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Decomposing the Consumption Response to Monetary Policy Shocks in Australia

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Abstract: Does monetary policy affect households differently depending on their position on the income distribution? If so, what drives the differences? This paper attempts to answer these questions by decomposing changes in consumption following a monetary policy shock into several direct and indirect channels of transmission. Although direct channels of transmission are the most important in traditional representative agent models, the indirect channels are dominant when households are heterogeneous. Using household-level data from Australia, households are grouped into income quintiles and allowed to differ in terms of their marginal propensity to consume, their balance sheet exposures and the sensitivity of their income to economic activity. The net impact of the monetary policy shock is calculated by aggregating the changes in consumption from each of the transmission channels.

An interest rate reduction stimulates the consumption of low-income earners the most, while high-income earners experience the smallest increase. This result is mostly explained by the capital gains channel, and to a lesser extent, the income channel. Changes in consumption through these indirect channels of transmission outweigh changes through the direct channels, for all income quintiles. Within quintiles, groups with sizable asset holdings such as retirees and homeowners, experience the largest changes in consumption. Though these results reflect unique aspects of the Australian context, they also align at a high level with other studies finding that expansionary monetary policy reduces inequality. More broadly, they demonstrate the importance of accounting for household heterogeneity to better understand the transmission of monetary policy and its distributional effects.

Keywords: Consumption, Household heterogeneity, Income distribution, Marginal propensity to consume, Monetary policy transmission

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1. Introduction

In light of the unprecedented scale of monetary policy stimulus during the global financial crisis and the COVID-19 pandemic, there has been an increased focus on the interactions between economic inequality and monetary policy. Central banks around the world have lowered interest rates (in some cases, even setting negative interest rates) and expanded their balance sheets through asset purchase programs. Some argue that these measures have exacerbated inequality by disproportionately benefiting the rich through higher asset prices (for example, see House of Lords, 2021). Others argue that expansionary monetary policy settings have disproportionately benefited the poor by supporting job creation and economic activity, thereby reducing inequality (for example, see Bernanke, 2015).

An understanding of how the various channels of monetary policy transmission reinforce or offset each other is necessary to assess its net effect on income, wealth and consumption inequality. Monetary policy can affect household consumption directly through partial-equilibrium effects that occur without any changes in income, or indirectly through the general equilibrium responses of income and prices to the shock. The main direct channel is intertemporal substitution, where households bring forward or delay consumption following interest rate movements by borrowing or saving. Another direct channel is the net interest rate exposure effect, where policy changes affect the amount of interest households pay and receive. The indirect channels include income effects from income growth, wealth effects from changing asset prices, and the nominal revaluation of balance sheets caused by inflation (the Fisher effect).

In traditional models with a single 'representative' agent, the intertemporal substitution channel accounts for almost the entire effect of monetary policy on consumption. However, a series of influential papers have shown that when agents are heterogeneous across factors such as liquid assets, income and wealth, the strength of the transmission mechanisms change (Kaplan, Moll and Violante, 2018; Auclert, 2019). The general-equilibrium effects of a monetary policy shock on income and prices play the most important role in how consumption responds to interest rate changes, while intertemporal substitution is much less important.

Understanding the magnitude of these channels is important for several reasons. Firstly, it is critical for the central bank to understand the strength of the transmission mechanism and its net impact in order to set optimal policy. As redistribution is a channel through which monetary policy operates (Auclert, 2019), having realistic distributions of income and wealth built into macroeconomic models allows for more precise estimation of the effects of monetary policy changes. In addition, the distribution of consumption, income and wealth is extremely important for welfare within a society (Attanasio and Pistaferri, 2016). Inequality acts as a dampener on the strength and durability of both current and future economic growth (Ostry et al., 2014). It limits the ability of lower-income households to invest in education and training (Jaumotte and Buitron, 2015), can lead to political instability and tensions (Morin, 2012), and is often seen as unfair and unjust. Understanding the nuances of how monetary policy may affect these distributions is therefore necessary both for achieving policy aims and for welfare maximisation.

While there is growing consensus that heterogeneity can impact the transmission channels, empirical studies on the effect of monetary policy on inequality yield mixed conclusions. One reason is that most studies tend to focus on one or two transmission mechanisms in isolation (Colciago, Samarina and de Haan, 2019), which leads to mixed conclusions due to the potentially

offsetting effects of different channels. The joint distribution of income, wealth and consumption also shapes whether the winners from one channel also benefit from others. For example, an interest rate cut could reduce income inequality by reducing unemployment, but may also lead to higher asset prices, which can increase wealth inequality. Moreover, many studies focus on US, European or Scandinavian contexts due to the size of those economies and the availability of high-quality micro data. However, the sensitivity of results to underlying factors in the economy such as the income and asset distribution mean that the results do not necessarily generalise to other economies.

The objective of this thesis is to contribute to the literature by analysing the transmission of monetary policy to households in Australia. Specifically, this thesis estimates the consumption response across the income distribution to a monetary policy shock and decomposes it into the direct and indirect channels. To do so, I follow the method described in Slacalek, Tristani and Violante (2020) (henceforth 'STV') to derive expressions for each of the direct and indirect effects. Households are grouped into quintiles based on equivalised disposable income and the consumption change for each quintile is calculated separately. This decomposition requires a number of inputs:

- Balance sheet, income and consumption information for each quintile is obtained from the Household, Income and Labour Dynamics in Australia (HILDA) survey, a panel dataset that follows over 7,000 households each year. Additional data on household consumption and income is sourced from the Australian Bureau of Statistics (ABS).
- The marginal propensity to consume (MPC) out of a transient income shock is estimated for each quintile using the Blundell, Pistaferri and Preston (2008) method. For each household, I obtain data on income and consumption from HILDA, and impose a series of restrictions on the income and consumption processes to identify the MPC.
- Estimates of the sensitivity of household income to fluctuations in aggregate income are obtained through a regression model. I again use household-level data from HILDA on income, consumption and other explanatory variables to isolate the effect of GDP growth on income growth for each quintile.
- The responses of aggregate income, inflation, house and share prices to a 100 basis point monetary policy shock are estimated using Bayesian vector autoregressions (BVARs).

These inputs are combined to calculate the direct and indirect effects, which are then summed to arrive at the aggregate consumption effect.

I focus on the effects of monetary policy (accounting for the direct and indirect channels) across the income distribution for several reasons. Firstly, while much of the literature has focused on the role of liquidity constraints in shaping consumption responses to monetary policy shocks, the share of liquidity-constrained households is lower in Australia than many other economies (Kaplan, Violante and Weidner, 2014), and has been declining (La Cava and Wang, 2021).

In addition, the effect of monetary policy on income inequality is often analysed with particular focus on the income channel (through wages and employment). While this is an important channel, such analysis may not capture the effect on welfare if the income effect is offset by other channels of transmission. The implications of the shock may therefore be different for income inequality than for consumption inequality.

Moreover, analysing effects along the income distribution is interesting because income is a useful proxy for consumption and welfare, which are typically more difficult to measure. Changes in consumption along the income distribution are therefore indicative of changes in welfare and consumption inequality more broadly.

Finally, HILDA data on income is available each year of the survey, while data on wealth and liquid assets is only available every four years. As such, dividing by income quintiles allows me to calculate the MPC (which requires consecutive observations) without having to rely on potentially strong assumptions about a household's position on the distribution in years for which the data are not available.

The results show that a fall in interest rates increases consumption for all income quintiles. A 100 basis point negative shock increases consumption by around 2.3 percent in the lowest income quintile after four quarters, and by 1.6 percent in the highest quintile. In this way, expansionary monetary policy reduces consumption inequality. The size of the change in consumption is quite large by empirical standards and is driven by the capital gains channel, which makes up 65-75 percent of the overall response. Between 85 and 90 percent of the entire consumption response is attributable to the indirect effects of the monetary policy shock.

Key drivers of these results are the significant holdings of property and equities across all income quintiles. Even in the lowest quintile, the average household has nearly AU$10,000 in equities and AU$370,000 in property. This is approximately equivalent to the holdings of the wealthiest subgroup in STV's analysis (households in Spain without liquidity constraints). In addition, the VAR estimates a strong response of house prices to the monetary policy shock. Together, these explain why the effect of the monetary policy shock on consumption is so large. Non-homeowners have a more muted consumption response than homeowners, though for both groups, there is a distributional effect as the lowest-earning households respond the most strongly. At least some of this pattern is driven by lifecycle effects and retirement.

The remainder of this thesis proceeds as follows: section 2 summarises the literature; section 3 describes the overall empirical approach; section 4 provides an overview of the data and model inputs; section 5 summarises the results; section 6 discusses extensions and limitations; and section 7 concludes.

2. Literature Review

This thesis contributes to the literature on heterogeneity and monetary policy.

2.1 Heterogeneous agents

In recent years, advances in modelling techniques have allowed researchers to relax the assumption of a 'representative agent' that describes the entire household sector. Researchers are increasingly accounting for different ways that households may interact with the same shock by introducing heterogeneous agents into models.

In the first instance, heterogeneity can affect how a monetary policy shock impacts households. For example, an interest rate decrease would reduce the interest payments of a household with a loan, leaving them with more disposable income, but would reduce the interest receipts (and income) of a household with savings. However, the household with savings may also have a

significant equities portfolio that increases in value and supports their consumption. In addition, heterogeneity can shape how strongly agents respond to the same monetary policy shock, or their MPC. If the household described above with a loan does not have access to liquid resources, they might struggle to meet their interest payments following an unexpected interest rate increase and might therefore have to cut back on consumption. Conversely, if they did not face liquidity constraints, they might not need to reduce consumption at all following the interest rate rise because they could borrow more or reduce their savings. Heterogeneity therefore has implications both for the effect of monetary policy on aggregate consumption and for the relative strength of the different transmission channels.

One important source of heterogeneity is liquid assets holdings. Households with very small amounts of liquid assets are considered 'hand-to-mouth' (HTM) consumers. Liquidity constraints affect the transmission of monetary policy because these households are not able to adequately smooth consumption and thus can have larger MPCs than non-constrained households (Kaplan, Violante and Weidner, 2014). In their seminal work, Kaplan, Moll and Violante (2018) develop a heterogeneous agent New Keynesian (HANK) model where there are 'poor' HTM households that have negligible amounts of liquid and illiquid assets, 'wealthy' HTM households who have illiquid assets, and non-HTM households who do not face liquidity constraints. Empirical evidence suggests that there indeed exists a not-insignificant number of liquidity-constrained households in a range of advanced economies.[1] Kaplan, Moll and Violante (2018) find that there is substantial heterogeneity in MPCs between these groups, which flows through to their consumption responses to shocks. HTM households do not adjust their borrowing or saving in response to interest rate shocks, rendering the intertemporal substitution channel insignificant. However, they are extremely sensitive to income changes and consume a large share of any additional income. The direct effects of the monetary policy shock are therefore minor whilst the indirect effects are much larger. As such, the existence of liquidity-constrained households has important implications for how monetary policy flows through to household consumption.

A number of other studies have also analysed the impact of liquidity constraints on monetary policy transmission. Ampudia et al. (2018) find that HTM households have different interest rate exposures to non-HTM households in Europe and therefore, benefit from an interest rate cut through reduced interest payments. On the other hand, non-HTM households lose interest income. Cloyne, Ferreira and Surico (2020) study mortgagors in the UK and the US and find that a substantial share are HTM and have high MPCs, which drive the overall consumption responses to shocks. Using Swedish data, Flodén et al. (2017) find stronger consumption responses through the cash-flow channel for households that face liquidity constraints.

There are a number of other factors that affect the transmission mechanism because they shape household exposures or responses through one or more transmission channels. For example, the composition of household income is important when different types of income, such as capital and labour income, respond to monetary policy shocks in different ways. Amberg et al. (2021) find that despite capital income across the income distribution being uniformly sensitive to monetary policy shocks, households experience different total income changes because they have varying

[1] For example, Kaplan, Violante and Weidner (2014) estimate that over 30% of the population in the USA, Canada, the UK and Germany are HTM. The share of HTM households in France, Italy and Spain is lower at around 20%.

shares of capital income. In a similar way, the composition of a household's balance sheet shapes their exposures to inflation and wealth effects (Aladangady, 2014). Finally, the extent to which a household is integrated into the international economy through their sector of employment and their access to capital markets also affects the sensitivity of their income and their interest rate exposures to monetary policy shocks (Guo, Ottonello and Perez, 2020).

This paper contributes to the literature by assessing how the balance sheet exposures of each income quintile and the sensitivity of their income to economic activity affect their overall consumption response and the relative strength of the transmission channels. Moreover, it assesses whether the MPC varies across the income distribution.

2.2 Heterogeneous MPCs

An important part of why differences between households flow through to consumption is because they have different MPCs. Auclert (2019) finds that when groups have different MPCs, redistribution is not only a by-product of monetary policy, but a channel through which it affects the economy as a whole. Households are differentially affected by the income changes, the nominal balance sheet revaluations and the real interest rate changes that arise from an interest rate shock. As such, the overall magnitude of the consumption response depends on the MPCs of the winners and losers. Using data from Italy and the US, Auclert (2019) finds that those who gain from expansionary policy have higher MPCs than those who lose, meaning inequality amplifies the effects of the monetary policy shock.

Empirical evidence indeed finds that MPCs can vary quite significantly between different groups. The Permanent Income Hypothesis posits that changes in the permanent component of income will result in equivalent changes in consumption, while transient changes will generate very small consumption responses (Friedman, 1957). However, empirical evidence generally suggests that the MPC out of transient shocks is varied and can be quite high for some groups. Using a structural estimation approach, Blundell, Pistaferri and Preston (2008) find that low-wealth households have higher MPCs than others. Jappelli and Pistaferri (2014) use survey data on self-reported MPCs and find evidence that the MPC varies with liquid assets, a finding which is supported by the analysis of Kaplan, Moll and Violante (2018), Cloyne, Ferreira and Surico (2020), and Crawley and Kuchler (2020). Johnson, Parker and Souleles (2006) and Misra and Surico (2014) use tax rebates as a natural experiment and find that lower-income households have higher MPCs. This paper contributes to this branch of the literature by using the structural approach to estimate whether the MPC varies across the income distribution in Australia.

