Monetary Policy and Inequality in Australia

Sofia Mendes (SID: 490378975)

School of Economics

The University of Sydney

Thesis submitted in partial fulfillment of the award course requirements of the Bachelor of Advanced Studies (Honours)

Supervised by Associate Professor Aarti Singh

Abstract

Australia has experienced growing income and consumption inequality over the past three decades. As interest rates rise, it is important to understand the impact of monetary policy on household income and consumption. This thesis uses data from the Household, Income and Labour Dynamics in Australia survey to investigate the distributional effects of monetary policy and the channels through which monetary policy transmits to households. I use the local projections method and find that monetary policy has distributional effects. When interest rates rise, earnings inequality worsens and consumption inequality decreases. I find that the distributional effects of monetary policy are transmitted through the earnings heterogeneity, income composition, and portfolio composition channels.

Keywords: Monetary policy, consumption inequality, earnings inequality

JEL: D31, E21, E52, E58

Statement of Originality

I hereby declare that this submission is my own work and to the best of my knowledge it contains no material previously published or written by another person. Nor does it contain any material which has been accepted for the award of any other degree or diploma at the University of Sydney or at any other educational institution, except where due acknowledgment is made in this thesis.

Any contributions made to the research by others with whom I have had the benefit of working with at the University of Sydney is explicitly acknowledged. I also declare that the intellectual content of this study is the product of my own work and research, except to the extent that assistance from others in the project's conception and design is acknowledged.

Acknowledgements

I would first like to thank my supervisor, Associate Professor Aarti Singh for her support and guidance over the past year. Her advice and feedback has been invaluable. I would also like to thank her for encouraging me to apply for the Brian Gray Scholarship. I am very much appreciative to both Australian Prudential Regulatory Authority and the Reserve Bank of Australia for their generosity in awarding me the Brian Gray Scholarship. Thank you also to my proposal markers Dr Christian Gillitzer and an anonymous marker, as well as Associate Professor Kadir Atalay and Matthew Joyce for their helpful suggestions and to all the seminar participants for their feedback and questions.

And lastly to my family and friends, I am forever grateful for their enduring support throughout my many years of study and many more to come!

Contents

1 Introduction

Over recent decades, income and consumption inequality has risen both here in Australia and abroad (Chatterjee, Singh, and Stone, 2016; Kaplan, La Cava, and Stone, 2018; Piketty and Saez, 2014; Alvaredo, 2018). As a result, central bankers and other policy makers have been increasingly wary of the distributional effects of monetary policy for two reasons (Carstens, 2014; Bullard et al., 2014). First, the impact of monetary policy on inequality and secondly, the impact of inequality on the transmission of monetary policy.[1] This paper focuses on the first and assesses implications of contractionary monetary policy shocks on inequality.

While there is a growing body of international literature assessing the impact of monetary policy on inequality, few have sought to estimate the distributional impact of monetary policy in Australia. This thesis will answer two key questions. First, I will assess whether monetary policy has distributional effects. Secondly, I will analyse the channels through which monetary policy has distributional effects.

Monetary policy is a blunt instrument which affects the economy as a whole, meaning the distributional effects are often "complex and uncertain" (Bernanke, 2015). On an aggregate level, it is understood that contractionary monetary policy lowers output, reduce prices and increase unemployment (Beckers, 2020). However, the transmission of the monetary policy can potentially impact the distribution of income and consumption. Ampudia, Georgarakos, Slacalek, Tristani, Vermeulen, and Violante (2018) summarise the channels through which monetary policy produces a heterogeneous impact; the first is the direct channel and the second is the indirect (see also, Colciago, Samarina, and de Haan, 2019 for a summary of the literature). They find that it is through these channels that monetary policy produces distributional effects.

The direct channel transmits through savings redistribution, interest rate exposure

[1] That is, whether the distribution of income and consumption affects the channels through which monetary policy transmits.

and portfolio composition whilst holding employment status, prices and wages constant. According to the *savings redistribution channel*, high interest rates benefit savers and hurt borrowers. The *interest rate exposure channel* finds contractionary policy shocks benefit those with positive unhedged interest rates exposures (UREs), such as short term deposit certificates, rather than negative UREs which include long-term bond investments (Colciago, Samarina, & de Haan, 2019). The *portfolio composition channel* captures the wealth effect of monetary policy shocks. Put simply, different households hold different types of assets and thus, are affected by monetary policy shocks in different ways.

The indirect channel takes into account that firms respond to monetary policy shocks by adjusting employment and prices. The effect of the new level of employment and wages on households is captured through the *earnings heterogeneity* and *income composition channel*. This is the indirect channel. Like Coibion, Gorodnichenko, Kueng, and Silvia (2017), I focus on the indirect channel and examine the effect of monetary policy on income inequality whilst considering the role of the portfolio composition channel in generating heterogeneous consumption outcomes amongst households.[2]

Heathcote, Perri, and Violante (2010) and Amaral (2017) posit that those on the lower end of the distribution are more likely to be affected by rising unemployment and reduced working hours, whereas, those on the upper end of the distribution are less affected. This would suggest that labour earnings inequality increases through the earnings heterogeneity channel.

The composition of income is also important for assessing the impact of monetary policy on income inequality. High income earners likely benefit from contractionary monetary shocks. This is because capital income is a greater share of total income for the top income decile (Productivity Commission, 2018). This means high income households benefit from high interest rates. At the same time, and moving in the opposite direction is the discount rate effect which causes asset prices, such as house prices and share prices, to

[2]I focus predominantly on the indirect channel, as I have annual data which limits the analysis of the direct channel and because it is unlikely that prices and employment do not adjust.

fall in response to higher interest rates. I find that the discount rate effect is particularly strong and offsets any gains in capital income. In contrast, the income composition of the bottom two deciles are skewed towards transfer income and labour earnings (Productivity Commission, 2018). I find that in Australia, government transfer income is able to offset the fall in earnings faced by those at the lower end of the distribution. This means that whilst unemployment falls and increases earnings inequality, government transfers are able to support those at the bottom and taxes reduce the gains made at the top. Thus, automatic stabilisers and fiscal intervention reduce the inequality generated by a contractionary monetary policy shock via the earnings heterogeneity channel and income composition channel.

The portfolio composition of a household is helpful in understanding the heterogeneity amongst consumption responses. Housing is the single largest asset owned by Australian households, being 37% of assets (Productivity Commission, 2018; La Cava, Wang, et al., 2021). A contractionary monetary policy shock leads to a sharp decline in house prices and also reduces aggregate consumption across for renters, mortgagors and outright homeowners. In particular, outright homeowners temporarily decrease their consumption the most. I discuss three explanations: first, the composition of consumption across tenure status, second, the intertemporal substitution effect and third, the wealth effect. All three channels potentially contribute to heterogeneous response of consumption to a contractionary monetary policy shock. As a result, consumption inequality decreases, particularly for homeowners, as those who consume the most reduce their consumption and those who consume the least increase their consumption following an increase in their income.

2 Related literature

My thesis relates to two strands of macroeconomic literature. The first is the effect of monetary policy on the aggregate economy and second is the distributional effects of monetary policy.

Examining the aggregate economy, Christiano, Eichenbaum, and Evans (1999)[3] find that following a temporary increase in the Federal Funds rate, unemployment rises and prices rise slightly before falling (Ramey, 2016).[4] At the same time, industrial production decreases before returning to its initial state. Since Christiano, Eichenbaum, and Evans (1999), new methods of estimating the effects of monetary shocks have been introduced into the literature. Romer and Romer offer a more robust estimate of monetary policy shocks and find that industrial production and prices falls whilst unemployment rises following a contractionary monetary policy shock. Like Romer and Romer, Beckers (2020) and Bishop and Tulip (2017), using Australian data, find that a contractionary monetary policy shock reduces output, lowers prices and increases unemployment.

Turning to the distributional effects of monetary policy, the New Keynesian paradigm with heterogeneous agents establishes a theoretical basis linking the aggregate and the distributional impacts of monetary policy. Such heterogeneity is important because households have different marginal propensities to consume and thus are affected by monetary policy shocks in different ways (Auclert and Rognlie, 2018). The HANK model (Kaplan & Violante, 2018) groups households into poor, wealthy hand-to-mouth, and non-hand-to-mouth based on their liquid wealth (e.g. cash) and illiquid wealth (e.g. other property or vehicle). Kaplan, Moll, and Violante (2018) find that a contractionary monetary pol-

[3]Christiano, Eichenbaum, and Evans (1999) posited that there was "considerable agreement" in the literature that following a contractionary monetary policy shock, aggregate output and employment fall whilst prices slowly rise. They estimated the Federal Reserve's feedback rule to then use a vector autoregression (VAR) to estimate the effects of a contractionary monetary policy shock.

[4]Conventionally, we expect contractionary monetary policy to cause prices to fall. However, many models have estimated the opposite and have faced the *price puzzle*. This is a perverse outcome and likely results from researchers failing to account for anticipated responses of central bank to future inflation (Beckers, 2020; Singh and Di Crestvolant, 2020; Ramey, 2016; Coibion, 2012; Christiano, Eichenbaum, and Evans, 1999).

icy shock increases liquid returns encouraging non-hand-to-mouth households to reduce consumption today, because of intertemporal substitution. Moreover, falling demand for goods cause firms to reduce production and decrease their demand for labour, either reducing wages or resulting in increased unemployment. While the wealth effect captures the response of households to falling asset prices, namely house prices, which fall as interest rates rise.

Turning to the empirical analysis, Coibion, Gorodnichenko, Kueng, and Silvia (2017) examine the distributional effects of monetary policy and finds that contractionary monetary policy shocks caused a persistent rise in both income and consumption inequality. Coibion, Gorodnichenko, Kueng, and Silvia (2017) use monetary policy shocks identified by Romer and Romer (2004) to examine the response of three quarterly measures of inequality (Gini, 90th-10th percentiles and cross-sectional standard deviations) using the local projections method. Like Coibion, Gorodnichenko, Kueng, and Silvia (2017), Mumtaz and Theophilopoulou (2017) find that the earnings heterogeneity and income composition are the key distributional channels through which contractionary monetary policy shocks increases earnings, income and consumption inequality in the UK. They use a structural VAR and FAVAR to estimate the effect of monetary policy tightening by the Bank of England. They find that contractionary monetary policy shocks cause wages and income to fall, which has greater impact on the lower end of the distribution than those on the upper end. Coibion, Gorodnichenko, Kueng, and Silvia, 2017, instead find that earnings for both high income and low income households rise, at least temporarily.[5]

Furceri, Loungani, and Zdzienicka (2018) conduct a cross country analysis by exploiting Standard World Income Inequality data to analyse the effect of monetary policy shocks across 32 economies. Furceri, Loungani, and Zdzienicka (2018) find the earnings heterogeneity channel plays a greater role in the transmission of monetary policy in countries where labour earnings are a greater share of income. They find that contractionary monetary policy shocks have a larger impact than expansionary monetary policy shocks,

[5]In addition, Mumtaz and Theophilopoulou (2017) find quantitative easing and large-scale asset purchases worsen income and non-durable consumption inequality.

particularly during expansions.

In Australia, the impact of monetary policy on the distribution of income and consumption has not been studied. However, the distributional effects of monetary policy have been considered more broadly. La Cava and He (2021) explore the distributional effects of monetary policy on local housing markets. Using the local projections method, they find that a higher cash rate target temporarily decreases housing wealth inequality. Loukoianova, Wong, and Hussiada (2019) also consider the impact of contractionary monetary policy shocks on household consumption and expenditure for households with differing levels of debt. Using HILDA, they find that those with more debt are more responsive to monetary policy shocks, and when monetary policy tightens they limit consumption and expenditure by more than those with low levels of household debt. Claus and Nguyen (2020) consider the impact of monetary policy shocks on consumer expectations based on CASiE using a latent factor model. They find that consumer expectations adjust immediately to monetary policy shocks, and consumers expect unemployment and inflation to rise, economic conditions and family finances to worsen in response to a contractionary monetary policy shock.

3 Data and Methodology

3.1 Household data

I use microlevel data from the Household Income Labour Dynamic in Australia (HILDA) survey. The panel data set follows approximately 7500 households and 18000 individuals annually (Summerfield, Garrard, Hahn, Jin, Kamath, Macalalad, Watson, Wilkins, and Wooden, 2021).[6] The survey has conducted 20 waves between 2001 and 2020 and contains four components: the household form, household questionnaire, person questionnaire and the self-completion questionnaire. I will use data imputed from both the person and the self-completion questionnaire to construct the measures of inequality for income, earnings, expenditure, and consumption.[7] All four variables are analysed at a household level. I restrict my sample to Wave 1 to 19.[8] All nominal variables are converted into 2019 prices using CPI.

I use HILDA over other Australian data sets such the ABS Survey of Income and Housing Costs (SIH) and Household Expenditure Survey (HES) for two reasons. First, HILDA is unique as it offers annual panel data, whereas, SIH is only conducted every two years and HES every six years. Second, HILDA provides more consistent estimates of income and consumption. This is particularly evident when compared with SIH and HES which had methodological changes in the mid 2000s. HILDA allows a comparison of income and consumption inequality over time. Below I define the variables used in my analysis.

[6]Australia does not have high frequency microdata. This is a limitation when assessing the impact of monetary policy shocks. I will use HILDA, which is the most frequently released panel data set which includes income and consumption. Note, household wealth data is only reported every four years in HILDA. As a result, I am unable to estimate the impact of monetary policy shocks on wealth inequality. However, I use the self-reported home value as a proxy.

[7]The completion rate for the household questionnaire is high with a 95.5% response rate in wave 20. However, 22-29% of households failed to provide financial year income data. Whilst for expenditure and consumption data, there was a 15-20% non-response rate (Summerfield, Garrard, Hahn, Jin, Kamath, Macalalad, Watson, Wilkins, and Wooden, 2021). As a result, income and household-level expenditure data are imputed.

[8]This is because the monetary policy shocks series covers 1994 to 2019. As a result, I exclude the pandemic period covered by Wave 20.

Income: is defined as disposable regular income measured over the financial year. Disposable regular income includes all sources of income from labour earnings, government transfers, business and investment income as well as regular private pensions but excludes inheritances and redundancies.

Earnings: captures all income derived from labour, that is wages and salaries.[9] Financial income is defined as investment income and is the returns on investments including interest, rent, dividends and royalties. Business income is defined as unincorporated business income. Other income is taken to include regular private pension such as regular superannuation and worker's comp, regular private transfers such as child support and importantly, Australian public transfers such as government pensions, family payments and government allowances.

Expenditure: is spending on non-durable goods including groceries, transport and meals out since 2006.[10]

Consumption: includes the service flow from imputed rent in addition to expenditure.[11] I include net imputed rent to comprehensively measure income and consumption. Net imputed rent is applied to homeowner occupiers. It represents the market rent homeowners would receive as landlords minus the costs of owning a home such as mortgage interest or repairs (Kaplan, La Cava, and Stone, 2018). Here, gross imputed rent is taken to be 5% of the dwelling value. The crucial 5% was estimated by Yates (1994) and Saunders and Siminski (2005) and reflects the rental yield. To calculate net imputed rent, I subtract mortgage repayments from gross imputed rent (Kaplan, La Cava, & Stone, 2018).

[9]Watson and Wooden (2004) compared HILDA estimates on income to the results of the SIH. They found HILDA reported higher wages, salaries and investment income (Summerfield, Garrard, Hahn, Jin, Kamath, Macalalad, Watson, Wilkins, and Wooden, 2021). Despite this, SIH and HILDA report similar distributional changes over time (Wilkins, 2014).

[10]HILDA only reports durable expenditure for Wave 6, 2006 through to Wave 10, 2010. To provide a rough estimate of durable expenditure and total spending, I estimate the total spending of household through imputation regressions like Windsor, Jääskelä, and Finlay (2015). HILDA's measure of expenditure still proves useful for measuring non-durable consumption in my analysis. I discuss this in my results.

[11]HILDA underestimates consumption when compared to the ABS. Windsor, Jääskelä, and Finlay (2015) finds that the HILDA measure of consumption is consistently one-half of the ABS measure. This is because the ABS data is broader as it includes more categories of expenditure and goes beyond HILDA which focuses on recurring spending (Windsor, Jääskelä, & Finlay, 2015).

Table 1: Correlations between inequality measures

Inequality	Corr(SD,Gini)	Corr(SD, 90th-10th)	Corr(Gini,90th-10th)
Income	0.722	0.824	0.868
Earnings	0.725	0.812	0.412
Expenditure	0.914	0.991	0.881
Consumption	0.922	0.947	0.952

Table 1 reports the correlation coefficint between the inequality measures for income, earnings, expenditure and consumption. The correlations are calculated between the cross-sectional standard deviations of log levels, Gini coefficient and difference of log levels at the 90th and 10th percentile.

To limit the effects of measurement errors at both the top and bottom end of the distributions, income, earnings, consumption and total expenditure are winsorized (Cox, 2006). This minimises the effects of outliers at either end of the distribution. Here, I have trimmed the 1st and 99th percentile.[12]

Measures of inequality: to estimate the effect of monetary policy on inequality, I use three measures of inequality: the Gini coefficient, 90th-10th percentiles and cross-sectional standard deviations. Gini coefficient is the ratio of the area between the Lorenz Curve[13] and 45° line and the total area under the 45° line. While the Gini coefficient places equal weight on every household along the distribution, the 90th-10th percentile and cross-sectional standard deviation require observations with a value of zero to be dropped. The 90th-10th percentile is the difference between the log level of the 10th percentile and the 90th percentile, and the cross-sectional standard deviation is the standard deviations of the log-level of the variable.

All three measures follow similar trends and are highly correlated with each other, as shown in Table 1. The correlations between the Gini coefficient, 90th-10th percentile and cross-sectional standard deviation for income, consumption and expenditure is greater than 0.7. Coibion, Gorodnichenko, Kueng, and Silvia (2017), also find strong positive correlations between inequality measures for each variable in US data.

[12]Refer to the Appendix B.6 for results without winsorizing.

