The Mortgage Debt Channel of Monetary Policy When Mortgages are Liquid*

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Abstract

We examine the effect of monetary policy on household spending when interest rates on loans are linked to short-term interest rates. Using bank transactions data we study the effect of a cumulative 425 basis point increase in the central bank policy rate in Australia. This increased mortgage repayment for variable rate mortgagors relative to fixed rate mortgagors by $13,800. We find little change in the spending of variable rate mortgagors relative to fixed rate mortgagors. Access to liquid wealth tempered the effect of interest rate increases, with variable rate mortgagors drawing down on mortgage prepayments, which had increased during the pandemic.

Keywords: monetary policy, spending, borrowing, liquid wealth, mortgage market design

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1 Introduction

The post-pandemic monetary policy tightening cycle has been the sharpest and most globally synchronized cycle since at least the 1970s (Forbes, Ha and Kose, 2024). We investigate how this impacted household spending through increases in required mortgage repayments, widely considered to be one of the most powerful channels of monetary policy transmission. Through this channel, increases in central bank policy rates raise interest rates and required repayments on variable rate mortgage debt, reducing disposable income.

It is often conjectured that monetary policy is more potent in economies with a larger share of variable rate mortgage debt. Bernanke (2007) hypothesizes that if household cash flows affect spending then changes in short-term interest rates may have more immediate effect on spending if mortgages are predominantly variable than fixed rate. Auclert (2019) infers from a model that increasing the share of adjustable rate mortgages would raise the sensitivity of aggregate consumption to monetary policy. These predictions assume a sizable share of variable rate mortgage holders having a high degree of excess sensitivity. However, if households have liquid saving buffers they can draw upon the consumption response may be modest.

Australia provides an ideal setting to study the transmission of monetary policy to household consumption. Australia has among the highest shares of variable rate mortgage debt globally (Calza, Monacelli and Stracca, 2013) and the pass through of changes in the central bank's policy rate onto variable mortgage rates is rapid, with interest rate changes typically passed on within two weeks. The household debt to income ratio is high in Australia. Household debt constitutes 217 per cent disposable income, the third highest ratio of any OECD country (OECD, 2025). We study the post-pandemic monetary policy tightening episode, in which the Reserve Bank of Australia (RBA) raised the policy rate from its effective lower bound of 0.1 percent to 4.35 percent between May 2022 and November 2023. Required repayments on the average variable rate mortgage increased from around $2,000 to $3,000 per month.

Our main finding is a modest spending response to the large and sharp monetary policy tightening. A comparison of spending for mortgage and non-mortgage holders previews our results (Figure 1a). Despite the large increase in required mortgage repayments, relative spending for the two groups remained little changed until at least early 2024.

Our main identification approach is based on a comparison of spending for households with fixed and variable-rate mortgages. While the share of fixed rate mortgages has historically been low in Australia, there was a sharp take-up in 2020 and the first half of 2021 during the pandemic. This occurred because the RBA provided a three year term funding at 0.1 percent which banks could access to fund fixed rate mortgages. The term funding facility complemented the RBA's forward guidance that the policy rate would remain at 0.1 percent until at least early 2024. Fixed rate mortgages constituted approximately 40 percent of new mortgage lending in 2020 and 2021. Most fixed rate mortgages had a 2 or 3 year interest fixation period, automatically reverting to variable rate loans on expiry.

We construct a monthly dataset of individuals currently servicing a mortgage using a rich dataset of de-identified bank transactions. We observe the mortgage account and linked transaction and saving accounts for customers of one of Australia's largest banks. Spending is measured from flows out of transaction accounts, as in Ganong and Noel (2019). We show that the data are representative of the population of mortgage holders.

We adopt an event study framework and compare the evolution of spending and other variables for variable-rate mortgagors to fixed-rate mortgagors between November 2020 and April 2024. In the 18 months after the RBA increased interest rates, mortgage repayments for variable-rate mortgagors increased by an average of $13,800 cumulatively relative to fixed rate mortgagors. Despite this large increase in repayments for variable rate borrowers, we find little change in non-durable, durable and services spending for variable rate mortgagors relative to fixed rate mortgagors. There was little difference in income between fixed and variable rate mortgagors over this period. Our results are mostly explained in an accounting sense by drawdown of liquid assets by variable rate mortgagors. Reduced liquid bank account

balances paid for 70 percent of the increase in repayments, with the remainder mostly coming from additional net inflows.

We discuss and address threats to identification from selection into mortgage type, attrition and anticipatory behavior. Observable characteristics of fixed and variable rate mortgage holders are broadly similar and substantial common support allows us to control in robustness exercises for observable differences that do exist. The panel dimension our dataset is short so attrition of expired fixed-rate mortgages to variable rate mortgages may not be observed. However, few fixed rate mortgages expired prior to 2023 and the panel dimension of the dataset is sufficient to address this concern. Finally, the limited difference in spending between variable and fixed rate mortgagors could partly reflect fixed rate mortgagors reducing spending in anticipation of expiry to variable rate loans with higher repayments. We address this concern with a supplementary analysis comparing spending of mortgagors and non-mortgagors, which shows little difference in spending between the two groups, reinforcing the results of the main analysis.

Structural features of the Australian mortgage market and a high level of saving accumulated during the pandemic explain our findings. An institutional feature of the Australian mortgage market is that variable rate mortgagors can make excess repayments on their loan. These excess payments can be extracted at the borrower's discretion, making mortgages highly liquid. Excess repayment buffers reduce the balance on which interest is charged, effectively providing a high return saving account. Average repayment buffers have been large and increased substantially during the pandemic (Figure 1b). In the 5 years prior to the pandemic, aggregate excess repayments averaged 26 percent of required repayments but rose to 42 percent of required repayments in 2020-2021 (RBA, 2025).

Given the high level of liquid assets, our finding that mortgagors smoothed consumption for an extended period in response to higher required repayments is unsurprising in light of economic theory. Consumption is sensitive to cash flows when high return assets are illiquid (Kaplan and Violante, 2014), which is not the case for mortgagors in Australia.

Our results provide a cautionary tale. Even in a country with a high share of variable rate mortgages, where the transmission from interest rates to required repayments is large and immediate, the effect on spending through increased required repayments need not be large. Institutional features that make mortgages liquid matter a lot. Because the level of saving held on mortgages varies over time, the effect of monetary policy on spending is state dependent.

We consider the implications of our findings for the overall effect of monetary policy on household consumption by constructing macroeconomic counterfactuals. Had the RBA kept interest rates unchanged through to 2024—as signaled until November 2021—our estimates imply that aggregate consumption would have been no more than 1 percent higher at the peak. In contrast, a representative optimizing household model with unitary elasticity of intertemporal substitution implies 5 percent higher spending at the peak. Thus, the mortgage debt channel explains no more than one-fifth of the overall response predicted by a standard model. Other channels of monetary policy could explain the remainder. But it is more likely that monetary policy had a modest aggregate effect on consumption in this episode compared with the prediction of a standard model.

Related literature: We contribute to a growing literature on the transmission of mortgage rate changes to household consumption. Important early papers in the literature are Di Maggio et al. (2017) and La Cava et al. (2016). Di Maggio et al. (2017) find a large increase in car purchases upon reset of fixed rate mortgages to lower-rate ARMs in the 2010-2012 period in the US. La Cava et al. (2016) exploited the fall in required repayments on variable relative to fixed rate mortgages in Australia at the onset of the financial crisis and estimate that variable-rate households predominantly used additional funds to increase mortgage prepayments. Agarwal et al. (2022) also study the effect of unexpected interest rate decreases during the financial crisis period. They compare credit card spending of mortgagors and non-mortgagors and infer an MPC of 0.4-0.5.

In contrast to the earlier literature, recent work has exploited more comprehensive admin-

istrative data to measure consumption. Flodén et al. (2021), Ahn, Galaasen and Mæhlum (2024) and Caspi, Eshel and Segev (2024) exploit variation in households' exposure of mortgage debt to short-term interest rates. They estimate large MPCs in response to changes in disposable income: 0.19-0.50 (Flodén et al., 2021); 0.185-0.38 (Ahn, Galaasen and Mæhlum, 2024) and; 0.4 (Caspi, Eshel and Segev, 2024). Caspi, Eshel and Segev (2024) find spending responses to be largest for mid- to lower-income households while Flodén et al. (2021) found the most pronounced effects for households with low liquidity. In contrast, Ahn, Galaasen and Mæhlum (2024) find variation in spending responses across the liquidity distribution only in the first few months after an interest rate change.

Most of the literature has studied spending responses to increased disposable income from mortgage rate decreases (Di Maggio et al., 2017; La Cava et al., 2016; Agarwal et al., 2022) or averages over increases and decreases (Ahn, Galaasen and Mæhlum, 2024; Flodén et al., 2021). This matters because households may respond asymmetrically to increases and decreases in cash flow (Baugh et al., 2021). There is disagreement in the literature whether responses are asymmetric for mortgage repayments. Kartashova and Zhou (2023) apply the Di Maggio et al. (2017) research design to Canadian data over a period with increases and decreases in policy interest rates. They find similar effects to Di Maggio et al. (2017) for decreases but no effect for increases. However, Caspi, Eshel and Segev (2024), who study the effect of a large post-pandemic rise in interest rates in Israel, estimate large consumption responses.

Our setting differs from most of the literature in studying consumption responses to a large increase in required repayments in an environment where variable rate mortgages are liquid and households had accumulated large savings buffers. Consistent with our findings, Aisbett et al. (2024) find no significant response of non-durable spending to the 2008 economic stimulus payments in Australia—in contrast to estimates for equivalent payments in the U.S. (Parker et al., 2013)—which they attribute to the relative liquidity of Australian mortgages.

2 Background

2.1 The Australian Mortgage Market

We use the high prevalence of adjustable rate mortgages in Australia to examine the cash flow channel of monetary policy. Variable rate mortgages have historically accounted for 85 per cent of the value of new lending. The pass through of central bank interest rate - the cash rate - increases to interest rates on adjustable rate mortgages is rapid. Over the period of our analysis, it took on average 9 days for policy rate increases to be passed on and all but one policy rate change got passed on within 14 days. Fixed rate mortgages in Australia have a relatively short interest-rate fixation period of between two to three years. After the interest fixation period ends, a fixed rate mortgage converts to a variable rate mortgage. Households can also hold a combination of fixed and variable rate mortgages.

There are differences between variable and fixed rate mortgages. A fixed rate mortgage, fixes an individual's loan repayments for the term of the loan. Historically, interest rates on fixed rate mortgages have been higher than those on variable rate mortgages to compensate lenders for the risk that the cash rate might rise over the interest fixation period, though this difference has been small, averaging 0.3 percentage points. It is difficult to change the terms of or refinance a fixed rate mortgage; the break fees on fixed rate loans are often substantial.

Interest rates on variable rate mortgages move with changes in the cash rate. While, the interest rate on a variable-rate mortgage increases soon after the cash rate increases, there is a three month lag before banks pass through the interest rate increase onto increased required mortgage repayments. In the three month period between when banks increase the interest rates on variable rate mortgages and when required mortgage repayments increase, variable-rate mortgagors incur higher interest costs on their mortgage but required repayments are unchanged.

An important feature of variable rate mortgages is that they provide a vehicle through which households can accumulate liquid wealth. Households can make mortgage repayments

in excess of the required minimum, without incurring any service costs. This allows households to reduce the interest expense on their mortgage and pay their mortgage off faster. Any excess mortgage repayments can be taken off the mortgage in the future, for example to fund consumption. This feature is known as redraw.[1] Redraw is available on all variable rate mortgages. It takes one day for an individual to withdraw excess repayments from their redraw account and convert it into cash. Around half of variable rate mortgages contain offset accounts. These are transactions accounts that are linked to a mortgage. An individual's mortgage balance is reduced or "offset" by the balance in their in the offset account, reducing the amount of interest that has to be paid. Funds in an offset account are at call. Redraw and offset accounts provide a cost effective place for households to place their savings as it allows them to offset the interest expense on their mortgage (and any interest saving is not taxed). Households can also extract liquidity easily from these redraw and offset accounts.

2.2 The RBA and forward guidance

We exploit a period which saw an sharp increase in the take up of fixed rate mortgages owing to the introduction of forward guidance by the Reserve Bank of Australia (RBA). On the 19 March 2020 the RBA committed to keeping the cash rate at close to zero for an extended period of time, which was defined to be "until 2024 at the earliest" (Lowe 2021).[2] As part of its forward guidance package, the RBA provided banks with a three-year term funding facility at a fixed rate of 0.25 per cent. This significantly reduced the cost of funds for banks for fixed rate loans. Interest rates on fixed rate mortgages fell to be 0.7 percentage points lower than on variable-rate mortgages (Figure 2a). Demand for fixed rate mortgages

[1] Individuals on a fixed rate mortgage can also make limited excess repayments on their mortgage, up to a cap set by the bank. These excess payments can only be withdrawn at the end of the loan term. In our sample only x per cent of people on fixed rate mortgages make excess repayments.