2.3 Impact of monetary policy on inequality

This paper also contributes to the extensive literature on how monetary policy affects inequality (see Colciago, Samarina and de Haan (2019) for a review). Expansionary monetary policy has been found to lower income inequality by disproportionately increasing the incomes of poor households, primarily due to transitions in and out of unemployment (Broer, Kramer and Mitman, 2021; Lenza and Slacalek, 2021). Others suggest that expansionary policy disproportionately stimulates capital income relative to labour income, benefiting those at the top of the income distribution the most (Coibion et al., 2017; Amberg et al., 2021). These results demonstrate the potentially offsetting effects of earnings heterogeneity and income composition on income inequality, which also likely varies between countries (Rawdanowicz, O'Farrell and Inaba, 2016).

Monetary policy also influences wealth inequality through its effect on asset prices, inflation and real interest rates. Expansionary policy typically boosts the value of assets such as property and equities and generates higher inflation. The effect on wealth inequality is ambiguous (Colciago, Samarina and de Haan, 2019); on one hand, it may lower inequality by reducing the value of debt, favouring borrowers over wealthier savers (Doepke and Schneider, 2006; Adam and Zhu, 2015). However, it can also increase inequality, depending on the relative price changes of different assets and which segments of the income distribution benefit the most. Colciago, Samarina and de Haan (2019) suggest that rising house prices benefit middle- to low-income households the most, whilst increasing equity prices are most beneficial for wealthier households.

Similarly, while monetary policy can affect consumption inequality if winners and losers have different MPCs, the offsetting nature of the transmission channels makes it difficult to assess the overall impact, particularly when studies focus on single transmission channels in isolation (Colciago, Samarina and de Haan, 2019). Slacalek, Tristani and Violante (2020) decompose the consumption response to monetary policy shocks in several countries in Europe into direct and indirect channels. They group households by HTM status and allow their balance sheet exposures, their sensitivity of household income to aggregate income and their MPCs to differ. STV find that the indirect channels (particularly the income and housing wealth channels) are the most important drivers of the consumption response. Moreover, they find that HTM households have a much higher aggregate consumption response than non-HTM households.

By replicating this decomposition and applying it to the Australian economy, this paper contributes to the literature on how heterogeneity affects consumption and in turn, consumption inequality. By grouping households by income quintile, I extend the literature on the impact of monetary policy on households along the income distribution. Rather than focusing solely on changes in income, this paper studies consumption inequality and additional channels of transmission, therefore presenting a comprehensive view of whether the distribution of income affects the overall consumption response of households. This paper also analyses whether balance sheet exposures, MPCs and income sensitivities vary along the income distribution, and the role of such differences in shaping consumption inequality.

More broadly, this thesis contributes to the research on heterogeneity and monetary policy in Australia. Kaplan, La Cava and Stone (2018) consider consumption and income inequality in Australia and find that both have increased slightly since the 1990s. They decompose income inequality and find that persistent income shocks explain the largest share of the increase in income inequality. He and La Cava (2020) examine the housing price channel and find that prices in areas with more wealthy residents, more investors and higher debt tend to be more sensitive to interest rate movements than other areas. La Cava, Hughson and Kaplan (2016) also use HILDA data and find that interest rate movements affect borrowers and lenders differently, with borrowers experiencing more pronounced consumption responses to monetary policy changes than lenders. By analysing several different channels, this paper should provide additional evidence about these effects while also assessing whether there are offsetting effects through alternative transmission channels.

3. Empirical approach

This section summarises the empirical approach taken in this paper. I firstly outline the overall theoretical framework and how the expressions for the direct and indirect channels of transmission are derived. I then describe how the MPC, the responses of aggregate variables to an interest rate shock and the sensitivity of income to economic growth fluctuations are calculated.

3.1 Theoretical Framework

The effects of a transitory monetary policy shock on consumption are decomposed into several direct and indirect channels. This decomposition replicates the approach taken in STV for non-HTM households.

Firstly, the standard household value maximisation function is defined as follows:

$$V(a, y; R) = \max_{c,a'} u(c) + \beta V(a', y'; R) \tag{1}$$

Such that:

$$a' = R(a + y - c) \tag{2}$$

Where β measures household impatience, a is real net assets (for now, assuming it is a highly liquid asset; this will be extended later), y is net income, R represents the real interest rate and a' represents a in the next time period. Income can either be consumed or saved by the household to maximise utility, which is assumed to be of the constant relative risk aversion (CRRA) form.[2] Using the Envelope Theorem, the first order condition with respect to consumption is defined as:

$$u_c(c) = \beta R V_a(a', y'; R) \tag{3}$$

Where $u_c(c)$ is the derivative of $u(c)$ with respect to c, and $V_a(a', y'; R)$ is equal to the derivative of $V(a', y'; R)$ with respect to a. We see here that the optimal consumption is a function of household impatience, the interest rate and the sum of utility arising from future income and assets. Totally differentiating the first order condition (with respect to consumption and assets in the next period) shows how optimal consumption varies as the decision of how much to save for the next period changes.

$$u_{cc}(c)dc = \beta R V_{aa}(a', y'; R)\, da' \tag{4}$$

The final element of the setup involves defining the MPC, μ. The MPC represents the unit change in consumption following a one unit change in liquid wealth (or income). Using (2),

$$\begin{aligned} \mu &= \frac{dc}{da} \\ &= 1 - \frac{1}{R}\frac{da'}{da} \\ \mu &= 1 - \frac{1}{R}\left(\frac{u_{cc}(c)}{\beta R V'_{aa}(a', y'; R)}\frac{dc}{da}\right) \end{aligned}$$

[2] Freestone and Breunig (2019) find evidence supporting the CRRA utility function in Australia.

$$= 1 - \frac{1}{R}\left(\frac{u_{cc}(c)}{\beta R V'_{aa}(a', y'; R)}\mu\right)$$

$$\mu = \frac{\beta R^2 V'_{aa}(a', y'; R)}{\beta R^2 V'_{aa}(a', y'; R) + u_{cc}(c)} \quad (5)$$

In this standard model, the interest rate affects the optimal level of consumption of a household and how their consumption reacts to changes in income or wealth. These effects can be direct or indirect and are decomposed below.

3.1.1 Direct effects

Monetary policy can have direct effects on household consumption in several ways. For example, interest rate movements affect the households' incentives to save or to consume their income. Lower interest rates reduce the return on savings and make borrowing less expensive, thereby encouraging households to increase current consumption and reduce future consumption. On the other hand, higher interest rates instead encourage households to postpone current consumption because borrowing is more costly, and they can earn a higher rate of interest on savings. This is known as the *intertemporal substitution effect.*

Interest rate movements also affect the interest earned and owed on existing stocks of savings and loans. This affects both short-term securities such as bank deposits, where the interest rate is reset on a regular basis, but also the share of long-term assets and liabilities that are maturing or have variable interest rates. Households with positive net interest rate exposures (because they are predominantly invested in short-term assets or have long-term fixed rate borrowings) will experience a fall in income and consumption after an interest rate cut, while those with negative interest rate exposures experience a reduction in their interest rate payments and an increase in income and consumption. This is known as the *net interest rate exposure effect* (Auclert, 2019).

To yield an expression for the direct effects of an interest rate change, I rewrite the first order condition (3) using the budget constraint (2):

$$u_c(c) = \beta R V_a(R(a + y - c), y'; R) \quad (6)$$

To assess how optimal consumption responds to interest rates changes, I totally differentiate (6) with respect to both consumption and interest rates (i.e., holding income constant). Note that $V_a(R(a + y - c), y'; R)$ is reduced to V_a for clarity:

$$u_{cc}(c)\, dc = \big(\beta V_a + \beta R V_{aa} \times (a + y - c)\big)dR - (\beta R^2 V_{aa})dc$$

$$(u_{cc}(c) + \beta R^2 V_{aa})\, dc = \big(\beta V_a + \beta R V_{aa}(a + y - c)\big)dR$$

$$\frac{(u_{cc}(c) + \beta R^2 V_{aa})}{u_{cc}(c)}\, dc = \frac{1}{u_{cc}(c)}\left(\frac{u_c(c)}{R} + \beta R V_{aa}(a + y - c)\right)dR$$

$$\frac{1}{1-\mu}dc = \frac{u_c(c)}{u_{cc}(c)}\frac{dR}{R} + \frac{\mu}{1-\mu}(a + y - c)\frac{dR}{R}$$

$$dc = \frac{1}{\gamma}(1-\mu)c\, dr + \mu(a + y - c)\, dr \quad (7)$$

The first term is the intertemporal substitution effect and the second is the net interest rate exposure effect. The intertemporal substitution effect is increasing in the elasticity of substitution, $\frac{1}{\gamma}$, and decreasing in the MPC. Intuitively, a household that consumes all of their income (i.e. has an MPC of 1) is unaffected by a change in the interest rate, while the consumption of a household that saves some of their income (MPC less than 1) will be more sensitive. The second term is the net interest rate exposure effect. The real net assets term, a, is expanded to include the share (δ) of all assets (A) and liabilities (L) that are maturing (8).

$$dc = \frac{1}{\gamma}(1-\mu)c\,dr + \mu(y - c + \delta^A A - \delta^L L)\,dr \tag{8}$$

$$dc = dc^{IES} + dc^{NIE} \tag{9}$$

Only maturing assets and liabilities affect the household's balance sheet exposure to interest rate changes (Auclert, 2019). For example, a household that only invests in long-term bonds will not experience a change in cash flows following an interest rate movement as their cash flows have been locked in for the duration of the bond. Alternatively, a household with short-term cash deposits will be affected because the interest rate on these assets is typically reset on a regular basis.

As such, we can see that the direct effects on consumption depend on several factors. The intertemporal substitution effect is a function of the elasticity of substitution ($\frac{1}{\gamma}$), the MPC (μ) and the level of consumption (c), while the net interest rate exposure effect depends on the level of assets and liabilities, consumption, income and the MPC.

3.1.2 Indirect effects

Monetary policy can also have indirect effects because changes in interest rates induce general equilibrium responses of aggregate variables, which then flow through to household consumption. Interest rate shocks affect aggregate demand across the economy, leading to changes in income and therefore consumption. For example, a negative interest rate shock may induce a consumer to borrow money to renovate their house; the builders they employ will experience an increase in income, and therefore consumption, as an indirect result of the interest rate shock. This is known as the *income effect*. Prices of illiquid assets such as housing and equities are also typically influenced by monetary policy, as interest rate movements affect the borrowing ability of households and their demand for assets, and may also contain information about the expected future path of the economy. The *capital gains effect* describes the changes in household consumption that arise from these price movements and associated changes in wealth. Finally, interest rates shocks alter the level of inflation in the economy and the real value of debt and assets. Borrowers benefit from unexpected inflation as the real value of their debt is eroded, while lenders, or those with financial assets lose out. *The Fisher effect* captures how these value changes flow through to household consumption.

To quantify these indirect effects, I first extend the value function to include housing and share prices, and to specifically refer to nominal assets and liabilities (10).

$$V(a, y; R, p, k) = \max_{c,a'} u(c) + \beta V(a', y'; R, p, k) \tag{10}$$

Such that:

$$\begin{aligned} a' &= R(a + y - c) \\ a &= A - L \\ na &= A \times p \\ nl &= L \times p \\ s &= kq \end{aligned}$$

FOC:

$$u_c(c) = \beta R V_a(R(a + y - c), y'; R, p, k) \tag{11}$$

Where a is real assets less real liabilities, na represents nominal assets, nl is nominal liabilities, p is the general price level and k captures asset prices. Note also that that the housing and equity components (s) of total real assets can be written as a function of asset price k and quantity q.

To assess the income effect, or how consumption responds to interest rate-induced income changes, I take the total derivative of the first order condition (11) with respect to consumption and income.

$$\begin{aligned} u_{cc}(c)\, dc &= (\beta R^2 V_{aa}) dy - (\beta R^2 V_{aa}) dc \\ (u_{cc}(c) + \beta R^2 V_{aa})\, dc &= (\beta R^2 V_{aa}) dy \\ dc &= \mu dy \end{aligned} \tag{12}$$

The size of the consumption response depends on a households MPC and the change in their income. It is important to note here, however, that there is substantial heterogeneity in how a household's income is affected by aggregate income movements. Labour income can be affected at the extensive margin, where firms change the number of people they employ, or the intensive margin, where firms change the number of hours that they work. Bishop, Gustafsson and Plumb (2016) find that both mechanisms play an important role in the Australian labour market, meaning those who are (or become) unemployed or are employed on flexible contracts may be more exposed to economic fluctuations than those who are employed in non-cyclical industries. Moreover, the composition of household income affects its exposure to aggregate fluctuations due to differing volatility between the labour and capital income components (Stone, 2016). Adjusting equation (12) by this exposure to aggregate fluctuations, e, yields the expression for the income effect:

$$dc = \mu\, e\, dY \tag{13}$$

Turning to the effect of asset price appreciations, the derivative of (11) is taken with respect to consumption and asset prices:

$$\begin{aligned} u_{cc}(c)\, dc &= (\beta R^2(q) V_{aa}) dk - (\beta R^2 V_{aa}) dc \\ (u_{cc}(c) + \beta R^2 V_{aa})\, dc &= (\beta R^2(q) V_{aa}) dk \end{aligned} \tag{14}$$

$$dc = \mu\, q\, dk$$

The consumption response is again driven by the MPC, but also the stock of assets experiencing capital gains. This implicitly assumes that the MPC out of income and illiquid wealth changes is the same. The MPC out of illiquid wealth is typically lower, however, due to the presence of transaction costs in the form of capital gains taxes, brokerage fees and real estate agent fees, and the greater difficulty in liquidating assets and accessing the gains. Despite this, consumption may still increase following asset price appreciations, irrespective of whether the household sells their assets or not, because such gains may increase confidence in the economy, or expectations about the future. To account for these differences, I use the MPC out of wealth rather than the MPC out of income.

$$dc = \mu_W\, q\, dk \tag{15}$$

Finally, the Fisher effect is obtained by differentiating the first order condition with respect to consumption and the price level:

$$u_{cc}(c)\, dc = -\left(\frac{\beta R^2 (na - nl) V_{aa}}{p^2}\right) dp - (\beta R^2 V_{aa}) dc$$

$$(u_{cc}(c) + \beta R^2 V_{aa})\, dc = -\left(\frac{\beta R^2 (na - nl) V_{aa}}{p^2}\right) dp$$

$$dc = -\left(\frac{na - nl}{p^2}\right) \mu\, dp$$

$$dc = -\mu\, (na - nl)\, dp \tag{16}$$

Normalising $p = 1$, the impact of a price change on consumption depends on the (negative) net nominal position of the household and its MPC. As described earlier, households with positive net nominal exposures (more assets than liabilities) lose from inflation, while those with negative net nominal positions benefit.