[13]The Lorenz Curve is the cumulative proportion of households ranked along the x-axis by income or consumption

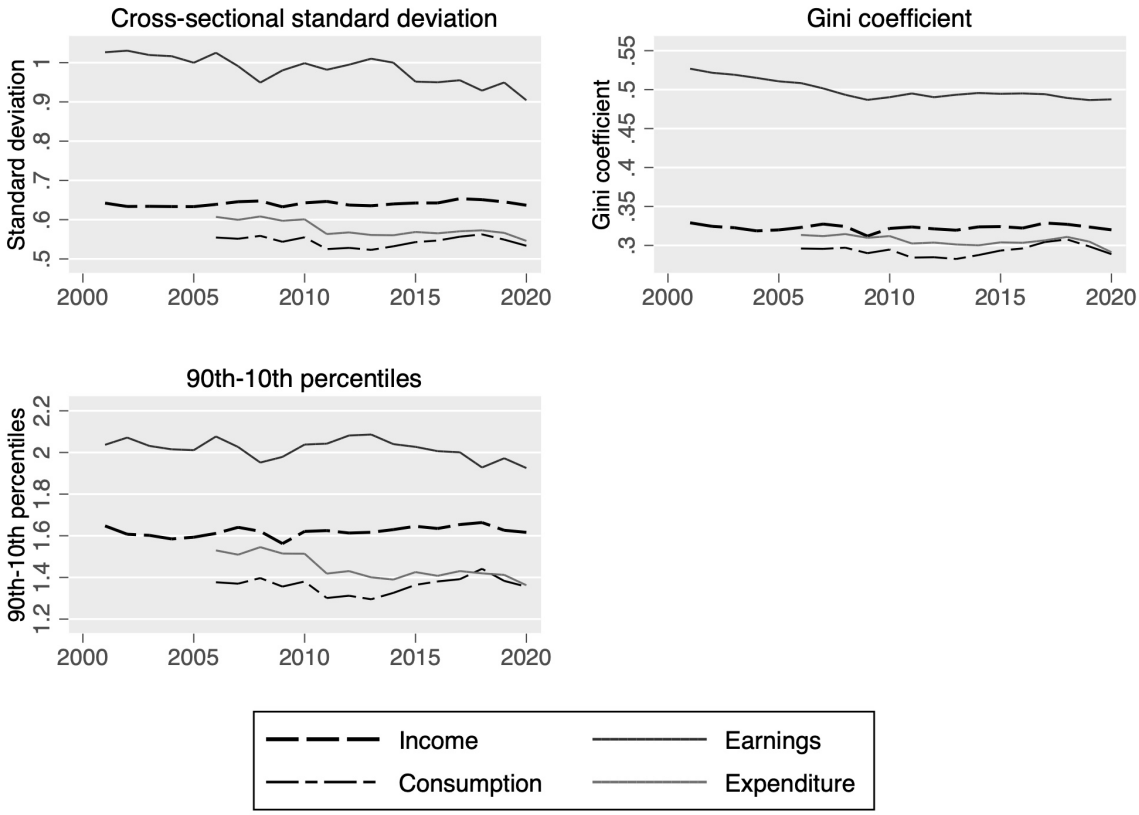

Figure 1: Inequality measures over time

Figure 1 plots income, earnings, consumption and expenditure inequality over time. The results are consistent with the Australian literature (Kaplan, La Cava, and Stone, 2018; Productivity Commission, 2018). Across all three measures of inequality,[14] pre-tax earnings (solid line) has the widest distribution which suggests that taxes in Australia play an important redistribution role. Figure 1 shows that post-tax income (black dash line) inequality falls across all three inequality measures. Imputed rent also narrows the distribution consumption, with lower estimates for consumption inequality when compared with expenditure. Both consumption and expenditure inequality trend below income inequality. This can partly be attributed to consumption smoothing by households over their lifecycle.

There exists some correlation between each inequality measure and macroeconomic

[14]90th-10th percentiles is most sensitive to changes in the distribution of each variable, reflected in the fluctuations in Figure 1. This is likely because the 90th-10th percentile calculated by comparing the income, consumption, earnings or expenditure on both ends of distribution.

variables suggesting that the business cycles in Australia has some impact on inequality.[15]

3.2 Monetary policy shocks

Bishop and Tulip (2017) apply the two step Romer and Romer (2004) approach to Australian data. The first stage isolates the residuals of a Taylor-type policy rule and the second stage removes the anticipated component of monetary policy from the residuals. This allows Bishop and Tulip (2017) to identify the unanticipated component of monetary policy shocks. Beckers (2020) builds on Bishop and Tulip (2017) by including credit market conditions in the policy rule to better account for the anticipatory component of monetary policy.[16]

The equation that estimates the monetary policy shock $\hat{m}_t$ is given below:

$$\Delta cr_t = \hat{\alpha} + \hat{\rho}_1 cr_{t-1} + \hat{B} Y^{fc}_{t+h|t} + \hat{\gamma} CS_t + \hat{m}_t \tag{1}$$

where Δcr_t is the change in the target cash rate in month t. CS_t is the credit market spreads. cr_{t-1} is the cash rate target from the previous meeting. $Y^{fc}_{t+h|t}$ is the RBA's estimates of macroeconomic variables h-quarters ahead.[17]

Beckers (2020) then purges the residual, the monetary policy shock, of its anticipated component. Beckers does this by removing the expectations of financial market participants of cash rate changes prior to RBA Board meetings. He then purges this anticipated component of monetary policy shocks from the residual $\hat{m}_t$.

I use the Beckers' unanticipated monetary policy monthly shock series from 1994 to 2019.[18] For the analysis, I aggregate the shocks both at a quarterly and annual frequency

[15]For robustness, I will test other measures of detrending inequality in further analysis.

[16]For robustness, I also observe the impact of narrative shocks from Bishop and Tulip (2017). I find that Beckers (2020) is able to overcome the price puzzle present in the Bishop and Tulip (2017). See Appendix B.5

[17]Beckers defines $Y^{fc}_{t+h|t}$ to include two-quarter ahead forecasts for inflation, real GDP growth, revision to forecasts from previous rounds and the nowcast for the unemployment rate.

[18]The series was updated in Nguyen, La Cava, et al. (2020) to include monetary policy shocks through

(see Ottonello and Winberry, 2020, Wong et al., 2019). Like Wong et al. (2019), I rely on the assumption that the quarterly and annual monetary policy shock series are orthogonal to the macroeconomic variables and inequality measures.

Table 2: Monetary policy shocks

	Raw shocks	Quarterly aggregate	Annually aggregate
Median (ppts)	0.009	0.009	-0.105
Mean (ppts)	0	0	0
Standard deviation (ppts)	0.157	0.326	0.696
Min (ppts)	-0.738	-1.742	-1.070
Max (ppts)	0.806	1.085	1.635
Numbers of shocks	309	103	26

Table 2 reports the raw, quarterly and annually aggregated Beckers (2020) shocks from January 1994 to September 2019

Table 2 provides summary statistics for the distribution of quarterly and annually aggregated monetary policy shocks which I compare to the raw shocks. In the quarterly series, there are 54 positive monetary shocks and 49 negative monetary shocks between 1994 and 2019. The balance between quarterly positive and negative monetary shocks are shown in Figure 2. The average unanticipated contractionary monetary policy shock is 20 basis points, whilst the average unanticipated expansionary monetary policy shocks is slightly larger at 22 basis points. The annual shock series has 11 positive monetary policy shocks and 15 negative monetary policy shocks. The mean annual cumulative positive monetary policy shock is 62 basis points, whilst the mean annual cumulative negative monetary policy shock is 45 basis points. This is shown in Figure 2 on the right.

2019.

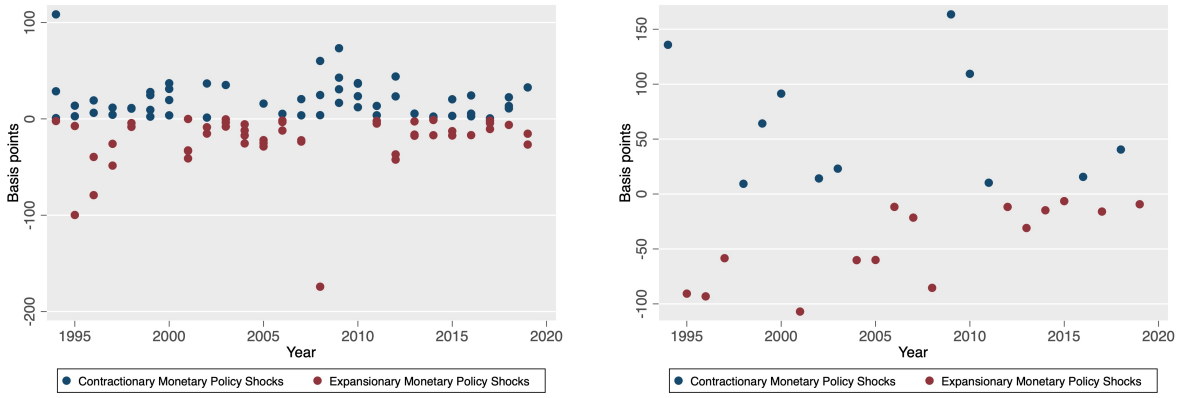

Figure 2: Quarterly and annual monetary policy shock series

3.3 Methodology

I use the local projections method a la Jordà (2005) to estimate the effects of monetary policy shocks on inequality. The local projections method uses the VAR companion form to solve for the first horizon, that is the first period, and then estimates the effects of monetary policy innovations at each horizon. This allows us to observe the impacts of shocks, here contractionary monetary policy, with a linear projection capturing the entire IRF. Over short horizons, the results of a VAR and local projections model are similar (Plagborg-Møller & Wolf, 2021).

Following Coibion, Gorodnichenko, Kueng, and Silvia (2017), the baseline equation is

$$x_{t+h} - x_{t+h-1} = c^{(h)} + \sum_{j=1}^{J} \alpha_j^{(h)}(x_{t-j} - x_{t-j-1}) + \sum_{i=1}^{I} \beta_i^{(h)} e_{t-i}^{B} + \varepsilon_{t+h}, \;\; h = 0, ..., H \qquad (2)$$

where x is the measure of inequality, e_t^B is the annual monetary policy innovations from Beckers (2020), h is the horizons. $(\hat{\beta}_i^{(h)})_{h=0}^{H}$ is the estimated accumulated impulse response of the changes in the measures of inequality to the monetary policy shocks.

The method requires the data, here aggregate macroeconomic variables and inequality measures, to be weakly stationary and the lag structure to be unrestricted (Plagborg-Møller & Wolf, 2021). To achieve this I take the first difference of the variables, with the

exception of the overnight cash rate. This ensures that the macroeconomic variables and inequality measures are weakly stationary. I use Driscoll-Kraay standard errors, these standard error estimates are heteroskedastic and allow for cross-sectional dependency as well as arbitrary serial correlation (Coibion, Gorodnichenko, Kueng, & Silvia, 2017). The standard errors have better small-sample properties than other covariance estimators with cross-sectional dependence (Hoechle, 2007).

4 Results

In this section, I first examine the impact of monetary policy on the aggregate economy. I then study the distributional effects of monetary policy on standard measures of inequality.

4.1 Monetary policy and the macroeconomy

Considering the following equation

$$x_{t+h} - x_{t+h-1} = c^{(h)} + \sum_{j=1}^{J} \alpha_j^{(h)} (x_{t-j} - x_{t-j-1}) + \sum_{i=1}^{I} \beta_i^{(h)} e_{t-i}^{B} + \sum_{l=1}^{R} \gamma_l X_{t-1} + \varepsilon_{t+h}, \ h = 0, ..., H \tag{3}$$

where the left hand side is the log first difference of the macroeconomic variable of interest, where the plotted cumulative response is estimated as $\beta_1^{(h)}$ over the twenty horizons, H.[19] The lag structure is $J = 2$ and $I = 20$ for the narrative shocks.[20] For the high frequency shocks $J = 2$ and $I = 1$. The vector X includes inflation, real GDP growth and the change in unemployment, I include 1 lag $\sum_{l=1}^{R} \gamma_l X_{t-l}$ like Beckers (2020). I use Driscoll-Kraay standard errors and display one and 1.65 standard errors. The p-value tests the null hypothesis that an unanticipated monetary policy shock has no impact on the quarterly macroeconomic aggregates, such that $\beta_1^{(h)} = 0$ at each horizon.[21]

Figure 3 plots the cumulative impulse response function to a 100 basis point increase in the cash rate over 20 quarters using narrative shocks. The null hypothesis can be rejected for each of the aggregate variables at the 1% level, meaning the impulse response deviates from zero in at least one horizon. In response to a contractionary monetary policy shock, the overnight cash rate increases, peaking two quarters after the shock at 1.3 percentage points. This response is less pronounced than the response of the Fed funds

[19] The estimated cumulative response for the overnight cash rate is $\beta_0^{(h)}$. This is because I allow for contemporaneous responses to the unanticipated monetary policy shock.

[20] For robustness, I test various lag structures. I find that the results are robust. See Appendix B.3.

[21] For robustness, I observe the impact of the annually aggregated monetary policy shock series on annual macroeconomic variables. I find the response is broadly the same. However, not statistically significant due to the large standard errors. See Appendix B.2.

rate to an unanticipated monetary policy shock which peaked at nearly two percentage points (Coibion, Gorodnichenko, Kueng, & Silvia, 2017; Ramey, 2016).

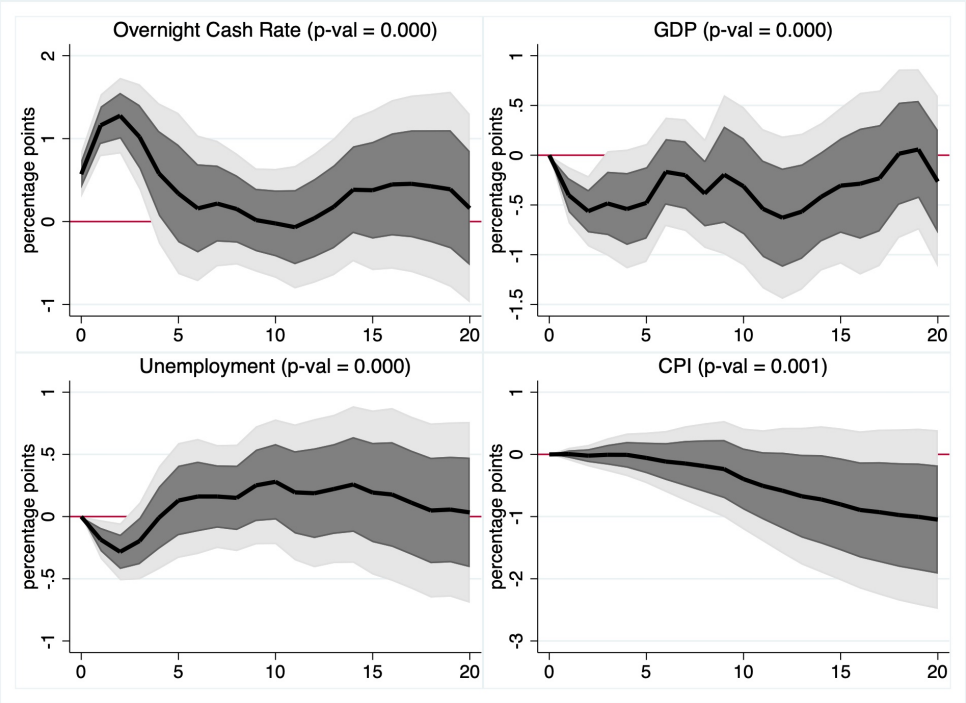

Figure 3: Response of real macroeconomic variables to a 100 b.p. unanticipated contractionary monetary policy shock, 1994:Q1-2019:Q4

I find that a contractionary monetary policy shock decreases real GDP and underlying CPI. This is consistent with the literature in both Australia and abroad (Coibion, Gorodnichenko, Kueng, & Silvia, 2017; Ramey, 2016; Romer & Romer, 2004). Real GDP is responsive to the impact of an unanticipated monetary policy shock, with GDP initially falling by 0.5 percentage points. These results are similar to Beckers (2020) who uses a SVAR.

Unemployment initially falls despite an unanticipated contractionary monetary policy shock, indicating an unemployment puzzle. However, four quarters after the shock, unemployment increases, albeit slightly with large standard errors. CPI begins to fall four quarters after the shock and declines by one percentage point after 20 quarters. This is consistent with the analysis of Beckers (2020) which shows the response of prices to monetary policy shocks are persistent and finds an unemployment puzzle is present.

4.2 Impact of monetary policy on income

4.2.1 Household earnings and income

Next, I consider the impact of monetary policy on three measures of inequality for earnings, pre and post-tax income.

Using Equation (4) with $J = 2$ and $I = 2$ for annual narrative shocks and $J = 2$ and $I = 1$ for annual high frequency shocks, I find the null hypothesis, that the response of inequality measures to monetary policy will be zero, can be rejected at the 1% level for all measures of inequality. Therefore, from a statistical perspective, Figure 4 clearly indicates that monetary policy has redistributive effects. This is true across both narrative and high frequency shocks, see in Figure 4 and Figure 29 in Appendix B.4 .

$$x_{t+h} - x_{t+h-1} = c^{(h)} + \sum_{j=1}^{J} \alpha_j^{(h)}(x_{t-j} - x_{t-j-1}) + \sum_{i=1}^{I} \beta_i^{(h)} e_{t-i}^{B} + \varepsilon_{t+h},\ h = 0, ..., H \quad (4)$$

Following a contractionary monetary policy shock, earnings inequality increases. Notably, the effect of a contractionary monetary policy shock is a persistent across all earnings inequality measures.

Income inequality, pre-tax and post-tax, increases slightly in the year after the rate hike. While a contractionary monetary policy shock increases earnings inequality, income changes only slightly. This could be because income is a broad measure which includes earnings, but also other sources of income such as business, financial and other income (e.g. government transfers). These other sources of income play a role in diminishing the distributional effect of a contractionary monetary policy shock on income. In addition, not surprisingly, pre-tax income inequality increases by more than post-tax income inequality, highlighting the redistributive role of taxes, see the second and third panel in Figure 4.

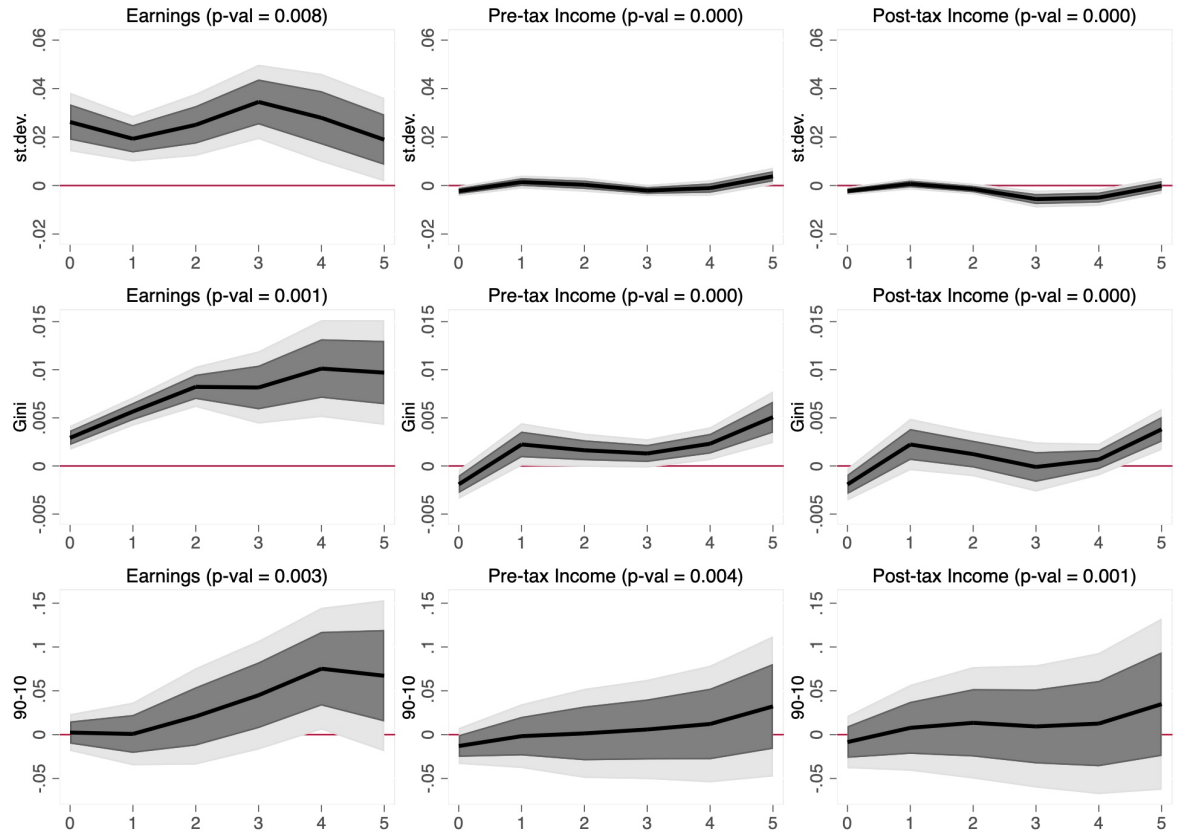

Figure 4: Response of inequality measures for earnings, pre-tax income, and post-tax income to a 100 b.p. unanticipated contractionary monetary policy shock

4.2.2 Earnings heterogeneity and income composition channels

Earnings heterogeneity and income composition channels play a significant role in the transmission of monetary policy (Coibion, Gorodnichenko, Kueng, and Silvia, 2017; Mumtaz and Theophilopoulou, 2017; Furceri, Loungani, and Zdzienicka, 2018; Colciago, Samarina, and de Haan, 2019; Aye, Clance, and Gupta, 2019). According to the earnings heterogeneity channel, a monetary policy shock affects households at the top and bottom end of the income distribution differently because households at the bottom are more likely to face unemployment and reduced hours or wages. Income composition channel means a monetary policy shock will impact households along the income distribution differently as they have different sources of income.