[2] On 19 March 2020 the RBA reduced the policy rate to 0.25 per cent and introduced a target on the yield for 3 year government bonds of 0.25 per cent. It also announced that interest rates would not be increased "until progress is being made towards full employment and it is confident that inflation will be sustainably within the 2–3 per cent target band" (Lowe 2020a). On 3 November 2020, the RBA announced that it did not expect to increase policy rates for at least three years (Lowe 2020b). On 2 February 2021, the RBA announced that it did not expect policy rates to rise until at least 2024 (Lowe 2021).

increased from accounting for 14 per cent of the share of the value of new lending to a peak of 46 per cent (Figure 2b).

The RBA abandoned forward guidance and the cash rate was increased in May 2022. Between May 2022 to the end of our sample, the RBA increased the cash rate, 13 times, cumulatively by 4.25 percentage points.

Importantly, during the period in which forward guidance was introduced and just prior to it being abandoned, households expected interest rates to be low into the future. Communications from the RBA into early 2022 indicated that the first increase in the cash rate was not expected until 2024 (of Australia", 2023). [It was not until xxx that professional forecasters started pointing to an increases in interest rates (put in reference here).] The bond market started started predicting interest rate slightly earlier, with the market implied cash rate from overnight swap markets increasing in November 2021 (Figure A1). While household surveys only asked questions about interest rate expectations on a semi-annual basis, monthly households inflation expectations data indicated that households did not revise up their inflation expectations noticeably until the June quarter 2022. Hence households from early 2020 to early 2022 would have expected interest rates to remain low. The short time period between when interest rate expectations rose and when actual interest rates started rising indicates that households had little time to adjust their behavior.

3 Data

3.1 Analysis sample

We utilize a large dataset of de-identified bank account transaction data from a major bank provided to a credit agency as part of a credit check (as a result of, for example, applications for a mortgage, credit card, buy-now-pay-later services, personal finance management apps and a change of utility providers). This bank holds approximately 25 per cent of the value of deposits and housing loans in the banking system and maintains branches

throughout Australia. The credit agency collects a history of transactions which captures all account inflows and outflows including an individual's spending, income, welfare payments, and balances on savings and debt accounts, including mortgage accounts. The average history captured by a credit check is 5 months. Our unit of observation is the set of all the bank accounts within this bank submitted to the credit check within a month. We refer to these accounts as 'individuals'.

We identify individuals with a mortgage from the presence of mortgage repayments outflows from a transaction (equivalent to a checking account in the United States) or savings account and mortgage repayments inflows into a home loan account. To ensure we are capturing the primary bank accounts of an individual we restrict our sample to individuals where we can match the size and date of all mortgage repayments outflows from their transaction accounts to repayments inflows into their mortgage account. In addition, we also impose the following restrictions on the data. Firstly, we restrict our analysis to individuals with at least five monthly outflows from their transaction accounts following Ganong and Noel (2019). An outflow is any debit from a transaction account including a cash withdrawal, an electronic payment, a debit payment or credit card payment. Secondly, we require that an individual has positive income inflows into their transaction or savings account in a given month. We also exclude the top and bottom one percent of values in terms of mortgage balances, repayments, spending and income and the top one percent of values for ATM withdrawals and incoming and outgoing external bank account transfers (these are bank account transfers to or from unobserved accounts). Overall, our sample consists of 83,321 individuals over the period from November 2020 to April 2024.

We are unable to see if an account belongs to an individual or a couple and would miss transactions for couples who maintain separate bank accounts. However, this issue is likely to be mitigated by the fact that 80 per cent of couples in Australia have a joint bank account (Huang, Perales and Western, 2019).

3.2 Constructing mortgage status, spending, income and assets

Mortgage variables – For individuals with mortgages, we observe, their outstanding mortgage balance, mortgage repayments, interest payments, any redraws made from excess payments and their stock of excess payments on the date of the credit check. We do not observe if an individual has a variable or fixed rate mortgage. We infer the type of mortgage they have from account information. Our assignment rule proceeds in three steps. In step 1, we classify individuals as having a variable rate mortgage if: (i) the individual receives a message from their bank that their home loan interest rate is going to change in the month that the RBA changes the cash rate[3], or (ii) if an individual has an offset account. In step 2, to classify the remaining loans, we calculate the interest rate on the loan using information on the mortgage balance, mortgage repayments and interest payments and the date when these transactions took place. We then look at what happens to an individual's home loan interest rate in the month that the cash rate changes. We classify individuals as having a fixed rate mortgage if the interest rate on their mortgage is less than 2.4 per cent after May 2022 and if the interest rate on their loan is little changed - moves by less than ± 0.05 percentage points - when the cash rate changes (note during its tightening cycle the RBA increased the cash rate in either 0.25 or 0.5 percentage point increments). This criteria picks up individuals who took out a fixed rate mortgage between April 2020 and December 2021 when interest rates on fixed rate loans were noticeably lower than those on variable rate loans and during the period when the RBA was signaling that interest rates were to remain low. In step 3, we classify remaining loans as a variable rate mortgage if the interest rate on the mortgage moves with the cash rate in the months that the cash rate changes.

In months where there was no change in the cash rate, we use information on the loan's status in previous or future months to classify the loan as fixed or variable if the calculated interest rate on the loan is similar to that in prior months. However, prior to May 2022,

[3]The RBA board meets on the first Tuesday of each month, except for January, and announces its interest rate decision immediately after the meeting. All changes in the cash rate were passed onto the mortgage rate in the same month.

the cash rate was unchanged. For loans observed prior to May 2022 (and where we did not classify the loan using the above steps in later time periods) we use the level of the interest rate on a loan to classify a loan. A loan is classified as fixed if the interest rate on the loan was less that 2.4 per cent and variable if the interest rate on the loan was more than 2.7 per cent. These figures represent the maximum interest rate for fixed rate loans and minimum interest rate for variable rate loans prior to the start of 2022. In our main estimation sample, we exclude individuals for whom we observe the expiry of a fixed rate home loan.

For individuals that hold a combination of fixed and variable rate mortgages, we are able to observe both the fixed rate and variable rate portions of the mortgage separately. In these cases we classify each mortgage separately and then aggregate over the individual to see what fraction of their mortgage balance is accounted for by a variable-rate home loan. Prior to the first increase in the cash rate combination, fixed and variable rate mortgages accounted for 10, 12 and 78 per cent of mortgages respectively.

Our classification scheme does a good job of classifying a mortgage as variable or fixed. We are able to match the increase in interest rates on variable-rate home loans in the data (Figure 3a). Figure 3b shows the distribution of interest rates on fixed versus variable rate mortgages defined using our assignment rules. The distribution is bi-modal. The upper mass shows the interest rate on variable mortgages moving rightward from when the cash rate started increasing in May 2022. In contrast, the lower mass represents interest rates on fixed rate mortgages which were unchanged over this period.

Spending – Spending is measured from debit and credit card transactions, cash withdrawals, and other electronic transactions captured through an individual's bank account. We exclude loan repayments and transfers to other accounts. We classify spending into two categories: (i) measured spending and (ii) uncategorised spending. Measured spending refers to spending where we know both the merchant and date in which spending took place. This consists primarily of debit card spending from the bank in our sample. For these transactions we are confident spending took place and we know the precise date in which spending occurred. Measured spending accounts for 68 per cent of spending. Uncategorised spending refers to spending associated with credit card repayments or cash withdrawals. These transactions likely reflect spending but we do not know the precise timing or merchant associated with the spending.

We also classify spending into durable goods, non-durable goods and services spending. For measured spending items, the credit agency classifies spending based on the merchant at which the transaction took place using a methodology similar to Ganong and Noel (2019) (for example supermarket spending is classified as groceries). We allocate each of these spending categories into durable, non-durable and services spending using the taxonomy from the national income and product accounts. We allocate uncategorised spending into each of these three spending categories using information from the RBA Consumer Payments Survey in 2022 and the 2022/23 annual national accounts. The RBA Consumer Payments survey asks respondents to record every payment made in a week including the payment method and the category of spending. For each category of spending it shows, what fraction is paid for by cash and credit card. Using this information we allocate cash purchases and credit card repayments to non-durable, durable and services spending.[4]

Using our data from the credit agency we can generate an aggregate measure of spending by summing the spending of mortgagors and non mortgagors in our dataset. This measure of aggregate spending lines up well with official aggregate spending statistics; the correlation

[4]We allocate 6.75, 40.68 and 52.57 per cent of cash spending to durable goods, non-durable goods and services spending respectively. For credit card transactions, 10.17, 45.15 and 44.69 per cent of the value of transactions are allocated to durable goods, non-durable goods and services spending. For other miscellaneous card payments, 9.83, 47.71 and 42.46 per cent of the value of transactions are allocated to durable goods, non-durable goods and services spending.

between monthly changes in our measure of spending and that from the Australian Bureau of Statistics's Household Spending Indicator is 0.8.

Income, account balances and other flows – We calculate disposable income as the sum of wage payments (less taxes), social security payments, rental income and other income inflows (for example dividend payments) and subtract net tax payments (these are primarily tax payments or refunds at the end of the financial year). Wages account for 81 per cent of disposable income.

We group all other inflows, besides disposable income, into a category called all other inflows. The largest component of all other inflows is incoming transfers from external bank accounts which account for 40 per cent of all other inflows. Similarly, all other outflows after spending and mortgage repayments are removed are grouped into a category called all other outflows. Outgoing transfers to external bank accounts is the largest component of all other outflows, accounting for close to 40 per cent of these outflows. We subtract all other outflows from all other inflows to form a category called all other net inflows.

We observe the dollar balance of savings and transaction accounts for an individual on the date of the credit check. We calculate the change in an individual's bank account balance in a given month by subtracting the sum of all bank account outflows from the sum of all bank account inflows. We refer to this as the change in savings.

3.3 Representativeness

To assess the representativeness of our sample we compare it to mortgagors from the Household Income and Labour Dynamics in Australia (HILDA) survey, a nationally representative household survey (Table 1). Individuals in our sample have lower incomes and higher mortgage debt and hence higher debt to income ratios than those from HILDA. This is also true by mortgage type (Table 2). This suggests our sample somewhat over represents younger mortgagors. The one measure of spending we can compare across both data sources is supermarket spending. Supermarket spending and mortgage repayments as a share of

income are slightly higher in our sample.

4 Framework

This section uses a potential outcomes framework to describe our identification approach and discuss threats to identification.

4.1 Potential outcomes framework

Let $c_{i,t}\left(M, \mathbb{E}_t\left[\{M_s\}_{s>t}\right], B\right)$ be consumption of mortgage holder i at time t with current required mortgage repayments M, an expected sequence of future required mortgage repayments $\mathbb{E}_t\left[\{M_s\}_{s>t}\right]$ and balance sheet B, which includes mortgage pre-payment buffers. We seek to estimate the effect of a Δ-sized shock to required repayments at time t on consumption of variable rate mortgage holders. Formally, we seek to estimate

$$dC_t\left(\Delta\right) = \mathbb{E}_i\left[c_{i,t}\left(M+\Delta, \mathbb{E}_t\left[\{M_s\}_{s>t}\right], B_t\right) - c_{i,t}\left(M, \mathbb{E}_t\left[\{M_s\}_{s>t} \middle| \Delta = 0\right], B_t\right) \middle| D = \mathrm{V}\right], \quad (1)$$

where $\mathbb{E}_t\left[\{M_s\}_{s>t} \middle| \Delta = 0\right]$ is expected future repayments had there been no shock to current repayments and $D = \mathrm{V}$ denotes always variable rate mortgage status (i.e. excluding fixed-rate mortgages that became variable on expiry). This definition allows for the increase in current required mortgage repayments to affect expectations of future required repayments. Equation (1) is the average treatment effect on the treated. It cannot be estimated directly because we do not observe variable rate mortgage holders in treated (experiencing a change in repayments) and untreated states (not experiencing a repayment change). However, fixed rate mortgage holders have unchanged mortgage repayments and can be used to construct a counterfactual. This motivates the difference-in-difference (DiD) estimate

$$\delta_{t_0 \to t_1} = \mathbb{E}_i\left[c_{i,t_1} - c_{i,t_0} \middle| D = \mathrm{V}\right] - \mathbb{E}_i\left[c_{i,t_1} - c_{i,t_0} \middle| D = \mathrm{F}\right], \quad (2)$$

where t_0 is the period before the increase in required repayments and t_1 where required repayments unexpectedly increase; $D = \mathrm{F}$ denotes fixed rate mortgages that expire and

become variable rate mortgages at some time $t > t_1$. Expressing Equation (2) in terms of the underlying potential outcomes gives

$$\delta_{t_0 \to t_1} = \mathbb{E}_i \left[c_{i,t_1} \left(M + \Delta, \mathbb{E}_{t_1} \left[\{M_s\}_{s>t_1} \right], B_{t_1} \right) - c_{i,t_0} \left(M, \mathbb{E}_{t_0} \left[\{M_s\}_{s>t_0} \right], B_{t_0} \right) \middle| D = \mathrm{V} \right] - \mathbb{E}_i \left[c_{i,t_1} \left(M, \mathbb{E}_{t_1} \left[\{M_s\}_{s>t_1} \right], B_{t_1} \right) - c_{i,t_0} \left(M, \mathbb{E}_{t_0} \left[\{M_s\}_{s>t_1} \right], B_{t_0} \right) \middle| D = \mathrm{F} \right], \quad (3)$$