The indirect effects can be combined to obtain the following expression:

$$dc = \mu\, e\, dY + \mu_w\, q\, dk - \mu\, (na - nl) dp \tag{17}$$

$$dc^{indirect} = dc^{income} + dc^{cap\ gains} + dc^{Fisher}$$

3.1.3 Summary of decomposition

Combining the previous expressions for the direct and indirect effects of a temporary interest rate shock, we arrive at the following expression:

$$\frac{dc}{dr} = \frac{1}{\gamma}(1 - \mu)c + \mu(y - c + \delta^A A - \delta^L L) + \mu\, e\, \frac{dY}{dr} + \mu_w\, q\, \frac{dk}{dr} - \mu\, (na - nl) \frac{dp}{dr} \tag{18}$$

$$dc = dc^{IES} + dc^{NIE} + dc^{income} + dc^{cap\ gains} + dc^{Fisher}$$

This equation is applied to each equivalised income quintile, so that the response of consumption to an interest rate shock can be determined across the income distribution. Given the overlap between the income and consumption distribution (OECD, 2021), this will also be indicative of the effect of monetary policy on consumption across the consumption distribution. In other words, it will indicate the effect of the monetary policy shock on consumption inequality, or welfare inequality more broadly. It will also facilitate an analysis of whether the channels of transmission act in the same direction or whether they are offsetting, which may have implications for the joint distributions of consumption, income and wealth.[3]

STV derive an alternative specification for HTM households. Given that these households cannot borrow to smooth consumption and do not have savings, the intertemporal substitution channel is shut down and the magnitude of the net interest rate exposure channel is equivalent to their credit limit. Moreover, poor HTM households also do not have illiquid assets and so do not experience capital gains. This naturally alters the relative importance of the channels of transmission.

Despite this, I use the same value function for all households, irrespective of their HTM status. This implicitly assumes that all households can borrow to smooth consumption and are not at a kink in their budget constraint, which is unlikely to be the case for a small subset of households. The magnitude of this potential bias, however, should be small. As described earlier and shown in Figure 4, the incidence of HTM households is quite low in Australia. Although there is a small degree of concentration in quintile 1, these households are reasonably dispersed across all quintiles (Figure 5). For robustness, I test this in Section 5.1 by relaxing the assumption and allow some households to face liquidity constraints.

3.2 Marginal propensity to consume - income

The MPC out of transient income shocks plays a critical role in quantifying the overall effect of an interest rate shock on consumption. It appears in each of the channels except for the capital gains channel (μ in equation 18), which instead features the MPC out of wealth. While the STV paper takes estimates of the MPC from income out of the literature, most estimates in the literature focus on the US and European contexts, which may not be directly relevant to the Australian context. Moreover, most estimates tend to be at the aggregate level, or are by HTM status, whereas this analysis requires MPCs by income quintile. It is therefore appropriate to estimate the MPC directly, which is done using the approach in Blundell, Pistaferri and Preston (2008).

This method involves decomposing income into its permanent and transient components by imposing covariance restrictions on the behaviour of consumption and income. The MPC cannot be estimated from aggregate income because the longevity and nature of income shocks affect the response of consumption. As such, income must be split into its different components to appropriately identify the MPC.

To do this, Blundell, Pistaferri and Preston (2008) express the log of income as a function of observable household characteristics Z (such as education level, gender and state of residence), a permanent component P (following a random walk process), and a mean-reverting temporary

[3] It may be for example, that income inequality (captured as part of the income effect) goes in one direction while other channels have the opposite effect, so the net effect on consumption inequality is more nuanced.

component v. Income is then regressed on the observable household characteristics in order to obtain an 'unexplained' income series. Changes in (unexplained) income (19) are due to independent and identically distributed (i.i.d.) shocks to the permanent process (ς) and changes in the temporary component ($\varepsilon_{i,t} - \varepsilon_{i,t-1}$).

$$\log Y_{i,t} = Z_{i,t} + P_{i,t} + v_{i,t}$$

$$\begin{aligned} P_{i,t} &= P_{i,t-t} + \varsigma_{i,t} \\ v_{i,t} &= \varepsilon_{i,t} \\ \Delta y_{i,t} &= \varsigma_{i,t} + \varepsilon_{i,t} - \varepsilon_{i,t-1} \end{aligned} \tag{19}$$

An expression for consumption growth (20) is similarly derived by first regressing consumption on household observables to obtain the residual series. Consumption growth is then written as a function of permanent income shocks (ς), transitory income shocks (ε) and i.i.d. shocks (ξ) unrelated to the income process.

$$\Delta c_{i,t} = \theta_{i,t}\varsigma_{i,t} + \psi_{i,t}\varepsilon_{i,t} + \xi_{i,t} \tag{20}$$

From this, the permanent and transient components are identified by imposing covariance restrictions on the income and consumption series. The key idea is that the permanent component of income only faces i.i.d. shocks which are uncorrelated over time. Therefore, any autocorrelation of income growth is attributable to the temporary component of income, while the residual variance of income is attributable to the permanent component. Similarly, income growth can be correlated with lagged consumption growth through the transient component, while the residual correlation between current income and consumption growth is attributable to the permanent component of income. Using these assumptions, Blundell, Pistaferri and Preston (2008) show that the MPC out of transient income shocks can be calculated as:

$$\psi = \frac{E(\Delta c_t \, \Delta y_{t+1})}{E(\Delta y \, \Delta y_{t+1})} \tag{21}$$

These θ and ψ parameters can also be considered as 'insurance' parameters, as they dictate the extent to which permanent and transient income shocks respectively affect consumption. If a household has full insurance and income shocks do not affect consumption at all, these will be zero. If they have no insurance and income shocks are passed through fully to consumption, these parameters will be one. As described earlier, the Permanent Income Hypothesis suggests an insurance parameter on permanent income shocks close to one, and close to zero for transient income shocks. However, the literature has found evidence of quite high MPCs out of temporary income shocks, particularly for lower-income or liquidity-constrained households.

3.3 Bayesian VARs

The effect of an interest rate shock on aggregate price levels, income and asset prices, as required by the model (equation 18), is estimated through Bayesian vector autoregressions (BVARs).

Vector autoregressions are widely used for modelling and forecasting macroeconomic time series due to their flexibility and ability to fit data well (Karlsson, 2012). However, when there is a large

number of variables and multiple lags, the model can be overparameterized and can overfit the data, therefore reducing forecast accuracy and generating imprecise estimates (Kotzé, no date).

To address these concerns, many macroeconomists use BVARs. This approach relies on Bayes Theorem, whereby a set of 'prior beliefs' about the data are combined with observed data to generate a set of 'posterior beliefs'. The idea is that prior information or beliefs about the parameters of a time series (for example, that GDP growth follows a random walk) will be updated with observed data, giving a more reliable set of parameter estimates (Kenny, Meyler and Quinn, 1998). As such, modellers do not need to impose as many specific restrictions on the data (for example, that the second-order lags are equal to zero) (Ciccarelli and Renucci, 2003).

A key element of the BVAR is the specification of the prior beliefs. I follow the literature and estimate a BVAR model using the Minnesota Prior for the model parameters and the Inverse-Wishart prior for the covariance matrix. The Minnesota Prior (also known as the Litterman Prior) is one of the most commonly used distributions, and is based on the notion that many macroeconomic time series can be characterised as random walks, or non-stationary unit root processes (Wozniak, no date). The Inverse-Wishart distribution relaxes the assumptions of the Minnesota Prior by allowing for correlation between the error terms of each of the equations. These specifications are commonly used for macroeconomic time series (Zhang, 2021; Kotzé, no date). I proceed using the default parameterisation in Stata, but note that this could be further refined in future work. An alternative approach would be to estimate the model using a structural VAR or the local projection method, which relies on non-parametric techniques. However, local projections can generate greater variance and can be less suited to macroeconomic data than BVARs (Li, Plagborg-Møller and Wolf, 2021). As such, I estimate a BVAR model and for robustness, also estimate a SVAR model (see Appendix C).

3.4 Income sensitivity

To calculate the sensitivity of income to fluctuations in aggregate income ($\boldsymbol{e}$ in equation 18), I largely follow the approach in Stone (2016) but apply it at the household level. Although much of the literature on income risk focuses on individual income, this model instead requires household-level income risk. Individual income is likely to be more exposed to aggregate fluctuations than household income because of insurance through additional family labour supply (whereby individuals can adjust their labour supply in response to other family members' income shocks) (Blundell, 2014).

While STV focus on labour income, I choose to use total disposable income as my income variable. Other sources of income such as investment and business income are also sensitive to fluctuations in economic activity. Excluding these components could lead to biased estimates of income sensitivity if the components have different sensitivities or if labour income is not the largest component of household income. For these reasons, I evaluate the sensitivity of total household disposable income to changes in GDP.

I calculate the below regression:

$$\Delta \ln(y_{i,t}) = \sum_{q=1}^{5} \alpha_q d_{i,t-1}^{q} + \sum_{q=1}^{5} \beta_q d_{i,t-1}^{q} \Delta \ln\,(GDP_t) + controls_{t-1} + \varepsilon_{i,t} \qquad (21)$$

Where *d* is a dummy variable for each of the income quintiles, *GDP* represents the change in log GDP. I include a series of controls to control for observables that may influence income growth, such as age, education levels, gender, migration status, marital status, and industry and state of residence fixed effects. I cluster standard errors at the household level. The coefficients on the beta terms capture the sensitivity of income to aggregate fluctuations for each quintile.

4. Data and model inputs

The main data source for this analysis is the 2020 release of the Household, Income, and Labour Dynamics in Australia (HILDA) survey, a nationally representative panel dataset that began in 2001 (Department of Social Services; Melbourne Institute of Applied Economic and Social Research, 2021; Summerfield et al., 2021). HILDA provides household- and individual-level data on a range of topics including income, demographics and wealth (every four years as a special topic). Data in HILDA are top-coded, which limits analysis of the very top of the income distribution. A Pareto distribution is fit to better estimate top-coded data, though this may still underestimate the true values (Armour, Burkhauser and Larrimore, 2016).

From HILDA, I obtain data for several parameters in the model (equation 18), including disposable income, assets and liabilities. I use figures from 2018, which is the most recent year of wealth data. I also obtain demographic information such as age, family size, home ownership status, employment status and state of residence, to be used in the MPC and income sensitivity calculations (detailed in following sections). The full list of variables used are detailed in Appendix A. Households are sorted into quintiles based on equivalised disposable income, which adjusts income by the OECD equivalence scale to allow for comparability between households of different sizes (OECD, no date). All data are deflated using the Consumer Price Index.

HILDA also contains data on expenditure. However, it only captures a subset of consumption items and provides lower estimates of consumption than other sources (Coates and Nolan, 2019). To address this issue, I supplement the data in HILDA where possible with consumption data from the Australian System of National Accounts (ASNA) (Australian Bureau of Statistics, 2022a). This source combines aggregate consumption data with distributional data to provide estimates of consumption, income and wealth by income and wealth quintiles. Although the ASNA data are more comprehensive than HILDA data, they are only available at the quintile level, rather than the household level. I therefore use ASNA data to derive estimates of total consumption for each income quintile and consumption-to-income and -wealth ratios and use HILDA data to estimate MPCs and income sensitivities, as these require household-level data.

Summary statistics from HILDA are presented in Table 1 below. Households in lower income quintiles are typically older, with retirees making up nearly half of the lowest income quintile. Consistent with this, lower income households are less likely to be employed, though they are also more likely to be unemployed. Self-employment, on the other hand, is concentrated at the top end of the distribution. Low-income households are more likely to be headed by a female and are less likely to be partnered or have a tertiary education. Home ownership rates increase steadily across the quintiles.