As Figure 5 shows, the composition of income differs significantly across income quintiles. Government transfers constitute 49% of the total income for the bottom 20% of households. While it constitutes only 0.98% of the top 20%. Earnings are however 90% of the top 20% but 36% of the bottom 20%.

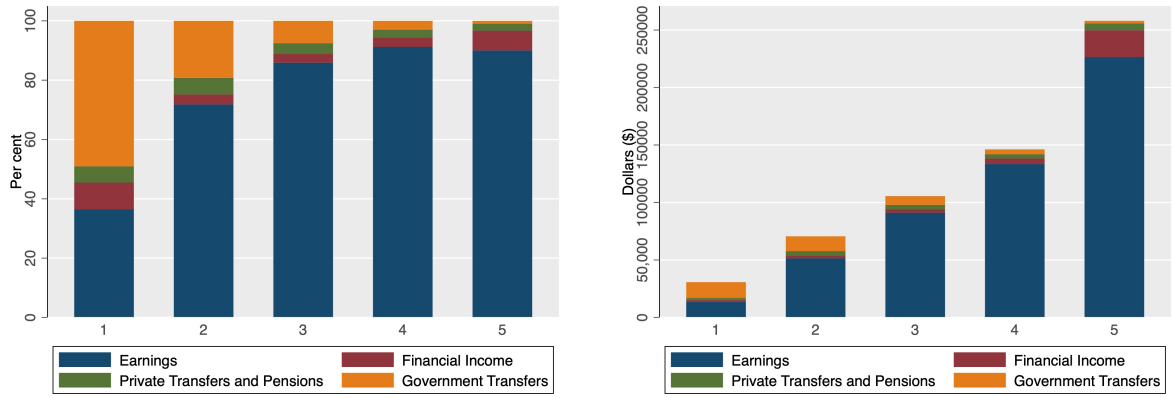

Figure 5: Income composition by quintile

I then decompose the impact of a contractionary monetary policy shock on the sources of pre-tax income. Using the annual monetary policy shock series and Equation (4) with $J = 2$ and $I = 2$.

The results from Figure 4 clearly show that there is a distributional impact of mon-

etary policy on earnings. To understand this further, I examine the impact of monetary policy on different points of the earnings distribution. The earnings of the 10th percentile falls significantly relative to the median, whilst the earnings of the 90th percentile increases slightly relative to the median. Figure 6 shows the earnings of bottom falls and the earnings of the top increases. Therefore, earnings inequality increases following a contractionary monetary policy shock as the earnings of the bottom fall sharply relative to the increase in the earnings of the top.

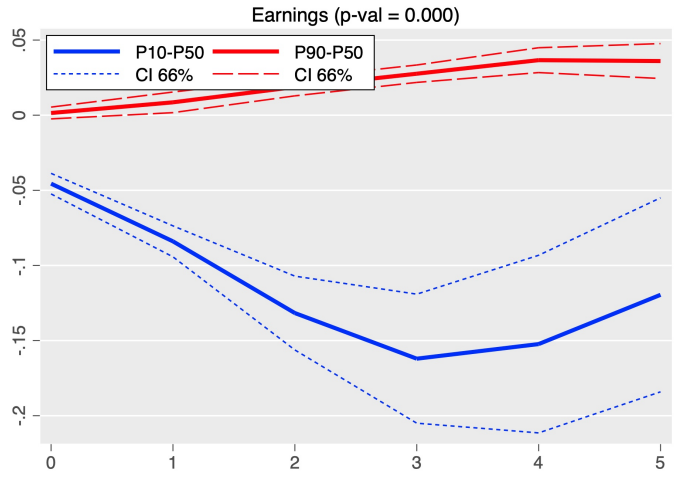

Figure 6: Log difference 90th-50th earnings percentile and 10th-50th earnings percentile

Is the rise and fall in earnings of the bottom related to the impact of monetary policy on unemployment? Figure 3 shows the aggregate unemployment rises following a contractionary monetary policy shock. By observing Figure 7 we see that for the bottom quintile of income, unemployment increases strongly and by more than the response of the aggregate unemployment. The increase in unemployment can be related to the fall in the earnings of those at the bottom relative to the median. I also find that for those in the bottom quintile who are employed see a fall in hours worked and wages (see Figure 8). Heathcote, Storesletten, and Violante (2009) similarly find that in the US those at the bottom face a decrease in hours worked and increase in unemployment following a contractionary monetary policy shock.

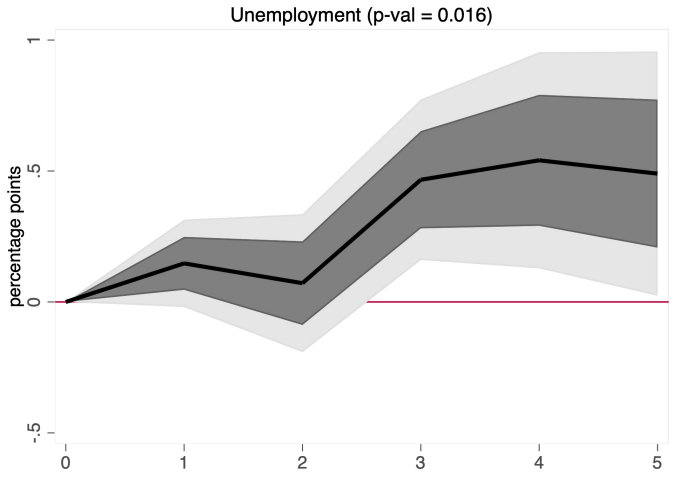

Figure 7: Response of unemployment of the bottom quintile to a 100 b.p. unanticipated contractionary monetary policy shock

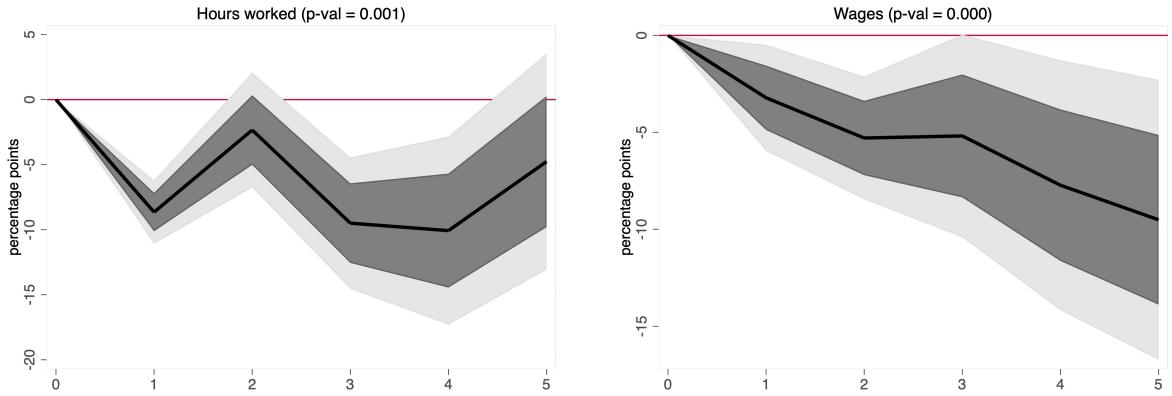

Figure 8: Response of hours worked and wages of the bottom quintile to a 100 b.p. unanticipated contractionary monetary policy shock

4.2.3 Fiscal policy counteracting monetary policy

As is typical following a fall in earnings or a rise in unemployment, households receive government transfers including unemployment benefits and family payments. Figure 9 shows that total benefits paid by the government increases four quarters after the shock. The trend is similar to aggregate unemployment in Figure 3.

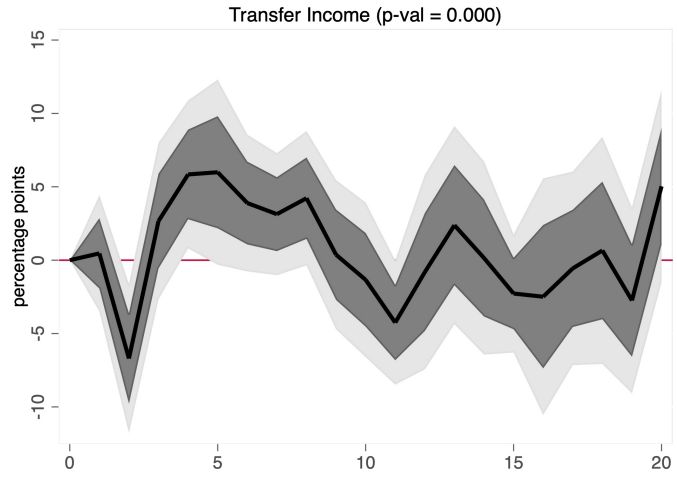

Figure 9: Response of government total personal benefits payments to a 100 b.p. unanticipated contractionary monetary policy shock

Government transfers effectively reduce inequality by increasing the income of the bottom decile relative to the median. The blue line depicts the log difference of earnings between the 10th percentile and 50th percentile. The left panel of Figure 10 shows the impact of a contractionary monetary policy shock on earnings, while the right, plots the impact on both earnings and government transfers. This shows clearly that government transfers are effective in increasing the income of the 10th percentile. In contrast, Coibion, Gorodnichenko, Kueng, and Silvia (2017) find that income inequality in the US remains the same despite government transfers. This is because as central banks tighten monetary policy, low income households will likely suffer as transfer income remains stagnant against rising real prices (Coibion, Gorodnichenko, Kueng, and Silvia, 2017). However, in Australia, transfer payments remain indexed, meaning that during periods of high inflation transfer payments increase nominally to maintain their real value (Klapdor, 2022).

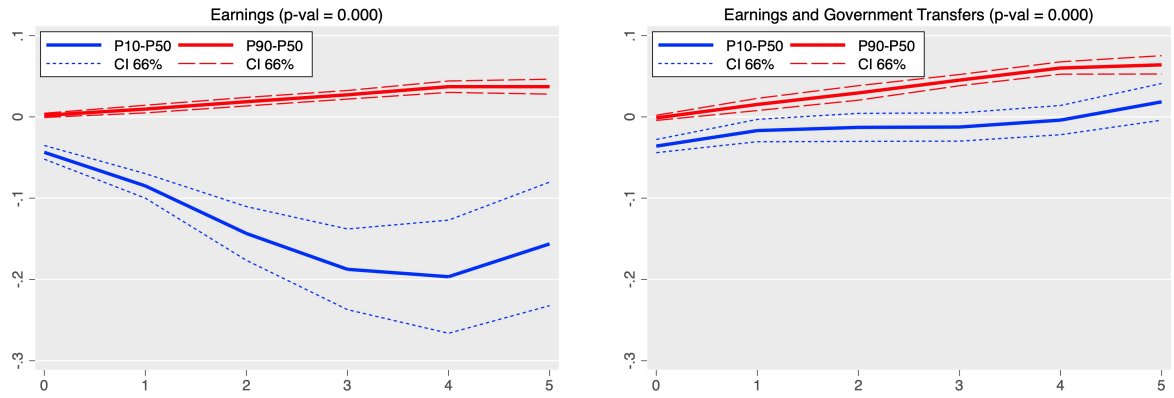

Figure 10: Response of earnings with and without government transfers to a 100 b.p. unanticipated contractionary monetary policy shock

Taxes also redistribute income. The progressive income tax system reduces gains of the 90th percentile relative to the median following a contractionary policy. This can be seen in Figure 11 which compares pre-tax income (left panel) and post-tax income (right panel). We can see the pre-tax income of the top increases relative to the median. These gains are dampened after tax, the right panel, with the post-tax income of the 90th percentile, only increase slightly when compared to the median. However, the pre-tax income of the 10th percentile relative to the median is largely unchanged, as represented by the blue line on the left panel of Figure 11. However, post-tax income of the 10th percentile relative to the median increases in response to a contractionary monetary policy shock. Thus, the post-tax income of bottom increases compared to those at the top from a contractionary monetary policy shock, relative to the middle.

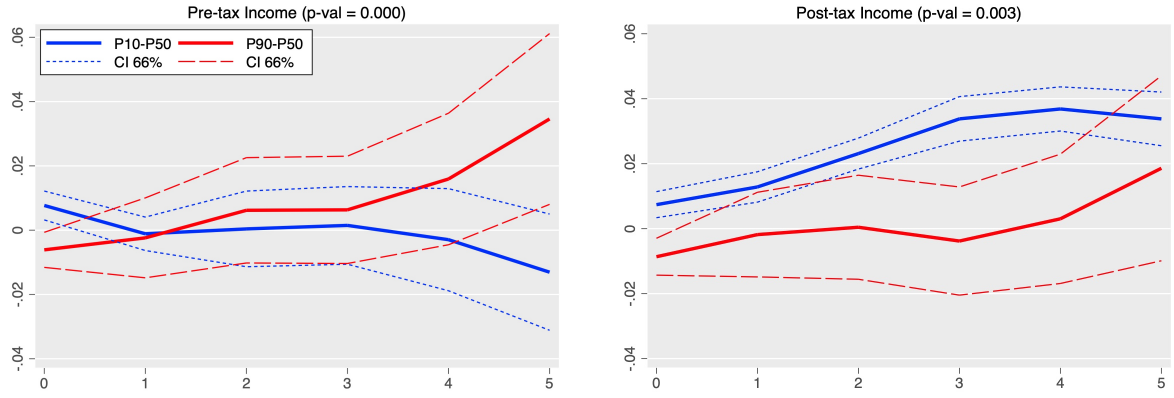

Figure 11: Response of income before and after tax to a 100 b.p. unanticipated contractionary monetary policy shock

4.3 Impact of monetary policy on consumption

4.3.1 Household consumption

I assess the impact of a contractionary monetary policy shock on non-durable and durable consumption as well as total spending at a household level. To do so, I estimate and impute total spending for 2006-2019, and run an imputation regression following the same specifications as Windsor, Jääskelä, and Finlay (2015). This approach allows me to provide a rough estimate of total spending and durable consumption for each household.[22]

Figure 12 plots the response of three inequality measures of non-durable consumption, durable consumption and total spending following a monetary policy shock. I find that non-durable consumption inequality decreases across all three measures, shown in the left panel of Figure 12. Durable consumption and total spending inequality initially decline across all three measures. Both then increase slightly for the Gini coefficient and cross-sectional standard deviation measures, as shown in the top right hand panel of Figure 12.

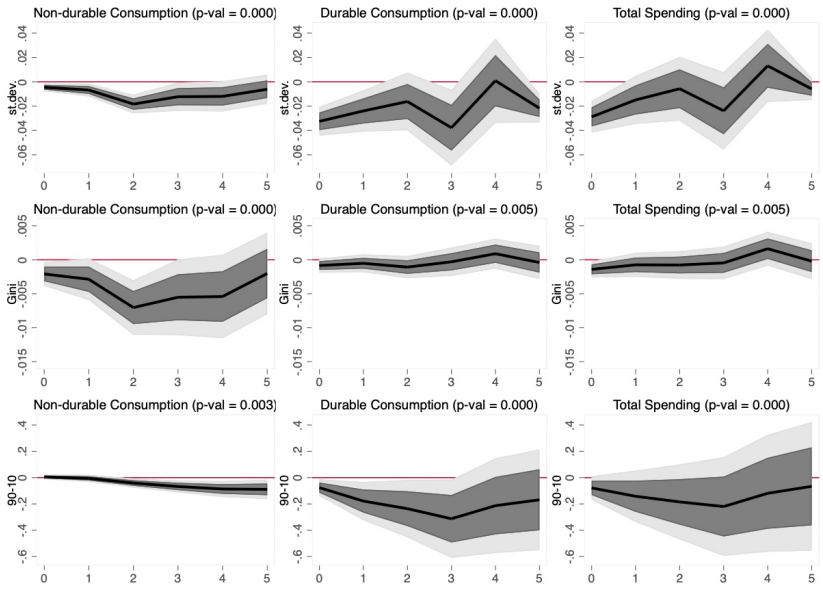

Figure 12: Response of inequality measures for non-durable consumption, durable consumption, and total spending to a 100 b.p. contractionary monetary policy shock

[22] I run the imputation regression $totalspending_{i,t} = \alpha_0 + \alpha_1 meo_{it} + \alpha_2 gro_{it} + \alpha_3 cc_{it} + \alpha_4 age_{it} + \alpha_5 age_{it}^2 + E_{it}$ for each category of housing tenure - renters, mortgagors and outright homeowners. See Appendix A.4.

I compare the consumption response of consumers in the 90th and 10th percentiles against the median for non-durable and durable consumption, as well as total spending in Figure 13. I find that the total spending of those at the top falls relative to the median, whilst the total spending of the bottom decreases slightly three years after the shock. This reflects the decrease in total spending inequality with the gap between the 90th percentile and 10th percentile of total spending narrowing, as shown in the bottom panel of Figure 13. The response of those at the top and the bottom relative to the median is most pronounced for durable consumption, plotted on the right panel of Figure 13. Inequality of total spending primarily decreases because those who consume the most reduce their consumption of durable goods and in turn total spending.

