore refer to γ_ϵ as the consumption response to transitory income shocks, and $\vartheta_\eta = 1 - \gamma_\eta$ as the consumption insurance against permanent income shocks. If markets were complete, households would have full insurance which implies $\gamma_\epsilon = 0$ and

[9] Our pass-through parameters can also be interpreted as marginal propensities to consume out of the respective shocks. See Jappelli and Pistaferri (2010).

$\vartheta_\eta = 1$. Also, according to the permanent income theory, any unexpected permanent income shocks would fully transmit to consumption so $\vartheta_\eta = 0$ but households would not respond to any transitory income shocks which again gives $\gamma_\epsilon = 0$.

To estimate the unobserved components model, we employ the quasi maximum likelihood approach of Chatterjee, Morley and Singh (2018). We refer the reader to their paper for more details about the methodology and how it compares to the moments based estimation approach.

Before getting into the main analysis, we compare the results for the whole sample in the two countries. Table 2 provides our estimates of parameters for the U.S. (right panel) and Australian (left panel) households. Looking at the whole sample, there is not much heterogeneity across the two countries except for the consumption responses to transitory income shocks. Households in the U.S. respond to transitory income shocks in which the transmission coefficient is 0.06 and statistically significant. The size of our estimate is similar to the finding by Blundell, Pistaferri and Preston (2008) who employ a moment based approach using the earlier sample and imputed consumption data from the CEX. In contrast, Australian households do not respond to such shocks. The pass-through coefficient for Australian households is 0.03 and statistically insignificant. Turning to the insurance against permanent income shocks, we find that households in the U.S. have slightly less insurance than Australian households. The estimate of ϑ_η is 56 for the U.S. households and 60 percent for Australian households. Our estimate of ϑ_η for the U.S. households is higher than that of Blundell et al. (2008) (36 percent).[10]

For our estimates on income and consumption dynamics, we find that the standard deviations for permanent and transitory income shocks are 0.16 and 0.28 in the U.S. and 0.13 and 0.28 in Australia, respectively. These estimates are in line with the ones reported in the income dynamics literature (see Heathcote, Storesletten and Violante (2014) for the U.S., Chatterjee, Singh and Stone (2016) and Kaplan, La Cava and Stone (2018) for Australia). The standard deviations of permanent shocks to consumption are slightly smaller, 0.08 in both surveys. Finally, the measurement error

[10]Using a precautionary savings model with household impatience, Carroll (2009) shows strictly positive levels of consumption insurance (1 - MPCs from permanent income shocks) which is in line with what we and Blundell et al. (2008) find, providing a quantitative evidence against permanent income hypothesis.

Table 2: Cross-country comparisons

	United States	Australia
	INCOME	
θ_y	0.21 (0.01)	0.16 (0.01)
σ_η	0.16 (0.00)	0.13 (0.00)
σ_ϵ	0.28 (0.00)	0.28 (0.00)
	CONSUMPTION	
σ_u	0.08 (0.00)	0.08 (0.00)
σ_v	0.36 (0.00)	0.14 (0.00)
γ_ϵ	0.06 (0.01)	0.03 (0.00)
ϑ_η	0.56 (0.02)	0.60 (0.02)

Notes: The table reports point estimates with standard deviations in parentheses.AS: ADD N, T and total observations in each of these tables..

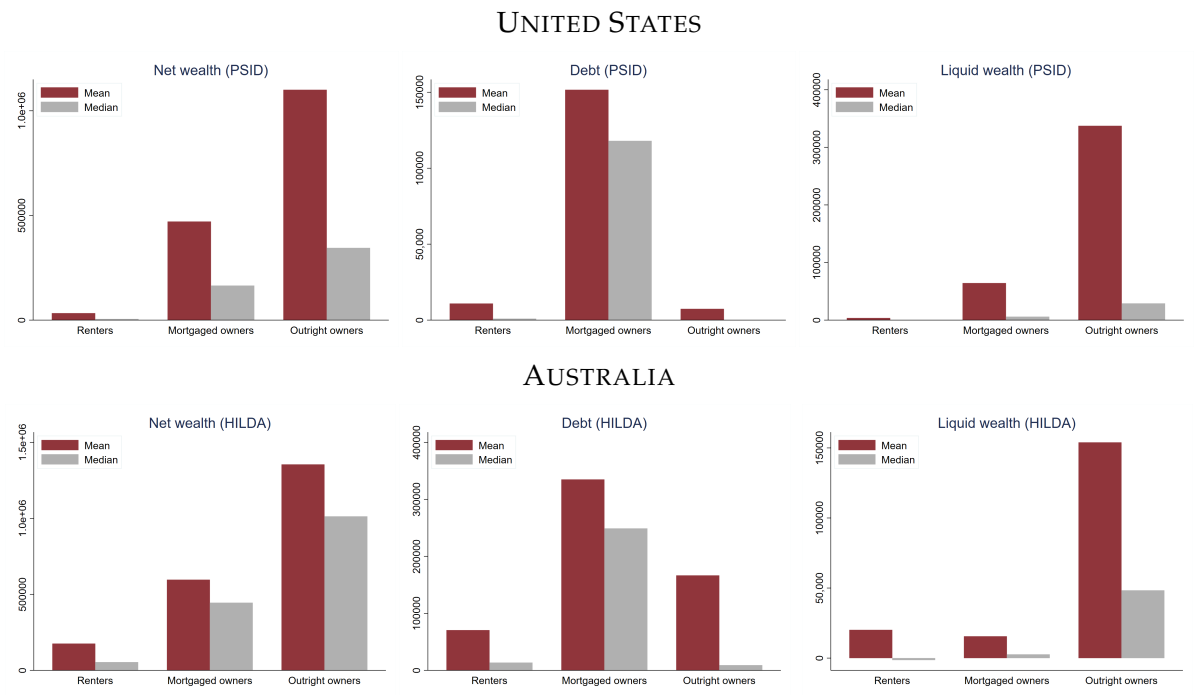
in consumption, captured by the estimates of σ_v, are 0.36 in the U.S. and 0.14 in Australia.

4 Heterogeneity in consumption responses

In this section we explore whether consumption response to an income shock, transitory and permanent, differs across households based on their financial position. To elicit the financial positions of households, we first use housing tenure status and consider the following subgroups: (1) renters; (2) mortgaged owners; and (3) outright owners. This is an effective grouping strategy for our purpose since mortgage debt is a large fraction of total household debt and therefore naturally yields three groups of households with distinctive balance sheet positions.[11]. We first document differences across these subgroups based on their financial position and their demographic characteristics and then provide our empirical estimates in the following subsections.

[11]In PSID and HILDA, mortgage debt accounts for 89 and 58 percent of total household debt for homeowners, respectively.