using the fact that fixed-rate mortgagors have unchanged repayments. Under the assumptions of (i) parallel trends for untreated outcomes and; (ii) no anticipation, $\delta_{t_0 \to t_1}$ is an unbiased estimate of $dC_t(\Delta)$:

$$\begin{aligned} \delta_{t_0 \to t_1} = & \underbrace{\mathbb{E}_i \left[c_{i,t_1} \left(M + \Delta, \mathbb{E}_{t_1} \left[\{M_s\}_{s>t_1} \right], B_{t_1} \right) - c_{i,t_1} \left(M, \mathbb{E}_{t_1} \left[\{M_s\}_{s>t_1} \middle| \Delta = 0 \right], B_{t_1} \right) \middle| D = \mathrm{V} \right]}_{\text{required mortgage repayments channel: } \mathrm{d}C_t(\Delta)} + \\ & \underbrace{\begin{aligned} & \mathbb{E}_i \left[c_{i,t_1} \left(M, \mathbb{E}_{t_1} \left[\{M_s\}_{s>t_1} \middle| \Delta = 0 \right], B_{t_1} \right) - c_{i,t_0} \left(M, \mathbb{E}_{t_0} \left[\{M_s\}_{s>t_0} \right], B_{t_0} \right) \middle| D = \mathrm{V} \right] \\ & - \mathbb{E}_i \left[c_{i,t_1} \left(M, \mathbb{E}_{t_1} \left[\{M_s\}_{s>t_1} \middle| \Delta = 0 \right], B_{t_1} \right) - c_{i,t_0} \left(M, \mathbb{E}_{t_0} \left[\{M_s\}_{s>t_1} \right], B_{t_0} \right) \middle| D = \mathrm{F} \right] \end{aligned}}_{\text{non-parallel trends bias}} - \\ & \underbrace{\mathbb{E}_i \left[c_{i,t_1} \left(M, \mathbb{E}_{t_1} \left[\{M_s\}_{s>t_1} \right], B_{t_1} \right) - c_{i,t_1} \left(M, \mathbb{E}_{t_1} \left[\{M_s\}_{s>t_1} \middle| \Delta = 0 \right], B_{t_1} \right) \middle| D = \mathrm{F} \right]}_{\text{anticipation bias: fixed}}. \end{aligned} \quad (4)$$

The parallel trends assumption requires consumption of variable and fixed rate mortgage holders to move together absent any change in required repayments for either group. This requires, for example, variable and fixed rate mortgage holders to be equally affected by changes in the state of the aggregate economy and that the intertemporal substitution channel of monetary policy operates with the same strength for both groups. It also requires that fixed and variable rate mortgage holders had the same expectations about future repayments before the shock to repayments. The no anticipation assumption requires fixed-rate mortgage holders to not respond in anticipation of changes in repayments. This is more likely to be true the longer is the period to expiry for fixed-rate mortgages.

4.2 Threats to Identification

There are three key threats to identification: anticipatory behavior by fixed rate mortgagors, sample attrition and selection effects. We discuss each of these in turn.

Anticipation——The no anticipation assumption is violated if fixed rate mortgage holders adjust spending in advance of changes in required repayments to smooth consumption. Anticipatory behavior for fixed-rate borrowers will bias δ_t downward. We address this threat in a supplementary analysis in Section 7 that uses non-mortgage holders as an alternative control group.

Attrition——Some of the fixed rate mortgages expire over the analysis period and become variable-rate mortgages. There are two ways through which this could bias our results. First, the characteristics of the fixed rate group could change over time if fixed rate loans that expire later are different from those that expire earlier. We can address this concern by controlling for observable loan characteristics, such as mortgage balance. Second, some mortgages in the variable group could be expired fixed-rate mortgages. To minimize this possibility, we exclude from the sample all loans for which we observe an expiry. However, we do not observe all expiries. Relatively few fixed-rate mortgages, less than 25 per cent, expired prior to 2023 (Lovic et al., 2023), implying that any variable rate mortgage observed before the end of 2022 is unlikely to have been an expired fixed rate loan. In a robustness check we restrict the sample of variable rate mortgages to those observed at least since the end of 2022.

Selection——The characteristics of fixed and variable mortgage holders can differ because households self-select into mortgage type. This could cause violations of the parallel trends assumption. Table 2 shows summary statistics for fixed and variable-rate mortgagors in our dataset. Fixed and variable-rate mortgagors have similar incomes and mortgage repayments and spending as a share of income. However fixed-rate mortgagors have more mortgage debt and higher debt to income ratios.

A range of economic factors affecting mortgage choice have been identified in the literature (Andersen et al., 2023). The literature has studied the typical situation in which the interest rate on new fixed rate mortgages exceeds that on variable rate mortgages; variable rate borrowers accept risk in exchange for a lower current interest rate. The first factor identified by the literature is the value of a lower initial interest rate on variable rate mortgages to ease

constraints on either current consumption or borrowing (through lower mortgage-payments to income). The second factor is beliefs: households that expect interest rates to fall will prefer a variable rate mortgage and those expecting interest rates to rise will prefer a fixed rate mortgage. The third factor is expected housing tenure. Households expecting to move in the near future will prefer variable rate mortgages because the value of insurance against distant interest rate rises is less.

The 2020-2021 period in Australia, when mortgage choice decisions of households in our sample were made, was atypical in two important respects. First, the interest rate on fixed rate mortgages was *below* that on variable rate mortgages. This implies constrained households prefer fixed rather than variable rate mortgages. Second, policy interest rates were at the effective lower bound. Lower initial interest rates on fixed rate borrowing and the inability of variable interest rate to fall implies borrowing costs were certain to be lower for fixed rate mortgages. Considerations about moving in the near future are less relevant in Australia because fixed rate mortgages are mostly for short 2 to 3 year periods. Hence, none of the main factors identified by the literature provide a rationale for variable over fixed rate mortgages over the 2020-2021 period in Australia.

A consideration not emphasized in the literature is the ability to make additional voluntary repayments on a variable (but not fixed) rate mortgage. These additional payments reduce interest payments on outstanding debt and permit paying off the loan ahead of schedule. Additional payments can also be redrawn at the borrower's discretion. An excess repayment buffer therefore provides a cost effective place to a hold precautionary saving buffer because it offsets the interest cost of mortgage debt. Appendix (A) provides a model that shows that the debt-to-income ratio is a significant predictor of mortgage choice in Australia. In particular, households with a lower debt to income ratio are more likely to have a variable-rate mortgage. This is consistent with what we observe in our dataset; the debt to income ratio is lower for variable-rate mortgagors (Table 2).

We empirically validate that debt to income is a predictor of mortgage choice by estimating

the linear probability model:

$$fixed_{i,t} = \alpha_s + \delta_t + \beta DTI_{i,t} + \epsilon_t \tag{5}$$

for mortgages observed prior to the first increase in the cash rate, where $fixed_{i,t}$ is an indicator equal to 1 if mortgagor i had a fixed rate at time t, α_s are state fixed effects, δ_t are time fixed effects and $DTI_{i,t}$ is the debt to income ratio of mortgagor i at time t.[5] The goodness-of-fit plot of Equation (5) shows that the debt to income ratio is able to predict the probability that an individual has a fixed-rate mortgage well across all deciles of the fixed-rate mortgage propensity (Figure A2). Hence, we include the debt to income ratio as a control variable to account for selection in our analysis below.

However, selection may also depend on unobservables. The inclusion of mortgage-type fixed effects controls for additive time-invariant unobservable determinants of selection. Ghanem, Sant'Anna and Wüthrich (2022) show that selection on time-varying unobservables is compatible with parallel trends if the unobservables follow a martingale property. They prove that imperfect foresight over the determinants of selection is a sufficient condition for unobservables to follow a martingale. This is plausible in our setting because selection into mortgage type occurred when the central bank policy rate was at its lower bound and widely expected to remain so throughout our analysis period. The martingale assumption on unobservables implies, for example, that households know (and can select on) their permanent income but do not know future realizations of transitory income when selecting into mortgage type.

[5]For simplicity, individuals with combination mortgages are excluded from the analysis.

5 Empirical strategy

We use a linear event study framework to study the effect of increases in the central bank policy rate on household spending. In the baseline specification we estimate:

$$y_{i,t} = \alpha_j + \theta_t + \sum_{k=-1}^{k=-T^{\text{pre}}} \delta_k \left(D_{i,T_0+k} - D_{i,T_0} \right) + \sum_{k=1}^{k=T^{\text{post}}} \gamma_k D_{i,T_0+k} + X_{i,t} + \varepsilon_{i,t} \tag{6}$$

where $y_{i,t}$ is the variable of interest for mortgagor i at time t; α_j is a mortgage-type fixed effect with $j \in \{\text{fixed, variable}\}$; θ_t are time fixed effects; D_{i,T_0+k} is an event-time indicator variable taking the value one for variable rate mortgagor i at time k quarters after the beginning of required repayment increases in T_0 = August 2022 and zero otherwise; $X_{i,t}$ are control variables, and; $\varepsilon_{i,t}$ is an error term. The regression specification restricts the sum of the pre-event coefficients δ_k to be equal to zero while the post event coefficients γ_k measure the estimated treatment effect relative to the pre-period average of zero. Estimation is at monthly frequency but the event-time coefficients are quarterly (to remove noise) with quarters centered on the commencement of interest rate increases in May-July 2022.

The variables of interest $y_{i,t}$ are mortgage repayments, measured and uncategorised spending, income, all other net inflows and the change in savings. In all regressions we include controls for the number of credit checks an individual experiences, the change in the number of bank accounts observed and the number of pay periods for that individual in a month. In some specification we include additional controls to capture differences in characteristics between fixed and variable-mortgagors and control for region specific effects. These include, lagged income, mortgage debt, the debt to income ratio and house prices and state $\times$ time fixed effects. Standard errors are clustered at an individual level.

The framework in Section (4) outlined the identification approach in a two-period difference-in-difference setting whereas the empirical model has multiple time periods. However, the event study coefficients γ_k are equivalent to a two-period difference-in-difference estimate relative to the pre-period:

$$\gamma_k = \left[\bar{y}_{T_0+k} - \bar{y}_{T_0^-} | D = V \right] - \left[\bar{y}_{T_0+k} - \bar{y}_{T_0^-} | D = F \right], \tag{7}$$

where T_0^- denotes the pre-period T^{pre} to T_0. The coefficient γ_k measures the dynamic effect of the cumulative increase in required repayments that have occurred between T_0 and $T_0 + k$. The no-anticipation assumption and parallel trends assumptions stated earlier (Equation 4) apply to all $t_1 = t' > t_0$ for the empirical model.

The baseline specification includes mortgagors with only fixed or variable rate loans. However, some mortgagors hold both fixed and variable rate loans. To include these combination mortgagors in the analysis, we modify Equation (6) by measuring the degree of treatment as the fraction of total debt held in variable rate loans $f_i \in [0,\ 1]$:

$$y_{i,t} = \alpha_j + \theta_t + \sum_{k=-1}^{k=-T^{pre}} \delta_k \left((D_{i,T_0+k} - D_{i,T_0}) \times f_i \right) + \sum_{k=1}^{k=T^{post}} \gamma_k \left(D_{i,T_0+k} \times f_i \right) + X_{i,t} + \varepsilon_{i,t}. \quad (8)$$

All other terms are unchanged.

6 Results

6.1 Baseline results

We start with the simplest event study specification which includes only fixed and variable-rate mortgagors and no additional controls. Figure 4 show the estimated γ_k coefficients from Equation (6). Mortgage repayments for variable-rate mortgagors move in line with mortgage repayments for fixed-rate borrowers prior to the initial increase in required repayments in August 2022. Note that while interest rates on variable-rate mortgages increased in May 2022, banks did not pass this increase onto higher required mortgage repayments until three months later in August 2022. We find that variable rate mortgagors did not increase their repayments until after banks raised required mortgage repayments.[6] After this period, we see a sustained increase in repayments for variable-rate mortgagors relative to fixed-rate mortgagors, consistent with the increasing interest rates faced by these mortgagors.

[6]The CDF of the change in the mortgage repayments during the three month period in which interest rates increased but repayments were unchanged looks similar to that prior to the first increase in interest rates. This shows that mortgagors do not adjust repayments until minimum required repayments increased. Following the increase in required repayments which started in August 2022, we see a larger fraction of variable rate mortgagors increase their mortgage repayment (Figure A3).

Despite this increase in repayments, there is little difference in either measure of spending between variable and fixed-rate mortgagors before and after the increase in required mortgage repayments. We can also decompose spending into durable and non-durable goods and services spending. Across each of these three categories we find little difference in spending between fixed and variable rate mortgagors (Figure 5). We find that variable-rate mortgagors financed the majority of the increase in required mortgage repayments through running down their savings. The bottom right panel of Figure 4 shows the cumulative change in the bank account balances of variable-rate mortgagors relative to fixed-rate mortgagors. Prior to the increase in required mortgage repayments, there was little difference between fixed and variable-rate mortgagors. After the increase in required mortgage repayments we see a large fall in the bank account balances of variable-rate mortgagors relative to fixed-rate mortgagors. Variable rate mortgagors also financed a smaller fraction of the increase in repayments through higher other net inflows in the last two quarters of the sample. This indicates that variable-rate mortgagors brought in funds from external sources to partially fund higher repayments. This is consistent with the results from Baugh et al. (2021), who find that households transfer in funds from external sources to smooth consumption when making anticipated tax payments. There is little difference in the incomes of variable and fixed-rate mortgagors both before and after the change in required repayments.