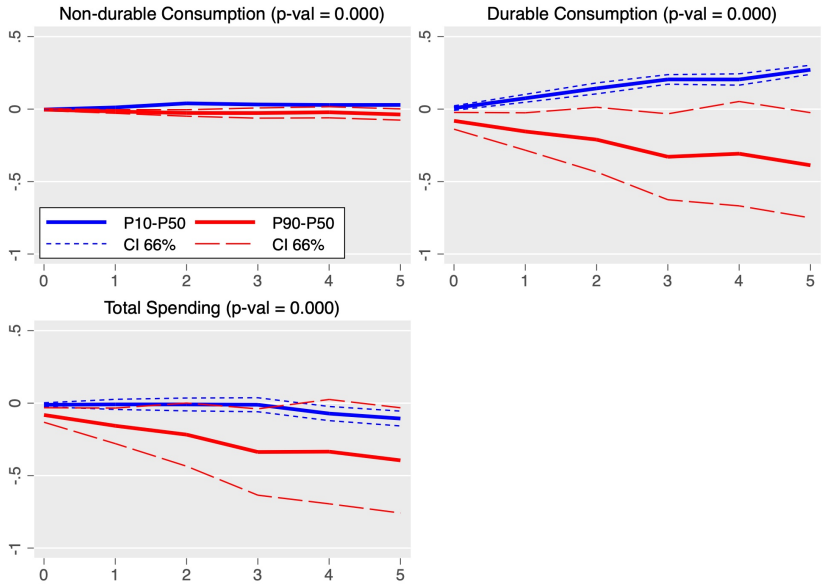

Figure 13: Response of log difference of 90th-50th percentile and 10th-50th percentile non-durable consumption, durable consumption, and total spending to a 100 b.p. contractionary monetary policy shock

I then decompose the response of non-durable consumption, durable consumption and total spending to a monetary policy shock by income quintile in Figure 14. I find that the total spending and non-durable consumption fall across the income distribution, as shown in the top and bottom panels of Figure 14. However, the fall in total spending and non-durable consumption is less pronounced for the bottom two income quintiles, as shown in the left panels of Figure 14. In fact, the total spending of the top income quintile,

plotted in the far right panel of Figure 14, is initially the most responsive to a monetary policy shock, with durable and non-durable consumption falling. However, the durable consumption of the bottom quintile remains persistently low. I find that there is clear heterogeneity in the consumption response of households across the income distribution.

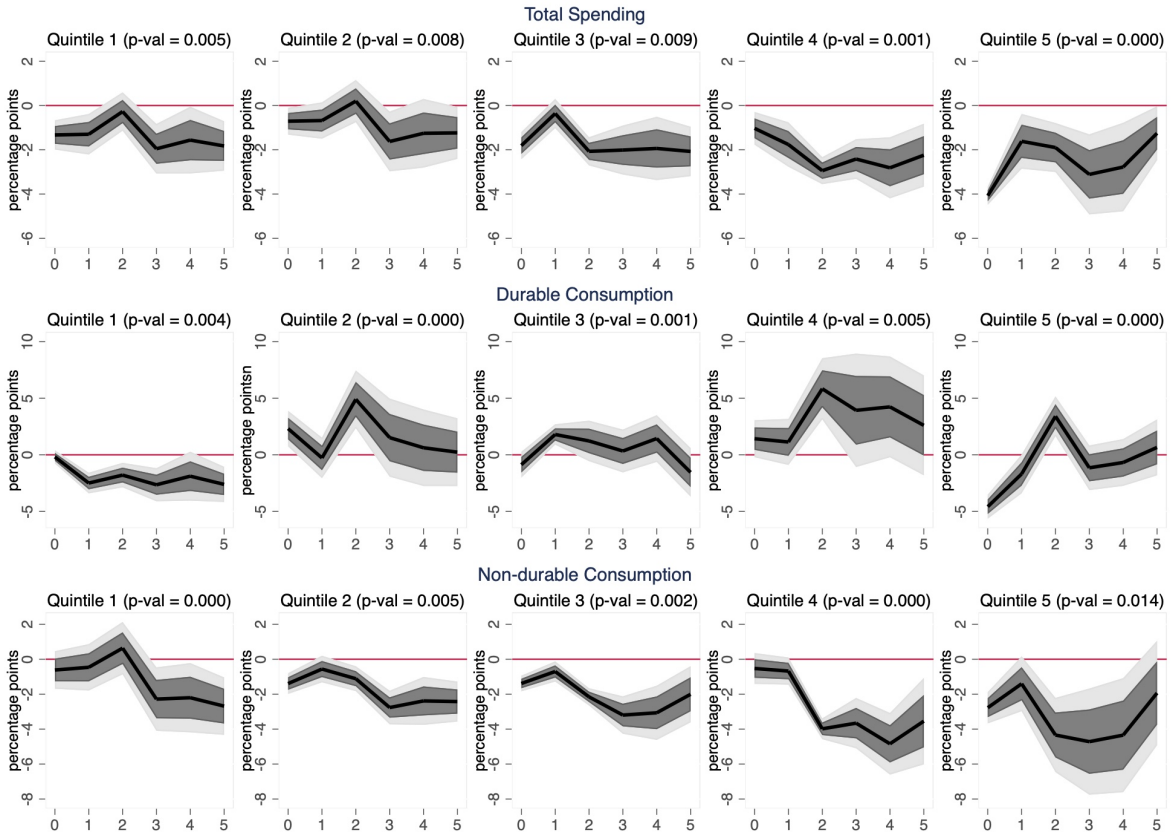

Figure 14: Response of total spending, durable and non-durable consumption to a 100 b.p. contractionary monetary policy shock by income quintile

The consumption of the bottom income quintile is less responsive to a contractionary monetary policy shock. This likely reflects the impact of monetary policy on income through the income composition channel. As discussed above, government transfers are a large share of total income for the bottom quintile. Thus, the consumption of the bottom quintile is less sensitive to monetary policy shocks because fiscal policy counteracts the negative income effect of monetary policy. The total spending of the top two income quintiles falls the most in response to a contractionary monetary policy shock. This is potentially because of the portfolio composition channel, as a large proportion of home-

owners are top income earners who would be affected by falling asset prices (see Table 3). I find that those who earn the most income are the most responsive to the initial effects of a monetary policy shock. In the next section, I explore the portfolio channel as a mechanism of monetary policy transmission.

I focus on the response of non-durable consumption to a contractionary monetary policy shock by homeownership status.[23] I do this for two reasons. Firstly, to use homeownership as a proxy for household wealth. This is because May, Nodari, and Rees (2019) identify that in Australia there is a positive and stable relationship between household wealth and consumption. Secondly, this allows me to assess the role of the portfolio composition channel, whereby households who hold different asset portfolios respond differently to monetary policy shocks.

[23]For robustness, I focus my analysis on non-durable consumption, as HILDA does not survey durable consumption. I include some discussion on durable consumption, using my rough estimate based on Windsor, Jääskelä, and Finlay (2015)

Table 3: Summary statistics by housing tenure

	Renters	Mortgagors	Outright	Total
Age	35	42	54	43
Household disposable income ($)	58,765	90,426	74,158	76,210
Total spending ($)	28,710	48,252	47,248	42,950
Real durable expenditure ($)	4,989	11,591	12,828	9105
Real nondurable expenditure ($)	22,526	35,320	33,262	28,980
Real liquid assets	3,462.5	13,099.2	50,131.4	13,317.8
Real liquid debt	0	0	0	0
Real liquid wealth	2,160.5	11,348.7	49,486.0	11,830.2
Real illiquid wealth	42,006.7	463,753.0	882,978.1	392,807.1
Real illiquid wealth excl. super	5,401.3	311,674.3	650,944.3	264,637.1
Real illiquid wealth excl. super and home	5,401.3	-197,216.3	87,066.9	-1,168.4
Real net wealth	53,439.8	494,101.6	1,008,175.6	429,139.4
Real net wealth excl. super	11,572.4	341,889.2	773,929.8	299,658.8
Real net wealth excl. super and home	11,572.4	-171,983.3	213,442.8	3,883.4
Income quintile 1	0.446	0.0562	0.135	0.200
Income quintile 2	0.288	0.149	0.177	0.200
Income quintile 3	0.151	0.246	0.187	0.200
Income quintile 4	0.0782	0.286	0.210	0.200
Income quintile 5	0.0361	0.263	0.290	0.200
HtM	0.334	0.163	0.0748	0.191
Wealthy HtM	0.190	0.156	0.0729	0.143
Poor HtM	0.144	0.00698	0.00194	0.0481
Non-HtM	0.667	0.837	0.925	0.809

Table 3 shows the median income and wealth for renters, mortgagors and outright homeowners, as well as the proportion which are Hand-to-Mouth both wealthy and poor as well as non-Hand-to-Mouth. Here, I distinguish between wealthy and poor Hand-to-Mouth by illiquid net wealth excluding superannuation and the owner-occupied home (*cf* Hughson, La Cava, Ryan, Smith, et al., 2016; Kaplan, Violante, and Weidner, 2014)

4.3.2 Portfolio composition channel

Portfolio composition channel is an important channel through which monetary policy has distributional effects. In Australia, the home is the largest single asset owned by a

household.[24]

Real house prices decrease significantly in response to a 100 basis point unanticipated monetary policy shock. House prices fall by seven percentage points eight quarters after the shock, but recover back to its initial state after 20 quarters. This response is inline with estimates from La Cava and He (2021) who find that house prices in the median area of Australia decline by nine percentage points two years after the unanticipated shock. Falling house prices will significantly impact the balance sheet of all homeowners. To analyse this distributional impact of monetary policy, I examine the effect of monetary policy on households based on housing tenure. I classify households as renters, mortgagors and outright homeowners.[25]

Figure 15 disaggregates the response of non-durable consumption, durable consumption and total spending by homeownership status. That is whether households are renters, mortgagors or outright homeowners. I define households as renters if rental payments per month are greater than zero. Mortgagors are defined as households who own their home and have mortgage payments are greater than zero. Outright homeowners are those who own their own home and have not made mortgage payments in the past twelve months.

I find that the total spending initially rises for renters, mortgagors and outright homeowners. However, two years after the shock, total spending falls for all three groups. Figure 15 shows homeowners reduce their total spending one year after the shock. They do so by reducing their non-durable consumption by two percentage points, shown in the bottom left panel of Figure 15. Surprisingly, durable consumption increases by five percentage points for both mortgagors and outright homeowners one year after the shock. This response is temporary, with durable consumption unchanged two years after the shock for outright homeowners and one percentage point higher five years after the shock for mortgagors. In contrast, the left panel of Figure 15 plots renters reducing their durable

[24] see Appendix A.6 for the entire asset composition.

[25] Households may move houses between HILDA waves. This may have a significant impact on liquid wealth, particularly for those who are buying or selling a home. For robustness, I drop all households which have moved address in the past 12 months. I find that my results are largely unchanged. See Appendix B.7 and A.6.

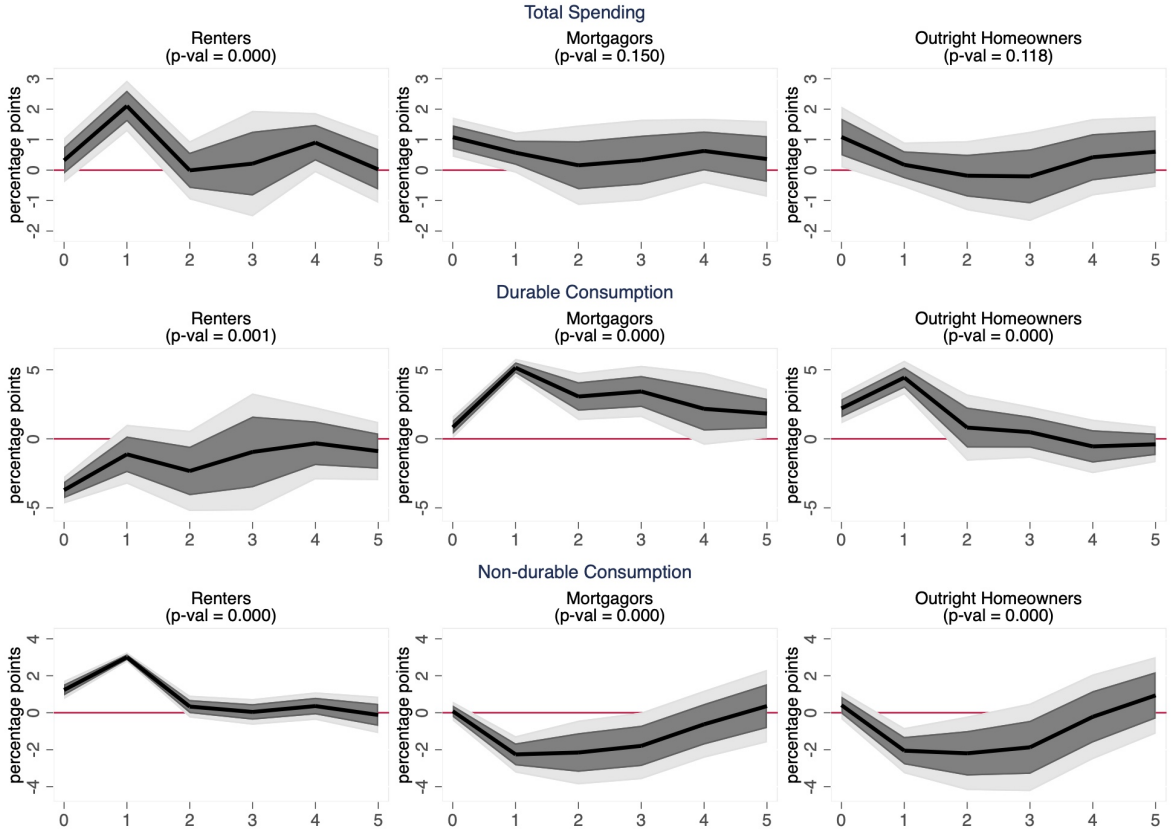

Figure 15: Response of total spending, durable consumption, and non-durable consumption to a 100 b.p. unanticipated contractionary monetary policy shock by homeownership status

consumption and increasing their non-durable consumption following a monetary policy shock. I find that total spending of renters, mortgagors and outright homeowners is responsive to monetary policy shocks.

My results show clear heterogeneity in the response of total spending to a contractionary monetary policy shock across the income and wealth distribution. This heterogeneity likely arises for three reasons. Firstly, the composition of total spending allows homeowners and those who consume and earn the most income to reduce their total spending the most (see Figure 13 and 14). Secondly, intertemporal substitution encourages mortgagors to save rather than spend and thirdly, the wealth effect discourages homeowners from consuming.

4.3.3 Composition of total spending

One reason for the heterogeneous response of total spending could be that the composition of total spending differs between those at the top and those at the bottom. Coibion, Gorodnichenko, Kueng, and Silvia (2017) identify that different groups consume very different bundles of goods. Those at the top typically consume more durable goods as a share of total spending as well as more discretionary goods as a share of their non-durable consumption. This means that those who consume the most, earn the most and likely own a home, have the greatest capacity to reduce their total spending (see Table 3, where homeowners have the consume and earn the most). Firstly, by reducing consumption of discretionary items and secondly, by delaying the purchase of durable goods.

Non-durable goods can be split into two categories: discretionary and essential. Discretionary goods includes alcohol, hospitality and recreation. May, Nodari, and Rees (2019) find that these goods are responsive to changes in household wealth as measured by short run elasticities. Discretionary non-durables goods are like durable goods in that they are particularly responsive to a house price shock. The consumption of non-durable discretionary goods display the same lumpy characteristic of durable goods (Berger & Vavra, 2014). It is typically understood that aggregate non-durable expenditure does not demonstrate a strong cyclical pattern. However, there are clear distributional effects of monetary policy on non-durable consumption and once decomposed into discretionary and essential I find that discretionary non-durable expenditure is volatile.[26]

Figure 16 highlights the volatility of discretionary non-durable consumption for those who spend the most on non-durable goods. The volatility is amplified further amongst outright homeowners who have clear spikes and troughs in discretionary non-durable consumption over time. This suggests that homeowners, particularly outright homeowners, who are spending the most - the 90th percentile, are the most sensitive to contractionary monetary policy shocks and reduce their discretionary non-durable consumption in re-

[26]I find that the essential non-durable expenditure does not have a cyclical pattern and has remained steady across the distribution over time, see Appendix A.4.

sponse.

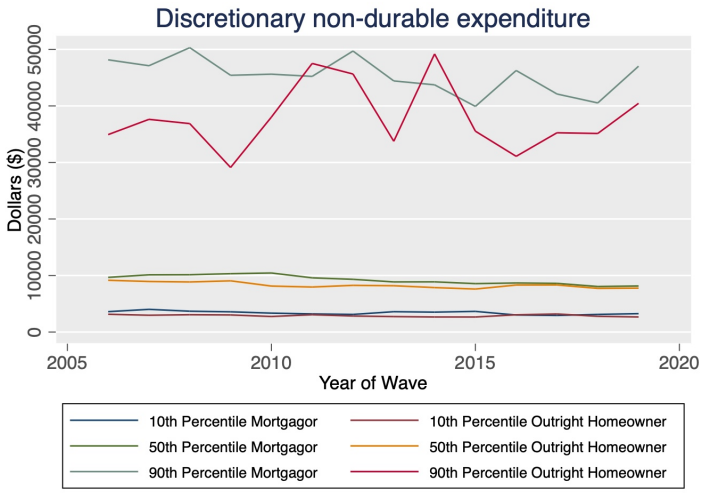

Figure 16: Discretionary non-durable consumption of homeowners over time by non-durable consumption percentile

Moreover, I find that non-durable consumption falls the most for homeowners who consume the most, as shown in Figure 17. The log difference of consumption between the 90th percentile and the median falls. This can be seen by the red line for both outright homeowners and mortgagors. I find that the fall is more pronounced for outright homeowners when compared to mortgagors. In contrast, the non-durable consumption of the 90th percentile when compared to the median is unchanged in response to a contractionary monetary policy shock for renters. The blue line shows the log difference between the non-durable consumption of the 10th percentile and the median. This allows us to consider the effect of a contractionary monetary policy on the non-durable consumption of the bottom when compared to the median. I find that the non-durable consumption of those at the bottom increase relative to the median for outright homeowners, mortgagors and renters. The effect of a contractionary monetary policy shock on the bottom is the strongest amongst renters. This means that renters who consume the least non-durable goods increase their non-durable consumption the most relative to the median.

Figure 17: Response of log difference of 90th-50th percentile and 10th-50th percentile non-durable consumption to a 100 b.p. contractionary monetary policy shock by housing tenure

Durable goods are an important component of consumption particularly in the transmission of monetary policy. This is because durable goods consumption is highly responsive to changes in the interest rate (McKay & Wieland, 2021). Spending on durable goods is lumpy and extremely volatile to economic shocks. Households are able to delay their consumption of durable goods. Building on Berger and Vavra (2014), McKay and Wieland (2021) highlight the role of intertemporal shifting through a fixed cost model of durable consumption demand. They find that following an expansionary monetary policy shock households close to their adjustment threshold accelerate their durable consumption. Here, the adjustment threshold is the point at which households purchase, replace and accumulate durable goods.

I find that durable consumption increases for homeowners, one year after the shock (Figure 15). This is a surprising result, but not an unusual one. The response of durable consumption could be attributed to the aggregation of variables on an annual level. This means the intertemporal shifting that occurs in the first four quarters cannot be observed. Instead, Figure 15 captures the new adjustment threshold, as households are unable to permanently delay purchasing durable goods. In addition, durable goods tend to be of

higher value, for example, vehicles and furnishings. This means that households likely save in anticipation of the adjustment threshold, the point at which the good needs to be replaced. This is in contrast to discretionary non-durable goods, such as hospitality and recreation, which can be permanently forgone and tend to be lower in value.

4.3.4 Intertemporal substitution

Secondly, an unexpected contractionary monetary policy shock encourages households to save instead of spend. This is because high interest rates are an incentive for households to save more for future periods. In particular, it encourages mortgagors to pay off their debt e.g. mortgage. I find intertemporal substitution is strongest amongst homeowners. This is likely the case for three reasons.