Figure 1: Household Balance Sheets of Subgroups



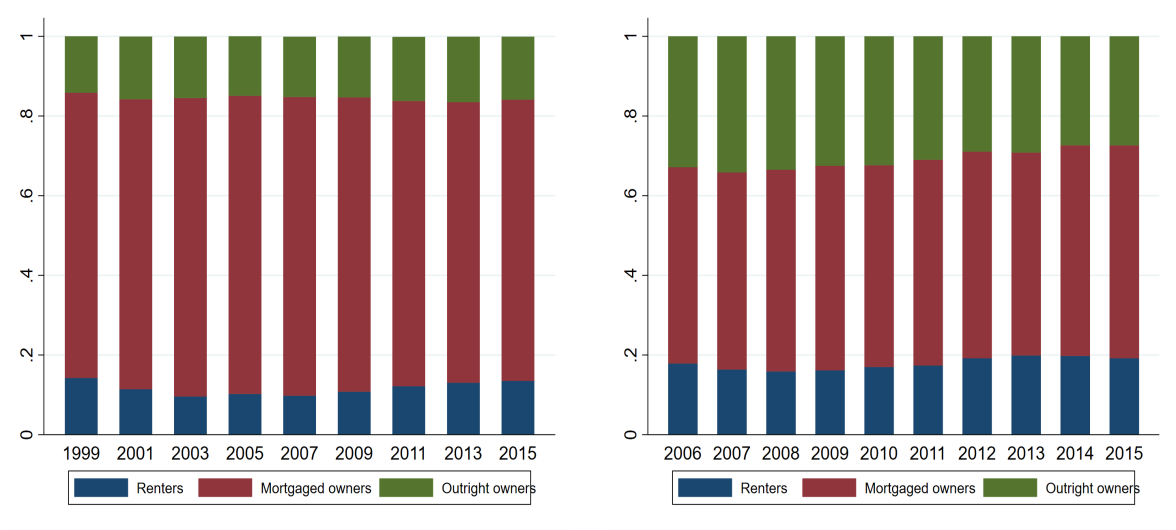
Notes: The figure displays mean and median of net wealth, debt and liquid wealth in the U.S. (top panel) and Australia (bottom panel) for each housing tenure group. The values are reported in USD for the U.S. and in AUD for Australia.

4.1 Subgroups

We document some of the characteristic differences across the three subgroups. These features of the subgroups will be relevant when understanding differences in consumption response to income shocks across these subgroups.

Figure 1 presents the mean and median of net wealth, debt and liquid wealth by the three groups of households based on housing tenure. As the left panel depicts, in both countries, outright owners have the highest net wealth while renters have the lowest. Approximately, net wealth of outright owners is twice higher than that of mortgaged owners. The top middle panel shows that the U.S. mortgaged owners on average have around 10 times more debt than renters and outright owners. While the similar pattern is observed for Australian households, we notice that both renters and outright owners have relatively larger debt sizes than their U.S. counterparts, as shown in the bottom middle panel in Figure 1. Put differently, the size of debt for Australian outright owners is only two times larger than that for outright owners in

Figure 2: Changing Share of Subgroups: U.S. (left) and Australia (right)



Notes: The figure displays the time trends in the share of renters, mortgaged owners and outright owners in the U.S. (left) and Australia (right). The data are sourced from PSID for the U.S. and HILDA for Australia.

Australia. The right panels in Figure 1 show that outright owners have much more liquid wealth than mortgaged owners and renters in both countries.

Tables 3 and 4 report the mean income, consumption and key demographic characteristics of renters, mortgaged and outright owners from PSID and HILDA, respectively. The characteristics in each subgroup are similar across the two countries, however they differ across the three subgroups. Renters on average have lower income and consumption, are younger and less educated. Mortgaged owners on the other hand have higher income and consumption, and have more education. While outright owners have high income and consumption, they tend to be older with the average age of 54 and a non-trivial proportion of the heads, around 20 percent in both countries, are not in the labor force. Moreover, the majority of outright owners do not have dependent children.

Figure 2 depicts the time series of housing tenure status from PSID and HILDA. Although our U.S. sample runs over the period of Great Recession, the changes in the share of housing tenure hardly changed. Likewise, the housing tenure share in Australia remained stable between 2006 and 2015. This evidence suggests that the issue of compositional change in housing tenure due to the recession is less likely to

Table 3: Summary Statistics of Subgroups (U.S.)

Variable	Renters	Mortgaged owners	Outright owners
Real total income (mean)	57,649	99,372	91.241
Real total consumption (mean)	20,722	33,477	33,600
Age (mean)	44.16	46.85	53.70
Employment (proportion)			
employed	0.85	0.91	0.75
unemployed	0.05	0.02	0.02
retired	0.03	0.04	0.17
other	0.07	0.03	0.06
Education (proportion)			
high school dropout	0.24	0.07	0.12
high school graduate	0.25	0.24	0.29
College dropout or higher	0.51	0.69	0.59
# of dependent children (proportion)			
0	0.34	0.42	0.69
1	0.22	0.20	0.13
2	0.24	0.25	0.12
3+	0.20	0.13	0.06
Working households other than head/wife	0.25	0.29	0.26
Proportion of total sample	0.12	0.73	0.15

Notes: Income, consumption are reported in USD. The consumption components are deflated using the corresponding component from the CPI. The income is deflated using the headline CPI.

drive our empirical results discussed in this section.

Based on the financial and demographic characteristics of each subgroup, we arrive at the following interpretation. First, typically renters are younger and have lower income and consumption, lower debt, and lower net and liquid wealth. It is quite likely that these households have limited access to the credit markets. Second, homeowners with mortgages are middle-aged, earn higher income, consume more, have highest levels of debt, hold mid-range of net and liquid wealth. Mortgaged owners are therefore a group of households who are wealthy but highly indebted. Finally, outright owners typically hold the large amounts of both net and liquid wealth and low levels of debt. These households are the wealthy households with low levels of debt.

Table 4: Summary Statistics of Subgroups (Australia)

Variable	Renters	Mortgaged owners	Outright owners
Real total income (mean)	109,099	146,515	151,546
Real total consumption (mean)	41,047	52,626	55,423
Age (mean)	43.42	45.04	53.78
Employment (proportion)			
employed	0.81	0.94	0.79
unemployed	0.04	0.01	0.01
not in the labor force	0.15	0.05	0.20
Education (proportion)			
high school dropout	0.24	0.15	0.18
high school graduate	0.09	0.09	0.07
TAFE or higher	0.67	0.76	0.75
# of dependent children (proportion)			
0	0.41	0.31	0.59
1	0.19	0.19	0.14
2	0.21	0.32	0.17
3+	0.19	0.18	0.10
# of households working (proportion)			
0	0.11	0.02	0.12
1	0.31	0.20	0.25
2	0.47	0.59	0.44
3+	0.11	0.19	0.19
Proportion of total sample	0.18	0.51	0.31

Notes: Income and consumption are reported in AUD. The consumption components are deflated using the corresponding component from the CPI. The income is deflated using the headline CPI.

4.2 Transitory income, balance sheet and consumption

In this section we present the following results: (i) the consumption response to a transitory income shock, γ_η , and the elasticity of consumption to a house price shock for the three subgroups (ii) heterogeneity in γ_η for subgroups that differ based on their balance sheet position, and (iii) time-varying estimates of γ_η.

4.2.1 Consumption responses and transitory income shocks

In Table 5, we provide our estimates of γ_ϵ.[12] We first note that mortgaged owners in the U.S. respond much more to transitory income shocks relative to other subgroups. In particular, 8 percent of such income shocks pass through to the consumption of mortgaged owners in the U.S., notably higher than that for outright owners and renters whose estimates are 0.02 and 0.01, respectively.[13] This is an interesting finding since mortgaged and outright owners are similar in term of demographic and other characteristics but their balance sheet positions as reported in Figure 1 and Table 3 are quite different. For the Australian households in our sample, we do not find any evidence of heterogeneity in γ_η across these subgroups where the pass-through of transitory income shocks to their consumption are all less than 5 percent. One potential reason why we find less heterogeneity in the Australian sample could be level of debt across the three subgroups. As Figure 1 shows, mortgage owners hold twice as much debt compared to outright owners in Australia, while in the U.S mortgage owners hold 10 times more debt than outright owners.