Column 1 of Table 3 summarizes the cumulative difference in our dependent variables between variable and fixed-rate mortgagors after the increase in required mortgage repayments from August 2022 to April 2024. Over this period, variable-mortgagors experienced a $13,884 increase in mortgage repayments relative to fixed-rate mortgagors. There was little difference in the spending and incomes between fixed and variable-rate mortgagors. We find that 70 per cent of the increase in mortgage repayments was paid for by individual's drawing down on their savings and 26 per cent by individuals bringing in funds from external sources.

6.2 Alternate specifications

Here we address the threats to identification outlined in Section 4.2. Columns 2 to 5 of Table 3 show results from the alternate specifications embedded in Equation (8).

Column 2 includes individuals with combination mortgages. Column 3 includes additional controls—lagged income, mortgage debt, the debt to income ratio and house prices and state $\times$ time fixed effects—to control for selection into mortgage type and region specific shocks.

Column 4 controls for attrition. Some mortgages which we classify as variable could have been a fixed rate mortgage in the past when we did not observe them. To reduce the possibility of including a variable-rate mortgage that might have been fixed in the past, we restrict our sample of variable-rate mortgages to those we observe prior to 2023 when there are relatively few fixed rate expiries. For variable-rate mortgages observed after 2023, we only include those where we know that the mortgage was variable in December 2022.

In column 5, we exclude observations with large net incoming transfers into an individual's observed bank account from external bank accounts that we cannot observe. In our baseline results we find that variable rate mortgagors financed a fraction of higher repayments through external sources. To address concerns that we might not be observing a full enough picture of an individual's bank account, we exclude observations where net incoming transfers are above the 95th percentile.

Across all specifications, we see a notable rise in the repayments of variable-rate mortgages relative to fixed rate mortgages. There is little difference in spending between fixed and variable-rate mortgagors. We find that on average across all specifications that around 80 per cent of the rise in repayments was financed by variable rate mortgagors drawing down on their bank account balances and around 25 per cent by all net other inflows. In the specification where we exclude individuals with large net incoming transfers from external accounts virtually all of the increase in repayments is paid for by variable-rate mortgagors reducing their bank account balances.

6.3 Evidence on liquid assets

We find that variable-rate mortgagors financed the majority of higher mortgage repayments by drawing down on their liquid assets, leaving spending unchanged. Here we provide evidence on the liquid assets of variable-rate mortgagors.

For each individual in our sample, we observe the balance on their bank and redraw accounts at the date of the credit check. Table 4 shows mean bank account and redraw (where excess repayments on the mortgage are stored) balances for variable and fixed-rate mortgagors six month prior to the commencement of the RBA tightening cycle in April 2022 and in the last six months of our sample after mortgage repayments had increased. The bank account and redraw balances of variable rate mortgagors fell by around $12,000 over this period. The bank account balances of fixed-rate mortgagors was similar to that of variable-rate mortgagors prior to the first rise in interest rates. While fixed rate mortgagors did experience a fall in their bank account balance, it is noticeably smaller, at around $3,000. Taking the difference in the change of account balance between variable and fixed-rate mortgagors over this period suggests that the variable-rate mortgagor account balances fell by $9,000 relative to fixed-rate mortgagor account balances. This is similar to the estimates from the baseline event study specification (see Table 3).

Variable-rate mortgagors can accumulate liquid savings by making excess repayments on their mortgage. Figure 7 shows the CDF of excess mortgage repayments as a percentage of required repayments prior to the commencement of the RBA's tightening cycle in May 2022 and in the last six months of our sample[7]. We find evidence that variable-rate mortgagors had accumulated savings in excess repayments buffers prior to the start of interest rate increases. Excess repayments were made on 70 per cent of variable-rate mortgagors prior to the first rise in interest rates. Around a quarter of variable-rate mortgages had repayments in excess of 40 per cent of required repayments. In the last six months of our sample, the share of variable-

[7]At certain times of year (typically at the end of a calendar or financial year or when interest rates change) the bank in our sample sends individuals a message about what their required repayment will be in three months time. Here we compare an individuals current repayments with what their required repayment will be in three months time.

rate mortgages with excess repayments declined to around 25 per cent. This is consistent with the fall in balances on redraw accounts in Table 4.

7 Supplementary evidence

This section presents supplementary evidence from alternative identification approaches that mortgagors smoothed consumption in response to increased required mortgage repayments. The first approach compares consumption of mortgagors and non-mortgagors. The second approach studies the behavior of consumption around expiry of fixed rate mortgages.

7.1 Comparison of mortgagors and non-mortgagors

The difference-in-difference estimates in the preceding section provide an unbiased estimate of the effect of an increase in required repayments in the absence of anticipatory behavior by fixed-rate mortgagors. A concern with the analysis in the previous section is that both variable and fixed-rate mortgagors might have responded to higher interest rates by reducing their spending. Variable rate mortgages reduced spending because of higher actual mortgage repayments, while fixed rate mortgages reduced spending in anticipation of higher future mortgage repayments when their fixed-rate loan expires (see the discussion in Section 4). If this was the case, then our result of no change in spending for variable-rate mortgagors could reflect both fixed and variable-rate mortgagors reducing their spending. To address this concern, we compare the spending of mortgagors to non-mortgagors who clearly do not experience any increase in mortgage repayments. If both fixed and variable-rate mortgagors pulled back on spending at the same time then we would expect the spending of mortgagors to fall relative to non-mortgagors. We do not see this occurring, indicating that both variable and fixed-rate mortgagors maintained their previous spending levels following the rise in interest rates.

We define a non-mortgagor as in individual who does not make mortgage repayments. We exclude renters and social security recipients from our sample of non-mortgagors. Renters

are excluded because there was a large increase in rents over the sample period which might have reduced renters' spending on other items. Social security recipients are excluded because these are low income individuals. For symmetry, we also exclude renters and social security recipients from our sample of mortgagors in this analysis.[8] Note the mortgagor sample includes both fixed and variable-rate mortgagors.

To compare the behavior of mortgagors to non-mortgagors we estimate the equation:

$$y_{i,t} = \alpha_j + \theta_t + \sum_{k=-1}^{k=-T^{\text{pre}}} \delta_k \left(D_{i,T_0+k} - D_{i,T_0} \right) + \sum_{k=1}^{k=T^{\text{post}}} \gamma_k D_{i,T_0+k} + X_{i,t} + \varepsilon_{i,t} \tag{9}$$

where $y_{i,t}$ is the outcome of interest for mortgagor or non-mortgagor i, α_j is a fixed effect denoting whether individual i is a mortgagor or non-mortgagor and D_{i,T_0+k} is an event-time indicator variable taking the value one if i is a mortgagor at time k quarters after the beginning of required repayment increases in $T_0 =$ August 2022 and zero otherwise. All other terms are as defined for Equation (6).

Results with controls are shown in Figure 6. Following the increase in required mortgage repayments starting in August 2022, mortgagors experience a sustained increase in mortgage repayments relative to non-mortgagors. However we see little difference in spending between mortgagors and non-mortgagors across either spending category. Mortgagors financed around half of increased mortgage repayments by drawing down on their savings, as indicated by the fall in mortgagors relative to non-mortgagors bank account balances (see the bottom right panel of Figure 6). The remaining half of the increase in repayments was financed from all other net inflows. Figure A6 in the Online Appendix shows the results excluding individuals whose average net incoming transfers are above the 95th percentile. After excluding individuals with large net incoming transfers, we find at around 85 per cent of the increase in repayments were financed by mortgagors drawing down on their bank account balances. Overall we find little evidence that mortgagors reduced their spending relative to non-mortgagors.

[8] Around 20 and 25 per cent of our sample of mortgagors are observed to pay rent or receive social security payments. These shares are similar across fixed and variable-rate mortgagors.

7.2 Expiry of fixed rate mortgages

A subset of low-interest fixed-rate mortgages originated before mid-2021 in our sample are observed to expire and reset to variable-rate loans with substantially higher interest rates. This setting provides a quasi-experimental setting to examine the consumption response to a large, anticipated increase in mortgage repayments at the time of expiry.

This identification strategy compares the outcomes of mortgagors whose fixed-rate loans have expired to those whose loans have yet to expire, using an event-study framework centered around the expiry date. Mortgagors with unexpired loans provide a valid control group if the timing of expiry is quasi-exogenous. This is plausible because the low-rate fixed rate loans we study were originated during a period when interest rate were expected to remain low until 2024, as signaled by the RBA. This research design has been used by Di Maggio et al. (2017) and Kartashova and Zhou (2023), among others. A strength of the approach is this it compares a relatively homogeneous group of borrowers.

For fixed rate loans in our sample expiring between July 2022 and March 2024, the mean increase in interest rate at expiry was 3 percentage points and the mean increase in monthly repayments was around $600 (Figures A7a and A7b). The rise in interest rate occurs almost immediately but it takes around 4 months for the full increase in repayments to occur, due to notification periods. For at least a year prior to expiry, variable interest rates were above the interest rate on fixed rate loans. Thus, higher repayments should have been anticipated by households.

Despite the large increase in repayments, there is no evidence of a dip in consumption around expiry (Figures A7c and A7d). This provides evidence that fixed rate mortgagors smoothed consumption in response to higher repayments. There is suggestive evidence that they did this by drawing down savings (Figure A7e), consistent with the behavior of variable rate mortgage holders in the main analysis.

Our findings here are consistent with Kartashova and Zhou (2023), who find no response of durable spending (proxied by new auto and installment loans) to increased repayments at

expiry of fixed rate mortgages in Canada for the 2017-2019 period. However, like Di Maggio et al. (2017), they find that durable spending rose when required repayments fell for expiries occurring earlier in their sample. Our findings are novel in providing evidence for this research design using a comprehensive consumption measure. However, some caveats apply to our analysis. The limited panel dimension of our data means we observe only around 4,000 expiries and the sample size declines with time relative to expiry. The full details of this analysis are reported in Appendix B.

7.3 Other evidence

The response of mortgagors to the first cut in interest rates, following the 4.25 percentage point increase in the cash rate studied in this paper, provides cross-validation for our results. After a 0.25 percentage point cut in the cash rate in February 2025, around 90 per cent of mortgagors chose to keep their mortgage repayments unchanged, rather than reduce their repayments.[9] The fact that household kept repayments unchanged after interest rates were cut, following a period in which there was a sustained increase in rates, indicates that few households were financially constrained, consistent with our main results.

Data on arrears and non-performing loans is also consistent with few households experiencing severe financial constraints. Both arrears and non-performing loans remained low, at below 1 per cent of total credit outstanding, during the period in which required mortgage repayments increased and were at levels lower than when forward guidance was introduced by the RBA (Figure A8).

[9]Data from three of four major banks that dominate the mortgage market in Australia indicate that between 86 to 95 per cent of borrowers kept repayments at the levels they were before the cut in interest rates. See Knight (2025)

8 Discussion

8.1 Mechanisms

Liquid assets held on mortgages provided the funds for households to smooth consumption in response to higher required mortgage repayments. We now discuss factors supporting the accumulation of these repayment buffers.

Excess repayment buffers have been substantial for a long period of time. Between 2010 and 2019 excess repayments averaged around one-quarter of required repayments (RBA, 2025). Holding excess funds on mortgages is financially advantageous. Excess repayments reduce the outstanding balance on which interest is charged, reducing interest expense for mortgagors. Placing excess funds in transaction accounts attracts a lower return because deposit rates are lower than mortgage interest rates.[10] While households could choose to hold savings in higher return assets, such as term deposits or bonds, these are less liquid.

The accumulation of excess repayments was facilitated by a long period of declining interest rates. The RBA's policy rate decreased monotonically from 4.5 percent to 0.1 percent between November 2011 and November 2020. Households could make excess repayments by keeping their repayments unchanged when interest rates declined.

Excess repayment buffers increased sharply during the pandemic, averaging 42 percent of required repayments between 2020 and 2021. This substantially reflects the effect of mobility restrictions which reduced consumption opportunities. The household saving ratio averaged 20 percent over the 2020-2021 pandemic years, compared with 7.7 percent in 2019 (Figure 1b). Disposable income was supported during the pandemic by wage subsidies (JobKeeper) and increased transfer payments to welfare recipients . A pre-pandemic counterfactual path for consumption implies that two-thirds of the increase in the household saving in 2020 and 2021 can be explained by lower consumption (Figure A9).

A government policy change during the pandemic providing early access to retirement

[10] Furthermore, earnings on deposit accounts are subject to taxation, making excess mortgage repayments tax preferred.

savings further boosted liquidity for some mortgagors. Mandatory retirement savings in Australia are held in individual accounts (Superannuation) that are ordinarily accessible only at retirement. However, the government permitted pre-retirement workers to withdraw up to $20,000 from their otherwise illiquid retirement accounts between April and December 2020. [X] percent of mortgagors in our sample made a withdrawal of at least $10,000 from their retirement saving account.

8.2 Relationship with the literature

[Say something here about prevalence of offset and redraw accounts in Australia vs countries finding large cash flow effects. Norway, Sweden and Israel are the countries with papers finding large-ish cash flow MPCs. We are working on tracking this down.]