First, elasticity of intertemporal substitution is not homogeneous across the distribution. The literature suggests that the elasticity of intertemporal substitution of households increases with wealth as well as stock market participation (Attanasio, Banks, and Tanner, 2002; Guvenen, 2006; Attanasio and Weber, 2010; Thimme, 2017; Cloyne, Ferreira, and Surico, 2020). Both are more likely to be true for homeowners rather than renters. Table 3 shows that wealth held by homeowners is substantially more than renters, especially liquid assets which include equity and cash investments.

Secondly, homeowners have the capacity to reduce their consumption, for example by reducing consumption on discretionary non-durable goods, as discussed above. This allows households to smooth their consumption over time. Kaplan and Violante (2018) highlight that non-hand-to-mouth households have a greater capacity to save for future periods. This is because non-hand-to-mouth households have a higher level of liquid wealth. Table 3 highlights that a large proportion of mortgagors and outright homeowners are non-hand-to-mouth households, meaning homeowners have a higher level of liquid wealth and capacity to save for future periods.

Thirdly, the impact of a contractionary monetary policy shock on the consumption

of homeowners is transitory. Berger, Guerrieri, Lorenzoni, and Vavra (2018) find that the aggregate elasticity of intertemporal substitution increases following a negative shock to house prices. This suggests that homeowners respond to a contractionary monetary policy shock and falling house prices by reducing their spending in favour of saving. Outright homeowners have a greater capacity to reduce their consumption, and as they have greater liquid wealth are more inclined to save. This could explain the sensitivity of particularly outright homeowners, to a contractionary monetary policy shock. As house prices normalise, homeowners resume spending, as can be seen in the top right panel of Figure 15.

4.3.5 Wealth effect

Lastly, the wealth effect likely plays a role in reducing the consumption of homeowners. This is because following an unanticipated 100 b.p. contractionary monetary policy shock aggregate house prices fall. Like house prices, consumption recovers and 5 years after the shock consumption is above its initial value. May, Nodari, and Rees (2019) find that consumption of durable goods and discretionary nondurable goods are responsive to changes in house prices. As house prices fall, homeowners reduce their consumption of these goods. Homeowners are more responsive to monetary policy shocks than renters due to the wealth effect.

5 Conclusion

As central banks globally tighten monetary policy, it is important to understand the impact on households. It is well understood that at an aggregate level contractionary monetary policy causes output and prices to fall and unemployment to rise (Romer and Romer, 2004; Bishop and Tulip, 2017; Beckers, 2020). However, the distributional impact of monetary policy shocks is less understood, particularly in Australia.

The first contribution of my thesis has been to determine whether monetary policy affects inequality. Using the local projections method (Jordà, 2005), I find that monetary policy has clear distributional effects. Namely, earnings inequality increases and consumption inequality decreases following a contractionary monetary policy shock. I then decompose the monetary policy shocks through high frequency identified shocks (Gürkaynak, Sack, & Swanson, 2004). I find that my results are robust and that responses to the pure policy component drive the distributional effects of a monetary policy shock.

Secondly, I find that monetary policy shocks are transmitted through the earnings heterogeneity, income composition and portfolio composition channels. This research builds on that of Coibion, Gorodnichenko, Kueng, and Silvia (2017) and Mumtaz and Theophilopoulou (2017) who highlight the role of earnings heterogeneity and income composition channels in the US and UK respectively. I find that earnings inequality widens as those at the bottom disproportionately face unemployment and reduced hours. Government automatic stabilisers offset the detrimental impact of a contractionary monetary policy shock on the earnings of the bottom quintile. It does so by providing transfer payments. Moreover, I find that Australia's progressive taxation system undercuts the gains made by those at the top from a contractionary monetary policy shock and reduces inequality. I then consider the role of the portfolio composition channel and find that housing is a significant asset in Australia with prices severely affected by a contractionary monetary policy shock. I consider the impact of the portfolio composition channel on consumption inequality by undertaking a heterogeneity analysis based on housing tenure.

I find that the consumption of homeowners that is, those who are wealthier, are the most sensitive to monetary policy shocks. I identify three channels of monetary policy transmission in Australia - earnings heterogeneity, income composition and portfolio composition all of which have distributional effects.

There are several possible lines of future research. First, central banks would benefit from research into the impact of inequality on the transmission of monetary policy. As central banks begin to normalise interest rates there is growing interest in the neutral rate. In a recent speech, Luci Ellis of the Reserve Bank of Australia discussed the role of rising inequality in lowering the neutral rate (Ellis, 2022; Mian, Straub, and Sufi, 2021; Rachel and Smith, 2018). Although this is broadly understood to be true, the role of inequality in the transmission of monetary policy is yet to be established and quantified in Australia.

Second, there is some evidence to suggest that the business cycle influences the impact of monetary policy on inequality (Colciago, Samarina, and de Haan, 2019; Furceri, Loungani, and Zdzienicka, 2018; O'Farrell, Rawdanowicz, and Inaba, 2016). That is whether the distributional effects of monetary policy are amplified during peaks and troughs in the business cycle. I believe this would be a constructive area for further research, particularly when monetary policy is used as a countercyclical tool to respond to changes in the business cycle.

Furthermore, it would be fruitful to understand whether households change their balance sheets in response to a monetary policy shock. This would extend the analysis of the portfolio composition channel, which for the purposes of this paper I assumed was fixed. Again, this analysis is limited by lack of publicly available high frequency survey data in Australia. Nonetheless, these avenues of future research would be valuable to the literature on inequality and monetary policy.

Monetary policy has clear distributional impacts. These effects are transmitted through the earnings heterogeneity, income composition and portfolio composition channel, result-

ing in earnings inequality increasing and consumption inequality decreasing in response to a contractionary monetary policy shock.

References

Alvaredo, F. (2018). The world inequality report. In *The world inequality report*. Harvard University Press.

Amaral, P. (2017). Monetary policy and inequality. *Economic Commentary*, (2017-01).

Ampudia, M., Georgarakos, D., Slacalek, J., Tristani, O., Vermeulen, P., & Violante, G. (2018). Monetary policy and household inequality.

Attanasio, O. P., Banks, J., & Tanner, S. (2002). Asset holding and consumption volatility. *Journal of political economy*, 110(4), 771–792.

Attanasio, O. P., & Weber, G. (2010). Consumption and saving: Models of intertemporal allocation and their implications for public policy. *Journal of Economic literature*, 48(3), 693–751.

Auclert, A., & Rognlie, M. (2018). *Inequality and aggregate demand*. National Bureau of Economic Research.

Aye, G. C., Clance, M. W., & Gupta, R. (2019). The effectiveness of monetary and fiscal policy shocks on us inequality: The role of uncertainty. *Quality & Quantity*, 53(1), 283–295.

Beckers, B. (2020). Credit spreads, monetary policy and the price puzzle.

Berger, D., Guerrieri, V., Lorenzoni, G., & Vavra, J. (2018). House prices and consumer spending. *The Review of Economic Studies*, 85(3), 1502–1542.

Berger, D., & Vavra, J. (2014). Measuring how fiscal shocks affect durable spending in recessions and expansions. *American Economic Review*, 104(5), 112–15.

Bernanke, B. (2015). Monetary policy and inequality. *Brookings Institution*, 1.

Bishop, J., & Tulip, P. (2017). Rdp 2017-02: Anticipatory monetary policy and the 'price puzzle'. *Reserve Bank of Australia Research Discussion Papers*, (May).

Bullard, J. B., et al. (2014). *Income inequality and monetary policy: A framework with answers to three questions*.

Carstens, A. (2014). Central banks and inequality. *International Monetary Review*, 38.

Chatterjee, A., Singh, A., & Stone, T. (2016). Understanding wage inequality in australia. *Economic Record*, 92(298), 348–360.

Christiano, L. J., Eichenbaum, M., & Evans, C. L. (1999). Monetary policy shocks: What have we learned and to what end? *Handbook of Macroeconomics*, 1, 65–148.

Claus, E., & Nguyen, V. H. (2020). Monetary policy shocks from the consumer perspective. *Journal of Monetary Economics*, 114, 159–173.

Cloyne, J., Ferreira, C., & Surico, P. (2020). Monetary policy when households have debt: New evidence on the transmission mechanism. *The Review of Economic Studies*, 87(1), 102–129.

Coibion, O. (2012). Are the effects of monetary policy shocks big or small? *American Economic Journal: Macroeconomics*, 4(2), 1–32.

Coibion, O., Gorodnichenko, Y., Kueng, L., & Silvia, J. (2017). Innocent bystanders? monetary policy and inequality. *Journal of Monetary Economics*, 88, 70–89.

Colciago, A., Samarina, A., & de Haan, J. (2019). Central bank policies and income and wealth inequality: A survey. *Journal of Economic Surveys*, 33(4), 1199–1231.

Cox, N. (2006). Winsor: Stata module to winsorize a variable.

Ellis, L. (2022). *The neutral rate: The pole-star casts faint light*. Reserve Bank of Australia.

Erosa, A., & Ventura, G. (2002). On inflation as a regressive consumption tax. *Journal of Monetary Economics*, 49(4), 761–795.

Furceri, D., Loungani, P., & Zdzienicka, A. (2018). The effects of monetary policy shocks on inequality. *Journal of International Money and Finance*, 85, 168–186.

Gertler, M., & Karadi, P. (2015). Monetary policy surprises, credit costs, and economic activity. *American Economic Journal: Macroeconomics*, 7(1), 44–76.

Gürkaynak, R. S., Sack, B. P., & Swanson, E. T. (2004). Do actions speak louder than words? the response of asset prices to monetary policy actions and statements. *The Response of Asset Prices to Monetary Policy Actions and Statements (November 2004)*.

Guvenen, F. (2006). Reconciling conflicting evidence on the elasticity of intertemporal substitution: A macroeconomic perspective. *Journal of Monetary Economics*, 53(7), 1451–1472.

Heathcote, J., Perri, F., & Violante, G. L. (2010). Unequal we stand: An empirical analysis of economic inequality in the united states, 1967–2006. *Review of Economic dynamics*, 13(1), 15–51.

Heathcote, J., Storesletten, K., & Violante, G. L. (2009). Quantitative macroeconomics with heterogeneous households. *Annu. Rev. Econ.*, 1(1), 319–354.

Hoechle, D. (2007). Robust standard errors for panel regressions with cross-sectional dependence. *The stata journal*, 7(3), 281–312.

Hughson, H., La Cava, G., Ryan, P., Smith, P., et al. (2016). The household cash flow channel of monetary policy. *RBA Bulletin, September*, 21–30.

Jarociński, M., & Karadi, P. (2020). Deconstructing monetary policy surprises—the role of information shocks. *American Economic Journal: Macroeconomics*, 12(2), 1–43.

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American economic review*, 95(1), 161–182.

Kaplan, G., La Cava, G., & Stone, T. (2018). Household economic inequality in australia. *Economic Record*, 94(305), 117–134.

Kaplan, G., Moll, B., & Violante, G. L. (2018). Monetary policy according to hank. *American Economic Review*, 108(3), 697–743.

Kaplan, G., & Violante, G. L. (2018). Microeconomic heterogeneity and macroeconomic shocks. *Journal of Economic Perspectives*, 32(3), 167–94.

Kaplan, G., Violante, G. L., & Weidner, J. (2014). *The wealthy hand-to-mouth*. National Bureau of Economic Research.

Kearns, J., Schrimpf, A., & Xia, F. D. (2020). Explaining monetary spillovers: The matrix reloaded.

Klapdor, M. (2022). *High inflation = higher social security rate increases*. Parliament of Australia.

La Cava, G., & He, C. (2021). The distributional effects of monetary policy: Evidence from local housing markets in australia. *Australian Economic Review*, 54(3), 387–397.

La Cava, G., Wang, L., et al. (2021). *The rise in household liquidity*. Reserve Bank of Australia.

Loukoianova, M. E., Wong, Y. C., & Hussiada, I. (2019). *Household debt, consumption, and monetary policy in australia*. International Monetary Fund.

May, D., Nodari, G., & Rees, D. (2019). Wealth and consumption. *RBA Bulletin, March, viewed*, 11.

McKay, A., & Wieland, J. F. (2021). Lumpy durable consumption demand and the limited ammunition of monetary policy. *Econometrica*, 89(6), 2717–2749.

Mian, A. R., Straub, L., & Sufi, A. (2021). What explains the decline in r*? rising income inequality versus demographic shifts. *Rising Income Inequality Versus Demographic Shifts (September 2, 2021). University of Chicago, Becker Friedman Institute for Economics Working Paper*, (2021-104).

Mumtaz, H., & Theophilopoulou, A. (2017). The impact of monetary policy on inequality in the uk. an empirical analysis. *European Economic Review*, 98, 410–423.

Nakamura, E., & Steinsson, J. (2018). High-frequency identification of monetary non-neutrality: The information effect. *The Quarterly Journal of Economics*, 133(3), 1283–1330.

Nguyen, K., La Cava, G., et al. (2020). News sentiment and the economy| bulletin–june quarter 2020. *Bulletin*, (June).

Nunes, R. C., Ozdagli, A. K., & Tang, J. (2022). Interest rate surprises: A tale of two shocks.

O'Farrell, R., Rawdanowicz, Ł., & Inaba, K.-I. (2016). Monetary policy and inequality.

Ottonello, P., & Winberry, T. (2020). Financial heterogeneity and the investment channel of monetary policy. *Econometrica*, 88(6), 2473–2502.

Penrose, G., La Cava, G., et al. (2021). *Job loss, subjective expectations and household spending*. Reserve Bank of Australia.

Piketty, T., & Saez, E. (2014). Inequality in the long run. *Science*, 344(6186), 838–843.

Plagborg-Møller, M., & Wolf, C. K. (2021). Local projections and vars estimate the same impulse responses. *Econometrica*, 89(2), 955–980.

Productivity Commission. (2018). Rising inequality? a stocktake of the evidence.

Rachel, L., & Smith, T. D. (2018). Are low real interest rates here to stay? *50th issue (September 2017) of the International Journal of Central Banking*.

Ramey, V. A. (2016). Macroeconomic shocks and their propagation. *Handbook of macroeconomics*, 2, 71–162.

Romer, C. D., & Romer, D. H. (2004). A new measure of monetary shocks: Derivation and implications. *American Economic Review*, 94(4), 1055–1084.

Saunders, P., & Siminski, P. (2005). Home ownership and inequality: Imputed rent and income distribution in australia. *Economic Papers: A journal of applied economics and policy*, 24(4), 346–367.

Singh, A., & Di Crestvolant, S. T. (2020). Transmission of monetary policy shocks: Do input–output interactions matter? *Macroeconomic Dynamics*, 24(8), 1881–1903.

Summerfield, M., Garrard, B., Hahn, M., Jin, Y., Kamath, R., Macalalad, N., Watson, N., Wilkins, R., & Wooden, M. (2021). Hilda user manual – release 20. *Melbourne Institute of Applied Economic and Social Research, University of Melbourne*.

Thimme, J. (2017). Intertemporal substitution in consumption: A literature review. *Journal of Economic Surveys*, 31(1), 226–257.

Watson, N., & Wooden, M. (2004). Sample attrition in the hilda survey. *Australian Journal of Labour Economics*, 7(2), 293–308.

Wilkins, R. (2014). Evaluating the evidence on income inequality in australia in the 2000s. *Economic Record*, 90(288), 63–89.

Windsor, C., Jääskelä, J. P., & Finlay, R. (2015). Housing wealth effects: Evidence from an australian panel. *Economica*, 82(327), 552–577.

Wong, A., et al. (2019). Refinancing and the transmission of monetary policy to consumption. *Unpublished manuscript*, 20.

Yates, J. (1994). Imputed rent and income distribution. *Review of income and wealth*, 40(1), 43–66.

A Data Appendix

A.1 Sources of data

Table 4: Sources of data

Variable	Description	Source	Series ID
Interest rates	Interbank Overnight Cash Rate; monthly average, original, per cent	RBA	FIRMMCRI
Real GDP	Gross domestic product, chain volume, seasonally adjusted, quarterly, $ millions	ABS	GGDPCVGDP
Unemployment rate	Monthly unemployment rate, monthly, seasonally adjusted, per cent	ABS	A84423050A
Inflation	Quarterly inflation - excluding interest and tax changes of 1999-2000, seasonally adjusted, per cent change	RBA	GCPIEITCQP
House Prices	Nominal house price, seasonally adjusted, quarterly, Reference year 2015	OECD	Analytical house price indicators
Consumption	Final consumption expenditure, chain volume, seasonally adjusted, quarterly, $ millions	ABS	A2303280V
Durables	Constructed by summation of Purchase of vehicles; Furnishings and household equipment and Clothing and footwear. All are chain volume, seasonally adjusted, quarterly, $ millions	ABS	A2303262R; A2303258X and A2303252K
Nondurables	Constructed by summation of Food; Cigarettes and tobacco; Alcoholic beverages. All are chain volume, seasonally adjusted, quarterly, $ millions	ABS	A2303246R; A2303248V; A2303250F
Services	Electricity, gas and other fuel; Health; Operation of vehicles; Communications; Recreation and culture; Hotels, cafes and restaurants; Rent and other dwelling services; Transport services; Education services and Insurance and other financial services. All are chain volume, seasonally adjusted, quarterly, $ millions	ABS	A2303256V; A2303260K; A2303264V; A2303268C; A2303270R and A2303274X; A2303254R; A2303266X; A2303272V and A2303276C

A.2 Sample selection

Table 6 and 7 show the number of observations for income, earnings, consumption and expenditure in each year. The observations are selected from HILDA to calculate the three measures of inequality. Table 6 shows the number of observations of income, earnings, consumption and expenditure in each year. Table 7 then also takes the logarithmic function of the Table 6 values. This requires observations with a value of zero to be dropped.

Table 5: Sample Selection - Real Variables

Year	**Income**	**Earnings**	**Consumption**	**Expenditure**
2001	10883	10883	0	0
2002	9914	9914	0	0
2003	9740	9740	0	0
2004	9484	9484	0	0
2005	9632	9632	0	0
2006	9644	9644	9644	9644
2007	9569	9569	9569	9569
2008	9548	9548	9548	9548
2009	9705	9705	9705	9705
2010	9742	9742	9742	9742
2011	13065	13065	13065	13065
2012	12993	12993	12993	12993
2013	13092	13092	13092	13092
2014	13043	13043	13043	13043
2015	13273	13273	13273	13273
2016	13398	13398	13398	13398
2017	13351	13351	13351	13351
2018	13315	13315	13315	13315
2019	13332	13332	13332	13332
2020	13056	13056	13056	13056
Total	229779	229779	180126	180126

Table 6: Sample Selection - Log Real Variables

Year	**Income**	**Earnings**	**Consumption**	**Expenditure**
2001	10883	8184	0	0
2002	9914	7518	0	0
2003	9740	7364	0	0
2004	9484	7175	0	0
2005	9632	7383	0	0
2006	9644	7501	9644	9644
2007	9569	7486	9569	9569
2008	9548	7540	9548	9548
2009	9705	7756	9705	9705
2010	9742	7793	9742	9742
2011	13065	10426	13065	13065
2012	12993	10447	12993	12993
2013	13092	10513	13092	13092
2014	13043	10401	13043	13043
2015	13273	10567	13273	13273
2016	13398	10610	13398	13398
2017	13351	10561	13351	13351
2018	13315	10580	13315	13315
2019	13332	10659	13332	13332
2020	13056	10357	13056	13056
Total	229779	180821	180126	180126

A.3 Monetary policy shocks

A.3.1 High frequency shocks

Table 7: Target shocks

	Raw shocks	Quarterly aggregate	Annual aggregate
Median (ppts)	0	0	-0.016
Mean (ppts)	0.003	0.010	0.034
Standard deviation (ppts)	0.058	0.101	0.221
Min (ppts)	-0.200	-0.144	-0.195
Max (ppts)	0.317	0.382	0.649
Numbers of shocks	149	39	11

Table 8: Path shocks

	Raw shocks	Quarterly aggregate	Annual aggregate
Median (ppts)	0.008	0.011	0.0213
Mean (ppts)	0	0	0
Standard deviation (ppts)	0.040	0.078	0.223
Min (ppts)	-0.218	-0.220	-0.532
Max (ppts)	0.118	0.143	0.280
Numbers of shocks	149	39	11

A.4 Composition of total spending

I construct measures of durable and non-durable expenditure like Penrose, La Cava, et al. (2021). Non-durables are measured from 2006 to 2019 and includes groceries, meals eaten out, alcohol and tobacco, transport, clothing and footwear, motor vehicle fuel and maintenance, home repairs, renovation and maintenance, healthcare fees and products, utilities, telecommunications, education fees and insurance. Holiday travel is only measured from 2006 to 2010. I exclude it from my analysis of non-durable consumption. Durables are also measured from 2006 to 2010 and are limited to motor vehicles (new and used), computers and related devices, audio visual equipment, household appliances and furniture.