Table 1: Summary statistics from HILDA

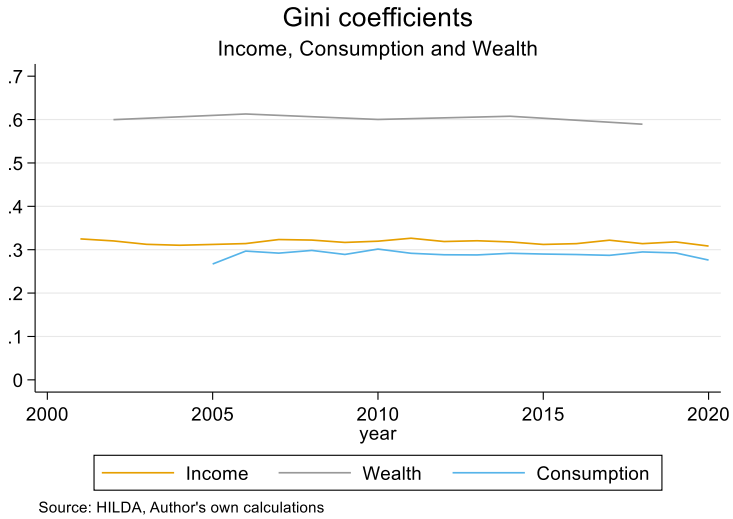
	Equivalised disposable income quintile

	1	2	3	4	5
Age	57.16	49.80	46.19	45.72	48.70
Number of adults	1.54	1.92	2.01	2.05	2.12
Number of children	0.40	0.86	0.74	0.59	0.43
Proportion of heads that are female, %	55.45	49.44	44.07	42.39	38.47
Married or de facto, %	33.55	54.21	59.38	65.78	74.12
Homeowner, %	49.02	53.90	61.92	68.94	78.62
Employed, %	20.74	55.59	76.38	82.58	82.75
Unemployed, %	7.13	3.18	1.75	0.79	1.19
Self-employed, %	5.32	8.72	10.49	8.91	15.14
Retired, %	48.17	26.77	15.04	11.50	11.18
Highest education = High school, %	36.46	33.74	30.83	21.03	15.19
Highest education = Post-school qualification (diploma or certificate), %	32.14	39.79	37.08	37.37	26.37
Highest education = University, %	11.35	16.67	24.84	36.36	53.45
Post-tax disposable income	27,507	57,692	81,097	106,778	174,677
Net worth	412,326	522,409	707,761	903,740	1,781,320
Assets	452,558	616,925	886,330	1,162,419	2,332,775
Debt	35,269	87,996	165,549	241,456	381,875
Number of households	1,991	1,950	1,888	1,774	1,843

Broadly speaking, income inequality in Australia, as proxied by the Gini coefficient, is slightly below the OECD average (Australian Council of Social Services, no date) and is largely unchanged since 2001 (Figure 1). Similarly, the wealth Gini coefficient has also been stable over time, though wealth is much less equally distributed than income. Consistent with much of the literature, I find that consumption inequality is lower than both income and wealth inequality (Kaplan, La Cava and Stone, 2018). Interestingly, HILDA data suggest that the income and wealth shares of the top 1% and 10% and the bottom 50% have also been remarkably stable since 2001. The exact trend is slightly unclear, as other data sources suggest there was a slight decrease in the wealth share of the bottom 50%, and that income inequality may have increased in the 2000s, before decreasing slightly in recent years (Productivity Commission, 2018).[4]

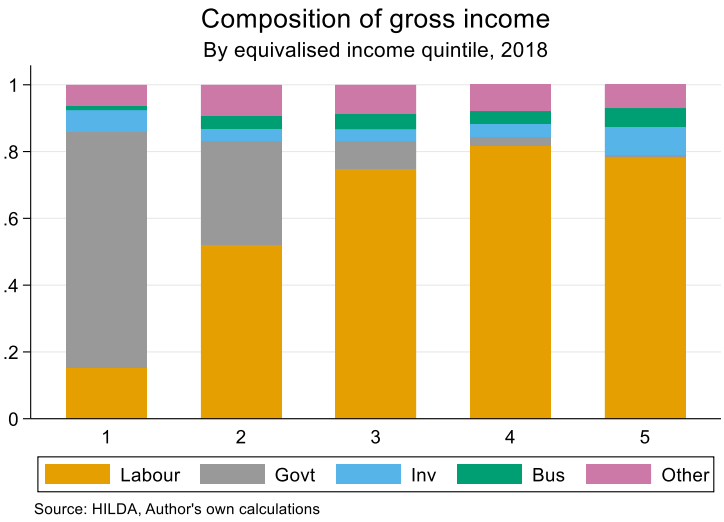
[4] Different definitions and sources explain the differences between the estimates. See Productivity Commission, (2018) for more information.

Figure 1: Gini coefficients



There are quite large differences in the composition of income and wealth across quintiles. The lowest income quintile earns less than 20% of income from labour, while government transfers constitute over 70% (Figure 2). The importance of government transfers is explained by the higher rates of unemployment in this group and the large share of retired households, as these groups are more likely to be receiving government welfare. In contrast, the upper quintiles earn the vast majority of their income from labour. The importance of business and investment income also typically increase across the quintiles, consistent with the increasing rates of self-employment.

Figure 2: Income by source

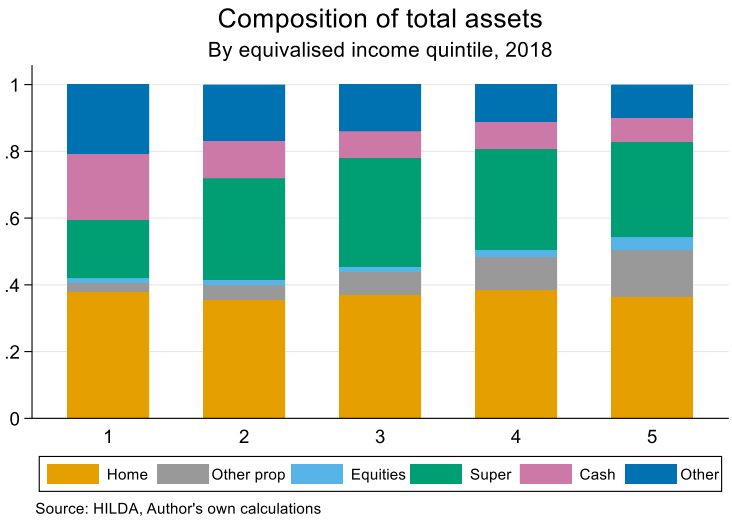


Turning to wealth, households across the income distribution tend to hold a similar share of their asset portfolio in their main residential property (Figure 3). This is highly heterogeneous within quintiles, however, particularly in the lower quintiles where around half of households do not own property. The portfolios of those in the first two income quintiles who are homeowners are heavily concentrated in property, which constitutes 70% of their assets. This group has substantially more assets across all categories than non-homeowners. Superannuation makes up a significant share of

wealth for all quintiles, reflecting the compulsory superannuation system that sees employed individuals accruing retirement savings over their working lives. Lower income quintiles have higher shares of their portfolio in cash or fixed income, perhaps reflecting a desire for access to liquid resources or lower risk preferences.

Taken together, these different exposures shed light on some of the potential distributional mechanisms. Different types of income will be affected differently by economic activity, while the types of assets a household owns will affect how exposed they are to capital gains, inflation and changes in interest income. The fact that households have such different exposures could generate substantial heterogeneity in both the overall consumption response and the relative importance of the different channels.

Figure 3: Assets by source



As described earlier, a growing body of research has discussed the importance of liquidity constraints for the transmission of monetary policy. In Australia, less than 15% of households can be classified as HTM, and the vast majority of those have illiquid asset holdings.[5] The share of liquidity-constrained households is greater for lower income quintiles, though nearly 80% of households are non-constrained. As such, HTM status may have some impact on the consumption responses of each income quintile, though should not be a driving factor.

[5] Following the definition in La Cava, Hughson and Kaplan (2016), I define HTM households as those whose liquid wealth is less than half of their approximate pay each period, or who have negative liquid wealth (but less than their credit limit). Wealthy HTM households have positive *illiquid* wealth. Their analysis yields slightly higher shares of HTM households than mine, though the share is still quite low.

Figure 4: HTM status over time

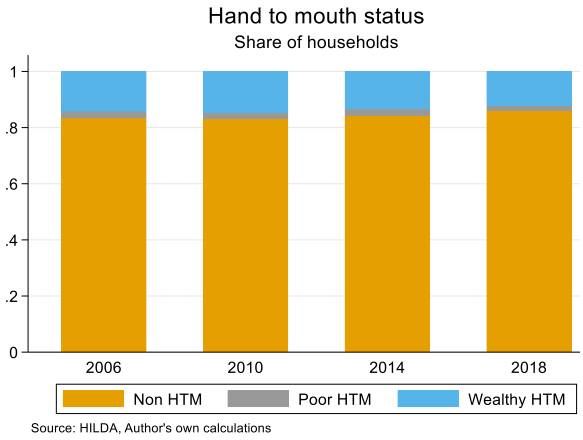
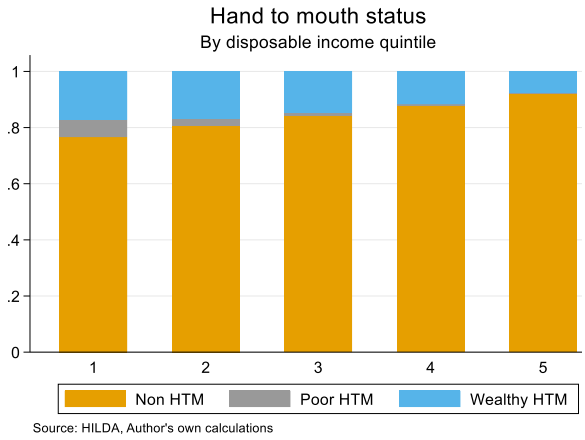


Figure 5: HTM status by income quintile



The model (equation 18) also requires an estimate of the elasticity of intertemporal substitution ($\frac{1}{\gamma}$). Havranek et al. (2015) conduct a meta-analysis of the literature and find significant cross-country variation in this parameter. The mean value of 32 estimates for Australia is 0.362, which is the value I use. Following STV, I assume that the interest rate returns to baseline after the initial shock and so adjust the direct channels by the average reduction (80 basis points). Additional parameters for the model are derived as described in the following sections.

4.1 Marginal propensity to consume - income

To calculate the MPC, I compile an unbalanced panel of households from the HILDA dataset from 2006-2020, which is the period for which all data are available. Although income data is also available at the individual level, household-level data is used both to ensure comparability with consumption, which is only available at the household level, and also because it provides a more accurate representation of income available to members of the household for consumption.[6]

Following Blundell, Pistaferri and Preston (2008), I use post-tax household income as the income measure, and non-durable expenditures as the consumption measure. Both are adjusted to include imputed rents, which is the value of the flow of services homeowners derive from living in their own dwellings. Doing so makes the income and consumption of renters and those living in their own homes comparable (Kaplan, La Cava and Stone, 2018). Although HILDA provides durables data, it is only from 2006-2010, which limits the sample period significantly. The full list of variables used to construct the income and consumption measures are detailed in Appendix A. I limit the dataset to working-age household heads between 18 and 75 who have not retired, as is typical in the literature (Ampudia et al., 2018; Auclert, 2019), though my results are robust to their inclusion.[7]

[6] For example, consider a married couple in which one partner works and the other does not. When looking at individual data, the non-working partner would fall into the lowest income quintile, irrespective of their partner's income. This is likely to distort the estimate of the relationship between income and consumption across quintiles.

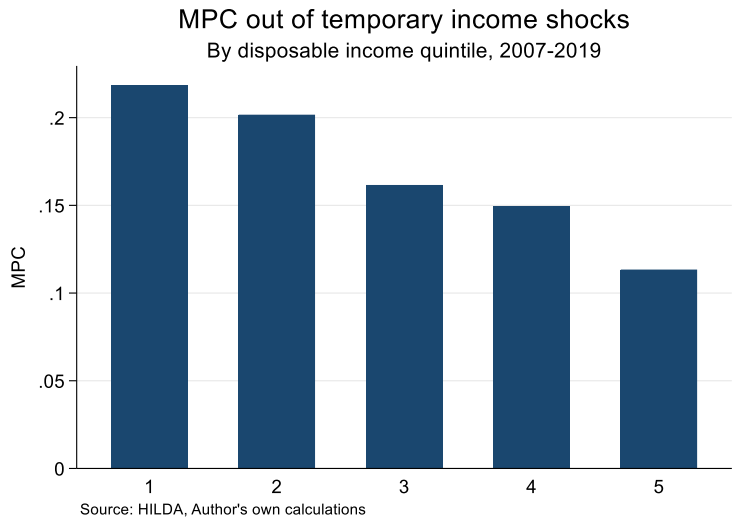
[7] Including retired households yields similar results, though the estimated MPCs are slightly lower and the distribution across the quintiles is more compressed. Retirees may have a lower MPC than working age households for several reasons including greater family support and wealth, which limits how their consumption reacts to income shocks.

To compute the MPC, I firstly regress the log of consumption and the log of income on observable household characteristics to obtain the unexplained component of income and consumption, $y_{i,t}$ and $c_{i,t}$ respectively, per equations 19 and 20. The observables, Z, include dummies for the year of birth, gender, marital, migration and disability status of the household head, the size of the family, income from other family members and whether the person works unpaid in a family business. I also include job industry dummies and interaction variables between the year and education levels, employment status and state dummies. I then calculate the change in log income and consumption for each household and each period.

I drop outliers of income and consumption growth, and outliers of the residual income and consumption series. Given that the specification requires changes in income and consumption in time *t* and *t+1*, I keep only those observations for which the household was also observed in the year prior and the year after. My final sample has 56,368 observations across 10,095 unique households.

For each year in the sample, households are grouped into 5 quintiles based on their equivalised disposable income in the previous period. This means that households are sorted before any income shocks occur (Mian and Sufi, 2016). The MPC is then obtained by multiplying this term by the average ratio of consumption to income for each quintile, which is obtained from the ABS. The results are shown in Figure 6.

Figure 6: MPC by equivalised disposable income quintile



As expected, the MPC from a transitory income shock declines over the income quintiles; the lowest quintile consumes nearly 22 cents of a temporary $1 increase in income, whilst the highest quintile consumes around 11 cents. These values are in line with other estimates from the literature, though at the lower end. For example, Berger-Thomson, Chung and McKibbin (2010) estimate an MPC of between 0.2 and 0.7 in Australia. In a meta-analysis of 144 studies, Havranek and Sokolova (2020) find a mean MPC estimate of 0.37, but note that estimates vary significantly along factors

For example, nearly 50 percent of retirees are in the first income quintile, though they hold significantly more wealth than the average working-age household in that quintile. They may also change their consumption patterns in anticipation of retirement. Including all households irrespective of age yields very similar results.

such as the time horizon and size of the income shock. Carroll et al. (2017) suggest that the MPC varies with factors such as wealth, but also age and impatience. This may explain the wide range of MPC estimates. Regardless, my estimates align with the large number of studies finding that the MPC from transient income shocks is different from zero and is higher for poorer households.