8.3 Macroeconomic counterfactuals

What do our findings imply about the potency of monetary policy for household consumption? We address this question by constructing counterfactual paths for aggregate consumption absent the monetary policy tightening beginning in May 2022. This exercise is a monetary policy analogue to Orchard, Ramey and Wieland (2025) for fiscal policy.

Our first counterfactual is consumption assuming aggregate nominal required mortgage repayments had remained at their level prior to the commencement of policy rate increases in 2022Q1 (Figure 8). It is constructed by multiplying the estimated MPC from our preferred estimation (Specification 1 in Table 3) by the difference between actual required repayments and their 2022Q1 level. A range is shown using the one-sided 95 percent confidence interval (truncated at zero) for the MPC.

Our second counterfactual is the path of consumption implied by a representative agent model had the policy rate remained at its effective lower bound until 2024Q1, as signaled but subsequently abandoned by the RBA. To construct this counterfactual we begin by

log-linearizing the consumption Euler equation for a representative household and iterating forward. Doing so, the percentage deviation in consumption from its observed level at time t is

$$\widetilde{C}_t = -\frac{1}{\sigma}\sum_{s=t}^{\infty}\widetilde{r}_s \tag{10}$$

where $\widetilde{r}_s$ is the difference between the actual and counterfactual $s-t$ period ahead expected real interest rate and σ is the intertemporal elasticity of substitution (IES). We conduct a partial-equilibrium exercise that assumes no change in inflation between the actual and counterfactual scenarios.[11] This implies

$$\widetilde{C}_t = -\frac{1}{\sigma}\sum_{s=t}^{\text{2024Q1}}\left[\mathbb{E}_{\text{2020Q1}}\left[i_s\right] - \mathbb{E}_t\left[i_s\right]\right], \tag{11}$$

for t between 2022Q1 and 2024Q1, where i_s is the nominal interest rate in period s. Using Equation (11), and assuming an IES of one, counterfactual consumption is shown in Figure 8. At the peak, counterfactual consumption would have been 5 percent higher under the counterfactual than the actual path.

These counterfactuals imply the mortgage repayments channel accounts for no more than one-fifth of the overall effect of monetary policy in the representative agent model. How plausible is it that other channels of monetary policy transmission account for the remainder? Intertemporal substitution is the only transmission mechanism in the representative agent model, but is best conceptualized as a proxy for detailed channels omitted from the model. Direct intertemporal substitution is minimal (Crawley, 2025), including specifically for mortgagors (Best et al., 2020).

Other potential channels affecting consumption are indirect effects operating through wealth, labor demand, and the exchange rate. Wealth effects are small except for constrained households (Cooper, 2013), who are relatively few in our sample. The unemployment rate was 3.9 percent at the commencement of monetary policy tightening in May 2022—its lowest level since the 1970s—and has remained below 4.2 percent since. This suggests limited

[11] This would understate the counterfactual increase in consumption if a more accommodative monetary policy led to higher inflation, which in turn lowered the real interest rate.

capacity for the labor market to be substantially tighter with more accommodative monetary policy. Although (real) wage growth could have been higher. Lower interest rate could have depreciated the exchange rate, although pass-through to consumer prices is estimated to be modest (Chung, Kohler and Lewis, 2011). Taken together, the evidence suggests monetary policy tightening had a modest effect on consumption in this episode.

9 Conclusion

Central bank policy rate increases have an almost immediate affect on cash flows for variable (adjustable) rate mortgages in Australia. We have studied the affect on spending of the large increase in required mortgage repayments due to Australia's post-pandemic monetary policy tightening. Despite monthly repayments on the typical variable rate mortgage rising by more than $1,000 between May 2022 and November 2023, the effect on spending was small for up to two years following the commencement of interest rate increases. Households smoothed consumption in response to higher required repayments by drawing down on accumulated savings, much of which was held as excess repayments on mortgages.

Our findings demonstrate that spending of mortgagors need not be sensitive to central bank policy rates even when the share of variable rate mortgages is large and pass-through of interest rate changes to mortgage interest rates is rapid. A key mechanism is the ability of variable rate mortgagors in Australia to make unlimited voluntary excess repayments that can be withdrawn at the borrowers discretion, either immediately (in the case of offset accounts) or with a 1-2 day delay (in the case of redraw accounts). These features make mortgages a high-return but liquid asset. The lack of sensitivity of mortgagors' consumption to increases in required repayments may seems to contradict convention wisdom but it is not surprising in light of economic theory. Consumption is sensitive to disposable income when high return assets are illiquid, which is not the case for Australian mortgages.

We contribute to a growing literature on the mortgage debt transmission channel of monetary policy. Most of the literature has found greater sensitivity of mortgagors spending to

required repayments than we do. These different findings can be explained by structural and episodic factors. The ability of variable rate mortgagors to make voluntary excess repayments is much more prevalent in Australia than other settings studied in the literature. The pool of savings accumulated during the pandemic facilitated smoothing of consumption by mortgagors, implying that the strength of the mortgage debt transmission channel is state dependent. More broadly, our findings contribute new findings to a literature studying how mortgage market structure and design affects monetary policy transmission.

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Table 1: Representativeness of the Credit Agency Sample

	Median		Mean	
	Credit Agency	HILDA	Credit Agency	HILDA
Income	8,980	11,589	10,102	13,007
Mortgage balance	355,527	308,000	418,566	363,920
Mortgage balance (frac. income)	3.22	2.39	3.45	2.33
Repayments	1,961	2,100	2,381	2,399
Repayments (frac. income)	0.22	0.19	0.24	0.18
Supermarket spending	1,210	1,000	1,325	1,061
Supermarket spending (frac. income)	0.13	0.09	0.13	0.08
Non-durable spending	2,237	1,653	2,509	1,769
Non-durable spending (frac. income)	0.25	0.15	0.25	0.14

Notes: This table compares mortgagors from the credit agency sample to mortgagors from the nationally representative HILDA survey. Statistics are calculated from August 2022 to February 2023, the period in which HILDA interviews were conducted.

Summary: Mortgagors in the credit agency sample have modestly higher mortgage debt and lower income than mortgagors in HILDA but are otherwise representative.

Table 2: Difference between Variable and Fixed Rate Mortgage Holders

	Credit Agency		HILDA	
	Variable	Fixed	Variable	Fixed
Income	10,951	10,734	12,789	11,307
Mortgage balance	390,601	451,780	349,959	428,926
Mortgage balance (frac. income)	2.97	3.51	2.28	3.16
Repayments	2,173	1,970	2,305	2,114
Repayments (frac. income)	0.20	0.18	0.18	0.19
Spending	7,651	7,017		
Spending (frac. income)	0.70	0.65		
Supermarket spending	1,388	1,227	1,164	1,024
Supermarket spending (frac. income)	0.13	0.11	0.09	0.09

Notes: This table shows summary statistics for variable and fixed-rate mortgagors. Statistics for the credit agency sample are calculated from November 2020 to April 2022, prior to the first increase in the cash rate.
Summary: Fixed-rate mortgagors have a higher mortgage debt to income ratio relative to variable-rate mortgagors.

Table 3: Cumulative Difference Between Variable and Fixed-rate Mortgagors: August 2022 to April 2024

	(1)	(2)	(3)	(4)	(5)
Repayments	13,884	12,245	10,417	11,053	10,230
	(520)	(526)	(409)	(442)	(408)
Measured spending	-226	768	748	496	–155
	(1,670)	(1,434)	(1,677)	(1,896)	(1,644)
Uncategorised spending	1,220	1,118	890	1,733	255
	(1,315)	(1,134)	(1,309)	(1,440)	(1,248)
Income	1,452	744	-38	855	1,060
	(3,283)	(2,796)	(2,685)	(3,039)	(2,753)
Residual	3,664	6,496	3,342	2,573	-1,582
	(4,604)	(3,755)	(4,601)	(5,065)	(4,657)
Δ account balances	-9,762	-6,892	-8,851	-9,854	-10,852
	(3,983)	(3,258)	(4,085)	(4,462)	(4,238)
Proportion of increased repayments paid by:					
Δ account balances	0.70	0.56	0.85	0.89	1.06
All other new inflows	0.26	0.53	0.31	0.23	-0.15
Combination mortgages		X	X	X	X
Controls			X	X	X
Ex obs post Dec-2022				X	
Excl. large incoming transfers					X

Notes: This table reports the estimated cumulative change in *repayments*, *spending*, *income* and *residual* account flows for the period August 2022 (the commencement of increases in required mortgage payments) to April 2024. *Residual* is the net inflow of all account flows other than repayments, spending and income. The sum of income and residual flows less repayments and spending equals the implied change in account balance. Column (1) shows cumulative changes for the baseline model. Column (2) includes combination mortgagors. Column (3) addresses the selection of mortgagors into fixed and variable-rate mortgages by including the covariates: lagged mortgage balance; lagged income; lagged mortgage balance-to-income ratio, and; state $\times$ time fixed effects. Column (4) addresses the issue that some of the variable-rate mortgagors might have been fixed-rate mortgagors in the past by excluding variable rate mortgagors entering the data after December 2022. Column (5) excludes the mortgagors in the top 5 percent of incoming transfers. All specifications include controls for the number of credit checks; changes in the number of visible accounts, and changes in the number of income payments. Standard errors, clustered at the person level, are reported in parentheses.

Summary: Cumulative spending and income flows were broadly unchanged over the 21-month period following the commencement of interest rate increases. The estimates indicate that 70 percent of the increase in repayments was financed by a draw down in account balances and the remainder by other net inflows coming into an individual's bank account.

Table 4: Account Balances

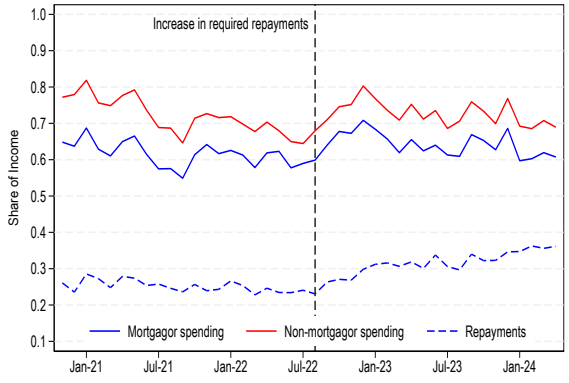
	Prior to rate rise	Last 6 months
	Variable rate mortgagors	
Bank account balance	25,745	17,464
Redraw balance	10,997	7,331
Total	36,743	24,795
	Fixed rate mortgagors	
Bank account balance	24,188	21,096

Notes: This table reports the mean bank account and redraw account balances for the period prior to the commencement of policy rate increases in April 2022 and in the last 6 months of our data (November 2023 to April 2024). Bank account balance are the total of all visible transaction, saving and offset accounts (where present).

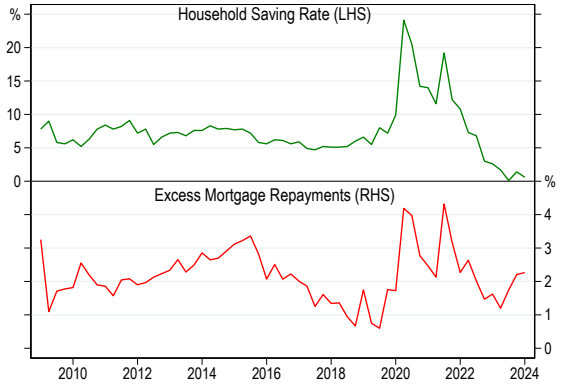
Summary: Savings declined by $8,856 for variable-rate mortgagors relative to fixed rate mortgagors, accounting for the bulk of the increase in required repayments for variable-rate mortgagors.

Figure 1: Background

(a) Consumption by Mortgage Status



(b) Savings

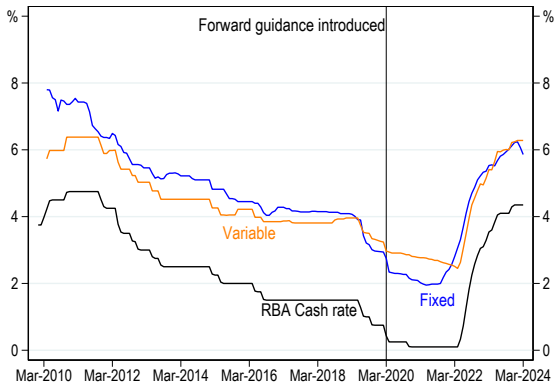


Notes: Panel (a) shows mean spending of mortgagors and non-mortgagors as a share of mean income for each group. *Repayments* is mean mortgage repayments by mortgagors, as a share of mean mortgagor income. Panel (b) shows the household saving ratio (top panel) and excess mortgage repayments as a share of household disposable income (bottom panel).