4.2.2 Consumption elasticity and house price shocks

Using the estimates of γ_η, we compute the consumption elasticity from the changes in house prices by following Berger et al. (2017).

[12] We also re-estimate our model after excluding households that changed their home-ownership status over the sample period. The results are qualitatively unchanged, see Tables A–9 and A–10 in the Appendix.

[13] Our estimates are however smaller is size relative to the estimates from studies that employ natural experiments. Commault (2017) argues that structural models tend to generate smaller estimates of pass-through of transitory shocks than the estimates from natural experiments because structural estimation often ignores correlations between past income shocks and consumption growth. In our UC model, we explicitly allow for the possibility of persistent effects via transitory income shocks, however, we do find any empirical support for such dynamics beyond a one-year horizon.

Table 5: Consumption Responses of Subgroups

	Baseline	Renters	Mortgaged owners	Outright owners
		UNITED STATES		
γ_ϵ	0.06 (0.01)	0.01 (0.01)	0.08 (0.01)	0.02 (0.04)
N	3213	353	2134	448
		AUSTRALIA		
γ_ϵ	0.03 (0.01)	0.01 (0.01)	0.03 (0.01)	0.03 (0.01)
N	4165	739	1995	1168

Notes: The table reports point estimates for pass-through of transitory income shocks with standard deviations in parentheses. N refers to the number of households in each sample. Tables with the full results are reported in the Appendix.

The elasticity of consumption with respect to house price shocks, according to Berger et al. (2017), is given by:

$$elasticity_t = MPC \times \frac{C_t}{Y_t} \times (1-\delta)\frac{P_t H_t}{C_t}, \tag{10}$$

where MPC is the estimated value of γ_ϵ, C_t is total consumption, Y_t is annual income, $P_t H_t$ is housing value, and δ is housing depreciation rate. Following Berger et al. (2017), we use the median value of C_t/Y_t in each group. Similarly, $P_t H_t$ is the median self-reported housing value from our data. We set the depreciation rate as 2 percent per annum which is a commonly used value in the quantitative macro-housing models.[14] The consumption elasticity with respect to house price shocks is 0.17 for mortgaged owners in our U.S. sample which is in line with the range suggested by Case et al. (2013). Using the U.S. data from 1978 to 2009, the authors show that the elasticity of consumption from changes in housing wealth ranges from 0.03 to 0.18. using the simulated data from a life-cycle model, Berger et al. (2017) compute the elasticity to be 0.23 . Other studies such as Mian et al. (2013) and Kaplan, Mitman and Violante (2016) also find similar estimates. Our estimates of consumption elasticity lend support to the view that homeowners with high leverages tend to have high MPCs and therefore exhibit higher responsiveness to a house price shock.

[14] Berger et al. (2017) also use the annual depreciation rate of 2 percent for their calculation of consumption elasticity.

4.2.3 Consumption responses and balance sheets

Why would mortgaged owners respond to transitory income shocks as seen from the estimates in Table 5? While our empirical analysis cannot establish a causal like between balance sheet effects and consumption, we can relate our empirical findings to theories that postulate such a relationship. For example, according to (Chetty and Szeidl, 2007) consumption commitment refers to a set of spending components that are difficult to adjust, primarily due to transaction costs, such as mortgage payments. Having debt, therefore, increases the level consumption commitments of a household as it requires them to incur regular expenses like interest payments. It is likely that these consumption commitments in turn make it harder for these households, mortgage owners in our sample, to smooth their consumption in the event of a transitory income shock.

To evaluate the role of debt and, in general, the balance sheet of the household, we further subgroup households based on the holdings of debt, net wealth, as well as liquid wealth. More specifically, a household is in the high (low) debt group if her debt level is higher (lower) than the top (bottom) 25th percentile of the debt distribution from the whole sample.[15] The same cutoff values are used for high net wealth and low net wealth groups. Along the liquid wealth dimension, we divide households using the criteria of Hand-to-Mouth from Kaplan et al. (2014).[16]

Table 6 reports the results for this subgroup analysis. For U.S. households, we find that households with higher debt and net wealth respond more to transitory income shocks than their counterparts. Households in the high debt group have a pass-through of 7 percent which is statistically significant and these households on average have 2.5 times larger debt than the sample average. Households in the high net wealth group also respond to transitory income shocks. It is worth pointing out that the overlap between high debt and high net wealth groups is around 33 percent. That is, over 30 percent of households that are in the high debt group are also in the high net wealth group. As a result, the average level of debt for the high net wealth

[15] Wealth information in PSID appears in every wave. However, in HILDA such information is available in every fourth year so we use the distribution of the averages of each wealth component across the years 2006, 2010 and 2014.

[16] In our sample, approximately 21 percent of households are classified into Hand-to-Mouth and out of them, 19 percent are wealthy Hand-to-Mouth. These percentages are similar to that in Kaplan et al. (2014).

Table 6: Consumption Responses and Balance Sheets

	High debt	Low debt	High nw	Low nw	HtM	N-HtM
			UNITED STATES			
γ_ϵ	0.07 (0.02)	0.02 (0.03)	0.06 (0.02)	0.03 (0.02)	0.08 (0.03)	0.04 (0.01)
N	649	770	719	695	650	1851
			AUSTRALIA			
γ_ϵ	0.02 (0.01)	0.03 (0.01)	0.02 (0.01)	0.04 (0.01)	0.02 (0.01)	0.03 (0.01)
N	920	1008	905	1043	1245	2497

Notes: The table reports point estimates for pass-through of transitory income shocks with standard deviations in parentheses. High (low) groups correspond to the level higher (lower) than 75th (25th) percentile of the respective wealth components. N refers to the number of households in each sample. Tables with the full estimation results are reported in the Appendix.

group is also large; it is about 1.3 times larger than the sample average. The last two columns in Table 6 show that households who are classified into Hand-to-Mouth have higher consumption responses to transitory income shocks, consistent with findings by the existing studies in the literature.[17] Households with lower liquid wealth (HtM) in the U.S. have a pass-through coefficient of 0.08.[18]

An interesting finding based on Table 6 is that for the U.S, households in the high debt group, column 2 in Table 6, are distinct from HtM households, column 6 in Table 6. Approximately 29 percent of HtM households are also in the high debt group.[19] When comparing to the total sample, the percentage of overlapping households between HtM and high debt groups is 7 percent. This would suggest that in our sample of U.S households, including the high debt households who do not overlap with the HtM would increase the number of households who are sensitive to transitory income shocks at least by 50 percent. As in the whole sample analysis, we find that

[17] Many existing studies using natural experiments such as fiscal stimulus or lottery winnings typically find a negative correlation between an individuals' the level of liquid wealth and their marginal propensity to consume out of transitory income shocks. See Johnson et al. (2006), Agarwal et al. (2007), Parker et al. (2013) and Fagereng et al. (2016).

[18] We have also subgrouped households using the distribution of liquid wealth by itself instead of following Kaplan et al. (2014)'s HtM criteria. When the cutoff point of 25th percentile was used, we find that households in the low liquid wealth group (bottom 25 percent) have a pass-through coefficient of 0.07.

[19] If we use the cutoff of 90th percentile to construct the high debt group, the overlap is just 11 percent. As reported in Table A–7, the consumption response of high debt households with 90th percentile cuttoff is 0.10.

Australian households do not respond to transitory income shocks, and there is not much heterogeneity across these subgroups.