Table 9: Non-durable expenditure by housing tenure table

	Renters	Mortgagors	Outright	Total
Alcohol ($)	1560.4	1791.2	1694.7	1692.9
Childrens clothing and footwear ($)	472.6	630.1	377.3	518.6
Cigarettes and tobacco ($)	1398.0	821.4	626.9	963.3
Education fees ($)	870.5	2209.9	1800.0	1675.3
Groceries ($)	7054.0	10182.5	10102.8	9142.5
Fees paid to health practitioners ($)	529.8	1119.4	1286.6	966.7
Home repairs/renovations/maintenance ($)	469.7	5355.1	4437.2	3542.4
Mens clothing and footwear ($)	468.2	626.9	619.8	573.4
Meals eaten out ($)	2880.1	3474.2	3106.7	3192.9
Motor vehicle fuel ($)	2052.1	2868.9	2718.3	2566.5
Motor vehicle repairs/maintenance ($)	747.8	1171.6	1215.7	1043.8
Other insurance ($)	774.3	2041.0	2175.2	1659.5
Public transport and taxis ($)	621.7	525.1	413.5	530.1
Private health insurance ($)	599.7	1582.0	1888.3	1334.2
Medicines ($)	295.8	474.0	582.6	441.7
Telephone rent, calls and internet charges ($)	2386.1	2085.6	1956.2	2152.9
Electricity bills, gas bills and other heating ($)	1366.2	2064.3	1886.4	1794.1
Womens clothing and footwear ($)	688.6	972.4	1021.1	891.4
Discretionary goods ($)	7937.7	13671.2	11883.7	11374.9
Essential goods ($)	17298.1	26324.1	26025.4	23307.3

A.4.1 Discretionary non-durable expenditure

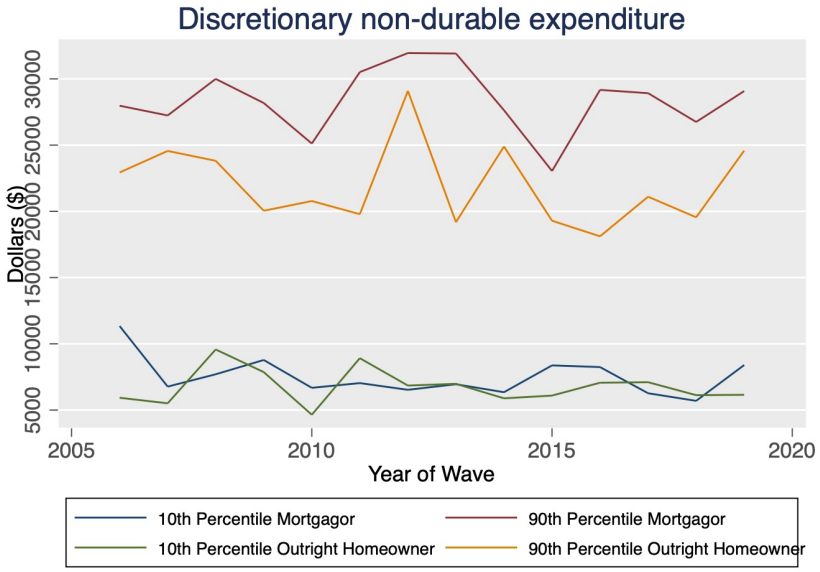

Figure 18: Discretionary non-durable expenditure of homeowners over time by income percentile

A.4.2 Essential non-durable expenditure

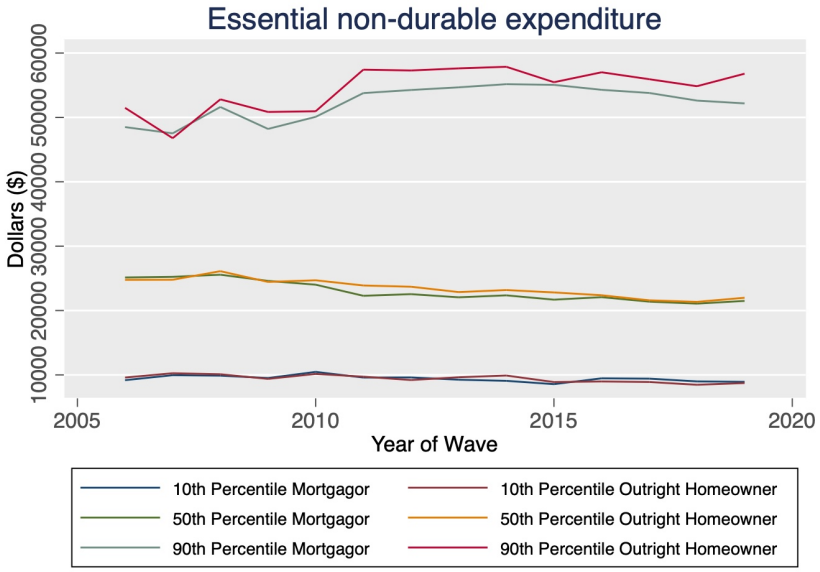

Figure 19: Essential non-durable expenditure of homeowners over time by percentile

A.5 Imputing total spending

A.5.1 Whole sample

Table 10: Total Spending - Whole Sample

$$totalspending_{i,t} = \alpha_0 + \alpha_1 meo_{it} + \alpha_2 gro_{it} + \alpha_3 cc_{it} + \alpha_4 age_{it} + \alpha_5 age_{it}^2 + E_{it}$$

	(1) Linear model	(2) Log linear model
Meals eaten out	2.993***	0.0000556***
Groceries	2.159***	0.0000439***
Childcare	0.301***	0.00000683***
Age	1148.3***	0.0285***
Age squared	-10.90***	-0.000299***
Constant	-10541.6***	9.335***
Adjusted R^2	0.338	0.344
Observations	40226	40226

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A.5.2 Homeowners

Table 11: Total Spending - Homeowners

$$totalspending_{i,t} = \alpha_0 + \alpha_1 meo_{it} + \alpha_2 gro_{it} + \alpha_3 cc_{it} + \alpha_4 age_{it} + \alpha_5 age_{it}^2 + E_{it}$$

	(1) Linear model	(2) Log linear model
Meals eaten out	3.022***	0.0000490***
Groceries	1.999***	0.0000357***
Childcare	0.205***	0.00000410***
Age	1018.1***	0.0218***
Age squared	-10.62***	-0.000249***
Constant	321.6	9.757***
Observations	28529	28529
Adjusted R^2	0.299	0.315

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A.5.3 Outright homeowners

Table 12: Total Spending - Outright Homeowners

$$totalspending_{i,t} = \alpha_0 + \alpha_1 meo_{it} + \alpha_2 gro_{it} + \alpha_3 cc_{it} + \alpha_4 age_{it} + \alpha_5 age_{it}^2 + E_{it}$$

	(1) Linear model	(2) Log linear model
Meals eaten out	3.087***	0.0000491***
Groceries	2.110***	0.0000376***
Childcare	0.195	0.00000496*
Age	1354.8***	0.0256***
Age squared	-13.83***	-0.000276***
Constant	-7846.5	9.635***
Observations	11187	11187
Adjusted R^2	0.323	0.328

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A.5.4 Mortgagors

Table 13: Total Spending - Mortgagors

$$totalspending_{i,t} = \alpha_0 + \alpha_1 meo_{it} + \alpha_2 gro_{it} + \alpha_3 cc_{it} + \alpha_4 age_{it} + \alpha_5 age_{it}^2 + E_{it}$$

	(1) Linear model	(2) Log linear model
Meals eaten out	2.953***	0.0000486***
Groceries	1.924***	0.0000345***
Childcare	0.217***	0.00000392***
Age	1527.9***	0.0329***
Age squared	-18.24***	-0.000407***
Constant	-6992.8*	9.584***
Observations	17342	17342
Adjusted R^2	0.287	0.309

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A.5.5 Renters

Table 14: Total Spending - Renters

$$totalspending_{i,t} = \alpha_0 + \alpha_1 meo_{it} + \alpha_2 gro_{it} + \alpha_3 cc_{it} + \alpha_4 age_{it} + \alpha_5 age_{it}^2 + E_{it}$$

	(1) Linear model	(2) Log linear model
Meals eaten out	2.673***	0.0000651***
Groceries	1.891***	0.0000523***
Childcare	0.233**	0.00000489**
Age	440.6***	0.0235***
Age squared	-5.964***	-0.000347***
Constant	3844.3	9.266***
Observations	11677	11677
Adjusted R^2	0.347	0.345

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A.6 Portfolio composition

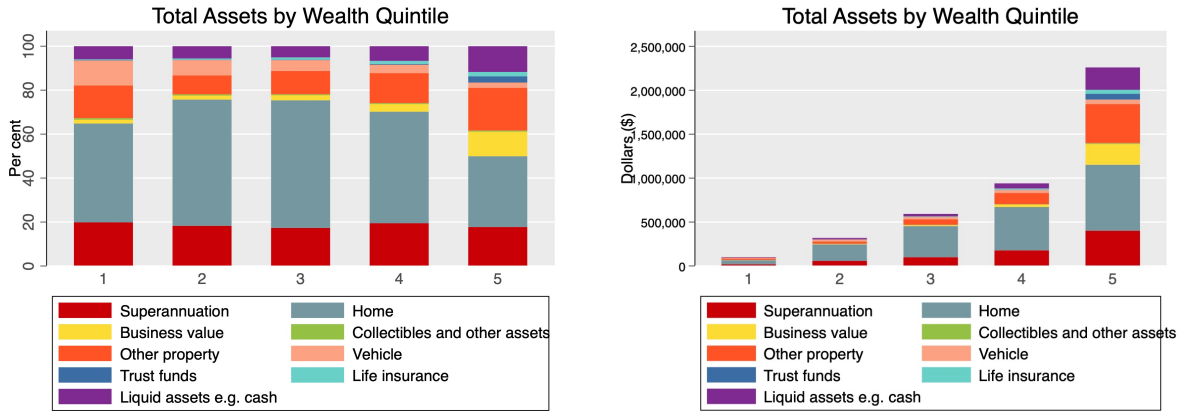

Figure 20: Total assets by wealth quintile

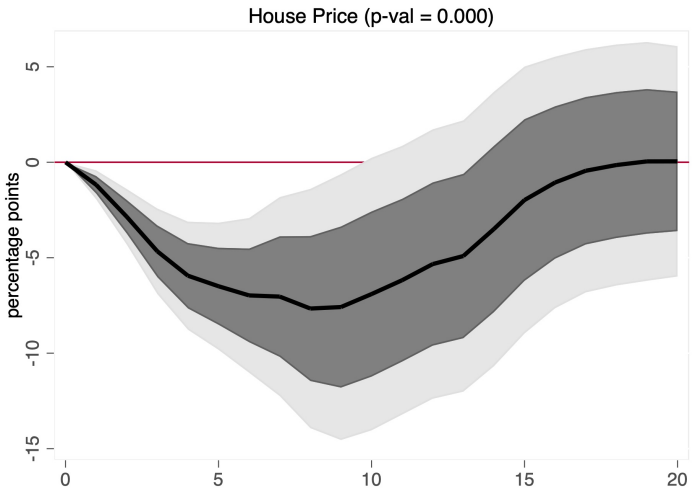

Figure 21: Response of aggregate house prices to a 100 b.p. unanticipated contractionary monetary policy shock by homeownership status

B Robustness Appendix

I undertake a number of robustness checks on my results. I find that my results are robust to aggregating monetary policy shocks on an annual basis, as well as different lag structures. I also compare the impact of monetary policy on inequality measures using narrative shocks from Bishop and Tulip (2017) instead of Beckers (2020). I then use high frequency shocks to disentangle the impact of short term interest rate setting, through the policy rate, from long term structural path of interest rates. I find that the impact of monetary policy on inequality occurs through the target shock. I then discuss the impact of the path shock on macroeconomic variables and inequality measures.

B.1 Inequality measures and macroeconomic variables

Over the past two decades, inequality has fluctuated, with pre-tax earnings inequality decreasing. At the same time, there have been slight increases in inequality for income, consumption and expenditure and more recently a decrease in consumption and expenditure inequality, most notably between 2006 and 2010. Table 15 assesses what is driving

these trends and whether these fluctuations are related to the business cycle.

Table 15: Correlations between inequality measures and macroeconomic variables

Panel A: Correlation with the annual inflation rate			
Inequality	Corr(π, SD)	Corr(π, Gini)	Corr(π, 90th-10th)
Income	0.580	0.497	0.478
Earnings	-0.068	0.141	-0.111
Expenditure	0.132	0.239	0.104
Consumption	0.225	0.257	0.183
Panel B: Correlation with the unemployment rate			
	Corr(UE, SD)	Corr(UE, Gini)	Corr(UE, 90th-10th)
Income	-0.272	-0.224	-0.183
Earnings	0.148	0.078	0.118
Expenditure	0.023	-0.1023	-0.007
Consumption	-0.002	-0.046	0.0001
Panel C: Correlation with the target cash rate			
	Corr(Cash Rate, SD)	Corr(Cash Rate, Gini)	Corr(Cash Rate, 90th-10th)
Income	0.258	0.257	0.245
Earnings	-0.103	0.076	-0.038
Expenditure	0.001	0.074	0.002
Consumption	0.068	0.095	0.065

Table 15 reports the correlation between the cyclical component of income, earnings, expenditure and consumption inequality with the inflation rate (π in Panel A), unemployment rate (UE in Panel B) and the target cash rate (Cash Rate in Panel C). The correlations are calculated against three measures of inequality - cross-sectional standard deviations of log levels (SD in Column 1), Gini coefficient (Gini in Column 2) and difference between log levels at the 90th and 10th percentile (90th-10th in Column 3). Inflation, unemployment and cash rate measures are four-quarter averages. Both inflation and unemployment, as well as the inequality measures have been HP-filtered.

Table 15 summarises the unconditional correlations between the cyclical component of income, earnings, expenditure and consumption inequality with three macroeconomic variables - inflation, unemployment and the RBA target cash rate. Both the inequality measures and macroeconomic variables, except the cash rate, are HP filtered to isolate the cyclical component. I then calculate the correlation between each measure of inequality and inflation, unemployment rate and the target cash rate.

I find that earnings inequality has a weak positive correlation with the unemployment rate, suggesting that earnings inequality worsens as unemployment increases. This would reflect the employment insecurity of individuals on low wages, who are more likely to be unemployed than those on high wages. These findings are consistent with Coibion,

Gorodnichenko, Kueng, and Silvia (2017).

In contrast, income inequality has a strong negative correlation with the unemployment rate. Income is composed of earnings as well as other sources of income such as financial or business income. Low-income households predominantly rely on transfers and earnings, whilst high-income households tend to have more diverse income sources including business or financial income. This measure of earnings excludes transfers. As the unemployment rate rises, more households rely on transfers, such as unemployment benefits. This may account for the different signs between the income and earnings inequality correlations as transfers offset the impact of a decrease in wages for low-income earners. The strong positive correlation between the cash rate, inflation and income inequality likely reflects the income composition channel, with non-labour income likely driving the income of high income earners. As interest rates rise, savers, likely those with higher incomes benefit from the savings redistribution channel through interest rate payments. These results differ from Coibion, Gorodnichenko, Kueng, and Silvia (2017) who find income inequality does not vary with the business cycle.

I find that there is, however, low correlation between expenditure and consumption inequality and unemployment and target cash rate. However, there is a weak positive correlation with inflation. This suggests that inflation acts as a regressive consumption tax, with those who consume little, consuming even less as prices rise (Erosa & Ventura, 2002).

B.2 Impact of annual MP shocks on macroeconomic variables

First, I assess the impact of aggregating my monetary policy shocks on an annual basis. I use the annual monetary policy shocks to determine the impact of monetary policy on inequality. To assess the robustness of the annually aggregated monetary policy shocks I observe the response of annually aggregated macroeconomic variables to the annually aggregate shocks. This allows me to compare the response of macroeconomic variables

when shocked by annual and quarterly aggregated monetary policy shock series.

Here I use include 2 lags of the monetary policy shock series and 2 for the dependent variables. I find that the annual macrovariables move in the same direction as the quarterly macrovariables in response to a monetary policy shock. However, these results are no longer statistically significant.

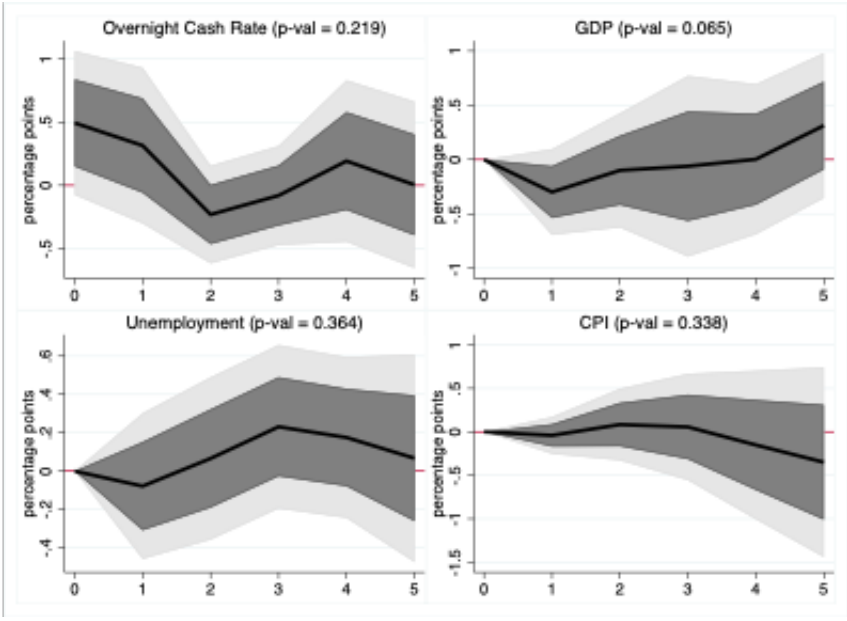

Figure 22: Response of real annual macroeconomic variables to a 100 b.p. unanticipated contractionary monetary policy shock, where the shock series has been aggregated annually, 1994:Q1-2019:Q4

B.3 Lag structure of inequality response to monetary policy shocks

I assess the lag structure used in my local projections method. I first extend the lag for the monetary policy shock to five years, in Figure 28.