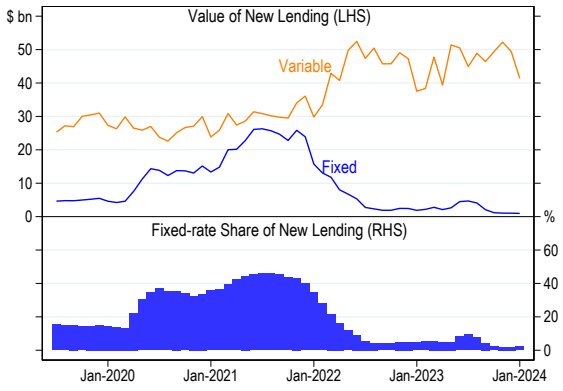
Summary: Mortgage repayments rose by around 10 percent of income for mortgagors between mid-2022 and early 2024. Despite this, there was little change in spending of mortgagors relative to non-mortgagors. Consumption smoothing for mortgagors was facilitated by a large increase in saving during the pandemic, part of which was accumulated in the form of excess mortgage repayments.

Figure 2: Home Loan Interest Rates

(a) Lending Interest Rates



(b) Lending Values and Shares

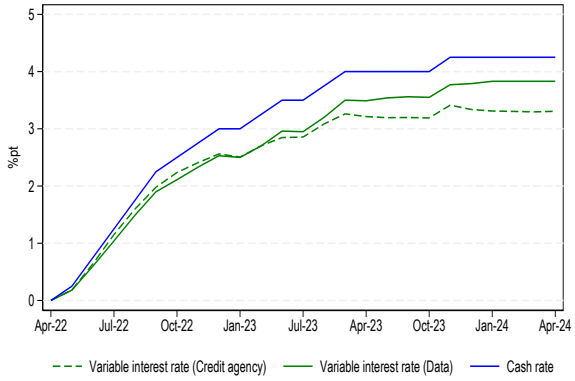


Notes: Panel (a) shows interest rates on new variable and fixed rate loans funded in the month from July 2019. Prior to July 2019 data are indicator home loan interest rates. *RBA Cash rate* is the central bank's policy interest rate. Panel (b) shows the value of new variable and fixed rate housing loans (top) and fixed rate home loans share of new housing lending (bottom). *Source:* RBA.

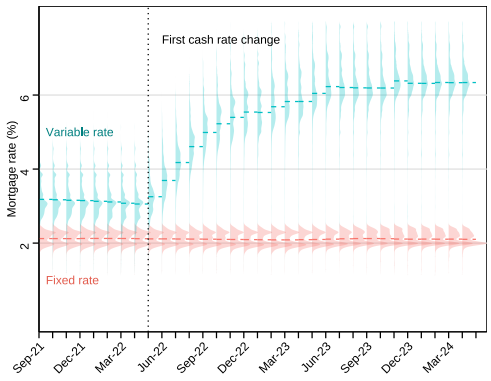
Summary: Following the introduction of forward guidance in March 2020, interest rates on fixed rate mortgages fell by 0.7 percentage points relative to variable rate mortgages. Demand for fixed-rate home loans increased following the introduction of forward guidance by the RBA.

Figure 3: Background

(a) Mean Interest Rate



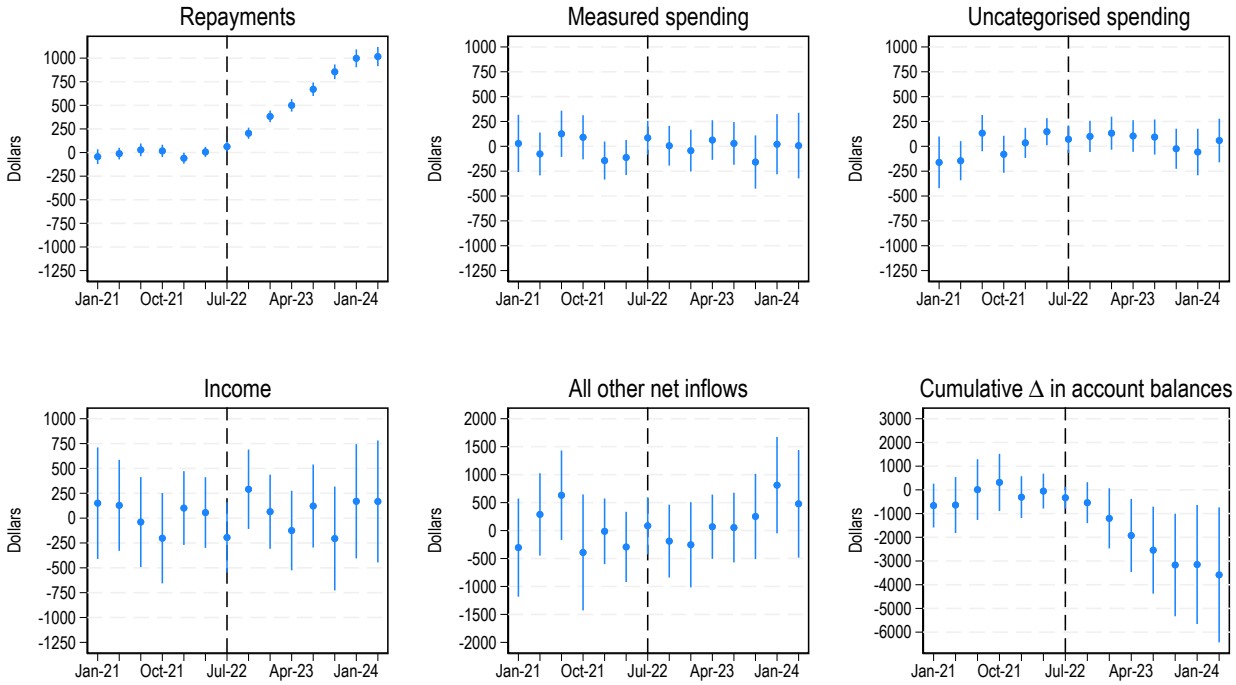
(b) Distribution of Interest Rates



Notes: Panel (a) shows the cumulative change in the RBA cash rate, the average mortgage interest rate from official data and the average interest rate from the credit agency data since the commencement of interest rate increases in May 2022. Mortgage interest rates rose by a little less than the cash rate because competition among lenders reduced lending margins. Panel (b) shows the mean and distribution of interest rates classified as variable and fixed.

Summary: Interest rate changes on loans in the credit agency data are representative of the population. Our classification accurately identifies fixed and variable rate loans.

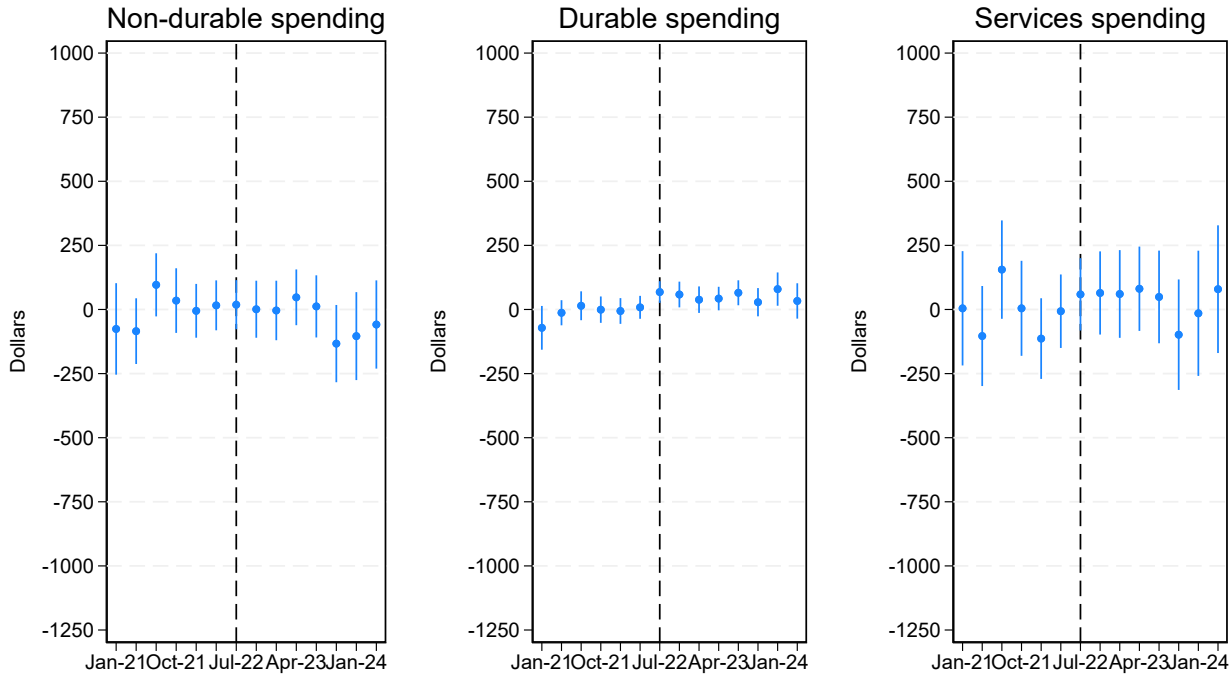
Figure 4: Event Study: Variable vs. Fixed Rate Mortgagors



Notes: This figure shows estimated coefficients δ_k (pre-event) and γ_k (post-event) from Equation (6). All flows shown are at monthly rates. *Cumulative change in account balance* is the sum of *income* and *all other net inflows* less the sum of *repayments* and *spending*. *Measured spending* is the sum of non-durable, durable and services (including rent) spending categorized by the credit bureau; *unmeasured spending* is the sum of other spending-related outflows (ATM withdrawals, miscellaneous card payments, credit card repayments and gambling). Measured spending account for around 60 percent of total spending. Standard errors are clustered at the person level and two standard error bands are shown

Summary: Mean monthly mortgage repayments rose by around $1,000 for variable relative to fixed rate mortgagors between mid-2022 and the start of 2024. However, there was little change in spending between the two groups.

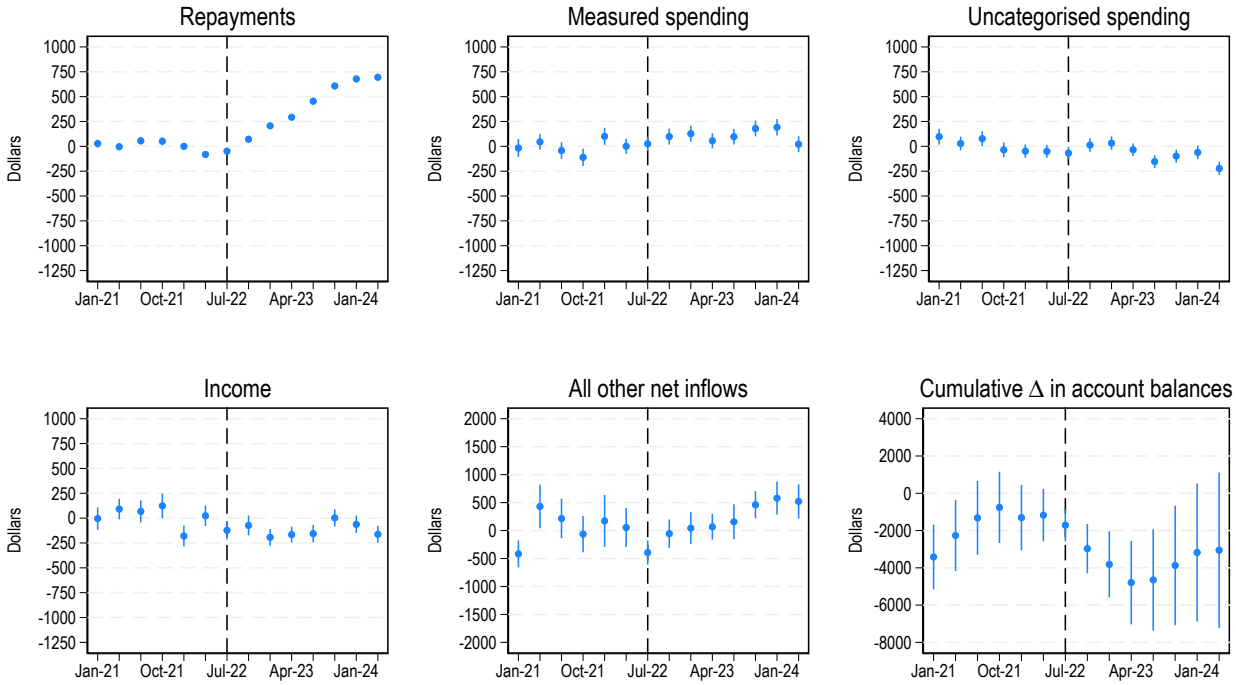
Figure 5: Event Study: Variable vs. Fixed Rate Mortgagors
Components of Categorized Spending



Notes: This figure shows estimates for the components of spending in Figure 4. Measured spending is categorized by the credit bureau. Uncategorised spending is then apportioned to each of these categories using information from the RBA Consumer Payments Survey.

Summary: There was little change in non-durable, durable and services spending for variable relative to fixed rate mortgagors.

