Household Balance Sheets and Consumption Responses to Income Shocks*

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Abstract

We examine how households with different balance sheet positions respond to income shocks using panel data from the United States and Australia. Mortgaged owners and households with high debt and low levels of liquid assets generally respond more to transitory income shocks, especially for U.S. households. In addition, time-varying estimates suggest that consumption of households with higher levels of debt, mortgaged owners, exhibited particularly high sensitivity to transitory income shocks during the Great Recession and during the recent housing boom in Australia. For both countries, households with higher wealth have more consumption insurance against permanent income shocks.

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

JEL codes: E21; C13; C33, D12; D14.

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1 Introduction

There is a growing literature that establishes a link between household balance sheets and consumption. Parker, Souleles, Johnson and McClelland (2013); Kaplan, Violante and Weidner (2014); Fagereng, Holm and Natvik (2018); 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), Baker (2018) and Garriga and Hedlund (2019) 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 version of the Blundell, Pistaferri and Preston (2008) model using the quasi maximum likelihood-based approach proposed by Chatterjee, Morley and Singh (2019). We elicit the financial positions of households by stratifying them based on their housing tenure status and consider the three main subgroups: renters, mortgaged owners, and outright owners.[1] In both datasets, renters have lower debt and wealth, mortgaged owners are relatively wealthy but highly indebted and outright owners have the highest level of wealth with low debt.

We find that the consumption of mortgaged owners are more sensitive to transitory income shocks than renters and outright owners in the U.S. While mortgaged and outright owners have similar demographic characteristics, the two groups of households are remarkably different in terms of their debt holdings which could be one reason why their consumption responses are different. Using our estimates of consumption responses, we compute the consumption elasticity with respect to house price shocks. The consumption elasticity is 0.17 for mortgaged owners in the U.S. This sensitivity of consumption to transitory income shocks by households who are highly indebted could be due to larger consumption commitments (Chetty and Szeidl, 2007).[2]

[1] 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 the heterogeneous responses to monetary policy shocks for households with different balance sheet positions.

[2] Chetty and Szeidl (2016), in a theoretical analysis, show that an increase in consumption commit-

Households with debt incur regular expenses such as interest payments on their debt which increases their consumption commitments. Faced with a negative income shock which is transitory, these households are less likely to change their interest payments on debt, i.e. their consumption commitments, but instead reduce spending on other non-durable consumption goods.

To further evaluate the role of debt, we stratify our sample based on the holdings of debt, wealth and liquid wealth. Consistent with evidence from subgroups based on housing tenure, households with higher debt respond more significantly to transitory income shocks. In addition, as in the existing literature, households with low liquid wealth, Hand-to-Mouth (HtM) households, also have higher consumption responses. Note that households who are classified as high debt are often distinct from HtM households and do not have low levels of liquid wealth. Our results therefore identify a new group of households who respond sensitively to transitory income shocks. In the U.S. sample, the total number of households that respond sensitively to transitory income shocks would increase by at least 30 percent if we also include high debt households in addition to HtM households.

We also estimate the time-varying pass-through of transitory income shocks to consumption. The results reinforce 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, especially for the mortgaged owners. For the Australian households, we find that mortgaged owners have experienced a continuous rise in the pass-through coefficient since 2008, which coincides with the housing boom and the rise in debt in Australia. Our estimates of time-varying consumption elasticities with respect to house price shocks for the U.S mortgaged owners provide empirical evidence of the rise in consumption elasticities during the housing boom which is consistent with the theoretical predictions of Berger, Guerrieri, Lorenzoni and Vavra (2017). Consumption elasticities increased during the house price boom because households took on more housing using debt, which in turn resulted in a higher sensitivity of consumption to transitory income shocks. The consumption elasticity with respect to house price shocks was 0.52 in 2009 for the U.S. mortgaged owners, the highest in the U.S. sample, and for Australian mortgaged owners, it has continued to increase and it was

ments can explain excess sensitivity of consumption that is commonly found in empirical microeconomic studies.

0.27 in 2017.[3]

Turning to consumption insurance against permanent income shocks, we find that households in both countries have similar levels of consumption insurance, approximately 50 percent. However, the estimates of consumption insurance vary depending on household balance sheets. Households with higher wealth, mortgaged owners and outright owners in both countries, have more consumption insurance relative to households with lower wealth. These households are likely to have more consumption insurance because of their ability to access buffer-stock wealth (Carroll, 1997). When these households encounter a permanent shock to their income, they may smooth their consumption by adjusting their wealth levels in spite of large adjustment costs.

Related literature. Our paper is related to three broad strands of the literature. It contributes to the empirical literature that estimates the MPCs from transitory income shocks, see for example Johnson, Parker and Souleles (2006), Parker et al. (2013), Kaplan et al. (2014), Clawley and Kuchler (2018), Fagereng et al. (2018), and Fuster et al. (2018), by emphasizing 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, our results show that households with higher debt respond more sensitively to transitory income shocks. Moreover, our time-varying estimates suggest that the consumption responses changed significantly during the Great Recession.

Our paper is also related to a relatively recent literature that tries to understand the relationship between household debt and consumption using micro-data, see for example Mian et al. (2013), Dynan (2012), Cloyne and Surico (2017), Baker (2018), Demyanyk, Loutskina and Murphy (2018), Cloyne, Ferreira and Surico (2019). We contribute to this literature by providing empirical evidence from two countries that household debt is indeed an important component of household balance sheet that is correlated with the consumption response of these households to transitory income shocks. Relative to the previous papers in the literature, our identification of unanticipated income shocks follows a statistical decomposition approach, which allows us to examine how consumption responds not just to one particular type of income shock but in general to any transitory or permanent income shock.

Finally, the results in this paper are also related to the literature on consumption insurance against permanent income shocks such as Blundell et al. (2008), Kaplan and Violante (2010) and Santaeulàlia-Llopis and Zheng (2018). We extend this literature by examining how estimates of consumption insurance vary across households that have

[3]Using different identification strategy and data sets, Mian et al. (2013) find that the elasticity of consumption with respect to housing net worth ranges between 0.60 and 0.75 during the Great Recession.

different balance sheet positions.

The rest of this paper is organized as follows: Section 2 describes the data. Section 3 presents the panel unobserved component model considered in this paper. Section 4 discusses the main results. Section 5 concludes.

2 Data

In this section we describe the two datasets used in our analysis. To ensure comparability of results across the two datasets, we use similar variables from the two surveys, except for instances where differences in survey design prevent us from doing so.

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 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 ten waves of data from 1999 to 2017.

We use the disposable household income as our measure of income.[4] It consists of taxable labor income, transfers and social security. To be consistent with the income 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 related literature, e.g. Blundell, Pistaferri and Saporta-Eksten (2016), 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 when imputing rent. The annual imputed rent is our analysis is 6 percent of self-reported housing value from the PSID survey based on the user cost estimates of Poterba and Sinai (2010). We deflate each consumption component using the corresponding component from the Consumer Price Index (CPI) obtained from Bureau of

[4]We calculate household disposable income based on information from NBER's TAXSIM.

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 real-estate properties, businesses, vehicles, and pensions. Our measure of debt includes mortgages and other debt such as credit cards, student loans, medical and legal bills, and borrowings from relatives. We define liquid debt as total debt less mortgages, and liquid wealth as liquid asset minus liquid debt.

Sample selection. The initial dataset consists of an unbalanced sample of 83,831 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.[5] 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 households who did not have information on their income and who reported negative values for liquid or illiquid assets. Households with annual gross 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 appeared in the survey for less than two consecutive years. In total, our PSID sample consists of 3,410 households with 19,058 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.

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.[6] 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

[5] Blundell, Pistaferri and Preston (2008) and Blundell et al. (2016) employ a similar sample selection procedure.

[6] From Wave 11 onwards, additional 2,153 households have been added to the survey and we include these households in our sample.