4.2.4 Time-varying consumption responses

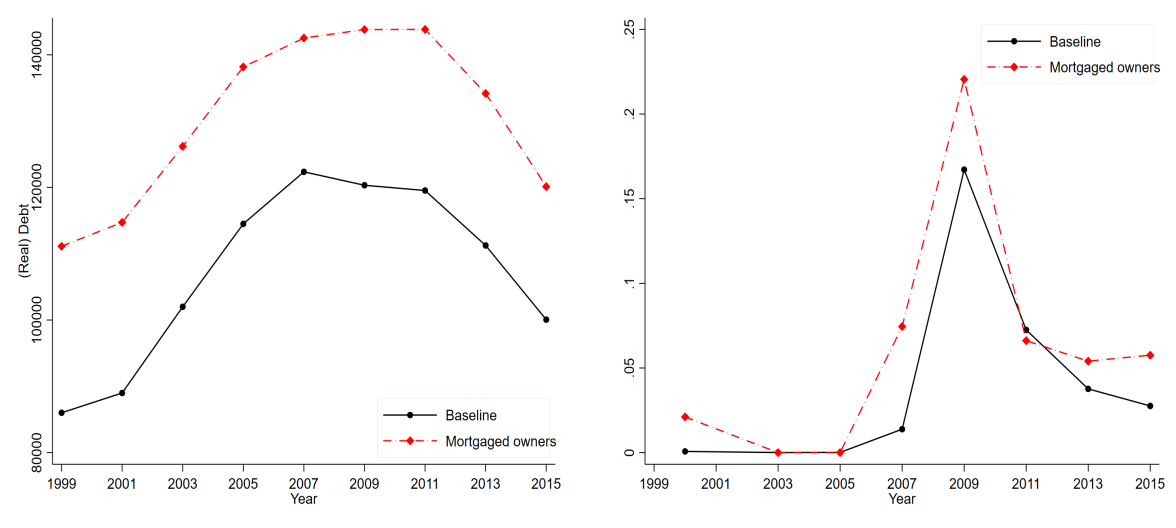
The results from the previous subsection highlight the importance of debt in understanding households' consumption responses to transitory income shocks. In this subsection, we present the time-varying estimates of γ_η in a model where we allow γ_ϵ and γ_η to vary over the sample period while holding the variability of income and consumption shocks constant. We then relate these time-varying estimates to the changing patterns of debt observed in the two countries. [20]

The left panel in Figure 3 shows the patterns of real debt for mortgaged owners (red dashed) and households in our baseline sample (black solid) from the PSID survey. The level of real debt increased prior to the Great Recession but decreased since then. The right panel in Figure 3 plots the consumption responses to transitory income shocks during our sample period. While the consumption response was muted until 2005, it increased substantially from 2007 and reached the peak in the middle of the Great Recession. For mortgaged owners, the estimate of γ_ϵ is 0.23 in 2009 which is almost four times higher than the aggregate estimate reported in Table 5. Other studies such as Gross et al. (2016) also find that the MPC was around 30 percent higher during the Great Recession.

Likewise, we present the time patterns of debt and consumption responses for Australian households in Figure 4. As depicted in the left panel, the level of household real debt has increased consistently over the last decade. The estimated γ_η has also increased over the sample period. Mortgage owners did not respond to transitory income shocks at all before 2008 but the responses increased gradually since then and were around 0.05 in 2015. What is interesting is that we do not observe much heterogeneity across Australian households in Tables 5 and 6 but along the time dimension we see that the response of mortgage owners has changed over time and that is also reflected in the aggregate, the black line in the right panel in Figure 5. Clearly, both the U.S. and Australian evidence suggest that the dynamics of consumption responses to

[20] Our time-varying analyses focus on households in the baseline sample and mortgaged owners group. We exclude renters and outright owners as their sample sizes are too small, i.e. $N < 250$, for a single year and hence we may suffer from a small sample issue.

Figure 3: Time-varying household debt (left) and consumption responses (right): U.S.

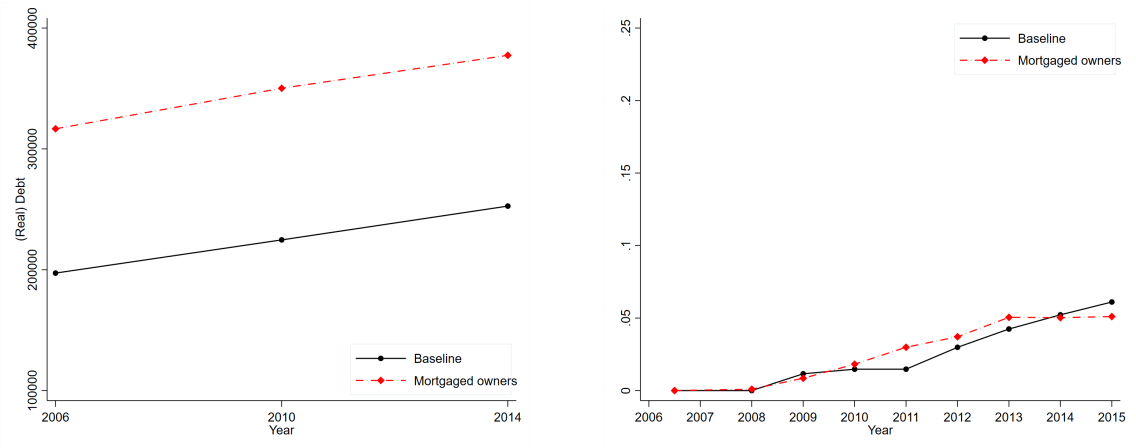


Notes: The left panel displays the time trends in the level of real debt from the baseline sample (black solid) and the subsample of mortgaged owners (red dashed) in the United States. The data are sourced from the PSID survey and expressed in USD. The nominal debt from the raw dataset is deflated using the headline CPI. The right panel displays the time-varying consumption responses to transitory income shocks. The full estimation results including standard deviations are provided in the Appendix.

transitory income shocks coincide with the patterns of debt dynamics.

Based on Table 5 and Figures 3 and 4, we conclude that our results provide new empirical evidence that debt plays a role in understanding the consumption responses to transitory income shocks. Here, we discuss the recent literature that emphasizes the role of household debt on consumption responses and how our results are supported by this literature. Cloyne and Surico (2017) exploit the exogenous change in income tax in the United Kingdom and show that homeowners with mortgages respond significantly to the tax shock more than outright homeowners and renters. Similar empirical evidence is found in Cloyne et al. (2019) where the authors examine the role of household balance sheets on the transmission of monetary policy. Using PSID, Dynan (2012) finds that highly leveraged homeowners had a larger drop in consumption during and aftermath of the Great Recession. Her finding is not driven by the wealth effect from the fall in house prices per se, but it is primarily driven by the high levels of debt holdings and their subsequent need for deleveraging. Baker (2017) also shows that, during the recent financial crisis, consumption responses to income

Figure 4: Time-varying household debt (left) and consumption responses (right): Australia