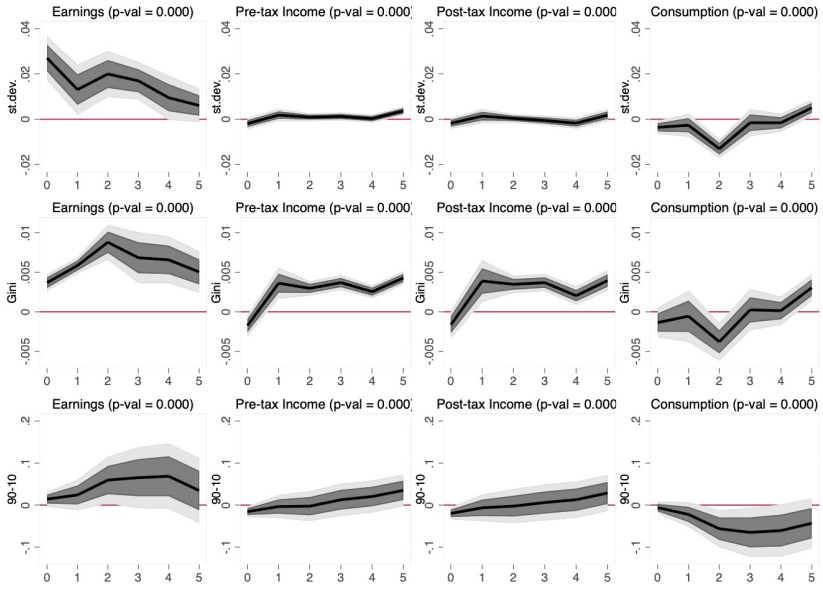

Figure 23: Response of earnings, pre-tax income, post-tax income and consumption inequality to a 100 b.p. unanticipated contractionary monetary policy shock

I then extend the lag for the dependent variable to five years. I find that the response of the inequality measures remains the same in Figure 29.

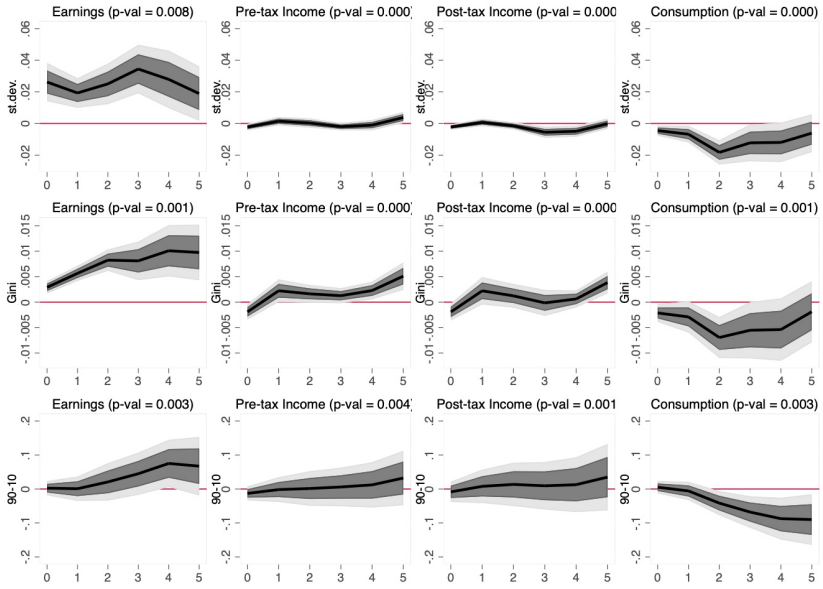

Figure 24: Response of earnings, pre-tax income, post-tax income and consumption inequality to a 100 b.p. unanticipated contractionary monetary policy shock

B.4 High frequency shocks

I also use high frequency shocks identified by Kearns, Schrimpf, and Xia (2020) to disentangle the long term interest rate path from short term unexpected changes in the cash rate. This allows me to compare the results of the narrative shocks against the target and path of shocks. Kearns, Schrimpf, and Xia (2020) follows Gürkaynak, Sack, and Swanson (2004); Gertler and Karadi (2015) and Nakamura and Steinsson (2018) and identifies high frequency monetary policy shocks in seven major economies, including Australia, Japan, UK and US. Like Gürkaynak, Sack, and Swanson (2004), Kearns, Schrimpf, and Xia (2020) identify two components of a monetary policy shock. The first is the target shock, which is measured as the change in the interest rate on Overnight Indexed Swaps (OIS), and the second is the path shock, which is measured as the change in the two year government bond yield independent of the OIS rate.[27] The target shock allows us to observe the short term unanticipated shock to markets as they readjust their expectations, for example, in response to timing surprises. The path shock captures the market's readjustment of the long term interest rate path, for example in response to forward guidance.

Kearns, Schrimpf, and Xia (2020) construct the series by observing the changes in interest rates for OIS and government bond yields before and after monetary policy announcements. Monetary policy announcements include bank board meetings but also speeches and Bank publications. Kearns, Schrimpf, and Xia (2020) identify a window 15 minutes before and after the shock to observe changes in interest rates. This 15 minute window is between 20 minutes and 5 minutes before and after the shock, with Kearns, Schrimpf, and Xia (2020) omitting the 5 minutes directly before and after the shock to allow the market to process the news and to reduce noise.

Like the narrative shocks from Beckers (2020), I aggregate the high frequency shocks at a quarterly and annual frequency between 2006 and 2015. I find that for the target

[27]Kearns, Schrimpf, and Xia (2020) identify a third component which is the risk premium shock which allows them to capture the impact of monetary policy at the zero lower bound. This is identified as the change in the 10 year government bond yield independent of the change in the 2 year yield. My analysis will be limited to the target and path shocks.

shocks series, shown in the left panel, there are 18 contractionary shocks aggregated on a quarterly level and four contractionary shocks when aggregated on an annual level. This can be seen in the left panel of Figure 25 and 26 respectively. In the right panel, I identify the path shock series. I find there are 26 quarterly contractionary path shocks and seven annual contractionary path shocks between 2006 and 2015.[28]

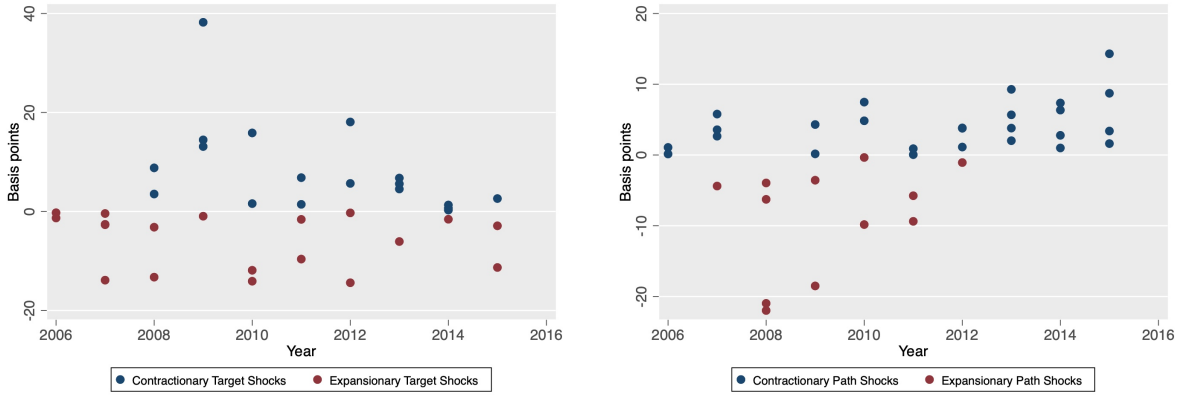

Figure 25: Quarterly target and path shock series

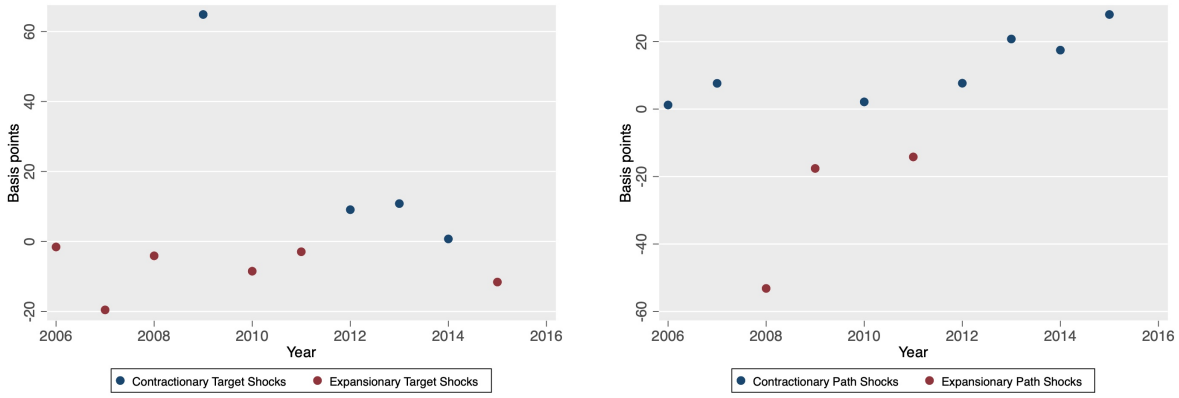

Figure 26: Annual target and path shock series

B.4.1 Target shocks and the macroeconomy

I undertake a robustness check of the narrative shocks used by Beckers (2020) by using high frequency shocks identified by Kearns, Schrimpf, and Xia (2020). I find that the response of macroeconomic variables to the target shock, shown in Figure 27, tracks the response to the narrative shocks.

[28] I include the summary statistics of the target and path shocks in the Appendix A.3.

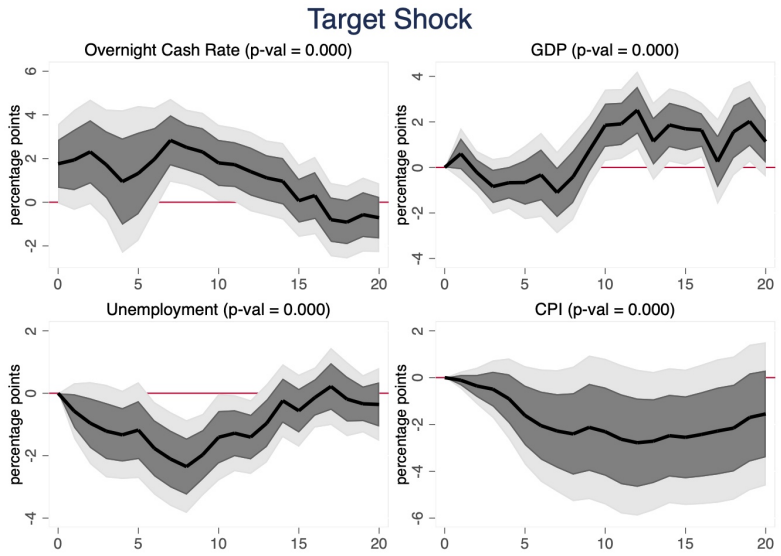

Figure 27: Response of real macroeconomic variables to a 100 b.p. target shocks, 2006:Q1-2015:Q4

Following a 100 b.p. target shock, I find that the overnight cash rate increases and remains high for some time before declining after 12 quarters. This can be seen in Figure 27. Output initially falls slightly before increasing eight quarters after the shock. Similar to the narrative shocks, the impact of a contractionary shock is found to decrease unemployment. This unemployment puzzle is also present following a path shock.[29] In addition, I observe prices fall following a contractionary target shock consistent with the responses to narrative shocks. These results are consistent with the literature which finds that in the US a target shock, or a pure policy shock, results in a fall in consumer prices and production (Nunes, Ozdagli, and Tang, 2022; Ramey, 2016; Jarociński and Karadi, 2020). The persistence of the impact of the Kearns, Schrimpf, and Xia (2020) target shock on the overnight cash rate is consistent with the impact of the Gertler and Karadi (2015) shock when using the Jordà framework (Ramey, 2016).

[29]See Appendix B.4 for discussion on the path shock.

B.4.2 Path shocks and the macroeconomy

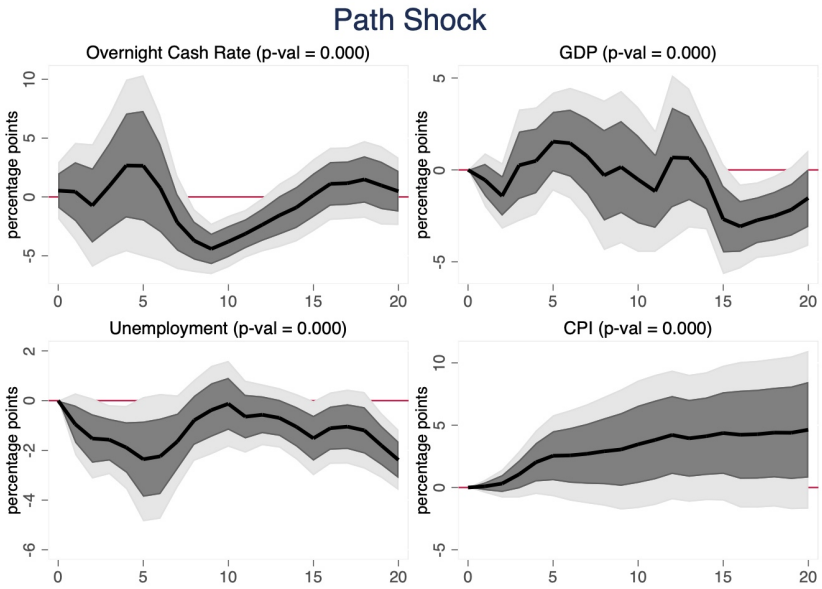

Figure 28: Response of real macroeconomic variables to a 100 b.p. path shock, 2006:Q1-2015:Q4

Macroeconomic variables are responsive to path shocks, with output increasing and prices rising falling a positive information shock. The information factor is significant and reflects market expectations of the future (Gürkaynak, Sack, & Swanson, 2004). When the market undertakes an upward revision of its expectations of future policy actions, it is typically in response to positive information from central banks regarding output and inflation. As Gürkaynak, Sack, and Swanson (2004) explain this could be a statement by the central bank anticipating higher than expected output or inflation in future periods. The new positive information causes higher levels of output and pushes prices upwards (Nunes, Ozdagli, & Tang, 2022). I find that the overnight cash rate increases after a lag of two quarters before decreasing after six quarters. Unemployment falls, like under the target and narrative shocks.

B.4.3 Target shocks and inequality

In Figure 29, I decompose the effect of monetary policy on inequality by using high frequency shocks. This allows me to disentangle the impact of monetary policy and determine whether the target or path component are driving the increase in earnings inequality and decrease in consumption inequality. I find that the pure policy shock, the target shock, propels the distributional effects of monetary policy.

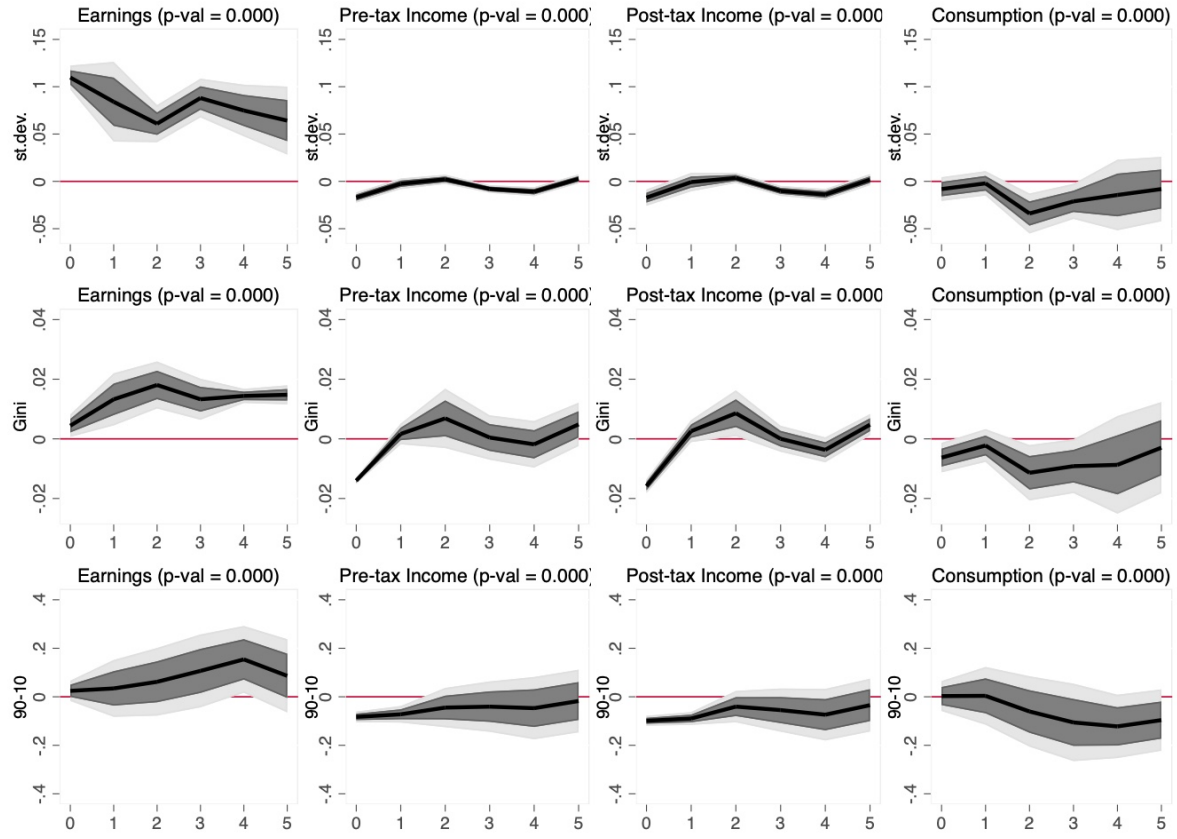

Figure 29: Response of inequality measures for earnings, pre-tax income, post-tax income and consumption to a 100 b.p. target shock

I find that the response of inequality to a 100 b.p. target shock closely follows the response of inequality to the narrative shock by Beckers (2020). In fact, the response of inequality measures to a target shock are more pronounced than the response to the narrative shock, approximately twice the size.