TABLE 1: SUMMARY STATISTICS

Variable	United States mean	United States median	Australia mean	Australia median
(Real) Household disposable income	77,398	63,673	115,065	100,091
(Real) Consumption				
Total	32,464	23,283	51,676	46,854
Food at home (grocery)	5,359	4,890	11,867	10,817
Meals eaten out	2,236	1,558	3,276	2,589
Gasoline	1,293	1,047	3,093	2,451
Utilities	3,243	3013	4,358	3,796
Motor vehicle repair	1,819	0	1,194	923
Public transport	203	0	511	0
Health services	1,151	602	1,691	993
Rent	7,871	6,975	17,731	16,932
Imputed rent	16,268	8,300	26,867	22,321
Assets				
Total	633,643	268,000	1,009,208	742,145
Liquid assets	99,681	10,000	88,851	16,000
Illiquid assets	533,963	240,000	920,637	697,586
Debt	116,053	80,000	248,708	135,000
Wealth	517,591	144,000	760,779	507,300
Liquid wealth	89,463	4,000	56,525	6,520
Demographics				
Age	47.65	47	47.42	47
Family size	3.39	3	3.45	3
No. of children	1.09	1	1.24	1
No. of working households	-	-	1.87	2
Working members other than head/wife	0.27	0	-	-
High school dropouts	0.10		0.17	
High school graduates	0.24		0.08	
College (TAFE) or higher	0.66		0.75	
Employed	0.88		0.87	
Native English speaker	-		0.88	
White	0.84		-	
Number of households	3,410		4,586	
Number of observations	19,056		30,814	

Notes: Data for the U.S. 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. Our datasets cover 10 Waves of PSID (1999-2017) and 12 Waves of HILDA (2006-17). Each consumption component is deflated using the corresponding component from the CPI. The income is deflated using the headline CPI. The base years of CPI are 1999 for the U.S. and 2012 for Australia. Items with a dash are not reported to be consistent with the actual questions in each survey.

income, expenditure, wealth and other demographic and socioeconomic factors that are standard in a typical household survey.

Unlike PSID, the HILDA survey contains many income measures including household disposable income. We use household total disposable income which includes after-tax income from labor, investment, business, pension and transfers. Since 2006, the HILDA survey started collecting a rich set of expenditure information. Therefore, we use 12 years of data from 2006 to 2017 in our analysis. 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 based on the estimate of 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 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, in HILDA mortgage paying households without data on mortgage payment are dropped. In total, our sample of HILDA consists of 4,586 households with 30,814 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.[7] 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.

Following Chatterjee et al. (2019), our panel unobserved components model decomposes idiosyncratic income and consumption for household i (measured as the residuals from regressions of household income and consumption on common observed factors) into permanent and transitory components following the specification in Blundell et al. (2008)

$$y_{i,t} = \tau_{i,t} + \epsilon_{i,t} + \theta\epsilon_{i,t-1}, \qquad \epsilon_{i,t} \sim i.i.d.N(0, \sigma_\epsilon^2), \tag{3}$$

$$c_{i,t} = \gamma_\eta \tau_{i,t} + \kappa_{i,t} + v_{i,t}, \qquad v_{i,t} \sim i.i.d.N(0, \sigma_{v,t}), \tag{4}$$

where transitory income is allowed to have an MA(1) structure with $|\theta| < 1$ and the permanent components are specified as random walks:

$$\tau_{i,t} = \tau_{i,t-1} + \eta_{i,t}, \qquad \eta_{i,t} \sim i.i.d.N(0, \sigma_\eta^2), \tag{5}$$

$$\kappa_{i,t} = \kappa_{i,t-1} + \gamma_\epsilon \epsilon_{i,t} + u_{i,t}, \qquad u_{i,t} \sim i.i.d.N(0, \sigma_u^2). \tag{6}$$

For household i, the common stochastic trend for income and consumption ("permanent income") is $\tau_{i,t}$, while $\kappa_{i,t}$ is an additional stochastic trend for consumption. The parameters γ_ϵ and γ_η capture the impact of permanent and transitory income shocks on consumption, respectively.

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

[7] The list of control variables is as follows: In PSID, we consider education, number of dependent children, family size, and a set of dummies including marital status, employment status, race, working family members other than head and partner, children living out of family. We also consider a set of interaction terms using education, state, race and employment, all interacted with year. While we keep the same regression specification for our HILDA sample, we use native English speaker instead of race and consider the big city dummy in the regressions.

the transitory consumption shock is $v_{i,t} \sim i.i.d.N(0, \sigma_v)$, where the latter could capture measurement error in the surveys. 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 implied consumption growth for household i, we get:

$$\Delta c_{i,t} = \gamma_\eta \eta_{i,t} + u_{i,t} + \gamma_\epsilon \epsilon_{i,t} + v_{i,t} - v_{i,t-1}. \tag{7}$$

Therefore, in 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.[8] We therefore refer to γ_ϵ as the consumption response to transitory income shocks, and $\vartheta_\eta = 1 - \gamma_\eta$ as consumption insurance against permanent income shocks. If markets were complete, households would have full insurance which implies $\gamma_\epsilon = 0$ and $\vartheta_\eta = 1$. Meanwhile, according to the permanent income hypothesis, any unexpected permanent income shocks would fully transmit, $\vartheta_\eta = 0$ but households would not respond to any transitory income shocks, $\gamma_\epsilon = 0$.

To estimate the unobserved components model, we employ the quasi maximum likelihood estimation (QMLE) proposed in Chatterjee et al. (2019).[9] We refer the reader to that paper for more details on why to use QMLE instead of generalized method of moments estimation.

Before discussing our main findings, we compare the results for the whole sample in the two countries. Table 2 provides our estimates of parameters for the U.S. and Australia. Looking at the whole sample, despite the different sample time periods, the differences across the two countries are not striking in most respects.[10] Note however that the estimate of γ_ϵ is 0.07 in the U.S and it is 0.02 for the Australian households. Also, the variability of transitory shocks to consumption in the U.S. is almost two times higher than that of Australia.

[8] Our pass-through parameters can also be interpreted as MPC out of the respective shocks, see Jappelli and Pistaferri (2010) for example.

[9] We also estimate the parameters of our model using generalized method of moments with optimally weighted matrices (OMD). The results are quantitatively different but qualitatively unchanged. However, for small sub-samples, such as for renters and outright owners, OMD performs very poorly as noted in Chatterjee et al. (2019). See, also, Altonji and Segal (1996).

[10] The estimates of income variability are consistent with the ones reported in the income dynamics literature, see for example Heathcote, Storesletten and Violante (2014) for the U.S. and Chatterjee, Singh and Stone (2016) and Kaplan, La Cava and Stone (2018) for Australia.

TABLE 2: CROSS-COUNTRY COMPARISONS

	United States	Australia
	INCOME	
θ_y	0.21 (0.01)	0.18 (0.01)
σ_η	0.14 (0.00)	0.10 (0.00)
σ_ϵ	0.25 (0.00)	0.27 (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	0.07 (0.01)	0.02 (0.00)
ϑ_η	0.52 (0.02)	0.51 (0.02)
T	10	12
N	3,410	4,586

Notes: The table reports point estimates with standard errors in parentheses for the whole sample of households in the two datasets.

4 Heterogeneity in consumption responses

In this section we explore whether consumption responses to income shocks, transitory or permanent, differ 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 as mortgage debt is a large fraction of total household debt and therefore naturally yields three groups of households with distinctive balance sheet positions.

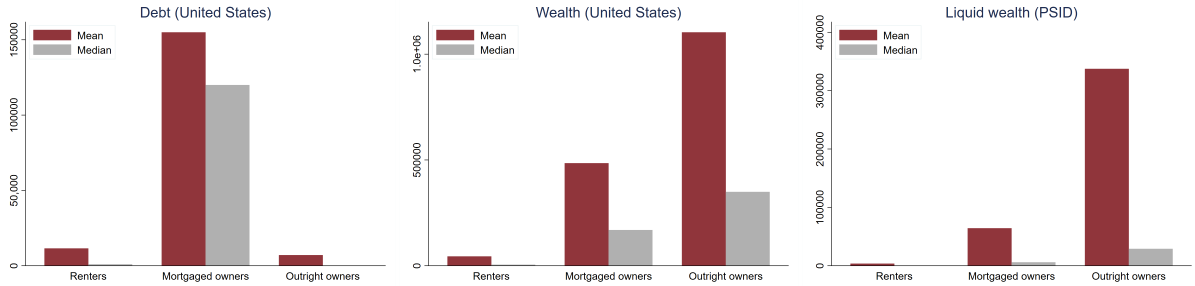
We first document differences across these subgroups based on their financial position and demographic characteristics and then provide our empirical estimates in the following subsections. Subsequently in our analysis, we group households based on other balance sheet characteristics such as debt, wealth and liquid asset.