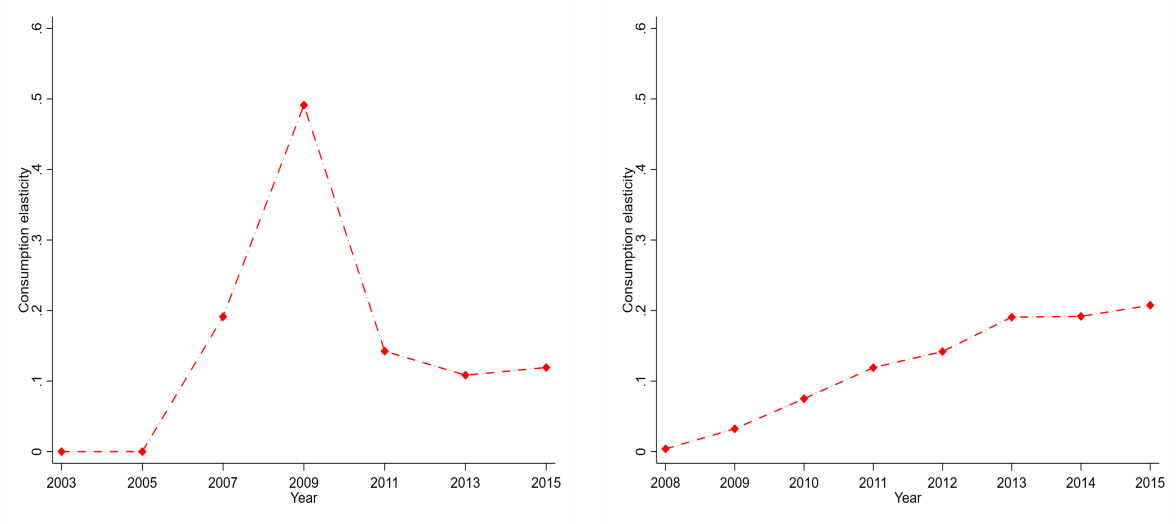
Notes: The left panel displays the time trends in the level of real debt from the baseline sample (black solid) and the subsample of mortgaged owners (red dashed) in Australia. The data are sourced from the HILDA survey and expressed in AUD. The nominal debt from the raw dataset is deflated using the headline CPI. The right panel displays the time-varying consumption responses to transitory income shocks. The full estimation results including standard deviations are provided in the Appendix.

changes were higher for indebted and credit constrained households. In general, there is ample empirical evidence that leverage plays a significant role in understanding heterogeneous consumption responses to income shocks.

The link between household debt and consumption are also extensively explored in the theoretical literature. In Guerrieri and Lorenzoni (2017), the authors show that households who are poor or closer to their borrowing limit reduce consumption more sharply in response to tightening of the borrowing constraint than rich or the least constrained households. In a more stylized model, Eggertsson and Krugman (2012) show that the borrowing limit and hence households' debt positions are crucial for understanding the reduction the aggregate demand during the Great Recession. In relation to our findings, these theoretical predictions provide a consistent view that households' ability to borrow and indebtedness are closely linked to consumption responses to income shocks.

As noted by Mian et al. (2013), the drop in consumption during the Great Recession was due to the sharp decline in housing net worth. Related to their findings, we also compute the time-varying consumption elasticities with respect to housing price shocks in the style of Berger et al. (2017). The left panel in Figure 5 shows that,

Figure 5: Time-varying Consumption Elasticities for mortgaged owners: U.S. (left) and Australia (right)



Notes: The figure displays the time-varying consumption elasticities to house price shocks.

for mortgaged owners in the U.S., the elasticity increased during the housing boom period, reached its peak in the middle of the Great Recession, and then decreased. The estimate of γ_ϵ and housing value are the key drivers of the consumption elasticity from house price changes. Intuitively, the consumption elasticity rises during the housing boom period because households purchase more housing using debt which in turn results in higher responsiveness to transitory income shocks. During the peak of the recession, the elasticity also reached its peak because of the high estimate of γ_ϵ. We find that the consumption elasticity for mortgaged owners is 0.49, close to the elasticity estimates by Mian et al. (2013) and Kaplan et al. (2016). Lastly, the right panel of Figure 5 shows that the consumption elasticity for Australian mortgaged owners has increased continuously and was 0.2 in 2015 which is also driven by the consistent rise in housing value and household debt, providing the identical qualitative interpretation to the U.S. evidence.

4.3 Permanent income shocks and consumption insurance

Thus far, our analysis focused on the implications of household balance sheet positions on the consumption responses to transitory income shocks. In this final subsection, we turn to the implications of household balance sheets on the consumption

Table 7: Consumption Insurance among Subgroups

	Baseline	Renters	Mortgaged owners	Outright owners
		UNITED STATES		
ϑ_η	0.56 (0.02)	0.46 (0.04)	0.56 (0.03)	0.60 (0.05)
N	3213	353	2134	448
		AUSTRALIA		
ϑ_η	0.60 (0.01)	0.55 (0.04)	0.57 (0.02)	0.67 (0.03)
N	4165	739	1995	1168

Notes: The table reports point estimates for pass-through of permanent income shocks with standard deviations in parentheses. N refers to the number of households in each sample. Tables with the full estimation results are reported in the Appendix

insurance with respect to permanent income shocks, another key parameter in our empirical model in Section 3.

4.3.1 Heterogeneity in consumption insurance across households

Table 7 reports the amount of consumption insurance faced by households in our main subgroups. For U.S. households, the degree of consumption insurance is highest for outright owners and lowest for renters (0.60 vs. 0.46). The level of insurance for mortgaged owners is 0.56, around 10 percentage points higher than that faced by renters. It is also worth noting that outright owners, despite they share similar demographic characteristics, have a higher level of insurance than mortgaged owners. We find a roughly similar pattern for Australian households where outright owners have the most consumption insurance and renters have the least (0.67 vs. 0.55). The mortgaged owners in Australia also have around 10 percentage points less insurance than outright owners.

The results in Table 7 suggest that household net wealth and debt may be important determinants of consumption insurance against permanent income shocks. In both countries, outright owners have the most insurance and renters have the least insurance. As depicted in Figure 1, the most notable difference in balance sheet characteristics between these two groups, renters and outright owners, is the level of net wealth. Mortgaged owners have lower insurance against permanent income shocks compared to outright owners suggesting that a key component of balance sheet, debt

Table 8: Consumption Insurance and Balance Sheets

	High nw	Low nw	High debt	Low debt	HtM	N-HtM
			UNITED STATES			
ϑ_η	0.65 (0.04)	0.33 (0.03)	0.45 (0.04)	0.57 (0.05)	0.45 (0.04)	0.49 (0.01)
N	649	770	719	695	650	1851
			AUSTRALIA			
ϑ_η	0.64 (0.03)	0.45 (0.04)	0.58 (0.03)	0.60 (0.03)	0.57 (0.03)	0.61 (0.02)
N	920	1008	905	1043	1245	2497

Notes: The table reports point estimates for pass-through of permanent income shocks with standard deviations in parentheses. High (low) groups correspond to the level higher (lower) than 75th (25th) percentile of the respective wealth components. N refers to the number of households in each sample. Tables with the full estimation results are reported in the Appendix.

might also impact a households ability to insure consumption from shocks to permanent income.

In order examine whether components of a household's balance sheet such as net wealth and debt are important drivers of consumption insurance, we further subgroup households based on their balance sheet positions.[21] The first two columns in Table 8 show that households in the high net wealth group have much more consumption insurance than those in the low net wealth group (0.63 vs. 0.35 for the U.S.; and 0.64 vs. 0.45 for Australia). Likewise, we find that households whose debt level is low have more insurance relative to those with higher debt, in particular for U.S. households. The last two columns in Table 8 show that, when households are subgrouped by their Hand-to-Mouth status, the difference in consumption insurance is not large, suggesting that the amount of liquid wealth may not be as important as other balance sheet factors such as net wealth and debt. In fact, Blundell et al. (2008) show that households with low wealth tend to have less insurance to permanent income shocks than those with higher wealth.