4.2 Marginal propensity to consume – wealth

The MPC out of wealth is important for estimating the scale of the consumption response following a movement in asset prices. The MPCs out of housing and equity market wealth are estimated separately because households typically respond differently depending on the source of the wealth shock (Caceres, 2019).

4.2.3 Housing

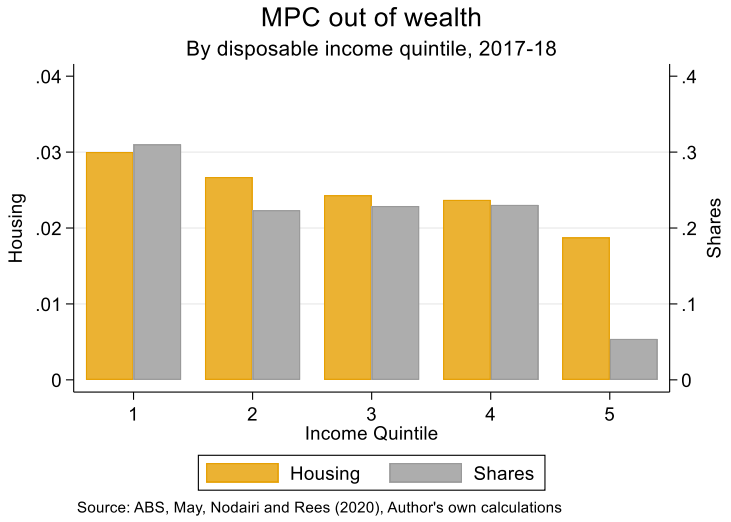
There is broad consensus in the literature that the MPC from housing wealth in Australia is approximately 0.02-0.03 (for example, see Dvornak and Kohler, 2007; May, Nodari and Rees, 2020). de Roiste et al. (2019) also estimate the MPC from housing wealth in New Zealand to be 0.03. These estimates are typically calculated at an aggregate level. In a recent paper, May, Nodari and Rees (2020) use aggregate data to estimate the elasticity of consumption with respect to house prices. Although they find that the elasticity of consumption has been stable over time, they note that the MPC (estimated as 0.03) has declined due to house prices having risen relatively more than consumption. Another reason for declining MPCs could be the aging of the population, since older, non-working cohorts often have lower MPCs than younger or working households (Caceres, 2019). To obtain more precise MPC estimates, I therefore combine stable elasticity estimates, ε, with the current value of consumption and wealth, rather than relying on past estimates.

$$MPC_q = \varepsilon \times \frac{Average\ consumption_q}{Average\ wealth_q} \tag{22}$$

I calculate the MPC out of housing wealth for each income quintile q. I use data on average consumption and residential and land holdings from the ABS, and an estimate of the elasticity of consumption from May, Nodairi and Rees (2020).[8] At an aggregate level, the MPC of 0.024 is at the lower end of estimates, in line with the notion of declining MPCs over time (this estimate uses 2018 data). The MPC declines marginally across the income quintiles, though does not vary much (Figure 7).

[8] I use aggregate ABS data rather than household-level HILDA data for this calculation because it is more comprehensive than HILDA consumption data.

Figure 7: MPCs out of housing and equity market wealth



4.2.4 Equities

The literature on MPCs out of financial wealth is more mixed and varies by country. In the US, estimates typically range between 1 and 10% (see Di Maggio, Kermani and Majlesi (2020) for a survey). In Europe, there is evidence of positive MPCs in Sweden (Di Maggio, Kermani and Majlesi, 2020) and Italy (Grant and Peltonen, 2008), while other analyses suggest that household consumption does not respond at all, or even falls, following financial wealth increases (Paiella and Pistaferri, 2017; Trivin, 2021). In Australia, May, Nodairi and Rees (2020) estimate an elasticity of 11 percent, equating to an MPC of 15 cents, while Dvornak and Kohler (2007) estimate the MPC to be between 6 and 9 cents.

There are several factors that may contribute to the heterogeneity of MPC estimates. MPCs may vary by age, though the evidence on this is mixed (Ampudia et al., 2018; Di Maggio, Kermani and Majlesi, 2020). Significant growth in equity market wealth and innovation in trading technology could mean that household consumption responses to wealth shocks are not constant over time. It is also difficult to isolate changes in share prices from exogenous factors that do not also affect household consumption, as equity prices reflect expectations of corporate profits which are tied very closely to general economic conditions (Carroll, Otsuka and Slacalek, 2011).

As with the housing wealth MPC, I use an estimate of the elasticity of consumption (obtained from May, Nodairi and Rees (2020)), and calculate the MPC using updated consumption and equity asset values from the ABS (Figure 7). The values I obtain are quite large and vary significantly between households. The first income quintile consumes the largest share of equity market wealth gains, with an MPC of 0.31 while the highest income quintile has the smallest MPC at just over 0.05.

In general, these are higher than most other estimates, though they align with the upper bound of estimates in Ampudia et al (2018). Moreover, the general pattern of MPCs declining with income aligns with the results of Di Maggio, Kermani and Majlesi (2020). One explanation for the size of these responses is innovation in financial technology making it easier and cheaper for households

to liquidate their equity market gains to increase consumption.[9] The growth of low-cost trading platforms and greater accessibility of equity market investment may have reduced the average transaction costs associated with equity market wealth, which could lead to higher MPCs. In addition, Australia has quite high equity market participation with around 30% of households investing directly in equities in 2018, though this has likely increased in the years since (Richardson, 2020).[10] This may translate to more active trading and higher MPCs. It is worth noting here that equity market wealth is much smaller than housing wealth, meaning that the overall consumption response is much smaller for equities wealth changes than housing wealth changes, despite the higher MPCs.

Given the lack of consensus around the MPC from equities, these estimates can be considered an upper bound on the true effect. Estimates using household level data may be biased due to the presence of omitted variables affecting both income and equity market returns, which is compounded by the fact that investors tend to display a strong home bias and invest primarily in local equities (Di Maggio, Kermani and Mailesi, 2020). Moreover, self-reported measures of capital gains can be prone to measurement error (Dynan and Maki, 2001). Finally, delays in adjusting consumption following an equity market wealth change may mean the true effect is lower than the ones estimated here. May, Nodairi and Rees (2020) find that just 25% of the total consumption response occurs within 6 months, though this is imprecisely estimated. Households may be slow to respond as equity markets can be volatile and they may not be certain that gains will last.

4.3 Bayesian VARs

I estimate a BVAR model using the log of underlying CPI, the log of real GDP, the log of a residential house price index, the log of the ASX200 share price index, the unemployment rate and a cumulative monetary policy shock series.[11] [12] See Appendix B for the data sources. Although foreign sector blocks are often added to VARs of small open economies such as Australia, for simplicity, I follow the approach in Beckers (2020). The data are quarterly, and the sample period has 60 observations from Q4 2003 to Q4 2018; data are also seasonally adjusted.

The Bayesian Information Criteria suggests using 1 lag, though residual white noise testing indicates that additional lags should be included. As such, I estimate the model with 4 lags, which should capture the full cycle of the data (Brandt and Williams, 2007). Diagnostic checking confirms the model with 4 lags has no residual serial correlation, that the errors are normally distributed and that the model is stable.

The results are summarised in the impulse response functions in Figure 8 and Figure 9. All variables are reported as first differences; impulse responses are therefore cumulated to obtain the effect on the underlying variable from the initial level. All variables are log-transformed except for the monetary policy shock and unemployment series, which are in levels. Multiplying the

[9] This analysis focuses only on unrealised capital gains; dividends are classified as income.
[10] Estimated using HILDA data from 2018. In Europe for example, Ampudia et al., (2018) estimate direct equity market participation in European countries to range between 4 and 25% of households. Giannetti and Koskinen (2010) also find that Australia has one of the highest rates of equity market participation globally.
[11] The interest rate shock series is estimated using an extension of the methodology proposed by Romer and Romer which strips interest rate changes of the central bank's forecasts (Beckers, 2020).
[12] Although the effect of interest rate shocks on unemployment is not required for the purposes of my model, I choose to include it both for comparability to existing studies, and because excluding it from the VAR leads to results that appear incorrect (such as inflation increasing in response to a monetary policy tightening).

coefficients on the log terms by 100% gives the percent change in the underlying variables after an interest rate shock.

Figure 8: Impulse response functions for inflation (panel 1) and GDP (panel 2)

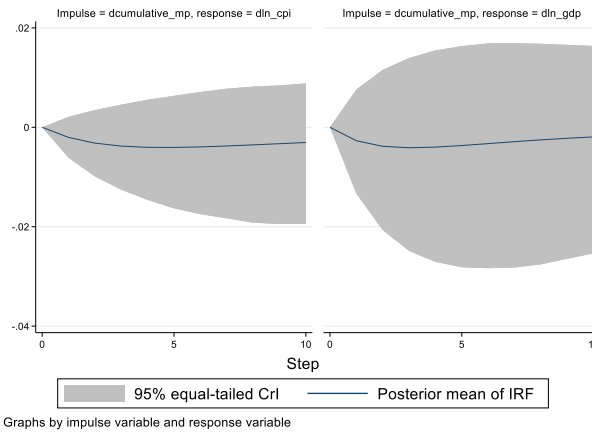
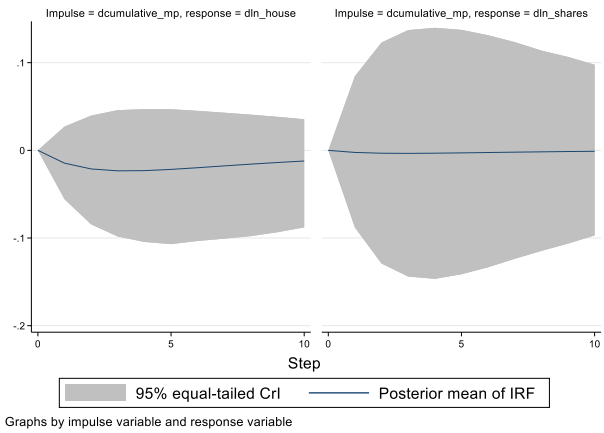


Figure 9: Impulse response functions for house prices (panel 1) and share prices (panel 2)



As expected, an increase in the interest rate leads to a fall in inflation, GDP, house and share prices, while the unemployment rate increases. A 100 basis point interest rate shock causes inflation to fall by approximately 1.3 percent after 4 quarters, while GDP declines by 1.5 percent. These figures are broadly in line with other estimates for the Australian economy (such as Beckers, 2020). However, all estimates have quite wide error bands and are not statistically significant.

House prices fall by around 8 percent four quarters after the interest rate shock, though the effect is likely to be highly heterogenous across different regions. When using a similar style of monetary policy shock, He and La Cava (2020) find that house prices in the median area fall by approximately 9 percent following a 100 basis point interest rate rise, though the variance is quite large. House prices are increasingly responsive to interest rate movements in areas where people have high incomes, high debt levels, and where there is a substantial share of investors. Moreover, Reserve Bank of Australia (2022) suggests a 200 basis point interest rate rise would lower house prices by 15%, while Abelson et al. (2005) suggest house prices move 5.4% for every 100 basis point movement. As such, although there is likely to be substantial variation across different types of properties in different areas and potential non-linearities, 8 percent is plausible for the purposes of this analysis.

The share price response to an interest rate rise is comparatively much smaller at just a 1.5 percent decline. Traditional economic theory suggests that share prices would fall following an interest rate rise, due to lower expected future earnings. On the other hand, however, share prices could actually increase if agents suspect that the interest rate rise is due to stronger than expected inflation (and therefore, likely economic growth and corporate earnings). The literature, however, generally suggests that share prices move in the opposite direction to interest rate cuts. He (2021) finds evidence that the traditional theory dominates the information effect, with share prices falling around 3% following a 100 basis point interest rate rise. Wang and Mayes (2012) find that share

prices move 1.1% in response to a 100 basis point interest rate shock, with symmetrical responses to interest rate increases and cuts. Estimates from Europe and the US are typically larger.[13]

The unemployment rate estimate appears to be smaller than other studies. The impulse response suggests a fall in the unemployment rate of just 0.03 percent four quarters after a 100 basis point interest rate shock, which is of an order of magnitude 10 times smaller than other published estimates (for example, Beckers (2020)). For this reason, I also consider an alternative, simplified structural VAR model, which yields improved results for the unemployment rate and responses of similar magnitudes for the CPI and GDP variables (Appendix B).

4.4 Income Sensitivity

I begin by compiling an unbalanced panel of household-level data from HILDA from 2001 to 2019.[14] As with the MPC analysis, I drop households whose head is younger than 18 or older than 75, though I include retired households.[15] I then assign households to income quintiles based on equivalised household disposable income in the previous period (refer to the MPC section for further explanation on this approach). I therefore keep only observations for which the household also appears in the dataset the previous year. The sample consists of 96,118 observations across 14,050 unique households.

The results are displayed in Figure 10. Household income in the lowest income quintile is the most sensitive to aggregate fluctuations; a 1 percent change in GDP leads to a 1.34 percent change in income. Sensitivity declines across the quintiles, with income in the highest quintile changing by just 0.47 percent. The declining sensitivity of income across quintiles is also found in other studies using individual-level income data in Australia (Stone, 2016), the US (Guvenen et al., 2017) and Europe (European Central Bank, 2019). Part of this is due to the large income changes that occur due to transitions in and out of unemployment, which is less important for those in the upper income quintiles. This can be determined by comparing the sensitivity of labour income for the full sample with the subset of households that are employed. The labour income sensitivity of this group is much lower than the full sample, suggesting it is employment transitions, rather than generalised wage growth, that contributes to this result.