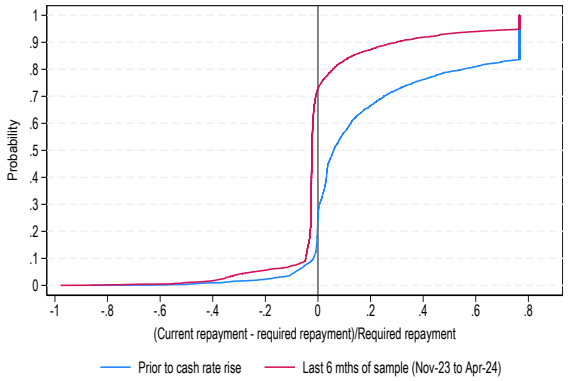
Figure 6: Event Study: Mortgagors vs. Non Mortgagors



Notes: This figure shows estimated coefficients δ_k (pre-event) and γ_k (post-event) from Equation (9). All flows shown are at monthly rates. *Cumulative change in account balance* is the sum of *income* and *all other net inflows* less the sum of *repayments* and *spending*. *Measured spending* is the sum of non-durable, durable and services (including rent) spending categorized by the credit bureau; *unmeasured spending* is the sum of other spending-related outflows (ATM withdrawals, miscellaneous card payments, credit card repayments and gambling). Measured spending account for around 60 percent of total spending. Standard errors are clustered at the person level and two standard error bands are shown.

Summary: Mean monthly mortgage repayments rose by around $750 for mortgagors relative to non-mortgagors between mid-2022 and the start of 2024. However, there was little change in spending between the two groups.

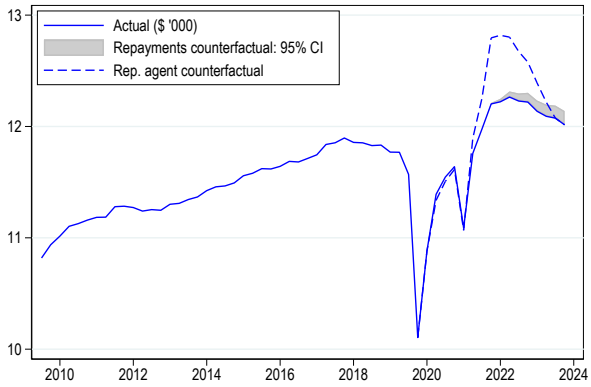
Figure 7: Excess Mortgage Repayments



Notes: This figure shows the cumulative distribution of excess mortgage repayments (current minus required repayments) as a percentage of required repayments, prior to the commencement of interest rate increases in May 2022 and for the last six months of the sample (November 2023 to April 2024). Note excess repayments above the 90th percentile have been grouped into a singe category.
Section <X>

Summary: Around 70 percent of mortgagors were making excess repayments prior to the commencement of interest rate increases, with around one-quarter making excess repayments of at least 40 percent of required repayments. The share making excess repayments declined to around one-quarter of mortgagors by the end of the sample.

Figure 8: Actual and Counterfactual Consumption



Notes: This figure shows quarterly real per capita Household Final Consumption Expenditure (from the national accounts) together with two counterfactuals. *Repayments counterfactual* is consumption assuming aggregate required mortgage repayments had remained at their level prior to the commencement of policy rate increases in 2022Q1. It is constructed by multiplying the estimated MPC from our preferred estimation (Specification 1 in Table 3) by the difference between actual required repayments and their 2022Q1 level. A range is shown using the one-sided 95 percent confidence interval (truncated at zero) for the MPC. *Rep. agent counterfactual* is the level of consumption implied by a representative agent model with an intertemporal elasticity of substitution equal to one if the policy rate remained at its lower bound until 2024Q1. *Sources:* ABS, RBA.

Summary: The required repayments channel of monetary policy can account for no more than one-fifth of the consumption response implied by a standard representative-agent model.

Online Appendix

(Not for Publication)

A Mortgage choice

This Appendix presents a stylized model of fixed versus variable mortgage choice in the Australian context. It provides a decomposition of the difference in value to holding a fixed vs. variable mortgage and shows that in the Australian institutional setting the capacity to make excess mortgage repayments is a determinant of the fixed vs. variable mortgage choice decision. We abstract from the choice of debt level to focus on the mortgage type decision.

The value of a variable rate mortgage is given by

$$V_t\left(b,d,y,r_V,\sigma_{r_V},e\right)=\mathbb{E}_{y,r_V}\left[\underset{\{c,\Delta_e\}}{max}\,u(c)+\beta\mathbb{E}_{y',r'_V}V_{t+1}\left(b',d',y',r'_V,\sigma'_{r_V},e'\right)\right] \tag{A.1}$$

subject to

$$\begin{aligned} b' &= b\left(1+r_b\right)+y-R-\Delta_e-c \\ d' &= \left(1+r_V\right)\left(d+e\right)+R+\Delta_e \\ e' &= e+\Delta_e \\ e' &\geq 0 \\ b &\geq 0 \end{aligned} \tag{A.2}$$

where $b \geq 0$ is the savings account balance, $d \leq 0$ is the mortgage balance, y is income, r_V is the variable interest rate on mortgage debt, σ_{r_V} is the volatility of the variable mortgage interest rate, $e \geq 0$ is the stock of excess repayments, and Δ_e is the change in excess repayments. Required mortgage repayments R are determined by the lender (as a function of d, r_V and loan term). The savings account earns a lower level of interest r_b than mortgage debt r_V.

Fixed rate mortgages in Australia have a fixed rate period of 2 to 3 years. After this the interest rate becomes variable. We model the fixed rate term to be a single period.

Accordingly, the value of a fixed rate mortgage is given by

$$F_t\left(b,d,y,r_F\right)=\mathbb{E}_y\left[\max_c u(c)+\beta\mathbb{E}_{y',r'_V}V_{t+1}\left(b',d',y',r'_V,\sigma'_{r_V},e'\right)\right] \tag{A.3}$$

subject to

$$b'=b(1+r_b)+y-R-e'-c$$

$$d'=(1+r_F)d+R$$

$$e'\geq 0$$

$$b\geq 0$$

A household refinancing from variable to fixed with excess payments buffer e can keep a fraction α of the payments buffer in their savings account and allocate the remained to reduced debt outstanding. It is optimal for a household with redraw balance e to refinance from variable to fixed if

$$\max_{\alpha}\ F_t\left(b+\alpha e,d+(1-\alpha)\,e,y,r_F\right)-V_t\left(b,d,y,r_V,\sigma_{r_V},e\right)>\phi \tag{A.4}$$

where ϕ is the cost of refinancing. Condition (A.4) can be decomposed into components of difference: i) current interest rate; ii) reduced consumption smoothing; iii) cost of holding a liquid buffer in the low return saving account, and; iv) interest rate uncertainty:

$$\begin{aligned}
&F_t\left(b+\alpha^*e,d+(1-\alpha^*)\,e,y,r_F\right)-V_t\left(b,d,y,r_V,\sigma_{r_V},e\right) \\
&\quad=\underbrace{\left\{F_t\left(b+\alpha^*e,d+(1-\alpha^*)\,e,y,r_F\right)-F_t\left(b+\alpha^*e,d+(1-\alpha^*)\,e,y,r_V\right)\right\}}_{\text{value of difference in current interest rate}} \\
&\quad+\underbrace{\left\{F_t\left(b+\alpha^*e,d+(1-\alpha^*)\,e,y,r_V\right)-F_t\left(b+e,d,y,r_V\right)\right\}}_{\text{reduced consumption smoothing buffer}} \\
&\quad+\underbrace{\left\{F_t\left(b+e,d,y,r_V\right)-V_t\left(b,d,y,r_V,0,e\right)\right\}}_{\text{increased cost of holding liquid saving buffer}} \\
&\quad-\underbrace{\left\{V_t\left(b,d,y,r_V,\sigma_{r_V},e\right)-V_t\left(b,d,y,r_V,0,e\right)\right\}}_{\text{insurance value}}>\phi
\end{aligned} \tag{A.5}$$

A special case is where there is no interest rate uncertainty ($\sigma_{r_V}=0$) and the household refinances from variable to fixed and retains all the excess payments buffer in the saving

account ($\alpha = 1$). Under these assumptions, the envelope theorem implies the approximation to Equation (A.5)

$$F_t - V_t \simeq \beta \mathbb{E}_{y',r'_V} \left[\frac{\partial V_{t+1}}{\partial d} \left(\underbrace{(r_F - r_V)\, d}_{\text{current interest rate}} - \underbrace{(r_V - r_b)\, e}_{\text{value of excess repayments}} \right) \right] > \phi \tag{A.6}$$

Switching from fixed to variable is optimal only if the interest saving on mortgage debt d is large relative to the interest cost of keeping excess funds e is a deposit account rather than offsetting the mortgage:

$$(r_F - r_V)\, d > (r_V - r_b)\, e + \phi. \tag{A.7}$$

Hence, we should expect variable rate borrowers to have excess payment buffers.

B Expiry of fixed rate mortgages

This Appendix provides evidence on the response of spending around expiry for fixed rate loans that reset to variable rate loans with higher required repayments. This research design exploits variation in the timing of expiry of fixed rate mortgages, comparing outcomes for expired fixed rate mortgages to those for yet-to-expire fixed rate mortgages. Late-expiring mortgagors are likely to be a good comparison group for early-expiring mortgagors because it was widely expected that interest rates would remain low at the time all the fixed rate loans in our analysis sample were originated.

We identify expired fixed-rate mortgages in loan-level data using three criteria: (i) messages from the mortgagors' bank notifying them of an expiry or loan status change; (ii) the appearance of features exclusive to variable-rate mortgages, such as an offset account; and (iii) a month-to-month interest rate increase of at least [2.5] percentage points. Applying these criteria, we identify approximately [4,000] mortgages expiring between mid-2022 and the first quarter of 2024. The number of expiries is relatively low due to the short panel dimension of the dataset (typically three months). Having identified expiries in the loan level data, the data are collapsed to the person level, aggregating across loans where more than

one is present.[12]

Our goal is to estimate the causal effect of increased required repayments on spending. Unexpired fixed-rate loans provide a suitable comparison group, whereas previously expired fixed-rate loans do not, since treatment effects may vary across expiry cohorts. To address this, we use the Sun and Abraham (2021) estimator, which relies only on the first valid comparisons, unlike the standard two-way fixed effects estimator. This method estimates a treatment effect for each expiry cohort, using fixed-rate loans with at least a certain time to expiry as the control group. The overall treatment effect is a weighted average across cohorts.

Formally, we estimate the expiry cohort-specific event study coefficients δ_k from the regression

$$y_{i,t} = \alpha_i + \gamma_t + \sum_{k=-6, k\neq -1}^{5,6-12} \delta_k^g \text{Event}_{i,t+k} + \varepsilon_{i,t} \tag{B.1}$$

where y is the variable of interest for person i at time t, α_i is an individual fixed effect, γ_t is a time fixed effect, g is the expiry cohort; $\text{Event}_{i,t+k}$ is an event-time indicator taking the value one if person i had a fixed rate loan that expired k periods after calendar time t, and $\varepsilon_{i,t}$ is an error term. The data are an unbalanced panel. The coefficients of interest are a weighted average across cohorts:

$$\delta_k = \sum_{g=1}^{g=T} w_k^g \delta_k^g \tag{B.2}$$

using weights w_g, with $\sum_{g=1}^{g=T} w_k^g = 1$ for all k. The first expiring cohort is $g_1 = 2022\text{m}7$ and the final expiring cohort is $g_T = 2024\text{m}3$. Observations outside the window of 6 months prior and 12 months post expiry are dropped. The estimation is conducted at a monthly frequency, with a pooled estimate for months 6–12 after expiry due to the decreasing sample size over time.

Ideally, the control cohort would use only loans with at least 6 months to expiry—the length of the pre-event window. However, due to the short panel dimension of our dataset few

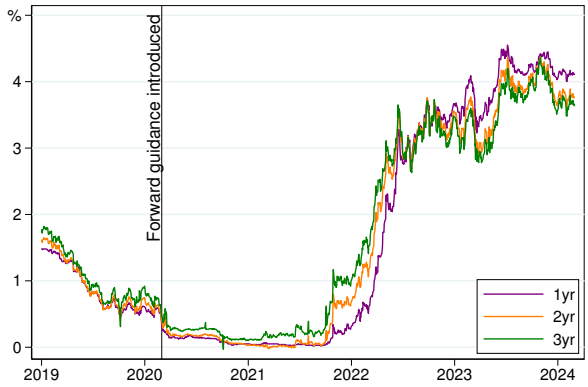
[12]This occurs primarily where an individual had a combination loan, which appears as separate fixed and variable loans. We drop a small number of individuals who had multiple loans expire at different times.

mortgagors are observed for at least 6 months before expiry. Instead, we use loans observed to have at least three months to expiry as the control cohort. Aggregate data (Ung, 2024, Graph 2) suggest an expiry rate of approximately 5 percent per month in 2023 (lower in 2022 and 2024). This implies that, probabilistically, at least 85 percent of loans in our control group remain unexpired for at least six months.

Figure A7 presents the results. At expiry, the interest rate rises sharply by $3\frac{1}{2}$ percentage points (Figure A7a), leading to an increase in repayments of approximately $600 (Figure A7b). However, the increase in repayments is delayed by 2–3 months due to the notification period before higher repayments take effect. Despite the substantial increase in required repayments, there is no evidence of a decline in categorized or uncategorized spending (Figures A7c-d). The absence of temporal variation in spending for at least the 6 months around expiry support using fixed rate mortgagors as a control group in the main analysis.