B.4.4 Path shocks and inequality

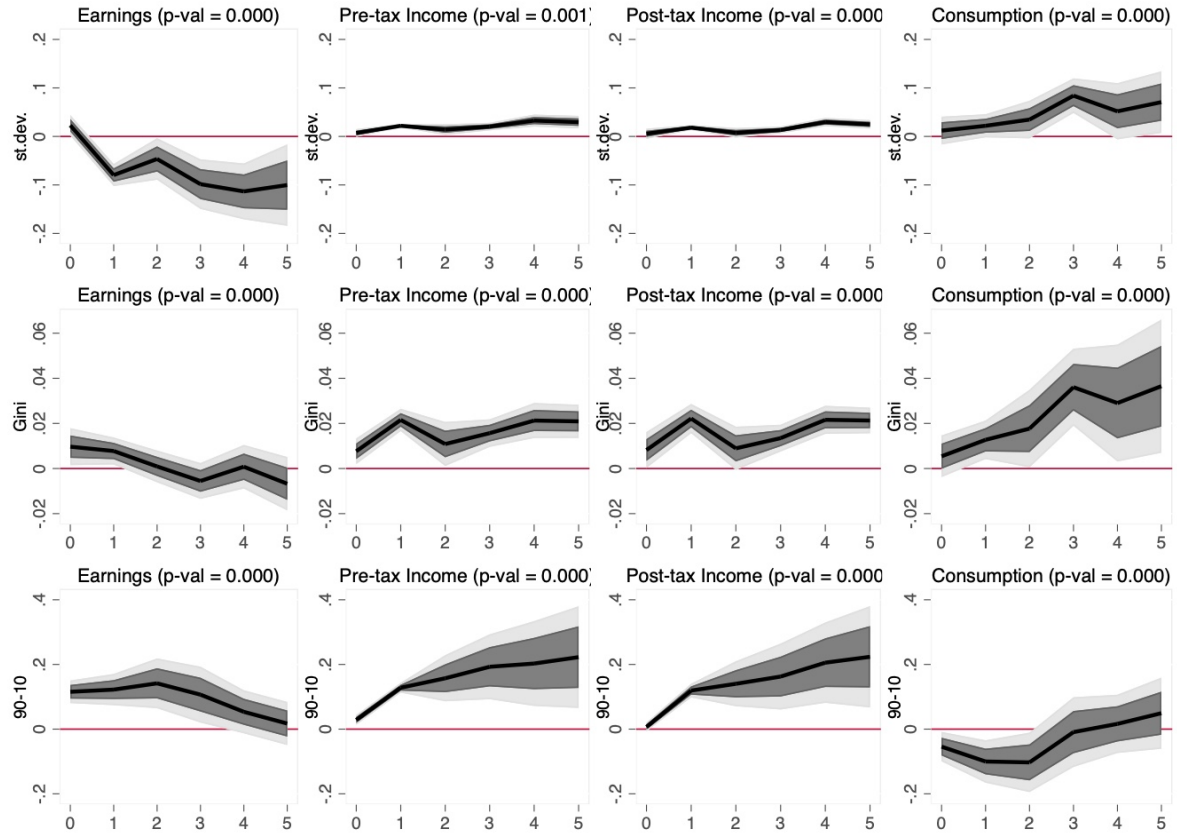

Figure 30: Response of inequality measures for earnings, pre-tax income, post-tax income and consumption to a 100 b.p. path shock

The response of inequality measures to the path shock, the information component of monetary policy shocks moves in the opposite direction of the response of inequality measures to the target shock and narrative monetary policy shocks. Earnings inequality initially increases in response to a positive information shock, then falls with earnings inequality decreasing cross-sectional standard deviation and Gini coefficient measures of inequality. Across both measures of income inequality, before and after tax, I find that inequality increases across all three measures of inequality. The impact of a positive path shock appears to have a persistent impact on income inequality. I similarly find that consumption inequality increases after five years across all three inequality measures, this increase is marked for both cross-sectional standard deviation and Gini coefficient measures.

It becomes clear that short term interest rates are driving the impact of monetary policy on inequality. This is because the response of inequality to narrative shocks follows the response of the target component. The distributional effect of the target shocks dominate the path shocks. This suggests that the effect of monetary policy on inequality results from the counter-cyclical stance of monetary policy.

B.5 Narrative shocks: Bishop and Tulip (2017)

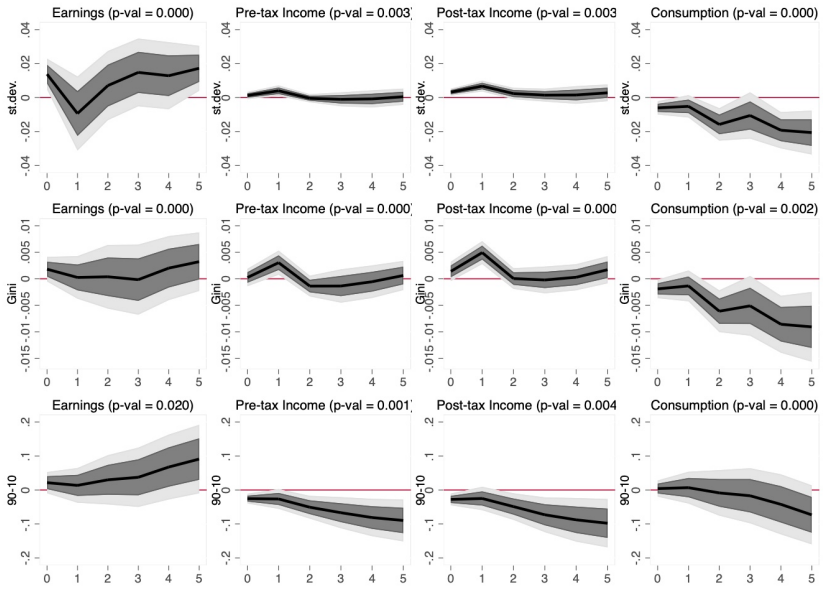

Figure 31: Response of earnings, pre-tax income, post-tax income, and consumption inequality to a 100 b.p. unanticipated contractionary monetary policy shock

My results using the Beckers (2020) are largely the same when using the Bishop and Tulip (2017). Although, the response of earnings inequality is less pronounced.

B.6 Sample selection

I reconstruct the inequality measures, this time without winsorising the top and bottom 1%. I find the results are the same. I then expand my sample and include persons of all ages including those over 65 and under 21 who are initially excluded from my sample. Again, my results are largely the same.

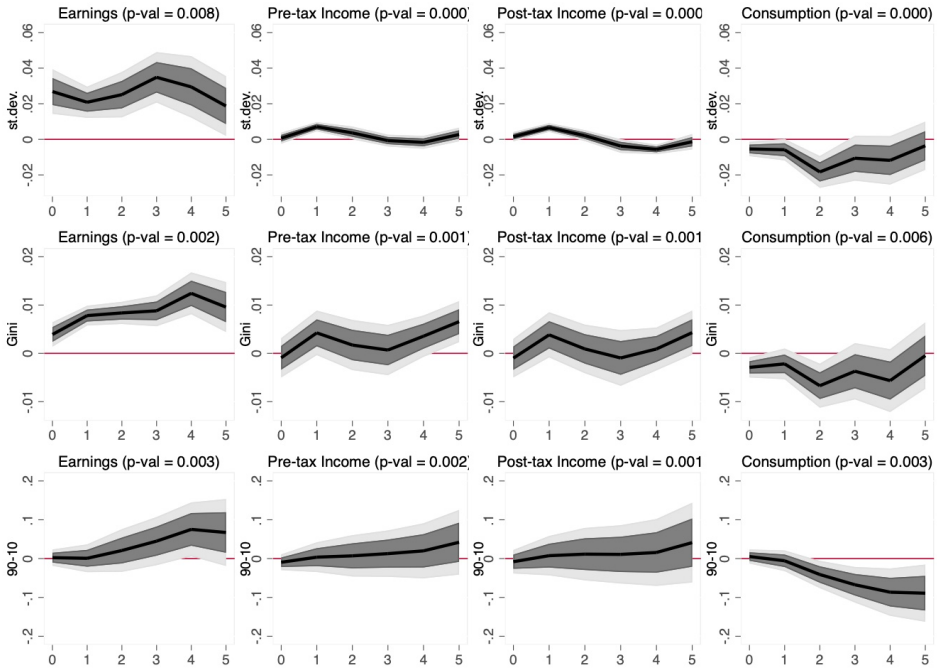

Figure 32: No winsorising: Response of earnings, pre-tax income, post-tax income and consumption inequality to a 100 b.p. unanticipated contractionary monetary policy shock, 1994:Q1-2019:Q4

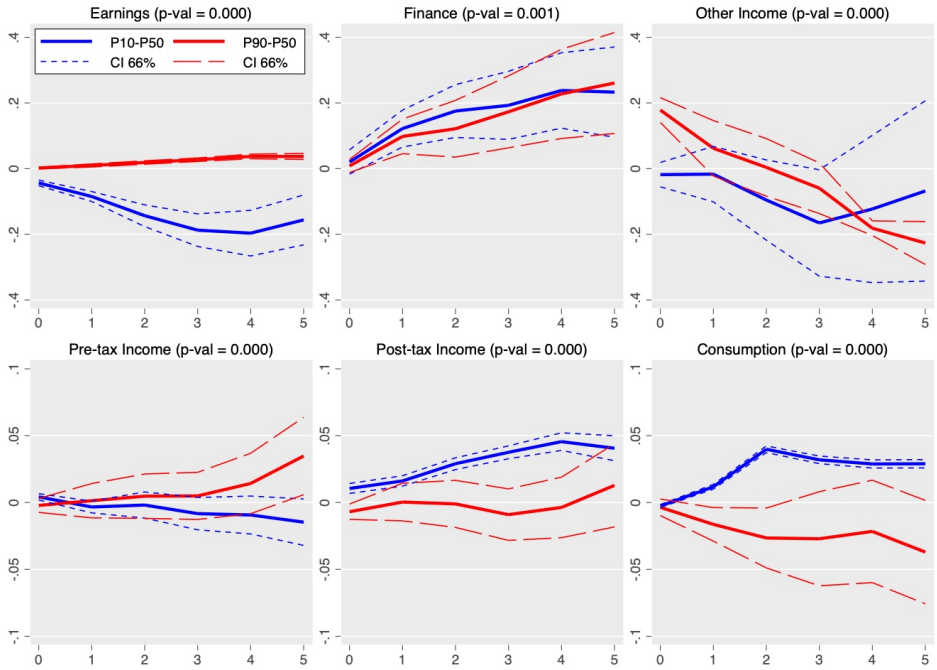

Figure 33: No winsorising: Response of log difference of 90th-50th percentile and 10th-50th percentile earnings, pre-tax income, post-tax income and consumption inequality to a 100 b.p. unanticipated contractionary monetary policy shock, 1994:Q1-2019:Q4

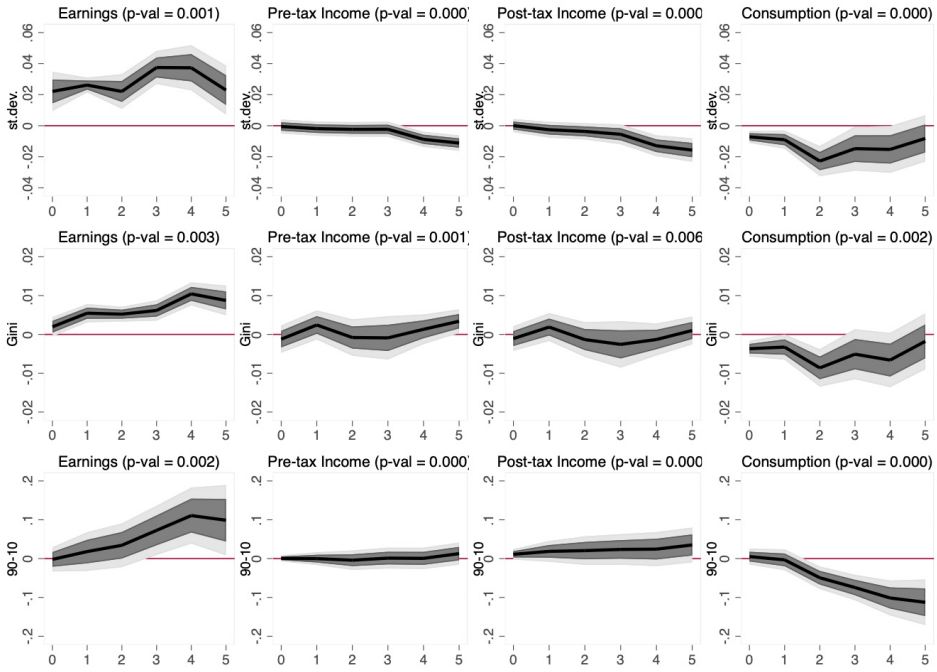

Figure 34: Full sample: Response of earnings, pre-tax income, post-tax income and consumption inequality (no winsorising) to a 100 b.p. unanticipated contractionary monetary policy shock, 1994:Q1-2019:Q4

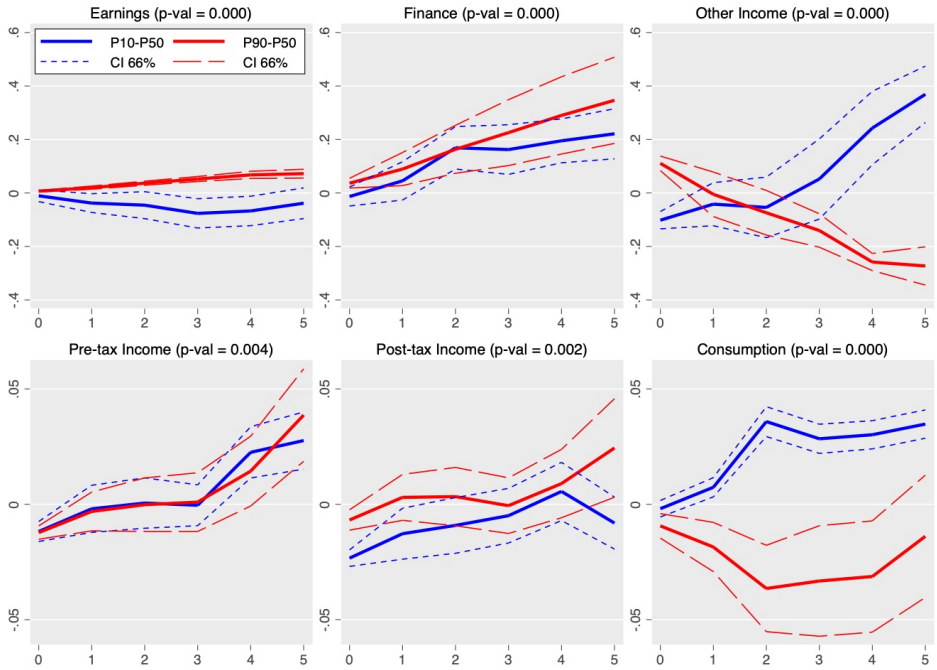

Figure 35: Full sample: Response of log difference of 90th-50th percentile and 10th-50th percentile earnings, pre-tax income, post-tax income and consumption inequality to a 100 b.p. unanticipated contractionary monetary policy shock, 1994:Q1-2019:Q4

B.7 Moving house

For robustness, I drop any household which has moved address in the past year from my sample, 29174 observations. This allows me to isolate the consumption response of households to house prices, rather observing a liquidity shock following the sale or purchase of a property and consumption associated with the purchasing of a property. I find the results are unchanged when I drop households who have moved address in the past year.

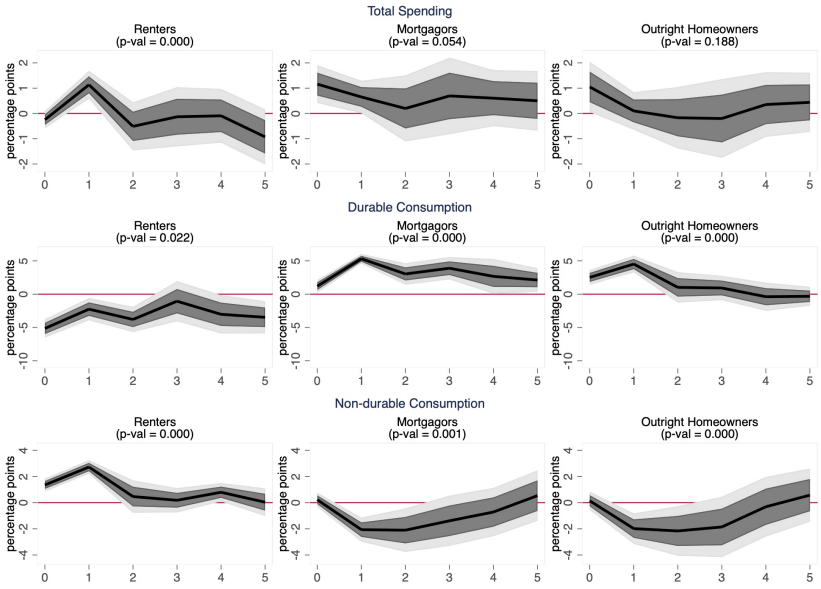

Figure 36: Response of total spending, durable consumption and non-durable consumption to a 100 b.p. unanticipated contractionary monetary policy shock by housing tenure controlling for moving addresses

B.8 Age

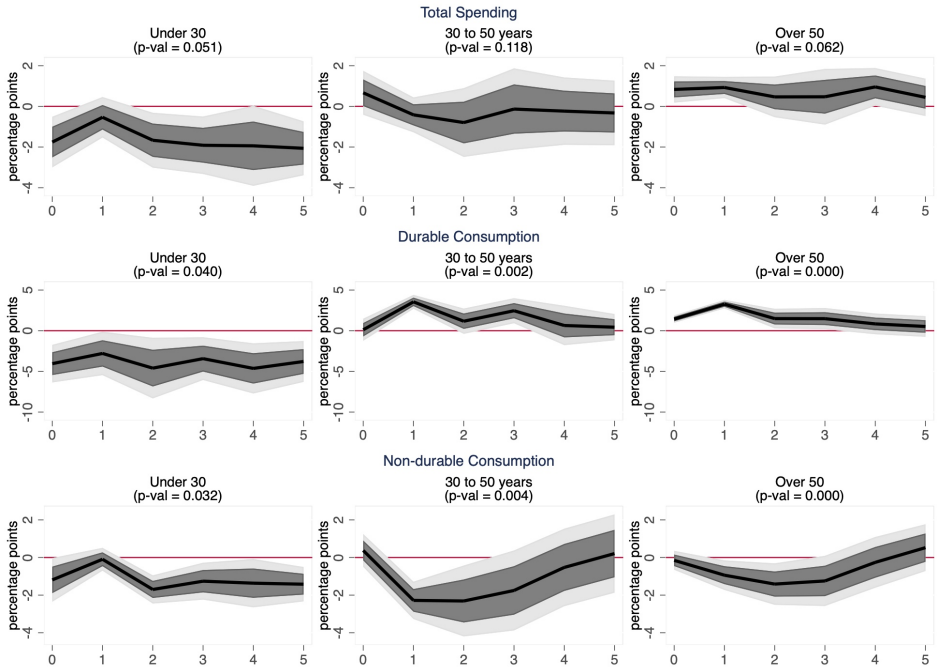

Figure 37: Response of total spending, durable consumption, and non-durable consumption to a 100 b.p. unanticipated contractionary monetary policy shock by age group

C Data Disclaimer

This paper uses unit record data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. The unit record data from the HILDA Survey was obtained from the Australian Data Archive, which is hosted by The Australian National University. The HILDA Survey was initiated and is funded by the Australian Government Department of Social Services (DSS) and is managed by the Melbourne Institute of Applied Economic and Social Research (Melbourne Institute). The findings and views based on the data, however, are those of the author and should not be attributed to the Australian Government, DSS, the Melbourne Institute, the Australian Data Archive or The Australian National University and none of those entities bear any responsibility for the analysis or interpretation of the unit record data from the HILDA Survey provided by the author.