My coefficients are similar in magnitude to those in Europe and the US but are smaller than Stone (2016), likely due to the insurance effects of family labour supply. When there are multiple income earners in a household, income shocks that affect one person can be smoothed by adjusting the working hours of the other (Blundell, Pistaferri and Saporta-Eksten, 2016). This enables the household to smooth total income and consumption, and may be particularly important for households that cannot smooth their income and consumption through other sources such as borrowing (Attanasio, Low and Sánchez-Marcos, 2005). This effect may be particularly strong in Australia, which has one of the highest rates of part-time employment in the OECD (Cassidy and Parsons, 2017), while nearly 57% of couple families have both partners working (Australian Bureau

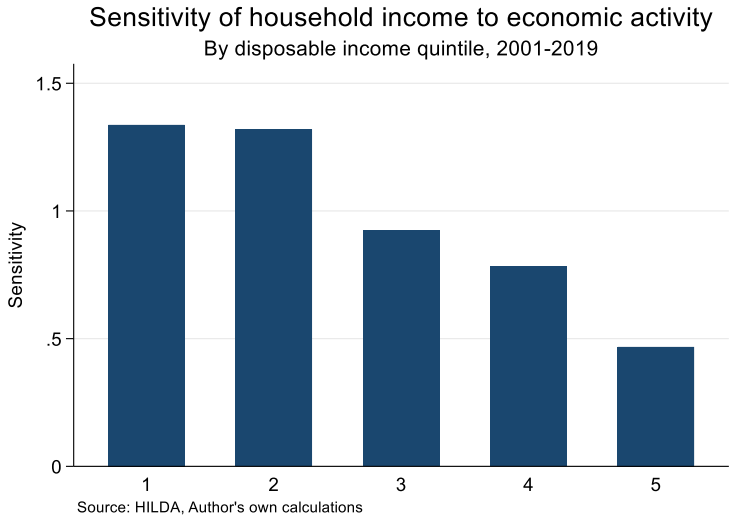
[13] For example, Corsetti, Duarte and Mann (2020) suggest equity prices fall around 4-5% in the 4 quarters after a 25 basis point shock, while Rigobon and Sack (2004) estimate that a 100 basis point shock causes equities to fall between 4 and 11 percent, depending on the index.

[14] 2020 is excluded from the sample due to the significant negative impact of the Covid-19 pandemic on GDP.

[15] Including retired households induces a downward bias in the results, particularly for quintiles 1 and 2, because their income is less responsive to GDP changes. Government benefits, which make up more than half of their income on average, are typically not tied to GDP growth fluctuations.

of Statistics, 2022d). As such, there may be considerable scope to adjust individual labour force supply in response to income shocks, lowering the sensitivity of overall household income.

Figure 10: Household income sensitivity by income quintile

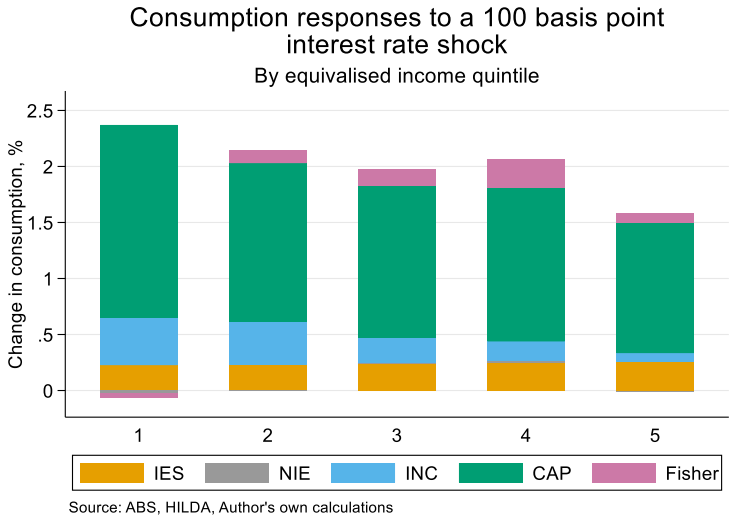


I also test the sensitivity of labour and capital income separately and find that both types of income exhibit a similar pattern whereby sensitivity declines across the quintiles. However, most coefficients are not significant at conventional levels.

5. Results

Figure 11 shows the overall results of the model calculated according to equation 18. A 100 basis point negative interest rate shock leads to an aggregate increase in consumption of 1.9 percent. The lowest income quintile experiences the strongest change in consumption, of around 2.3 percent, while the wealthiest quintile experiences the weakest consumption growth of around 1.6 percent. Compared to other empirical estimates of the effect of monetary policy on consumption, these figures are all quite large, mostly due to the strength of the capital gains channel (Ampudia et al., 2018; Loukoianova et al., 2019; Holm, Paul and Tischbirek, 2021). Looking at median balance sheet positions, rather than the mean, leads to smaller responses across all quintiles, indicating that there are some extremely large exposures (see Appendix D). Each of the channels will be discussed in more detail below.

Figure 11: Consumption responses



5.1 Intertemporal elasticity of substitution

The consumption response due to intertemporal substitution is reasonably homogenous across quintiles. It accounts for approximately 0.23-0.26 percentage points of the total response, with the variation arising due to differences in the MPC. The response of non-HTM households in STV is slightly larger in magnitude as they use a larger value for the elasticity of substitution.

If anything, these results may slightly overstate the magnitude of this channel by ignoring the fact that there are HTM households for whom the intertemporal substitution effect is zero. Rescaling the intertemporal substitution effect size by the share of non-HTM households naturally reduces its magnitude, though the effect is negligible. The IES share reduces by between 0.017 and 0.054 percentage points, with the largest reduction for the lowest income quintile.

These results are quite important because, as described earlier, intertemporal substitution is the main channel through which monetary policy in representative agent models affects household consumption. The fact that it is such a small share of the overall consumption response in this model suggests that ignoring heterogeneity significantly underestimates the total consumption response. Moreover, it may give the incorrect impression that all households are equally affected by the monetary policy shock.

5.2 Net interest rate exposure effect

A household's net interest rate exposure (or unhedged interest rate exposure) is defined as the difference between maturing assets and liabilities (Auclert, 2019). To calculate maturing assets, I use bank deposits and bond investments scaled by the average duration of government bonds at the time (Australian Office of Financial Management, 2022).[16] Maturing liabilities are defined as the sum of all variable rate mortgages, half the value of mortgages with a combination of fixed and floating interest rates, all credit card debt and overdue bills.[17] Income and consumption are

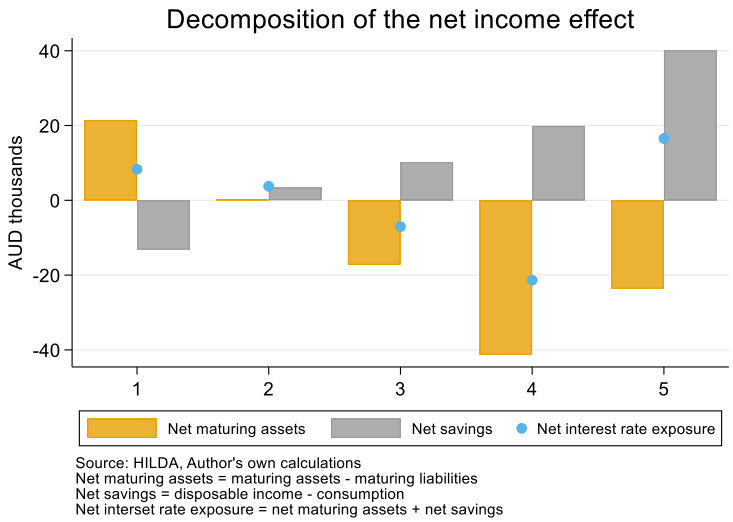
[16] The average maturity was 6.6 years, so I assume that 1/6.6 of the bond portfolio is maturing.
[17] Other studies such as La Cava and Hughson (2016) estimate that higher shares of overall debt are linked to variable rates. They have access to additional data on the interest rate type of personal and business debt, and estimate that

included as assets and liabilities respectively, so that the measure fully captures the flow of resources that will need to be invested or financed each period (Tzamourani, 2019).

The net interest rate exposure channel has a very small effect on consumption, both at an aggregate and quintile level. The third and fourth quintiles see a small increase in consumption following an interest rate cut, while quintiles 1, 2 and 5 experience a decrease in consumption.

The small magnitude of the consumption responses and the net interest exposures is somewhat surprising, given the extremely high levels of household debt in Australia (Bank for International Settlements, 2021). This is due to the mostly offsetting effects of the net maturing asset and net savings positions of households (Figure 12). For example, the two lowest income quintiles have more maturing assets than liabilities, as shown in yellow, meaning a fall in the interest rate lowers their interest income (and consumption). The other quintiles, however, have more maturing liabilities than assets, so the reduction in interest payments outweighs the fall in interest income. At an aggregate level, this is consistent with the existence of a borrower effect (La Cava, Hughson and Kaplan, 2016). However, these exposures are offset for each quintile by net savings, as shown in grey. This exposes them to interest rate risk in the other direction. While the interest rate cut reduces the income of the first quintile, the lower interest rates allow them to consume more (because it is cheaper to finance). The opposite is true for the other quintiles, who have excess savings to invest at the lower rate of interest. The offsetting effects of net maturing assets and savings act as a natural interest rate hedge for households.

Figure 12: Breakdown of the net income effect



These results differ from other studies that typically find that higher income is correlated with more positive interest rate exposures, because of the prevalence of variable rate mortgages, which generate more negative interest rate exposures (Auclert, 2019; Tzamourani, 2019; Slacalek, Tristani and Violante, 2020). Most mortgage debt in Australia has a variable rate of interest, meaning borrowers are exposed to interest rate shocks. In contrast, fixed mortgages are not exposed to interest rate risk. Mortgages make up over 80% of total debt (Adams et al., 2020), the majority of

around 55-65 percent of this debt has a variable rate. However, I do not have access to updated data and so do not include these types of debt.

which is either fully or partially linked to variable interest rates.[18] This is quite similar to the Spanish mortgage market as analysed in STV, where non-HTM households also have quite small net interest rate exposures. Because of the prevalence of variable rate mortgages, a much larger share of total debt is maturing in each quarter than assets. As described earlier, most wealth is held in housing and superannuation, which are not directly exposed to interest rate risk. However, the lowest income quintile has the highest share of cash and cash investments.

Another key driver of this result is the presence of retirees, particularly in the first quintile. They tend to have large holdings of assets (including liquid assets) which make the net interest exposures more positive. This will be analysed section 6.2.

5.3 Income effect

The income channel is a key driver of different responses between the two groups. It increases consumption by 0.42 percent for the lowest income quintile, and just 0.08 percent for the top quintile. As discussed previously, income is more sensitive for the bottom income quintile due to the large income changes that are associated with transitioning in and out of unemployment. In addition, the lower-income groups have higher MPCs, amplifying the impact on consumption.

While clearly an important component of the overall consumption response, the income effect appears less important than in Europe, for example. Lenza and Slacalek (2018) find that the magnitude of the consumption response to quantitative easing shocks in four European countries depends on the sensitivity of unemployment to monetary policy, and the generosity of the welfare system for those who are unemployed. They find quite large income changes in Spain and Italy, where the unemployment rate is very sensitive to monetary policy and the replacement rate is low. The smaller income effect in Australia may be due to a lower sensitivity of unemployment to monetary policy than in those countries, which have higher unemployment rates (OECD, 2022). In addition, the differences in effect size between income quintiles is not as large in my results. Interestingly, just under 45% of unemployed individuals are in the lowest income quintile (when sorted by household income). As such, all quintiles enjoy some increase in income from the monetary policy shock, meaning the differences are less pronounced. In some countries in Lenza and Slacalek's sample, the unemployed are strongly concentrated in the lowest income quintile, and so the differences between quintiles are more stark.

Another reason for the smaller size of my income effect is that my analysis focuses on *all* components of disposable income, rather than exclusively labour income. As noted earlier, government income makes up a substantial share of income for the lowest income quintiles in particular. This source of income does not display a clear relationship with economic activity and may instead fluctuate along with individual characteristics (such as returning to study or having another children). For example, when looking only at labour, capital and business income, I find that the sensitivity of income to GDP growth is much higher and decreasing across income quintiles.

[18] Data on variable or fixed interest rates are not complete in HILDA. For those that have been reported, around 61% of mortgages by value have variable interest rates, 19% have fixed rates and 20% have a combination of fixed and variable rates.

Despite the fact that it is smaller than other studies, the income effect is still the second largest channel through which monetary policy affects consumption, and has distributional consequences due to its heterogeneous impact across the income distribution.

5.4 Capital gains effect

The most striking result is the dominance of the capital gains effect, which makes up 65-75 percent of the overall consumption response in each quintile. This is overwhelmingly driven by housing (Figure 13). The first quintile experiences the largest percentage growth, though the fifth quintile experiences the largest absolute consumption change.

The magnitude of this effect is larger than in STV's analysis in Europe, where capital gains are only a small component of the overall consumption response for non-HTM households, but around one third of the consumption response of wealthy HTM households. This is primarily because the average holdings of housing and equities in Australia is much larger than the European countries in their sample, especially when retirement assets are included. In Australia, the average property portfolio of each quintile is between AU$370,000 and AU$1.3 million (Figure 14); by contrast, in STV's sample, the non-HTM in Spain have the largest property portfolio which is worth around €250,000, or the equivalent of approximately AU$370,000. Therefore, for the same MPC, the same change in house prices will have a much larger effect on consumption in Australia.