One possible mechanism which households with higher net wealth have more consumption insurance is the ability to access buffer-stock wealth (Carroll, 1997). When households receive permanent income shocks, they can smooth their consumption by adjusting their wealth. However, if a household is highly indebted, her wealth

[21] We apply the same cutoff strategy as we used for the results in Table 6.

is tied with debt and therefore she would find it difficult to run down her wealth to insure against permanent income shocks.

5 Conclusion

In this paper, we have examined how households with different balance sheet positions respond differently to unanticipated transitory and permanent income shocks. Using longitudinal household survey data from the U.S. and Australia, we estimated an unobserved components model of income and consumption using the likelihood-based approach and arrived at five findings. First, consumption responses to transitory income shocks are higher for households with higher debt levels. Second, consumption elasticities from house price shocks are also higher for households with higher debt. Third, the time-varying analysis suggests the pass-through of transitory income shocks is larger during the period when the debt levels were high. These estimates reinforces our first two findings and highlight the role of debt before and soon after the Great Recession. Fourth, households with higher net wealth and lower debt have more consumption insurance against permanent income shocks.

The results in this paper offer new insights into the relationship between household balance sheets and consumption as well as how this relationship has changed over the Great Recession period. They also suggest that macroeconomic models and policies should pay careful attention to household debt and its impact on consumption, both at individual and aggregate levels. One important future work arises from our finding. There is a scope to develop the consumption models, e.g. two-asset incomplete markets model as in Kaplan and Violante (2014) that account seriously for household debt and examine whether such models could explain the empirical findings in this paper. This is an important avenue for future research.

References

Agarwal, Sumit, Chunlin Liu, and Nicholas S Souleles, "The Reaction of Consumer Spending and Debt to Tax Rebates: Evidence from Consumer Credit Data," *Journal of Political Economy*, 2007, *115* (6), 986–1019.

Altonji, Joseph G and Lewis M Segal, "Small-sample bias in GMM estimation of covariance structures," *Journal of Business & Economic Statistics*, 1996, *14* (3), 353–366.

Baker, Scott, "Debt and the Response to Household Income Shocks: Validation and Application of Linked Financial Account Data," 2017.

Berger, David, Veronica Guerrieri, Guido Lorenzoni, and Joseph Vavra, "House prices and consumer spending," *The Review of Economic Studies*, 2017, *85* (3), 1502–1542.

Blundell, Richard, Luigi Pistaferri, and Ian Preston, "Consumption Inequality and Partial Insurance," *American Economic Review*, 2008, *98* (5), 1887–1921.

_ , _ , and Itay Saporta-Eksten, "Consumption Inequality and Family Labor Supply," *American Economic Review*, 2016, *106* (2), 387–435.

Carroll, Christopher D, "Buffer-Stock Saving and the Life Cycle/Permanent Income Hypothesis," *Quarterly Journal of Economics*, 1997, *112* (1), 1–55.

_ , "Precautionary saving and the marginal propensity to consume out of permanent income," *Journal of monetary Economics*, 2009, *56* (6), 780–790.

Carroll, Christopher, Jiri Slacalek, Kiichi Tokuoka, and Matthew N White, "The distribution of wealth and the marginal propensity to consume," *Quantitative Economics*, 2017, *8* (3), 977–1020.

Case, Karl E, John M Quigley, and Robert J Shiller, "Wealth Effects Revisited 1975–2012," *Critical Finance Review*, 2013, *2* (1), 101–128.

Chatterjee, Arpita, Aarti Singh, and Tahlee Stone, "Understanding Wage Inequality in Australia," *Economic Record*, 2016, *92* (298), 348–360.

_ , **James Morley, and Aarti Singh**, "Full Information Estimation of Household Income Risk and Consumption Insurance," Technical Report, University of Sydney 2018.

Chetty, Raj and Adam Szeidl, "Consumption commitments and risk preferences," *The Quarterly Journal of Economics*, 2007, *122* (2), 831–877.

_ **and** _ , "Consumption commitments and habit formation," *Econometrica*, 2016, *84* (2), 855–890.

Cloyne, James, Clodomiro Ferreira, and Paolo Surico, "Monetary policy when households have debt: new evidence on the transmission mechanism," *Review of Economic Studies*, 2019, *Forthcoming*.

Cloyne, James S and Paolo Surico, "Household Debt and the Dynamic Effects of Income Tax Changes," *Review of Economic Studies*, 2017, *84* (1).

Commault, Jeanne, "How Does Consumption Respond to a Transitory Income Shock? Reconciling Natural Experiments and Structural Estimations," Technical Report 2017.

Dynan, Karen, "Is a Household Debt Overhang Holding Back Consumption?," *Brookings Papers on Economic Activity*, 2012, *2012* (1), 299–362.

Eggertsson, Gauti B and Paul Krugman, "Debt, Deleveraging, and the Liquidity Trap: A Fisher-Minsky-Koo Approach," *Quarterly Journal of Economics*, 2012, *127* (3), 1469–1513.

Fagereng, Andreas, Martin Holm, and Gisle James Natvik, "MPC Heterogeneity and Household Balance Sheets," 2016.

Fox, Ryan and Peter Tulip, "Is Housing Overvalued?," Technical Report, Reserve Bank of Australia 2014.

Fuster, Andreas, Greg Kaplan, and Basit Zafar, "What Would You Do With 500? Spending Responses to Gains, Losses, News and Loans," Technical Report, National Bureau of Economic Research 2018.

Gross, Tal, Matthew J Notowidigdo, and Jialan Wang, "The marginal propensity to consume over the business cycle," Technical Report, National Bureau of Economic Research 2016.

Guerrieri, Veronica and Guido Lorenzoni, "Credit Crises, Precautionary Savings, and the Liquidity Trap," *Quarterly Journal of Economics*, 2017, *132* (3), 1427–1467.

Heathcote, Jonathan, Kjetil Storesletten, and Giovanni L Violante, "Consumption and Labor Supply with Partial Insurance: An Analytical Framework," *American Economic Review*, 2014, *104* (7), 2075–2126.

Jappelli, Tullio and Luigi Pistaferri, "The Consumption Response to Income Changes," *Annu. Rev. Econ.*, 2010, *2* (1), 479–506.

Johnson, David S, Jonathan A Parker, and Nicholas S Souleles, "Household Expenditure and the Income Tax Rebates of 2001," *American Economic Review*, 2006, *96* (5), 1589–1610.

Kaplan, Greg and Giovanni L Violante, "How much consumption insurance beyond self-insurance?," *American Economic Journal: Macroeconomics*, 2010, *2* (4), 53–87.

_ **and** _ , "A Model of the Consumption response to Fiscal Stimulus Payments," *Econometrica*, 2014, *82* (4), 1199–1239.

_ **, Gianni La Cava, and Tahlee Stone**, "Household Economic Inequality in Australia," *Economic Record*, 2018.

_ **, Giovanni L Violante, and Justin Weidner**, "The Wealthy Hand-to-Mouth," *Brookings Papers on Economic Activity*, 2014, *2014* (1), 77–138.

_ **, Kurt Mitman, and Giovanni L Violante**, "Non-durable Consumption and Housing Net Worth in the Great Recession: Evidence from Easily Accessible Data," Technical Report, National Bureau of Economic Research 2016.

Mian, Atif and Amir Sufi, "The Consequences of Mortgage Credit Expansion: Evidence from the U.S. Mortgage Default Crisis," *Quarterly Journal of Economics*, 2009, *124* (4), 1449–1496.