4.1 Subgroups

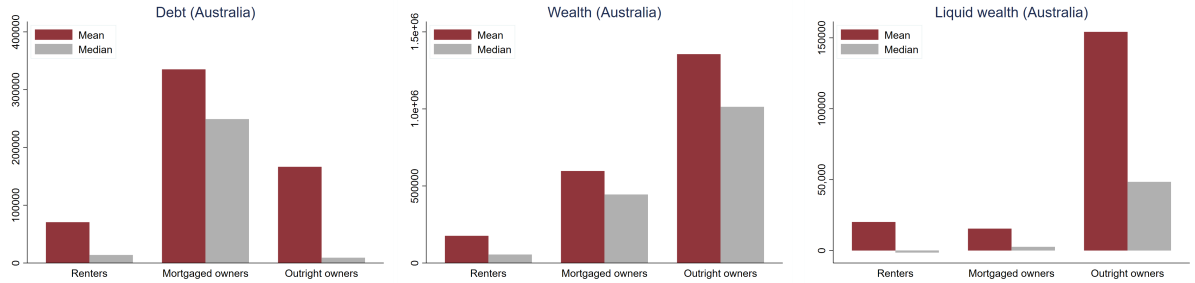
For the three subgroups, renters, mortgaged owners and outright owners, Figure 1 presents the mean and median of debt, wealth and liquid wealth. The U.S. mortgaged owners, top left panel, on average have around 10 times more debt than renters and outright owners. While the similar pattern is observed for Australian households, bot-

FIGURE 1: HOUSEHOLD BALANCE SHEETS OF SUBGROUPS

UNITED STATES



AUSTRALIA



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

TABLE 3: SUMMARY STATISTICS FOR THE U.S. SUBGROUPS

Variable	Renters	Mortgaged owners	Outright owners
Real disposable income (mean)	50,708	82,339	74,815
Real total consumption (mean)	21,170	33,813	33,359
Age (mean)	44.07	46.91	53.87
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	0.23	0.07	0.12
High school graduate	0.25	0.23	0.29
College dropout or higher	0.52	0.70	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	0.28	0.25
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.

tom left panel, note that the size of debt for renters and outright owners is relatively large compared to their U.S. counterparts. As a result, the size of average debt for Australian mortgaged owners is only two times larger than that for outright owners in Australia. In both countries, outright owners have the highest wealth while renters have the lowest, see the middle panel in Figure 1. The wealth of outright owners is around twice larger than that of mortgaged owners. The right panels show that outright owners have approximately 5 to 10 times 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.

Based on the financial and demographic characteristics of each subgroup, we interpret the subgroups as follows: First, typically renters are younger and have lower income and consumption, lower debt, and lower wealth 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

TABLE 4: SUMMARY STATISTICS FOR THE AUSTRALIAN SUBGROUPS

Variable	Renters	Mortgaged owners	Outright owners
Real disposable income (mean)	92,064	117,577	125,179
Real total consumption (mean)	41,213	52,975	56,003
Age (mean)	43.35	45.18	53.88
Employment (proportion)			
Employed	0.81	0.94	0.79
Unemployed	0.04	0.01	0.02
Not in the labor force	0.15	0.05	0.19
Education (proportion)			
High school dropout	0.23	0.14	0.17
High school graduate	0.09	0.09	0.07
TAFE or higher	0.67	0.77	0.76
# of dependent children (proportion)			
0	0.40	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 households (mean)	1.61	2.02	1.78
Proportion of total sample	0.19	0.52	0.30

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.

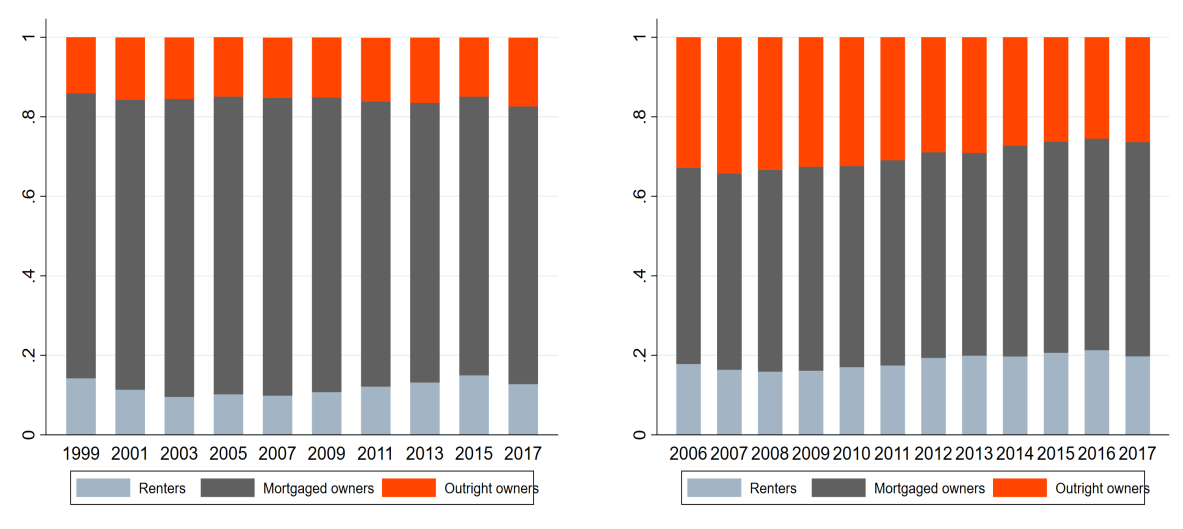
highest levels of debt, hold mid-range of wealth and liquid wealth. Mortgaged owners are therefore a group of households who are wealthy but highly indebted. Third, outright owners typically have high levels of wealth and liquid wealth and low levels of debt. These households are the wealthy households with low levels of debt.

Figure 2 plots shares of the three subgroups in the total sample. Although our U.S. sample includes the Great Recession, these shares have not changed much. In the Australian data, while the share of renters and mortgaged owners has increased, the share of outright owners has decreased since 2008. However, these changes are very gradual. We find that our results are qualitatively unchanged when we exclude households that experienced changes in their housing tenure status, see Tables A–8 and A–9 in the appendix.

4.2 Transitory income shocks and consumption responses

In this subsection we present the following results: (i) the consumption response to a transitory income shock, γ_ϵ , and the elasticity of consumption to a house price shock for subgroups based on housing tenure status (ii) estimate of γ_ϵ for subsamples based on balance sheet positions such as debt, wealth and liquid wealth, and (iii) time-varying estimates of γ_ϵ. The full sets of estimates are reported in the Appendix.

FIGURE 2: SHARE OF SUBGROUPS IN THE WHOLE SAMPLE



Notes: The figure displays the time trends in the share of renters, mortgaged owners and outright owners in the whole sample. The left panel plots the data for the U.S. and the right panel plots the data for Australia.

4.2.1 Consumption responses of subgroups

In Table 5 we provide our estimates of γ_ϵ. We first note that mortgaged owners in the U.S. respond much more to transitory income shocks relative to other subgroups. In particular, 9 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 pass-through are 4 and 1 percent respectively.[11] Mortgaged and outright owners are similar in terms of demographic and other characteristics but their balance sheet positions as reported in Figure 1 and Table 3, in particular the debt levels, are quite different. However, for Australian households in our sample, we do not find any evidence of heterogeneity in γ_ϵ across these two subgroups and their estimates for all three subgroups are all less than or equal to 3 percent.[12] One potential reason why the estimates for Australia do not exhibit any heterogeneity could be that the debt levels

[11] Our estimates are however smaller in 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 model, we explicitly allow for the possibility of persistent effects of transitory income shocks, however, we do find any empirical support for such dynamics beyond a one-year horizon.

[12] Australian households in general are insensitive to transitory income shocks. A related study by Aisbett, Brueckner, Steinhauser and Wilcox (2013) examine the consumption responses to 2009 Australian fiscal stimulus following the same identification strategy in Johnson et al. (2006) and Parker et al. (2013). The authors find that non-durable consumption did not respond in any meaningful way, consistent with our results.

TABLE 5: ESTIMATES OF CONSUMPTION RESPONSES FOR SUBGROUPS

	United States	Australia
Whole sample	0.07 (0.01)	0.02 (0.00)
Renters	0.01 (0.05)	0.01 (0.01)
Mortgaged owners	0.09 (0.01)	0.03 (0.01)
Outright owners	0.04 (0.03)	0.03 (0.01)

Notes: The table reports point estimates of consumption responses to transitory income shocks with standard errors in parentheses. The number of households, N, in each subgroup is as follows. For the U.S., N is 3,410 for whole sample, 382 for renters, 2,238 for mortgaged owners and 471 for outright owners. For Australia, N is 4586 for whole sample, 871 for renters, 2,259 for mortgaged owners and 1,281 for outright owners.

across the three subgroups in the Australian sample is not as strikingly different as in the U.S. sample, see Figure 1.[13] Also note that while in PSID, mortgage debt accounts for 89 of total household debt for homeowners, in HILDA it is only 58 percent.