Figure 13: Capital gains effect channel

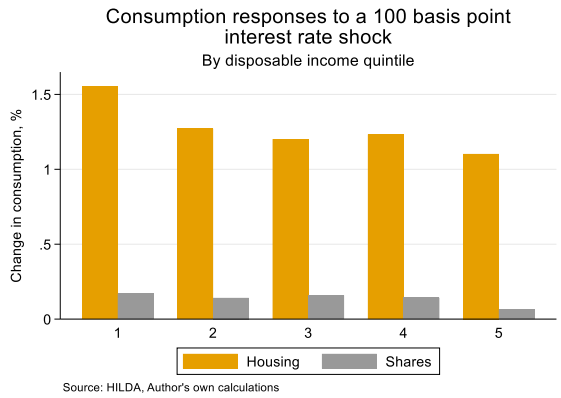
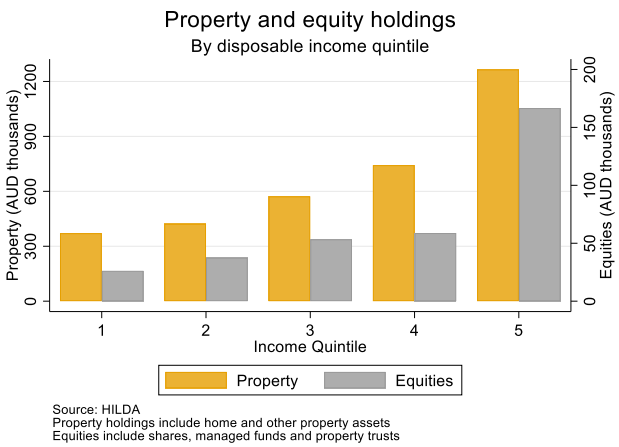


Figure 14: Holdings of property and equities



Another reason for the strength of the effect is the sizeable response of house prices to monetary policy shocks from the VAR. The response of around 8% is much higher than the house price reaction in Europe (in STV). One limitation with this estimate is that it assumes that all house prices respond identically to a monetary policy shock, which is unlikely to be the case in practice. Research has shown that house prices in areas with more investors and higher house prices are more sensitive to interest rate shocks (He and La Cava, 2020). Although these figures suggest that expansionary monetary policy reduces consumption inequality through housing, incorporating heterogenous house price responses may lead to different conclusions. This would be an interesting extension to this work.

In calculating these positions, I opt to include the superannuation assets of retirees, allocating them based on the average portfolio allocation of superannuation funds at the time (ASFA, 2018). Given that superannuation is a liquid asset for retirees, any wealth changes from price movements in the

underlying assets could easily be consumed. I exclude superannuation assets for people who have not retired, however, as they are not able to access their superannuation and any valuation gains are therefore unlikely to influence their current consumption. Moreover, although retirees are typically more risk-averse than non-retired households, they do not necessarily restrict their investments to cash or other similarly low-risk assets. As a robustness check, I run the model without these superannuation assets, but the differences in results are negligible.

It is worth noting that these estimates are likely an upper bound of the true effect for several reasons. For example, Berger et al. (2018) find that the immediate consumption response to a change in house prices is higher when the shock is transient. This is because households can somewhat take advantage of the temporary nature of the price change by timing the market and selling their house when prices are high, then buying when prices fall again. A short-term shock thereby encourages more people to buy and sell, which flows through to consumption. As this paper analyses a temporary monetary policy shock which wears off over time, the results may therefore be at the upper limit of the potential effect.

STV also note that while some households will reduce their consumption when house prices rise as they expect their future housing costs to be higher, they expect this effect to be quite small given that the shock is temporary in nature. Similarly to the logic of Berger et al (2018), households may be able to delay additional housing costs (such as purchasing a house) rather than reducing consumption. Finally, the household's consumption response may be limited by the potentially large transaction costs, the lumpiness of housing asset adjustment and behavioural biases. For example, if households have present-biased time preferences, Laibson, Maxted and Moll (2021) show that the monetary policy transmission is slower because households procrastinate actions such as refinancing their mortgage. For these reasons, my estimates are likely to be an upper bound of the true effect. However, the sheer size of my estimated effect in relation to the other channels suggests that even if the true effect were somewhat smaller, it is still likely to remain a key driver.

Looking only at the mean, however, may be misleading, particularly for the two lowest quintiles, where only around half of households own property. In section 6.1 below, I compare the consumption responses of homeowners with those who do not own a home.

5.5 Fisher effect

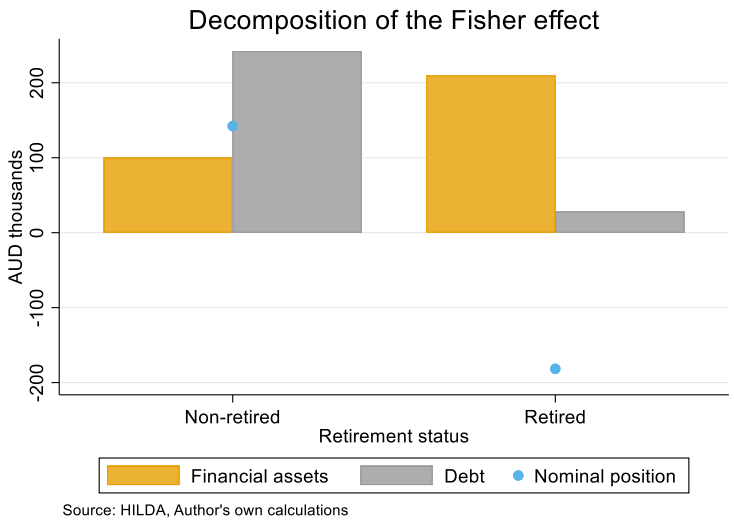
Net nominal positions are calculated as the difference between financial assets (mostly cash and bonds), and total debt. Per convention, indirect nominal positions arising through equity investments are removed; although equities are financial assets, firms often issue net debt and so equity holdings act as an inflation hedge (Doepke and Schneider, 2006). An unexpected increase in inflation, as occurs with an expansionary monetary policy shock, increases the consumption of all quintiles except the first. These quintiles all have negative net nominal positions, with more debt than financial assets. The positive net nominal position of the first quintile, on the other hand, means that they lose out from inflation because it erodes the value of their financial assets.

In this sense, unexpected inflation caused by an interest rate cut worsens consumption inequality by disproportionately affecting the lower income quintiles. This aligns with other studies finding that the high cash holdings of lower-income groups cause them to suffer more from inflation than higher-income groups (Erosa and Ventura, 2002). However, empirical evidence is mixed, with

some studies finding that inflation benefits the poor because they have more debt (Colciago, Samarina and de Haan, 2019).

The key driver behind this result is the balance sheet structure of retirees, who make up nearly half of the lowest income quintiles (see section 6.2 for more discussion). Retirees tend to be negatively exposed to inflation because they have much more financial assets than debt (Figure 15). Removing them from the sample, we see that non-retirees across quintiles benefit, on average, from unexpected inflation because they have more debt than financial assets. As described earlier, housing and superannuation are the most important wealth classes for households across the distribution, while financial assets tend to make up a smaller share.

Figure 15: The Fisher effect for retirees and non-retirees



All up, the Fisher channel affects consumption by between -0.05% and 0.25%. While small, it does have distributional effects due to differences in underlying net nominal positions between the quintiles. This distributional effect acts in the opposite direction to the other channels, with expansionary monetary policy worsening consumption inequality.

6. Discussion

Like most of the literature on heterogeneity and monetary policy, these results clearly demonstrate the importance of the indirect transmission channels. The direct transmission channels (intertemporal substitution and net interest exposure) together account for between 9 and 16% of the total effects of the monetary policy shock; low-income households are least impacted through these channels. This demonstrates the clear importance of heterogeneity for analysing the impact of monetary policy on household consumption. Looking only at the aggregate effect masks different responses within income quintiles.

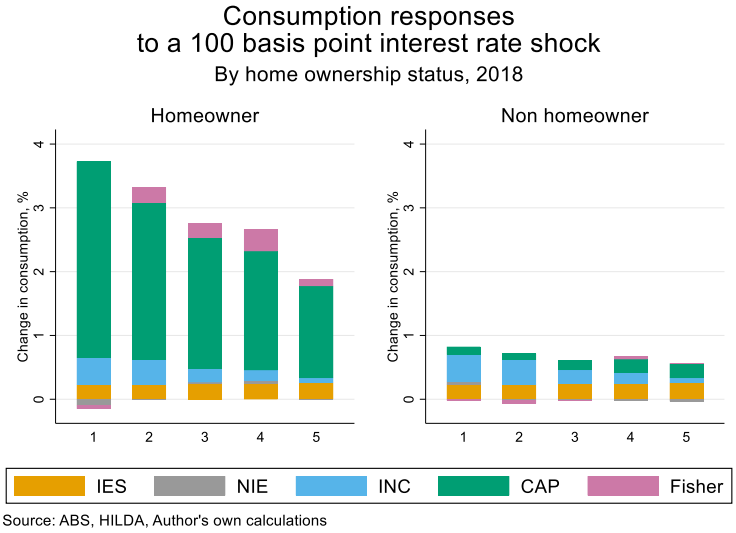
These results also point to other important differences between households within income quintiles that have implications for monetary policy transmission.

6.1 Homeowners

Home ownership is clearly the most important channel through which monetary policy affects household consumption. Around 65% of Australian households own a property, though this figure varies by quintile and has been declining over time (Table 1). In the lowest income quintile, 49% of households own a home, compared to 75% in the top income quintile. As house prices have continued to grow significantly faster than incomes over recent years (Burke, 2022), it may become increasingly difficult for households to purchase a home, which could see even larger differences in home ownership rates across the income distribution.

Dividing each quintile by home ownership status allows us to assess the importance of home ownership for consumption. As expected, Figure 16 shows quite a dramatic effect of housing wealth, particularly for those in the lowest income quintile. For this group, the house price channel accounts for an increase in consumption of 2.7 percent, while the overall effect is around 3.4 percent. This is driven by a high housing wealth-to-consumption ratio. Although it could be an indication of liquidity constraints restricting consumption to suboptimal levels before the interest rate cut (i.e. consumption being too low), we actually see that this group are *less* likely to be liquidity constrained than the non-homeowners in quintile 1. Non-homeowners tend to be younger, have larger families and lower consumption than their homeowning peers. Instead, the magnitude of the homeowner's consumption increase simply reflects the large size of their asset holdings, rather than especially low consumption.

Figure 16: Consumption responses of homeowners and non-homeowners



The interest rate cut also increases consumption for homeowners through the Fisher and net interest rate channels. Although they have a higher net worth than non-homeowners, their assets are concentrated in property and superannuation, which do not directly earn interest, nor lose value immediately from inflation. As such, their assets are unaffected while their interest costs and real debt fall. This translates into higher consumption following an interest rate rise. Non-homeowners have less debt but also have fewer financial and interest-earning assets, rendering the net effect of these channels insignificant.

Interestingly, there is no evidence across any quintiles that non-homeowners invest more in equities to offset their lack of property holdings, even when excluding the superannuation of

retired households. As discussed earlier, homeowners on the whole are much wealthier than non-homeowners in the same income quintile. This is likely due to these groups being in different stages of life; the relative youth of non-homeowners means they haven't had as much time to accumulate wealth. This will be further explored below.

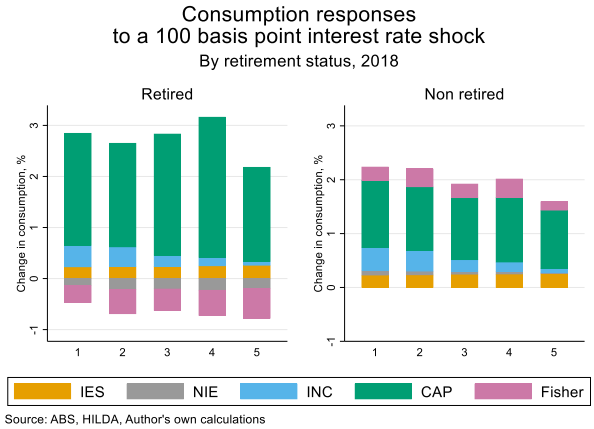
On the whole, monetary policy does still have a small distributional effect for both homeowners and non-homeowners, with expansionary policy reducing consumption inequality by stimulating the consumption of the lowest income quintiles the most. For non-homeowners, this is mainly due to the income effect, which dominates the consumption response for low-income households. High-income households mostly react through intertemporal substitution. However, the main distributional effects occur through home ownership and the capital gains channel.

6.2 Retirees

Another important source of heterogeneity within income quintiles, particularly the lowest, is whether the household head has retired. By definition, many retirees fall into the lower income quintiles as they stop working and no longer earn labour income. Indeed, nearly 70% of retirees are in the two lowest income quintiles. On average, however, retirees across all quintiles hold much greater wealth than non-retired households, which influences their exposure to monetary policy.

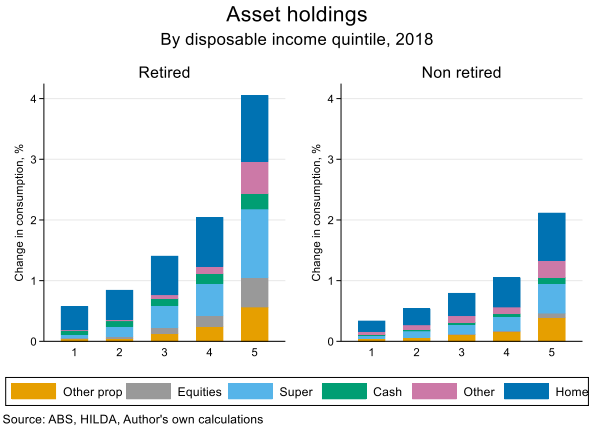
Figure 17 splits each quintile into retired and non-retired households. Retired households have larger consumption responses to monetary policy shocks than non-retired households, which is mostly driven by the capital gains channel. Asset holdings differ substantially between the two groups across all income quintiles (Figure 18). This is unsurprising, given that retired households are at a later stage in the life-cycle than working-age households and have therefore had more time to accumulate assets (per standard life-cycle theory).