_ **and** _ , "House prices, home equity-based borrowing, and the US household leverage crisis," *American Economic Review*, 2011, *101* (5), 2132–56.

_ **, Kamalesh Rao, and Amir Sufi**, "Household Balance Sheets, Consumption, and the Economic Slump," *Quarterly Journal of Economics*, 2013, *128* (4), 1687–1726.

Parker, Jonathan A, Nicholas S Souleles, David S Johnson, and Robert McClelland, "Consumer Spending and the Economic Stimulus Payments of 2008," *American Economic Review*, 2013, *103* (6), 2530–2553.

Poterba, James and T Sinai, "Tax Expenditures for Owner-Occupied Housing," *American Economic Review: Papers and Proceedings*, 2010, *82* (2), 237–242.

A Additional Figures and Tables

Table A–1: Sample Selection (PSID)

Description	Dropped	Remaining
Initial unbalanced sample		74,224
No sig. change in family composition	4,417	69,807
Married household head	35,731	34,076
Male head	0	34,076
Age from 30 to 65	7,592	26,484
No missing demographics	909	25,575
No zero food expenditure	98	25,477
No missing income	24	25,453
No income outliers	250	25,201
No negative liquid/illiquid assets	10	25,191
No SEO households	4,640	20,551
At least two consecutive years of appearance	3,227	**17,324**

Notes: The table reports sample selection from PSID with the number of dropped observations in the second column and remaining observations in the third column.

Table A–2: Sample Selection (HILDA)

Description	Dropped	Remaining
Initial unbalanced sample		594,390
Households with couples	152,412	441,978
Post 2006	150,365	291,613
Age from 30 to 65	222,538	69,030
Male head	34,691	34,339
No missing demographics	2,743	31,596
No negative housing value	1,017	30,597
No information on mortgage payment	508	30,071
No income outliers	406	29,665
No zero food expenditure	41	29,624
At least two consecutive years of appearance	4,799	**24,825**

Notes: The table reports sample selection from HILDA with the number of dropped observations in the second column and remaining observations in the third column.

Table A–3: Full Estimation Results: by Housing Tenure (United States)

	Baseline	Renters	Mortgaged owners	Outright owners
			INCOME	
θ_y	0.21 (0.01)	0.21 (0.05)	0.21 (0.02)	0.18 (0.04)
σ_η	0.16 (0.00)	0.15 (0.01)	0.15 (0.00)	0.17 (0.01)
σ_ϵ	0.28 (0.00)	0.30 (0.01)	0.26 (0.00)	0.30 (0.01)
			CONSUMPTION	
σ_u	0.08 (0.00)	0.06 (0.01)	0.08 (0.00)	0.09 (0.01)
σ_v	0.36 (0.00)	0.25 (0.01)	0.32 (0.00)	0.40 (0.01)
γ_ϵ	0.06 (0.01)	0.01 (0.02)	0.08 (0.01)	0.02 (0.03)
ϑ_η	0.56 (0.02)	0.36 (0.04)	0.56 (0.03)	0.60 (0.05)
N	3213	353	2134	448

Notes: The table reports point estimates with standard deviations in parentheses.

Table A–4: Full Estimation Results: by Housing Tenure (Australia)

	Baseline	Renters	Mortgaged owners	Outright owners
			INCOME	
θ_y	0.16 (0.01)	0.13 (0.04)	0.16 (0.02)	0.19 (0.02)
σ_η	0.13 (0.00)	0.12 (0.01)	0.12 (0.00)	0.14 (0.00)
σ_ϵ	0.28 (0.00)	0.28 (0.01)	0.24 (0.00)	0.32 (0.00)
			CONSUMPTION	
σ_u	0.08 (0.00)	0.07 (0.00)	0.04 (0.00)	0.09 (0.00)
σ_v	0.14 (0.00)	0.17 (0.00)	0.12 (0.00)	0.13 (0.00)
γ_ϵ	0.03 (0.00)	0.01 (0.01)	0.03 (0.01)	0.03 (0.01)
ϑ_η	0.60 (0.01)	0.45 (0.04)	0.57 (0.02)	0.67 (0.03)
N	4165	739	1995	1168

Notes: The table reports point estimates with standard deviations in parentheses.

Table A–5: Full estimation result: by Household Balance Sheets (United States)

	High nw	Low nw	High debt	Low debt	HtM	N-HtM
			INCOME			
θ_y	0.21 (0.03)	0.21 (0.03)	0.27 (0.03)	0.22 (0.04)	0.26 (0.04)	0.25 (0.02)
σ_η	0.21 (0.01)	0.14 (0.01)	0.17 (0.01)	0.17 (0.01)	0.14 (0.01)	0.15 (0.00)
σ_ϵ	0.32 (0.01)	0.28 (0.01)	0.27 (0.01)	0.30 (0.01)	0.28 (0.01)	0.28 (0.00)
			CONSUMPTION			
σ_u	0.16 (0.01)	0.06 (0.00)	0.07 (0.01)	0.09 (0.01)	0.05 (0.01)	0.08 (0.00)
σ_v	0.21 (0.01)	0.24 (0.00)	0.20 (0.00)	0.49 (0.01)	0.34 (0.01)	0.20 (0.00)
γ_ϵ	0.06 (0.02)	0.03 (0.02)	0.07 (0.02)	0.02 (0.03)	0.08 (0.03)	0.04 (0.01)
ϑ_η	0.63 (0.04)	0.35 (0.03)	0.45 (0.04)	0.57 (0.05)	0.45 (0.04)	0.49 (0.01)
N	649	770	719	695	650	1851

Notes: The table reports point estimates with standard deviations in parentheses. High (low) groups correspond to the level higher (lower) than 75th (25th) percentile of the respective wealth components.

Table A–6: Full estimation result: by Household Balance Sheets (Australia)

	High nw	Low nw	High debt	Low debt	HtM	N-HtM
			INCOME			
θ_y	0.16 (0.02)	0.13 (0.02)	0.18 (0.02)	0.17 (0.02)	0.13 (0.02)	0.17 (0.01)
σ_η	0.16 (0.00)	0.11 (0.00)	0.15 (0.00)	0.13 (0.00)	0.12 (0.00)	0.14 (0.00)
σ_ϵ	0.31 (0.00)	0.27 (0.00)	0.27 (0.00)	0.31 (0.00)	0.25 (0.00)	0.28 (0.00)
			CONSUMPTION			
σ_u	0.10 (0.00)	0.27 (0.00)	0.09 (0.00)	0.09 (0.00)	0.08 (0.00)	0.08 (0.00)
σ_v	0.12 (0.00)	0.16 (0.00)	0.13 (0.00)	0.16 (0.00)	0.14 (0.00)	0.13 (0.00)
γ_ϵ	0.02 (0.01)	0.04 (0.01)	0.02 (0.01)	0.03 (0.01)	0.02 (0.01)	0.03 (0.01)
ϑ_η	0.64 (0.03)	0.45 (0.04)	0.58 (0.03)	0.60 (0.03)	0.57 (0.03)	0.61 (0.02)
N	920	1008	905	1043	1245	2497

Notes: The table reports point estimates with standard deviations in parentheses. High (low) groups correspond to the level higher (lower) than 75th (25th) percentile of the respective wealth components.