Using the estimates of γ_ϵ, we compute the consumption elasticity from the changes in house prices by following Berger et al. (2017). The elasticity of consumption with respect to house price shocks is given by:

$$elasticity_t = MPC \times \frac{C_t}{Y_t} \times (1-\delta)\frac{P_t H_t}{C_t}, \tag{8}$$

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 the depreciation rate of housing. We use the median value of C_t/Y_t and the median self-reported housing value $P_t H_t$ for each subgroup to compute elasticity. The annual depreciation rate is 2 percent; a commonly used value in the quantitative macro-housing models and also used by Berger et al. (2017).

The consumption elasticity with respect to house price shocks is 0.19 for mortgaged owners and 0.07 for outright owners in our U.S. sample.[14] Our estimates of consumption elasticity lend support to the view that homeowners with high leverage tend to have high MPCs and therefore exhibit higher responsiveness to a house price shock. However, for Australia, the aggregate consumption elasticity for both mortgaged and outright owners are high, 0.14 and 0.17, respectively despite the fact that the estimate of γ_ϵ was low. This is due to the fact that the consumption to income ratio and the house

[13] See Table A–3 in Appendix for more detail regarding differences in debt across subgroups and subsamples in the two datasets.

[14] Using the U.S. data from 1978 to 2009, Case et al. (2013) find that the elasticity of consumption from changes in housing wealth ranges from 0.03 to 0.18. Berger et al. (2017) compute the elasticity to be 0.23 using simulated data from a life-cycle model.

value to consumption ratio of the Australian homeowners, including both mortgaged and outright owners, are 1.5 and 2 times higher than their corresponding counterparts in the U.S sample; partly due to the recent housing boom in Australia.

4.2.2 Consumption responses and balance sheets

Why would mortgaged owners respond more to transitory income shocks, as seen from the estimates in Table 5? While our empirical analysis cannot establish a causal link 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 components of spending that are difficult to adjust, primarily due to transaction costs, such as mortgage payments. Debt, therefore, increases the consumption commitments as it requires households to incur regular expenses like interest payments. It is likely that these consumption commitments in turn make it harder for these households to smooth their consumption in the event of a transitory income shock.

To evaluate the role of household balance sheet, we stratify households based on the holdings of debt, wealth and liquid wealth. More specifically, a household is in the high (low) debt group if the household's debt is higher (lower) than the top (bottom) 10th percentile of the debt distribution of the whole sample.[15] The same cutoff is applied to high wealth and low wealth subsamples. Along the liquid wealth dimension, we use the Hand-to-Mouth classification of Kaplan et al. (2014).[16]

Our estimates in Table 6 suggest that U.S. households with higher debt and higher wealth respond more to transitory income shocks than their counterparts. Households in the high debt subsample have a high and statistically significant pass-through of 14 percent. The average debt of these households is 4 times higher debt than the average debt in the whole sample, see Table A–3 in the Appendix. We also note that almost every household (over 99 percent) in the high debt subsample is a mortgaged owner. Households in the high wealth subsample also respond to transitory income shocks. It is worth pointing out that the overlap between high debt and high wealth subsamples is 33 percent, and as a result, the average level of debt for the high wealth group is also large; it is about 1.5 times higher than the whole sample average.[17] In addition, the

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

[16]In our U.S. (Australian) sample, approximately 26 percent (31 percent) of households are classified into Hand-to-Mouth and out of them, 88 percent (95 percent) are wealthy Hand-to-Mouth. These percentages are similar to that in Kaplan et al. (2014).

[17]Using the PSID but a different empirical strategy, Fisher, Johnson, Smeeding and Thomson (2019)

TABLE 6: ESTIMATES OF CONSUMPTION RESPONSES FOR SUBSAMPLES

	United States	Australia
High debt	0.14 (0.02)	0.03 (0.01)
Low debt	0.02 (0.04)	0.02 (0.01)
High wealth	0.16 (0.05)	0.02 (0.01)
Low wealth	0.02 (0.04)	0.03 (0.02)
HtM	0.09 (0.03)	0.01 (0.01)
N-HtM	0.04 (0.01)	0.03 (0.01)

Notes: The table reports point estimates of consumption responses to transitory income shocks with standard errors in parentheses. The high (low) subsample is the higher (lower) than 90th (10th) percentile of the distribution of the respective balance sheet component. The classification of households as HtM and N-HtM follows Kaplan et al. (2014). For the U.S., N is 297 for high debt, 464 for low debt, 250 for high wealth, 241 for low wealth, 695 for HtM, and 1,942 for N-HtM. For Australia, N is 597 for high debt 489 for low debt, 617 for high wealth, 455 for low wealth, 1,326 for HtM, and 2,840 for N-HtM.

overlap between mortgaged owners and high wealth households is 65 percent.[18]

Figure 3 plots the estimate of consumption responses by the tercile of household debt. Consistent with our previous findings in Table 6 where we examine the consumption responses at the extreme ends of the distribution, the left panel for U.S. households shows that the estimates of consumption response to transitory income shocks are positively associated with the level of debt.

We also find that households who are classified as Hand-to-Mouth have higher consumption responses than those who are not Hand-to-Mouth, last two rows in Table 6.[19] Households with lower liquid wealth (HtM) in the U.S. have a pass-through coefficient of 0.09.[20]

show that households with higher wealth have lower marginal propensities to consume. Relative to their work, our empirical analysis considers the response of consumption to both permanent and transitory income shocks. While debt appears to be a more relevant balance sheet component than wealth for the response of consumption to transitory income shocks in our analysis; household wealth is crucial for heterogeneity in consumption insurance against permanent income shocks as seen in Section 4.3.

[18]The estimate of γ_e becomes somewhat smaller (0.13) when high debt households are removed from the high wealth group. Further, when mortgaged owners are removed from high wealth group, the estimate becomes even smaller (0.05) and is statistically insignificant.

[19]Many existing studies using natural experiments such as fiscal stimulus or lottery winnings typically find a negative correlation between an individuals' 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. (2018).

[20]In a recent study, Auclert (2019) employs alternative measures of household balance sheet to examine the transmission of monetary policy to consumption. His measures are aimed at capturing the exposure of household balance sheet to changes in interest rate, unhedged interest rate exposure (URE), and to changes in the price level, net nominal position (NNP). We calculate URE as household disposable income - consumption + liquid asset - debt, and NNP as deposit + bond - debt. While the objective

It is important to note that for the U.S. households with higher levels of debt, mortgaged owners in Table 5 and high debt subsample of households in Table 6, are distinct from HtM households in Table 6. Only 27 percent of mortgaged owners and 29 percent of the high debt households are classified as HtM. These overlaps account for 19 percent and 3 percent of the whole sample. Note that the estimated γ_ϵ when we exclude HtM households from mortgaged owners and high debt subgroup households is 0.10 and 0.08 respectively, still higher than the estimates from the whole sample as well as other related subgroups.

In our empirical analysis we find that households who respond sensitively to transitory income shocks, namely mortgaged owners and high debt, generally have more liquid wealth than the sample average. For instance, the median liquid wealth levels, normalized by the median consumption of the whole sample, for mortgaged owners and high debt subsample are 0.14 and 0.51 while that for the whole sample is 0.09. See Table A–3 in the Appendix for more details. Therefore, in our U.S. sample, a significant fraction of households respond to transitory income shocks despite non-trivial liquid wealth holdings. As in the whole sample analysis, we find that Australian households are less sensitive to transitory income shocks, and whether they have high levels of debt or low levels of liquid wealth, there is less heterogeneity in their consumption responses. Taken together, the results in Table 6 suggest that households with high levels of debt *and* low levels of liquid asset respond more to transitory income shocks.