Figure 17: Consumption responses of retired and non-retired households



Source: ABS, HILDA, Author's own calculations

Figure 18: Assets of retired and non-retired households



Source: ABS, HILDA, Author's own calculations

The effect of the net interest exposure and Fisher channels also differ notably between groups. The average retired household across all income quintiles holds more financial wealth than debt, and therefore, incurs a loss of wealth and consumption following an interest rate cut (as shown by the negative pink bars). The effect is particularly large for high-income households, reducing their overall consumption by 0.42 percent. The sample size of this particular group is small, however,

potentially limiting the interpretation of this result.[19] Similarly, retired households on average are net receivers of interest, which also falls following an interest rate cut. The effect (shown in grey) is fairly uniform across quintiles. In contrast, non-retired households are typically net borrowers and therefore benefit from an interest rate cut due to the real reduction of their debt, and reduced interest payments. This is because households typically pay down their mortgage debt as they get older, while often accumulating more assets.

It is clear that retirees have different consumption patterns to non-retired households on account of their different balance sheets. Accumulated wealth plays a more important role for retired households in financing consumption, whilst working age households tend to hold less wealth, but instead rely on labour income. It is therefore unsurprising that there is no strong pattern across income quintiles for retired households; analysing the consumption responses of these households across the *wealth* distribution may yield more interesting results, and would be an interesting channel for future research. Heterogeneity within wealth quintiles suggests that there may not be a particularly strong overlap between the income and wealth distributions, so this analysis may lead to different conclusions. More broadly, these results point to the importance of the life cycle in shaping household consumption responses. Life-cycle theory suggests that households borrow when they are younger, then progressively accumulate wealth through their working life before drawing down their wealth on retirement (Sablik, 2016). This clearly has implications for consumption through the capital gains channel. Analysis on heterogeneous consumption responses across age groups, through both different balance sheet exposures and different MPCs, would therefore be an interesting avenue for further research.

6.3 Limitations

There are several limitations that could be addressed to improve this analysis. One key limitation is that all property prices are assumed to react the same in response to a monetary policy shock. As discussed earlier, the sensitivity of house prices to interest rate movements is likely to depend on a range of factors such as the type of property and the geographical area. Moreover, the house price series used in the BVAR only captures residential property prices in the capital cities, which may not be a useful proxy for prices in other urban or rural area. Incorporating heterogeneity along these lines into this analysis would yield much richer insights on the distributional effects of monetary policy. In all likelihood, the magnitude of the capital gains effect would reduce for lower income quintiles and increase for higher income quintiles. This could perhaps lead to more uniform effects of monetary policy along the income distribution. However, the distributional effects would likely be much larger when considering other elements of household heterogeneity such as home ownership.

Another important limitation is the assumption that MPCs do not change over time. There are a number of factors that can influence a household's MPC over time, such as changes in risk preferences, life circumstances and changes in the structure of the economy. While some of these factors can be controlled for in the estimation of the MPC, others cannot. For example, Christelis et al. (2020) find that the Covid-19 pandemic induced a significant fall in the MPC as households worried about the detrimental financial effects of the pandemic. Such changes would impact the consumption response to monetary policy shocks in ways this model cannot capture.

[19] Only 206 households out of the 1843 households in the top income quintile are retired

Moreover, this model is not a general equilibrium model, so it abstracts from potential reactions in other parts of the economy. For example, it does not allow for the possibility that agents adjust their labour supply at the external margin, which might lower their income and consumption. It also ignores any possible fiscal policy responses, such as raising taxes or issuing more debt.

More broadly, this model relies on a large number of parameters, but also calculated inputs (such as the MPC) that themselves rely on assumptions. Errors in these inputs or measurement error in the parameters would bias both the estimation of the model input, but also the aggregate results. This model generates a point estimate, and as such, does not directly account for uncertainty in the inputs. These figures should therefore not be interpreted as the definitive impact of monetary policy on consumption, but rather, an indication of the forces at play and the different channels and heterogeneities that shape consumption.

7. Conclusions and future work

This paper estimates the consumption response to a monetary policy shock in Australia, the relative importance of the different transmission channels, and how they differ across the income distribution. The results clearly indicate that household consumption across the income distribution responds in different ways to the monetary policy shock. Expansionary monetary policy boosts the consumption of lower-income households the most, predominantly through the capital gains and income channels of transmission. These indirect channels, together with the Fisher channel, make up the vast majority of the consumption response of each quintile to interest rate shocks.

These results are driven by several factors. Lower-income households have a higher MPC out of income than households in higher income quintiles, meaning their consumption is more responsive to interest rate change. In addition, their income is more sensitive to aggregate fluctuations. Finally, differences in the balance sheet composition of households across income quintiles affect how the household's income and net worth responds to the shock. Homeowners and retirees across all income quintiles are especially responsive to interest rate shocks, due to their large holdings of property, which increase in value quite strongly after an interest rate shock. For these households, the most important channel of monetary policy transmission is overwhelmingly the capital gains channel. Non-retired households benefit from the reduction in the real value of their debt, while the income effect is particularly important for households that do not own property. Monitoring household balance sheet structures is therefore crucial to understanding the drivers of consumption.

My results clearly demonstrate the importance of wealth in influencing the size of household consumption responses. While this analysis has focused on heterogeneity across income, dividing households instead along the wealth or liquid asset distribution would be valuable, given both the importance of housing wealth in Australia and the emphasis on liquid assets in the literature. Life-cycle effects also play an important role in defining how a household is affected. More broadly, there are a myriad of ways in which households differ that influence their consumption and how they respond to a monetary policy shock. Further research on the implications of these heterogeneities will improve our understanding of the transmission of monetary policy.

These results have important implications for policymakers both in terms of the implementation of monetary policy and for welfare more broadly. Incorporating heterogeneous MPCs is important

for understanding the aggregate effect of economic shocks on consumption, be they interest rate shocks or other shocks in the macroeconomy. Moreover, policies that affect the housing market, such as lending restrictions, are likely to affect the monetary policy transmission mechanism. Depending on the type of policy, this could amplify or reduce the effect of monetary policy, which will have consequences for consumption inequality between homeowners and non-homeowners. Finally, the distributional effects of monetary policy may require other targeted interventions (through fiscal policy) to manage the welfare consequences.

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Appendices

Appendix A - Variables and sources

Variables used in the MPC calculation:

Variable	Description	Source
Disposable income	After-tax income, adjusted for imputed rent	HILDA
Consumption*	Non-durable consumption, adjusted for imputed rent	
Year of birth	Dummy variable for year of birth of the household head	
Family income	Dummy variable for whether another member of the household is earning income	
Migrant	Dummy variable for whether the household head or their family migrated to Australia	
Adult	Number of adults in the household	
Children	Number of children in the household	
Gender	Gender of the household head	
Disability	Dummy variable for whether the household head has a disability	
Unpaid family employment	Dummy variable for whether the household head works unpaid in a family business	
High school	Dummy variable for whether high school is the highest level of education achieved	
University	Dummy variable for whether university is the highest level of education achieved	
Post school	Dummy variable for whether a post-graduate certificate or diploma is the highest level of education achieved	
Partnered	Dummy variable for whether the household head is married or in a de facto relationship	
Unemployed	Dummy variable for whether the household head is unemployed	
Employed	Dummy variable for whether the household head is employed	
Self-employed	Dummy variable for whether the household head is self-employed	
Industry	Industry of employment	
State	State of residence	
Year	Year of survey	

*Non-durable consumption variables:

Variable	Description	Source
hxygrci	Annual household expenditure – groceries (imputed)	HILDA
hxyalci	Annual household expenditure – alcohol (imputed)	
hxycigi	Annual household expenditure – cigarettes and tobacco (imputed)	
hxymli	Annual household expenditure – meals eaten out (imputed)	
hxypbti	Annual household expenditure – public transport and taxi (imputed)	
hxymvfi	Annual household expenditure – motor vehicle fuel (imputed)	
hxymvri	Annual household expenditure – motor vehicle repairs/maintenance (imputed)	
hxyhlpi	Annual household expenditure – fees paid to health practitioners (imputed)	
hxyphmi	Annual household expenditure – medicines, prescriptions, pharmaceuticals, alternative medicines (imputed)	
hxyphii	Annual household expenditure – private health insurance (imputed)	
hxytlii	Annual household expenditure – telephone rent, calls and internet charges (imputed)	
hxyutli	Annual household expenditure – electricity bills, gas bills and other heating fuel (imputed)	
hxyhmri	Annual household expenditure – home repairs/renovations/maintenance (imputed)	
hxyoii	Annual household expenditure – other insurance (home/contents/motor vehicle) (imputed)	
hxyedci	Annual household expenditure – education fees (imputed)	
hxymcfi	Annual household expenditure – mens clothing and footwear (imputed)	
hxywcfi	Annual household expenditure – womens clothing and footwear (imputed)	
hxyccfi	Annual household expenditure – childrens clothing and footwear (imputed)	

Variables used in the income sensitivity calculation:

Variable	Description	Source
Income growth	After-tax income, adjusted for imputed rent	HILDA
Age	Age of the household head	

Age squared	Age squared	
Migrant	Dummy variable for whether the household head or their family migrated to Australia	
Gender	Gender of the household head	
High school	Dummy variable for whether high school is the highest level of education achieved	
University	Dummy variable for whether university is the highest level of education achieved	
Partnered	Dummy variable for whether the household head is married or in a de facto relationship	
Industry	Industry of employment	
State	State of residence	
Year	Year of survey	

Appendix B – List of data sources for the BVARs

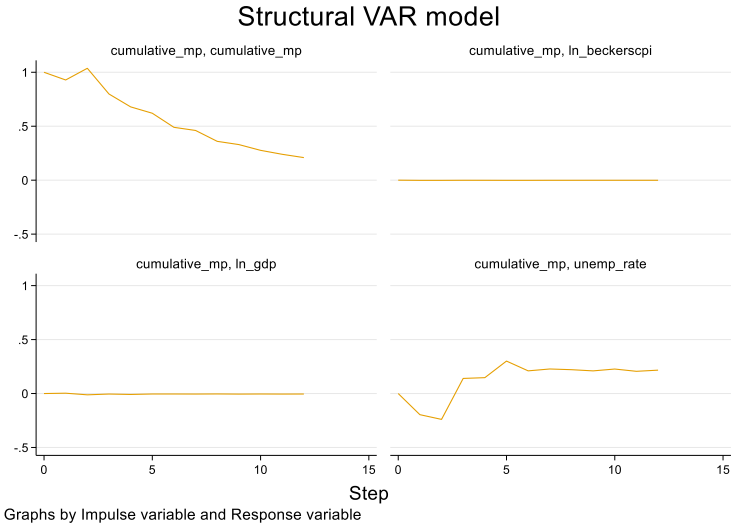
Series	Source	Table/series
Real GDP	(Australian Bureau of Statistics, 2022b)	Table 5206.0 Australian National Accounts: National Income, Expenditure and Product
Underlying CPI	(Australian Bureau of Statistics, 2022e)	Table 6401.0 Consumer Price Index, Australia
House Prices	(Australian Bureau of Statistics, 2021)	Table 6416.0 Residential Property Price Indexes: Eight Capital Cities
Equity Prices	(OECD, 2022)	Share prices, Monthly Monetary and Financial Statistics
Unemployment	(Australian Bureau of Statistics, 2022c)	Table 6202.0 Labour Force, Australia
Monetary policy shock series	Beckers (2020)	BT-CS series

Appendix C – Structural VAR analysis

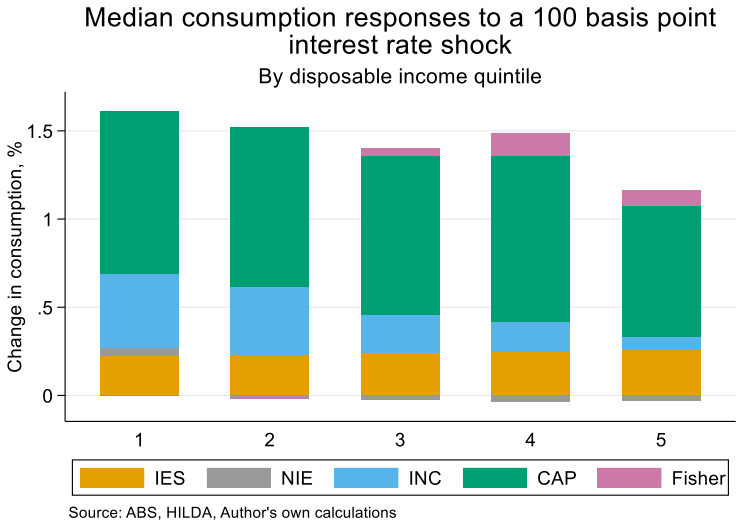
I estimate a SVAR model with log of CPI, the log of GDP, the unemployment rate and the monetary shock, in line with the model estimated by Beckers (2020). This approach allows me to extend the model to include data from Q1 1994 until Q4 2018. This model is more simplified than the BVAR as it has fewer variables and does not require the specification of a set of prior assumptions. However, it requires the specification of a set of restrictions in order to be able to identify the structural parameters. I impose the standard recursive assumptions, whereby changes in the interest rate do not have a contemporaneous effect on other variables; any impact occurs with a lag. Similarly to the BVAR model, I use 4 lags. Diagnostic checking supports the stability of this model.

Impulse response functions are shown below (Figure 19). Interestingly, the size of the inflation and GDP responses to the interest rate shock are largely similar in both the BVAR and SVAR models, lending support to the results of the BVAR. However, the SVAR generates much more realistic estimates of the effect on the unemployment rate. In line with the literature, it suggests that a 100 basis point interest rate shock increases unemployment by around 0.15 percent by the 5th quarter.

Figure 19: Impulse response functions using the SVAR model



Appendix D – Results using median balance sheet exposures



Using median balance sheet exposures rather than mean generates smaller consumption responses, as the data are skewed by few quite large exposures. The most notable differences are for the net interest exposure and Fisher effects. When using mean balance sheet positions, all quintiles except for the first increase their consumption through these channels following the rate cut. Focusing on the net interest exposure effect, the median household in quintile 1 increases their consumption following an interest rate cut, while all other quintiles experience a loss in interest income. The upper three quintiles increase their consumption through the Fisher effect, meaning they have more debt that financial assets. These results are indicative of the large debt positions of these quintiles that are not classified as maturing (for example, business debt).