Table A–7: Full estimation result: by Household Balance Sheets, 90th percentile (United States)

	High nw	Low nw	High debt	Low debt
		INCOME		
θ_y	0.23 (0.07)	0.23 (0.10)	0.29 (0.05)	0.27 (0.05)
σ_η	0.28 (0.02)	0.15 (0.01)	0.20 (0.01)	0.18 (0.01)
σ_ϵ	0.35 (0.02)	0.30 (0.02)	0.31 (0.01)	0.31 (0.01)
		CONSUMPTION		
σ_u	0.21 (0.01)	0.06 (0.01)	0.08 (0.01)	0.10 (0.01)
σ_v	0.23 (0.07)	0.24 (0.01)	0.19 (0.01)	0.48 (0.01)
γ_ϵ	0.12 (0.05)	0.01 (0.04)	0.10 (0.02)	0.01 (0.04)
ϑ_η	0.71 (0.07)	0.26 (0.07)	0.48 (0.01)	0.54 (0.07)
N	228	224	274	432

Notes: The table reports point estimates with standard deviations in parentheses. High (low) groups correspond to the level higher (lower) than 90th (10th) percentile of the respective wealth components.

Table A–8: Full estimation result: by Household Balance Sheets, 90th percentile (Australia)

	High nw	Low nw	High debt	Low debt
		INCOME		
θ_y	0.14 (0.04)	0.07 (0.03)	0.17 (0.03)	0.19 (0.03)
σ_η	0.19 (0.01)	0.13 (0.01)	0.17 (0.01)	0.13 (0.01)
σ_ϵ	0.32 (0.01)	0.27 (0.01)	0.29 (0.01)	0.31 (0.01)
		CONSUMPTION		
σ_u	0.12 (0.00)	0.07 (0.00)	0.10 (0.00)	0.09 (0.00)
σ_v	0.12 (0.00)	0.19 (0.00)	0.13 (0.00)	0.14 (0.00)
γ_ϵ	0.02 (0.02)	0.02 (0.02)	0.03 (0.02)	0.03 (0.01)
ϑ_η	0.62 (0.04)	0.53 (0.02)	0.56 (0.04)	0.57 (0.05)
N	391	420	386	459

Notes: The table reports point estimates with standard deviations in parentheses. High (low) groups correspond to the level higher (lower) than 90th (10th) percentile of the respective wealth components.

Table A–9: Full estimation result: by Housing Tenure, without transitions (United States)

	Baseline	Renters	Mortgaged owners	Outright owners
			INCOME	
θ_y	0.22 (0.02)	0.11 (0.06)	0.24 (0.02)	0.13 (0.05)
σ_η	0.16 (0.00)	0.17 (0.01)	0.15 (0.00)	0.18 (0.01)
σ_ϵ	0.27 (0.00)	0.27 (0.01)	0.26 (0.00)	0.30 (0.01)
			CONSUMPTION	
σ_u	0.08 (0.00)	0.06 (0.01)	0.08 (0.00)	0.09 (0.01)
σ_v	0.32 (0.00)	0.25 (0.01)	0.29 (0.00)	0.40 (0.01)
γ_ϵ	0.07 (0.01)	0.06 (0.04)	0.06 (0.01)	0.03 (0.04)
ϑ_η	0.55 (0.02)	0.44 (0.06)	0.52 (0.02)	0.66 (0.07)
N	2225	197	1515	226

Notes: The table reports point estimates with standard deviations in parentheses.

Table A–10: Full estimation result: by Housing Tenure, without transitions (Australia)

	Baseline	Renters	Mortgaged owners	Outright owners
			INCOME	
θ_y	0.18 (0.01)	0.13 (0.03)	0.18 (0.02)	0.20 (0.02)
σ_η	0.12 (0.00)	0.11 (0.01)	0.11 (0.00)	0.14 (0.01)
σ_ϵ	0.28 (0.00)	0.28 (0.01)	0.24 (0.00)	0.32 (0.01)
			CONSUMPTION	
σ_u	0.08 (0.00)	0.07 (0.00)	0.07 (0.00)	0.09 (0.00)
σ_v	0.14 (0.00)	0.17 (0.00)	0.12 (0.00)	0.14 (0.00)
γ_ϵ	0.03 (0.01)	0.02 (0.02)	0.03 (0.01)	0.03 (0.01)
ϑ_η	0.58 (0.02)	0.40 (0.05)	0.55 (0.03)	0.68 (0.04
N	2800	519	1185	738

Notes: The table reports point estimates with standard deviations in parentheses.

Table A–11: Full estimation result: time-varying estimates (United States)

		Baseline	Mortgaged owners
θ_y		0.21 (0.01)	0.22 (0.02)
σ_η		0.14 (0.00)	0.12 (0.00)
σ_ϵ		0.29 (0.00)	0.28 (0.00)
σ_u		0.08 (0.00)	0.08 (0.00)
σ_v		0.34 (0.00)	0.30 (0.00)
γ_ϵ	1999-2001	0.00 (0.00)	0.02 (0.01)
	2003	0.00 (0.00)	0.00 (0.00)
	2005	0.00 (0.00)	0.00 (0.00)
	2007	0.01 (0.01)	0.07 (0.01)
	2009	0.17 (0.01)	0.22 (0.02)
	2011	0.07 (0.01)	0.07 (0.02)
	2013	0.04 (0.01)	0.05 (0.02)
	2015	0.03 (0.01)	0.06 (0.02)
γ_η	1999-2001	0.55 (0.04)	0.60 (0.03)
	2003	0.49 (0.01)	0.52 (0.02)
	2005	0.51 (0.01)	0.52 (0.02)
	2007	0.51 (0.00)	0.52 (0.03)
	2009	0.46 (0.03)	0.48 (0.01)
	2011	0.42 (0.02)	0.48 (0.02)
	2013	0.47 (0.03)	0.49 (0.01)
	2015	0.47 (0.10)	0.52 (0.02)

Notes: The table reports time-varying point estimates of γ_ϵ and γ_η with standard deviations in parentheses.

Table A–12: Full estimation result: time-varying estimates (Australia)

		Baseline	Mortgaged owners
θ_y		0.15 (0.01)	0.14 (0.02)
σ_η		0.11 (0.00)	0.10 (0.00)
σ_ϵ		0.29 (0.00)	0.28 (0.01)
σ_u		0.08 (0.00)	0.07 (0.00)
σ_v		0.14 (0.00)	0.17 (0.00)
γ_ϵ	2006-07	0.00 (0.00)	0.00 (0.00)
	2008	0.00 (0.00)	0.00 (0.01)
	2009	0.01 (0.00)	0.01 (0.01)
	2010	0.02 (0.00)	0.02 (0.01)
	2011	0.03 (0.00)	0.03 (0.01)
	2012	0.04 (0.00)	0.04 (0.01)
	2013	0.04 (0.00)	0.05 (0.01)
	2014	0.05 (0.00)	0.05 (0.01)
	2015	0.06 (0.01)	0.05 (0.01)
γ_η	2006-07	0.52 (0.02)	0.49 (0.01)
	2008	0.48 (0.02)	0.49 (0.01)
	2009	0.46 (0.02)	0.45 (0.01)
	2010	0.46 (0.02)	0.47 (0.02)
	2011	0.43 (0.01)	0.44 (0.02)
	2012	0.41 (0.01)	0.43 (0.02)
	2013	0.40 (0.01)	0.43 (0.02)
	2014	0.39 (0.01)	0.44 (0.02)
	2015	0.40 (0.01)	0.44 (0.02)

Notes: The table reports time-varying point estimates of γ_ϵ and γ_η with standard deviations in parentheses.