4.2.3 Changing patterns of debt and 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_ϵ of our UC model, described in Section 3, but where we allow γ_ϵ and γ_η to vary over the sample period while holding the variability of income and consumption shocks constant.[21] We then relate these time-varying estimates to the changing patterns of debt observed in the two countries.[22]

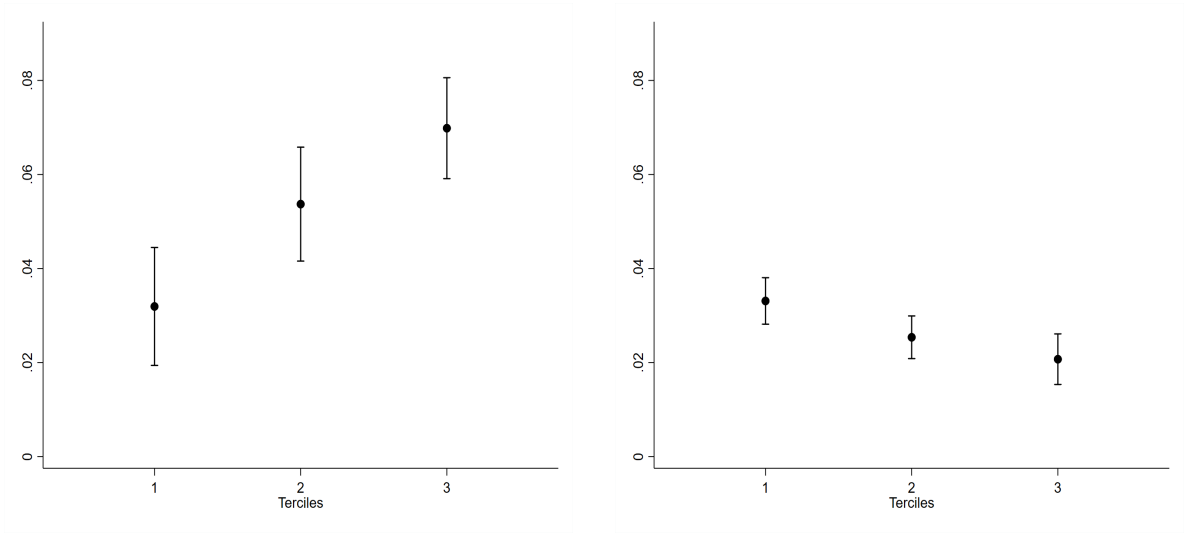
The left panel in Figure 4 shows the patterns of real debt for households in our whole sample (solid) and mortgaged owners (dashed) in the PSID. The level of real

of our analysis is different from that of Auclert (2019), in our analysis households with higher debt would have low URE and low NNP, implying that for these households consumption is likely to be more sensitive to transitory shocks to income. Our estimates for the U.S. in Table A–6 confirm this.

[21] We have tried a version of model where we also vary σ_η and σ_ϵ over time. The estimates of γ_ϵ and γ_η are hardly affected, and also the time-varying patterns are unchanged.

[22] We only consider the whole sample and mortgaged owners group as the sample sizes of renters and outright owners are small for a meaningful time-varying analysis, in particular for the U.S. sample.

FIGURE 3: CONSUMPTION RESPONSES OVER DEBT TERCILE

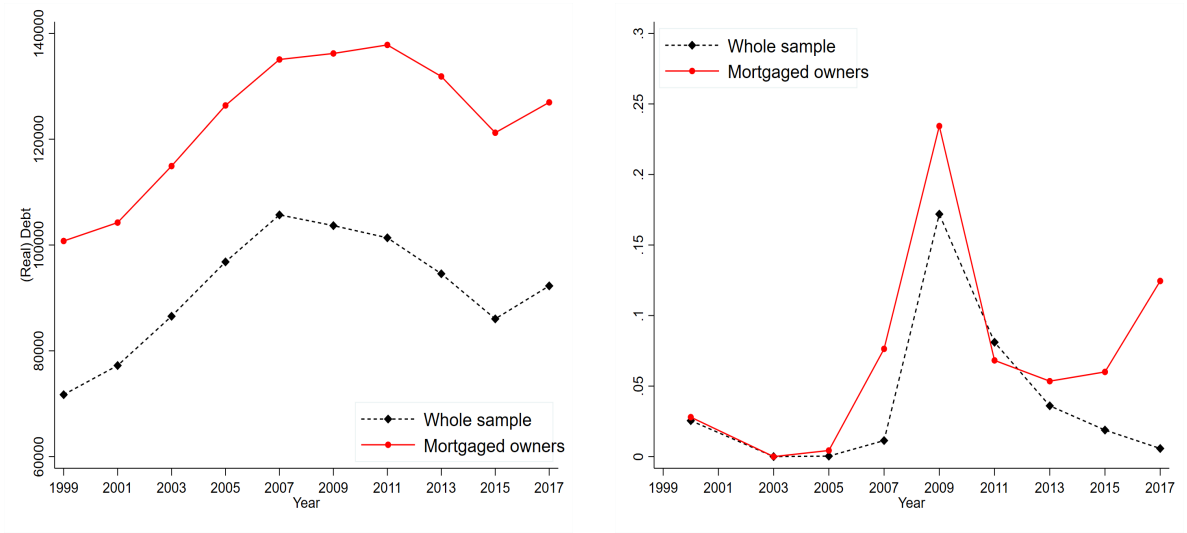


Notes: The figures plots the estimates of consumption responses to transitory income shocks with standard errors across the tercile of debt for U.S. households (left) and Australian households (right). The vertical axis measures the estimates of γ_ϵ.

debt increased prior to the Great Recession but decreased since then. The right panel in Figure 4 plots the time-varying estimates of γ_ϵ for the whole sample and the mortgaged owners. While the estimate of consumption response was small and insignificant until 2005 for mortgaged owners, it increased substantially in 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 three times higher than the aggregate estimate reported in Table 2 and also over two times higher than the average response of mortgaged owners reported in Table 5. Other studies such as Gross, Notowidigdo and Wang (2019) 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 5. As depicted in the left panel, the level of mortgaged owners' real debt has increased over the last decade, the period of housing boom in Australia. The estimated γ_ϵ for mortgaged owners has also increased over the sample period. Mortgaged owners did not respond much to transitory income shocks before 2008 but the response has increased gradually since then and it reached 0.06 in 2017. What is interesting is that we do not observe much heterogeneity in γ_ϵ across Australian households in Tables 5 and 6 when we stratified households either based on housing tenure or their balance sheet positions. But along the time dimension, we observe that the response of mortgaged owners has changed, the red solid line in the right

FIGURE 4: TIME-VARYING HOUSEHOLD DEBT AND CONSUMPTION RESPONSES IN THE U.S.



Notes: The left panel displays the time trends in the level of real debt from the whole sample (solid) and the subsample of mortgaged owners (dashed) in the U.S. 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 plots the estimates of time-varying consumption responses to transitory income shocks.

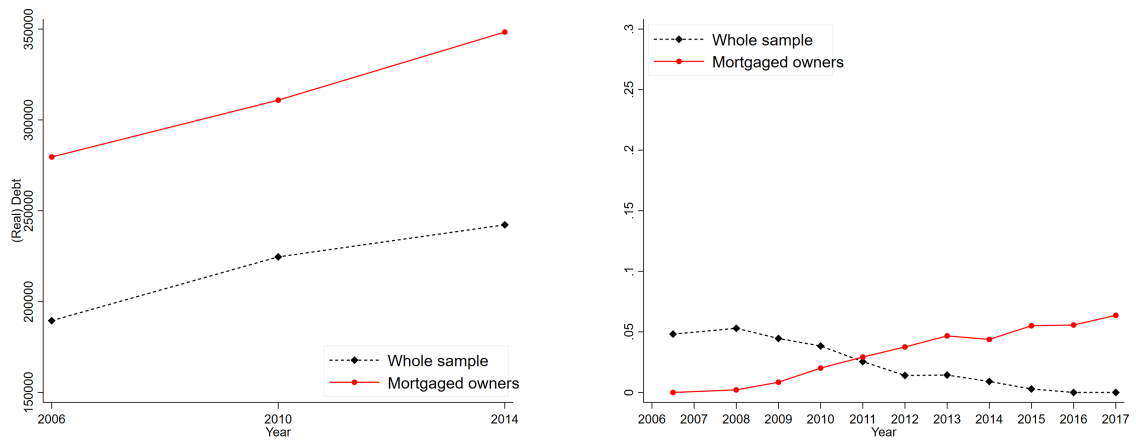
panel in Figure 5.[23] In general, our time-varying analysis suggests that the dynamics of consumption responses coincided with the patterns of debt dynamics in both the U.S. and Australia.

Using the time-varying estimates of γ_ϵ, we also compute the time-varying consumption elasticities with respect to housing price shocks in the style of Berger et al. (2017). The solid line in Figure 6 shows that, 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. During the peak of the recession, the consumption elasticity for mortgaged owners in the U.S. was 0.52, close to the elasticity estimates of Mian et al. (2013) and Kaplan et al. (2016). The consumption elasticity of Australian mortgaged owners has increased continuously during the housing boom and was 0.27 in 2017.

Our empirical results suggests that another key component of an household's balance sheet, apart from liquid wealth, that is correlated with the response of consumption to transitory income shocks is household debt. Our findings are consistent with recent related empirical literature. Cloyne and Surico (2017) exploit the exogenous change in income tax in the United Kingdom and show that homeowners with mortgages respond significantly more to a tax shock more than outright homeowners and

[23] We find that both renters and outright owners' consumption responses decreased over time and their debt levels remained relatively steady, contributing to the decreasing trend for the overall sample.

FIGURE 5: TIME-VARYING HOUSEHOLD DEBT AND CONSUMPTION RESPONSES IN AUSTRALIA



Notes: The left panel displays the time trends in the level of real debt from the whole sample (solid) and the subsample of mortgaged owners (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 plots the estimates of time-varying consumption responses to transitory income shocks.

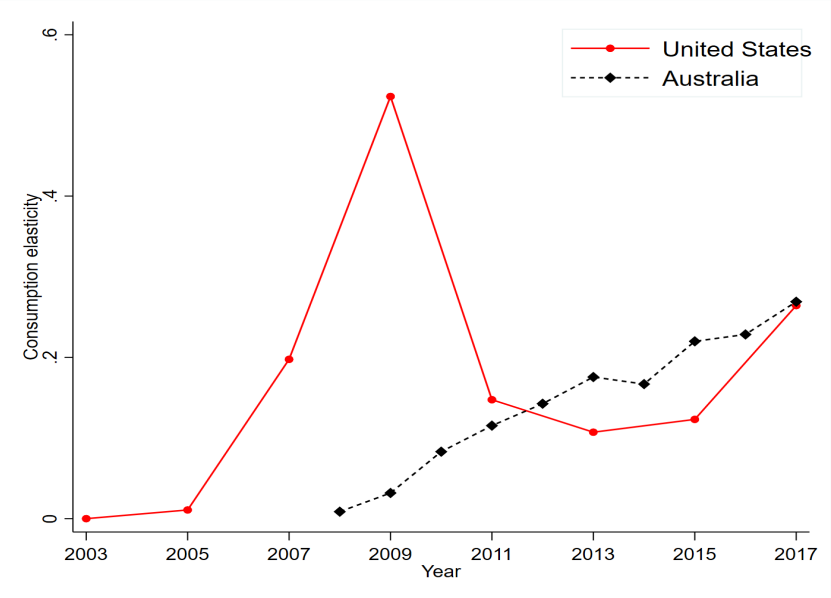
renters. Using PSID, Dynan (2012) finds that highly leveraged homeowners had a larger drop in consumption during the Great Recession; primarily due to the high levels of debt holdings and the subsequent need for deleveraging and not due to the wealth effect from the fall in house prices. Baker (2018) also shows that during the recent financial crisis, consumption responses to income changes were higher for indebted and credit constrained households. Moreover, Demyanyk et al. (2018) in a recent study argue that during the Great Recession, fiscal stimulus could have been more effective in areas with higher debt as households in those areas tend to have higher MPCs.

The related quantitative-theoretical literature also emphasizes a link between household debt and consumption, see for example, Guerrieri and Lorenzoni (2017) and Eggertsson and Krugman (2012). More closely related to our analysis is Garriga and Hedlund (2019) in which the authors show that homeowners and more indebted households experienced a greater decline in consumption during the Great Recession in the U.S.

4.3 Permanent income shocks and consumption insurance

We report the estimate of ϑ_η for the subgroups in Table 7. In the U.S, outright owners have the highest consumption insurance with respect to permanent income shocks, followed by mortgaged owners and then renters who have the lowest (0.57 vs. 51 vs.

FIGURE 6: TIME-VARYING CONSUMPTION ELASTICITY FOR MORTGAGED OWNERS



Notes: The figure plots the time-varying consumption elasticity to house price shocks for mortgaged owners in both countries.

0.30). Our estimates for Australia also exhibit a similar pattern for the three subgroups (0.64 vs. 0.43 vs. 0.31). Note that based on Figure 1, one of the most notable differences in balance sheet characteristics between outright owners and renters is the level of their wealth.

To examine how consumption insurance differs across households based on their balance sheet components, in particular wealth, we use the same method used in classifying households as in Table 6. Based on the estimates in Table 8, households in the high wealth subsample have higher consumption insurance than their counterparts; 0.71 versus 0.26 for the U.S. and 0.49 versus 0.36 for Australia. However, differences in

TABLE 7: CONSUMPTION INSURANCE AND SUBGROUPS

	United States	Australia
Whole sample	0.52 (0.02)	0.51 (0.01)
Renters	0.30 (0.07)	0.31 (0.05)
Mortgaged owners	0.51 (0.02)	0.42 (0.02)
Outright owners	0.57 (0.04)	0.64 (0.03)

Notes: The table reports point estimates for consumption insurance against permanent income shocks with standard errors in parentheses for for the whole sample and three subgroups.

TABLE 8: CONSUMPTION INSURANCE AND HOUSEHOLD BALANCE SHEETS

	United States	Australia
High wealth	0.71 (0.10)	0.49 (0.01)
Low wealth	0.26 (0.06)	0.36 (0.06)
High debt	0.50 (0.00)	0.42 (0.04)
Low debt	0.48 (0.02)	0.47 (0.02)
HtM	0.41 (0.06)	0.47 (0.03)
N-HtM	0.44 (0.03)	0.52 (0.01)

Notes: The table reports point estimates for consumption insurance against permanent income shocks with standard errors in parentheses for the six subsamples.

consumption insurance among subgroups based on debt and liquid wealth are not as noticeable.

Figure 7 plots the estimates of ϑ_η across the tercile of household wealth. In both countries, there is a clear positive cross-sectional correlation between the levels of wealth and consumption insurance.

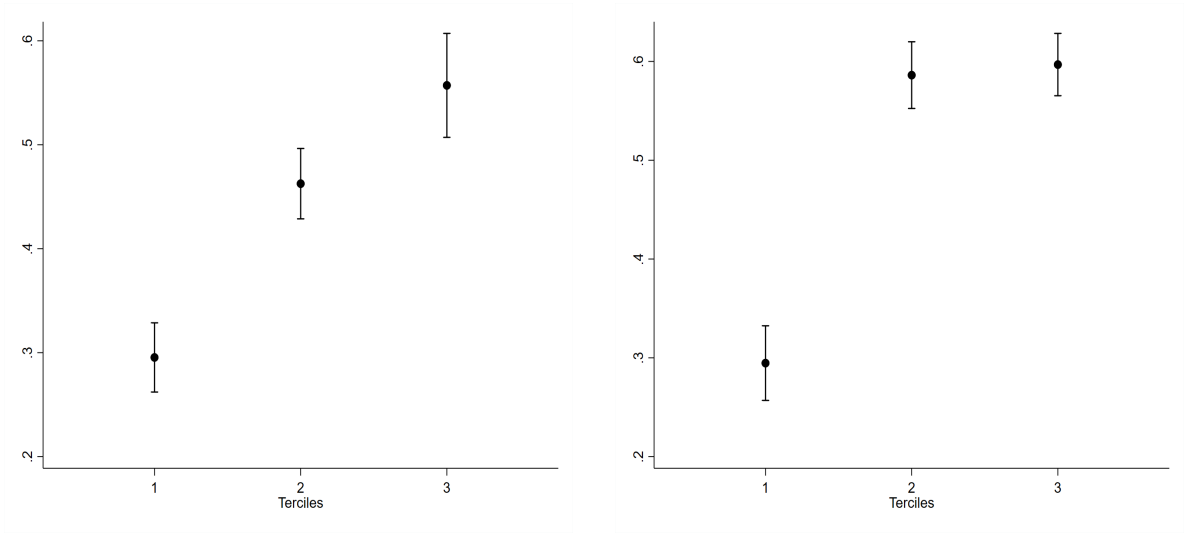
The time-varying consumption insurance estimates do not have any notable trends in both countries, refer to Tables A–10 and A–11, even though the wealth level of U.S. households increased prior to the Great Recession.

One possible mechanism by which households with higher wealth have more consumption insurance is their ability to access buffer-stock wealth. When households receive large income shocks affecting their permanent income, they can smooth their consumption by adjusting their wealth. This mechanism contrasts with the consumption commitment channel discussed in the previous subsection where households do not adjust their wealth when a shock is small and transitory.

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 four main findings. First, mortgaged owners in the U.S. tend to exhibit a greater sensitivity to transitory income shocks than renters and outright owners. Second, households with higher debt also have higher consump-

FIGURE 7: CONSUMPTION INSURANCE OVER WEALTH TERCILE



Notes: The figures plots the estimates of consumption insurance against permanent income shocks with standard errors across the tercile of wealth for U.S. households (left) and Australian households (right). The vertical axis measures the estimates of ϑ_η.

tion responses to transitory income shocks relative to households with lower levels of debt in the U.S. Third, the time-varying analysis suggests the pass-through of transitory income shocks is larger during the period when the debt levels were high; before the Great Recession in the U.S and during the housing boom in Australia since 2008. Fourth, households with higher wealth have more consumption insurance against permanent income shocks in both the U.S. and in Australia.

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. In particular, our analysis emphasizes that households who respond to transitory income shocks either have low liquid wealth or high debt, and these two groups are distinct from each other. It therefore suggests that household debt is as important as liquid wealth when it comes to understanding heterogeneous consumption responses across household balance sheets and should play a greater role in macroeconomic models and policy analysis.

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A Additional Tables

TABLE A–1: SAMPLE SELECTION FOR PSID

Description	Dropped	Remaining
Initial unbalanced sample		83,831
No sig. change in family composition	5,186	78,645
Married household head	40,574	38,071
Male head	3	38,068
Age from 30 to 65	8,566	29,502
No missing demographics	1,429	28,073
No zero food expenditure	106	27,967
No missing income	0	27,967
No income outliers	310	27,657
No negative liquid/illiquid assets	11	27,646
No SEO households	5,141	22,505
At least two consecutive years of appearance	3,447	**19,058**

TABLE A–2: SAMPLE SELECTION FOR HILDA

Description	Dropped	Remaining
Initial unbalanced sample		709,733
Households with couples	176,086	533,647
Post 2006	160,980	372,667
Age from 30 to 65	288,064	84,603
Male head	42,531	42,072
No missing demographics	3,263	38,809
No negative housing value	1,199	37,560
No information on mortgage payment	623	36,937
No income outliers	493	36,444
No zero food expenditure	64	36,380
At least two consecutive years of appearance	5,566	**30,814**

TABLE A–3: DEBT AND LIQUID WEALTH OF HOUSEHOLDS

	Debt				Liquid wealth			
	United States		Australia		United States		Australia	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
Whole sample	2.67	1.84	4.93	2.67	2.06	0.09	1.12	0.13
Renters	0.26	0.02	1.40	0.27	0.08	0	0.40	-0.03
Mortgaged owners	3.57	2.76	6.64	4.93	1.54	0.14	0.31	0.05
Outright owners	0.16	0	3.30	0.18	7.88	0.66	3.06	0.96
High debt	10.2	8.86	20.07	15.85	4.52	0.51	0.71	0.20
Low debt	0	0	0	0	7.38	0.41	3.75	0.80
High wealth	4.03	1.27	7.36	2.81	22.1	8.82	7.51	2.94
Low wealth	2.06	0.46	6.11	3.57	-0.62	-0.16	-0.75	-0.14
HtM	3.13	2.30	7.36	2.81	-0.62	-0.34	-1.05	-0.30
N-HtM	2.50	1.61	4.35	2.18	3.59	0.51	2.24	0.46
High URE	1.90	0	1.88	0.02	23.3	10.4	9.26	5.02
Low URE	8.87	8.29	19.39	14.86	-0.02	0	-1.20	0.02
High NNP	0.86	0	0.50	0.00	11.6	2.88	6.53	3.15
Low NNP	9.95	8.75	19.98	15.61	1.47	0.14	0.17	0.10

The table reports mean and median liquid wealth of households in each subgroup, normalized by the mean and median consumption in the whole sample. High (low) subsamples correspond to the level higher (lower) than 90th (10th) percentile of the distributions of the respective balance sheet component. The classification of households as HtM and N-HtM follows Kaplan et al. (2014). The definitions of unhedged interest rate (URE) and net nominal position (NNP) are from Auclert (2019).

TABLE A–4: ESTIMATES FOR SUBGROUPS IN THE U.S.

	Whole sample	Renters	Mortgaged owners	Outright owners
		INCOME		
θ_y	0.21 (0.01)	0.19 (0.05)	0.20 (0.02)	0.18 (0.04)
σ_η	0.14 (0.00)	0.14 (0.01)	0.13 (0.00)	0.15 (0.01)
σ_ϵ	0.25 (0.00)	0.28 (0.01)	0.24 (0.00)	0.27 (0.01)
		CONSUMPTION		
σ_u	0.08 (0.00)	0.05 (0.01)	0.08 (0.00)	0.08 (0.01)
σ_v	0.36 (0.00)	0.26 (0.01)	0.32 (0.00)	0.39 (0.01)
γ_ϵ	0.07 (0.01)	0.01 (0.05)	0.09 (0.01)	0.04 (0.03)
ϑ_η	0.52 (0.02)	0.30 (0.04)	0.51 (0.03)	0.57 (0.05)
N	3410	382	2238	471

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

TABLE A–5: ESTIMATES FOR SUBGROUPS IN AUSTRALIA

	Whole sample	Renters	Mortgaged owners	Outright owners
		INCOME		
θ_y	0.18 (0.01)	0.16 (0.02)	0.19 (0.02)	0.19 (0.02)
σ_η	0.10 (0.00)	0.09 (0.00)	0.09 (0.00)	0.12 (0.00)
σ_ϵ	0.27 (0.00)	0.26 (0.00)	0.23 (0.00)	0.31 (0.00)
		CONSUMPTION		
σ_u	0.08 (0.00)	0.06 (0.00)	0.07 (0.00)	0.08 (0.00)
σ_v	0.14 (0.00)	0.17 (0.00)	0.12 (0.00)	0.13 (0.00)
γ_ϵ	0.02 (0.00)	0.01 (0.01)	0.03 (0.01)	0.03 (0.01)
ϑ_η	0.51 (0.01)	0.31 (0.05)	0.42 (0.02)	0.64 (0.03)
N	4586	871	2259	1280

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

TABLE A–6: ESTIMATES FOR SUBSAMPLES BASED ON BALANCE SHEETS IN THE U.S.

	High wealth	Low wealth	High debt	Low debt	HtM	N-HtM	High URE	Low URE	High NNP	Low NNP
					INCOME					
θ_y	0.19 (0.06)	0.20 (0.09)	0.12 (0.08)	0.21 (0.03)	0.28 (0.04)	0.23 (0.02)	0.20 (0.07)	0.26 (0.01)	0.23 (0.06)	0.07 (0.06)
σ_η	0.21 (0.01)	0.14 (0.01)	0.19 (0.01)	0.16 (0.01)	0.12 (0.01)	0.14 (0.00)	0.23 (0.01)	0.12 (0.01)	0.17 (0.01)	0.16 (0.01)
σ_ϵ	0.31 (0.02)	0.26 (0.01)	0.25 (0.01)	0.28 (0.01)	0.25 (0.01)	0.25 (0.00)	0.28 (0.02)	0.26 (0.01)	0.28 (0.01)	0.23 (0.01)
					CONSUMPTION					
σ_u	0.21 (0.01)	0.05 (0.01)	0.08 (0.01)	0.10 (0.01)	0.05 (0.01)	0.08 (0.00)	0.09 (0.01)	0.26 (0.01)	0.09 (0.01)	0.08 (0.01)
σ_v	0.21 (0.01)	0.25 (0.01)	0.20 (0.01)	0.47 (0.01)	0.35 (0.01)	0.20 (0.00)	0.18 (0.01)	0.20 (0.01)	0.32 (0.01)	0.22 (0.01)
γ_ϵ	0.16 (0.05)	0.02 (0.04)	0.14 (0.02)	0.02 (0.04)	0.09 (0.03)	0.04 (0.01)	0.09 (0.04)	0.21 (0.05)	0.04 (0.04)	0.10 (0.05)
ϑ_η	0.71 (0.10)	0.26 (0.07)	0.50 (0.01)	0.52 (0.02)	0.41 (0.06)	0.44 (0.03)	0.66 (0.05)	0.69 (0.18)	0.62 (0.06)	0.41 (0.06)
N	250	241	297	464	695	1942	249	240	380	253

Notes: The table reports point estimates with standard errors in parentheses. High (low) subsamples correspond to the level higher (lower) than 90th (10th) percentile of the distributions of the respective balance sheet component. The classification of households as HtM and N-HtM follows Kaplan et al. (2014). The definitions of unhedged interest rate (URE) and net nominal position (NNP) are from Auclert (2019).

TABLE A–7: ESTIMATES FOR SUBSAMPLES BASED ON BALANCE SHEETS IN AUSTRALIA

	High wealth	Low wealth	High debt	Low debt	HtM	N-HtM	High URE	Low URE	High NNP	Low NNP
					INCOME					
θ_y	0.20 (0.02)	0.06 (0.02)	0.22 (0.03)	0.16 (0.03)	0.16 (0.02)	0.17 (0.01)	0.21 (0.03)	0.18 (0.03)	0.22 (0.02)	0.19 (0.03)
σ_η	0.14 (0.00)	0.10 (0.00)	0.12 (0.00)	0.12 (0.01)	0.10 (0.00)	0.11 (0.00)	0.12 (0.01)	0.12 (0.01)	0.11 (0.01)	0.13 (0.01)
σ_ϵ	0.32 (0.01)	0.25 (0.00)	0.28 (0.01)	0.32 (0.01)	0.23 (0.00)	0.27 (0.00)	0.33 (0.01)	0.27 (0.01)	0.33 (0.01)	0.27 (0.01)
					CONSUMPTION					
σ_u	0.10 (0.00)	0.06 (0.00)	0.09 (0.00)	0.08 (0.00)	0.07 (0.00)	0.08 (0.00)	0.08 (0.00)	0.10 (0.00)	0.08 (0.00)	0.09 (0.00)
σ_v	0.12 (0.00)	0.19 (0.00)	0.13 (0.00)	0.14 (0.00)	0.15 (0.00)	0.13 (0.00)	0.13 (0.00)	0.12 (0.00)	0.14 (0.00)	0.12 (0.00)
γ_ϵ	0.02 (0.01)	0.03 (0.02)	0.03 (0.01)	0.02 (0.01)	0.01 (0.01)	0.03 (0.01)	0.03 (0.01)	0.00 (0.01)	0.02 (0.01)	0.02 (0.01)
ϑ_η	0.49 (0.01)	0.36 (0.06)	0.42 (0.04)	0.53 (0.02)	0.53 (0.03)	0.48 (0.01)	0.53 (0.06)	0.48 (0.02)	0.55 (0.05)	0.45 (0.04)
N	617	455	597	489	1326	2840	623	398	629	386

Notes: The table reports point estimates with standard errors in parentheses. High (low) subsamples correspond to the level higher (lower) than 90th (10th) percentile of the distributions of the respective balance sheet component. The classification of households as HtM and N-HtM follows Kaplan et al. (2014). The definitions of unhedged interest rate (URE) and net nominal position (NNP) are from Auclert (2019).

TABLE A–8: ESTIMATES OF SUBGROUPS WITHOUT TRANSITIONS IN THE U.S.

	Whole sample	Renters	Mortgaged owners	Outright owners
			INCOME	
θ_y	0.21 (0.01)	0.12 (0.05)	0.22 (0.02)	0.16 (0.04)
σ_η	0.14 (0.00)	0.15 (0.01)	0.08 (0.01)	0.15 (0.01)
σ_ϵ	0.25 (0.00)	0.26 (0.01)	0.23 (0.00)	0.27 (0.01)
			CONSUMPTION	
σ_u	0.08 (0.00)	0.05 (0.01)	0.08 (0.00)	0.08 (0.01)
σ_v	0.35 (0.00)	0.27 (0.01)	0.31 (0.00)	0.38 (0.01)
γ_ϵ	0.09 (0.01)	0.05 (0.06)	0.08 (0.01)	0.04 (0.03)
ϑ_η	0.56 (0.02)	0.41 (0.11)	0.51 (0.01)	0.59 (0.05)
N	2859	207	1943	435

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

TABLE A–9: ESTIMATES OF SUBGROUPS WITHOUT TRANSITIONS IN AUSTRALIA

	Whole sample	Renters	Mortgaged owners	Outright owners
			INCOME	
θ_y	0.19 (0.01)	0.14 (0.03)	0.21 (0.02)	0.17 (0.02)
σ_η	0.10 (0.00)	0.08 (0.00)	0.09 (0.00)	0.13 (0.01)
σ_ϵ	0.27 (0.00)	0.26 (0.00)	0.23 (0.00)	0.31 (0.01)
			CONSUMPTION	
σ_u	0.07 (0.00)	0.06 (0.00)	0.07 (0.00)	0.08 (0.00)
σ_v	0.14 (0.00)	0.17 (0.00)	0.12 (0.00)	0.13 (0.00)
γ_ϵ	0.03 (0.01)	0.01 (0.02)	0.03 (0.01)	0.02 (0.01)
ϑ_η	0.51 (0.01)	0.24 (0.05)	0.41 (0.04)	0.63 (0.04)
N	2937	574	1185	760

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

TABLE A–10: TIME-VARYING ESTIMATES (UNITED STATES)

		Whole sample	Mortgaged owners
θ_y		0.21 (0.01)	0.21 (0.02)
σ_η		0.12 (0.00)	0.10 (0.00)
σ_ϵ		0.26 (0.00)	0.25 (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	0.03 (0.02)	0.03 (0.01)
	2003	0.00 (0.00)	0.00 (0.00)
	2005	0.00 (0.01)	0.00 (0.00)
	2007	0.01 (0.02)	0.07 (0.02)
	2009	0.17 (0.01)	0.23 (0.02)
	2011	0.08 (0.01)	0.07 (0.02)
	2013	0.04 (0.01)	0.05 (0.02)
	2015	0.02 (0.02)	0.06 (0.02)
	2017	0.02 (0.02)	0.06 (0.02)
γ_η	1999-2001	0.59 (0.05)	0.68 (0.04)
	2003	0.53 (0.03)	0.59 (0.03)
	2005	0.56 (0.02)	0.59 (0.03)
	2007	0.56 (0.03)	0.58 (0.03)
	2009	0.51 (0.01)	0.54 (0.03)
	2011	0.46 (0.02)	0.53 (0.03)
	2013	0.52 (0.03)	0.55 (0.03)
	2015	0.52 (0.02)	0.58 (0.03)
	2017	0.46 (0.03)	0.51 (0.02)

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

TABLE A–11: TIME-VARYING ESTIMATES (AUSTRALIA)

		Whole sample	Mortgaged owners
θ_y		0.15 (0.01)	0.17 (0.01)
σ_η		0.11 (0.00)	0.07 (0.00)
σ_ϵ		0.29 (0.00)	0.23 (0.00)
σ_u		0.08 (0.00)	0.07 (0.00)
σ_v		0.14 (0.00)	0.12 (0.00)
γ_ϵ	2006-07	0.05 (0.00)	0.00 (0.00)
	2008	0.05 (0.00)	0.00 (0.01)
	2009	0.04 (0.00)	0.01 (0.01)
	2010	0.04 (0.00)	0.02 (0.01)
	2011	0.03 (0.00)	0.03 (0.01)
	2012	0.01 (0.00)	0.04 (0.01)
	2013	0.01 (0.00)	0.05 (0.01)
	2014	0.01 (0.00)	0.04 (0.01)
	2015	0.00 (0.00)	0.06 (0.01)
	2016	0.00 (0.00)	0.06 (0.01)
	2017	0.00 (0.00)	0.06 (0.01)
γ_η	2006-07	0.58 (0.02)	0.59 (0.03)
	2008	0.52 (0.01)	0.58 (0.03)
	2009	0.51 (0.01)	0.53 (0.02)
	2010	0.51 (0.01)	0.55 (0.02)
	2011	0.47 (0.01)	0.53 (0.02)
	2012	0.45 (0.01)	0.51 (0.00)
	2013	0.43 (0.01)	0.51 (0.01)
	2014	0.44 (0.01)	0.52 (0.01)
	2015	0.45 (0.01)	0.51 (0.00)
	2016	0.43 (0.01)	0.54 (0.02)
	2017	0.44 (0.01)	0.53 (0.02)

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