Although account flows are noisy, the results indicate no change in net inflows to the account (Figure A7e). One possibility is that fixed-rate mortgagors begun reducing consumption in anticipation of higher repayments earlier than our 6 month pre-event window. The other possibility is that they maintained spending by drawing down on account balances after expiry. Consistent with this, the point estimates suggest that account balances decline over time (Figure A7f). This supports the no-anticipation assumption made in the main analysis (see Section 4).

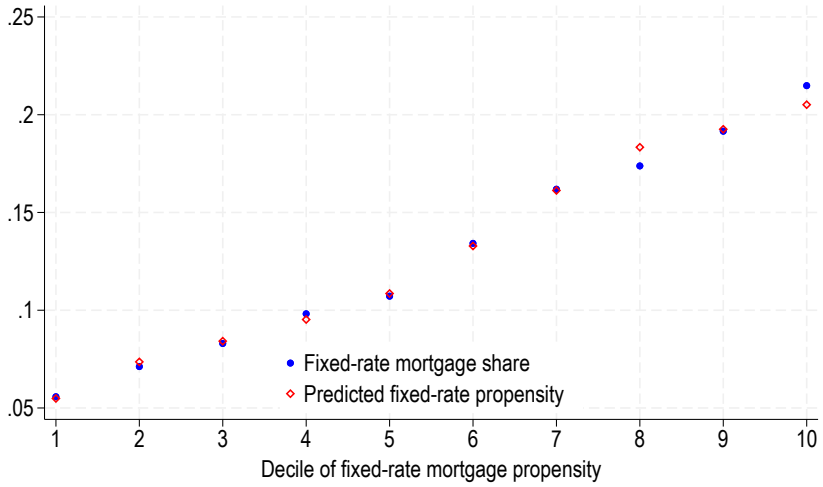
Figure A1: Yields on Zero-Coupon Government Bonds



Notes: Yields on one, two and three year zero-coupon government bonds. *Source*: RBA.

Summary: Between 2020 and October 2021, yields on government bonds indicated that interest rates would remain low in the future.

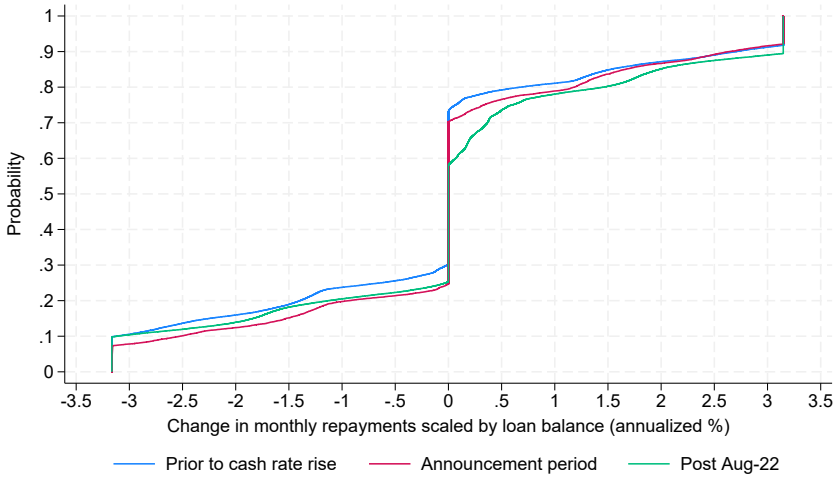
Figure A2: Good of Fixed: Fixed-Rate Mortgage Propensity



Notes: This figure shows the mean fixed-rate mortgage propensity and mean share of mortgages that are fixed-rate, by decile of the fixed-rate mortgage propensity, prior to the first increase in the cash rate in May 2022.

Summary: The fixed-rate mortgage propensity variable has substantial predictive ability for the probability that an individual has a fixed-rate mortgage. It has excellent fit across the distribution of fixed-rate mortgage propensity.

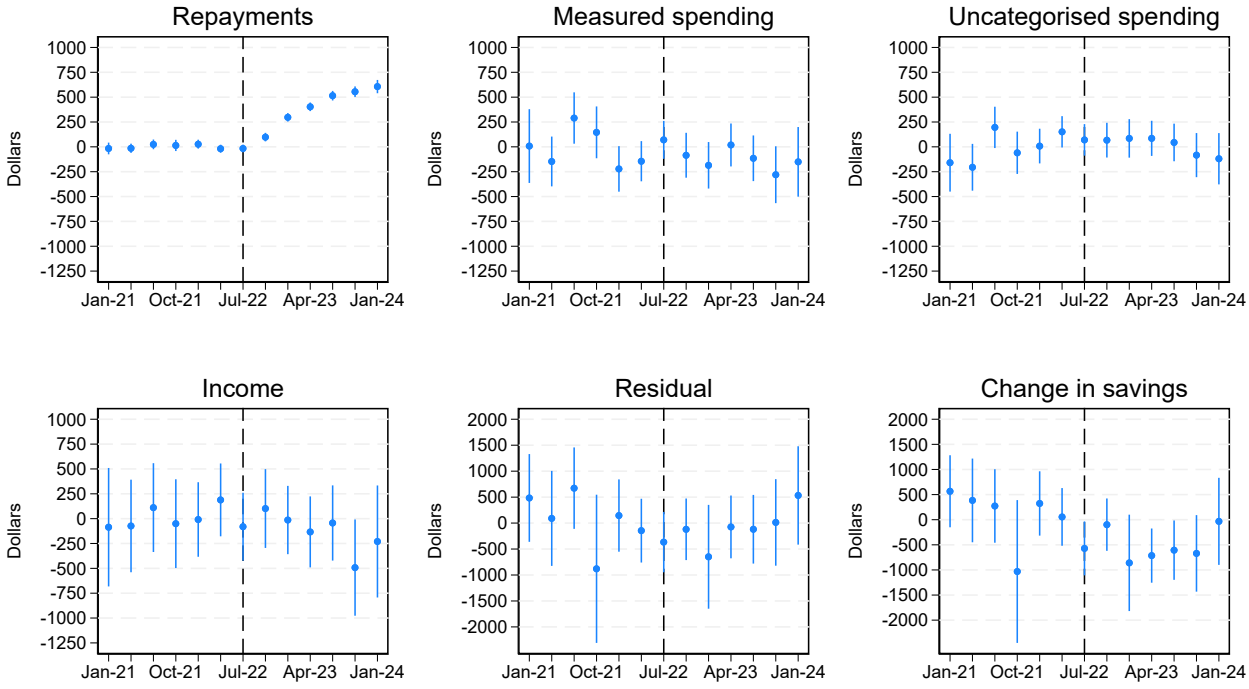
Figure A3: Monthly Change in Mortgage Repayments:
Cumulative Distribution Function



Notes: This figure shows the CDF of the monthly change in mortage repayments for variable-rate mortgagors over three periods: (i) prior to the first rise in the cash rate, (ii) during the three-month period when interest rates increased but required repayments were unchanged and (iii) after repayments first increased.

Summary: Variable-rate mortgagors do not adjust repayments until minimum required repayments increased.

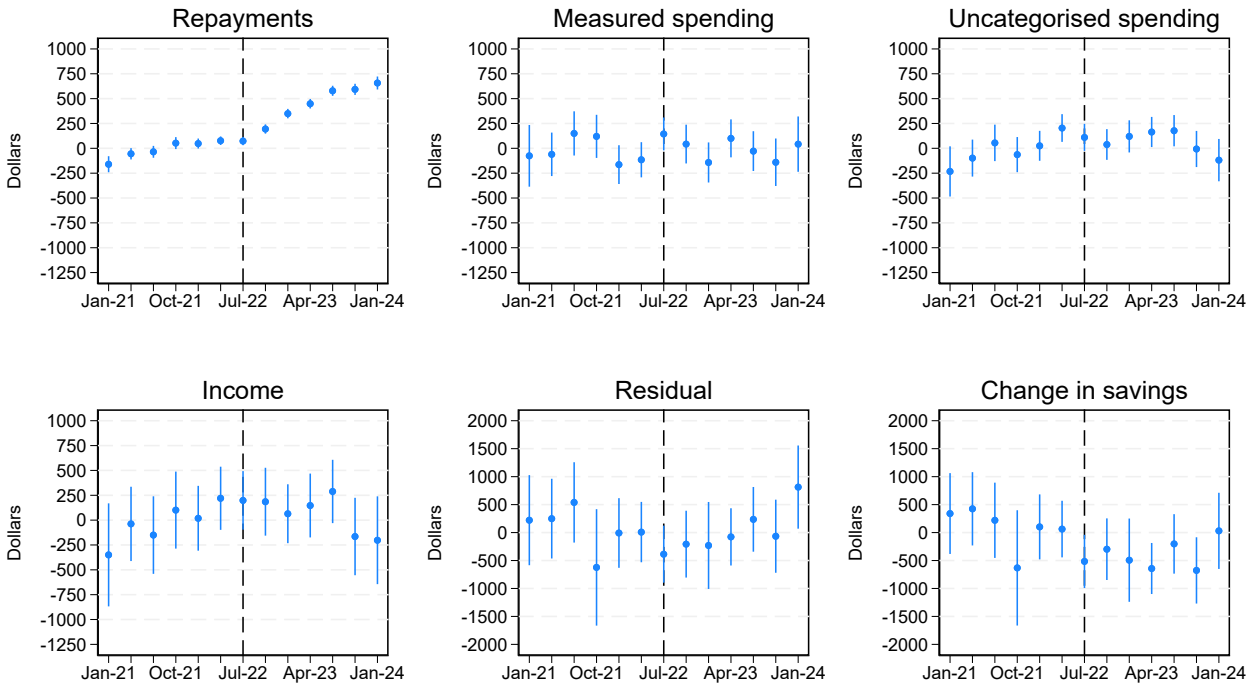
Figure A4: Event Study: Variable vs. Fixed Rate Mortgagors:
Including Control Variables



Notes: This figure reports results analogous to Figure 4 including the following control variables: lagged mortgage balance, lagged income, lagged debt-to-income ratio, interest-only loan status and state × time fixed effects.

Summary: Results including control variables are broadly similar to the baseline results in Figure 4.

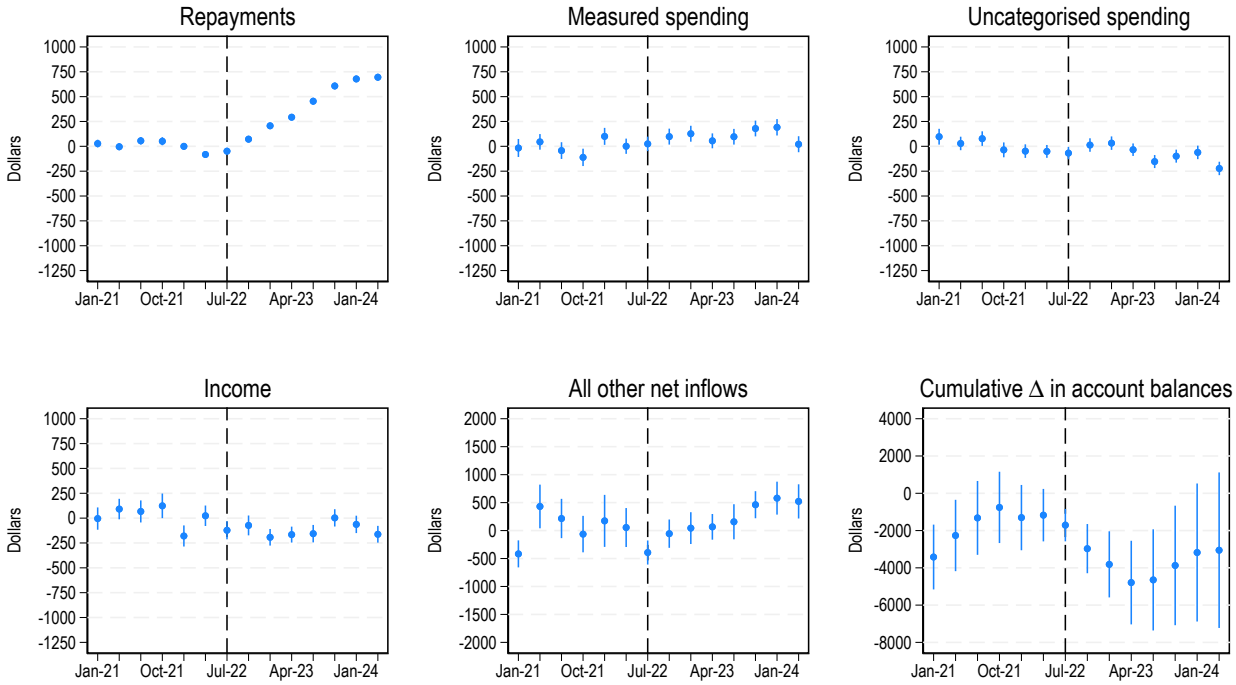
Figure A5: Event Study: Variable, Combination and Fixed Rate Mortgagors



Notes: This figure report results analgous to Figure 4 where the data are augmented to include combination (split fixed and variable rate) borrowers. It shows coefficients δ_k (pre-event) and γ_k (post-event) from Equation (8). The event study coefficient can be interpreted as the change in variable y between the average over the pre-period $t \leq T_0$ and time $T_0 + k$ for a mortgagor with only variable rate loans compared to a mortgagor with only fixed rate loans.

Summary: Results including combination mortgagors are broadly similar to the baseline results in Figure 4.

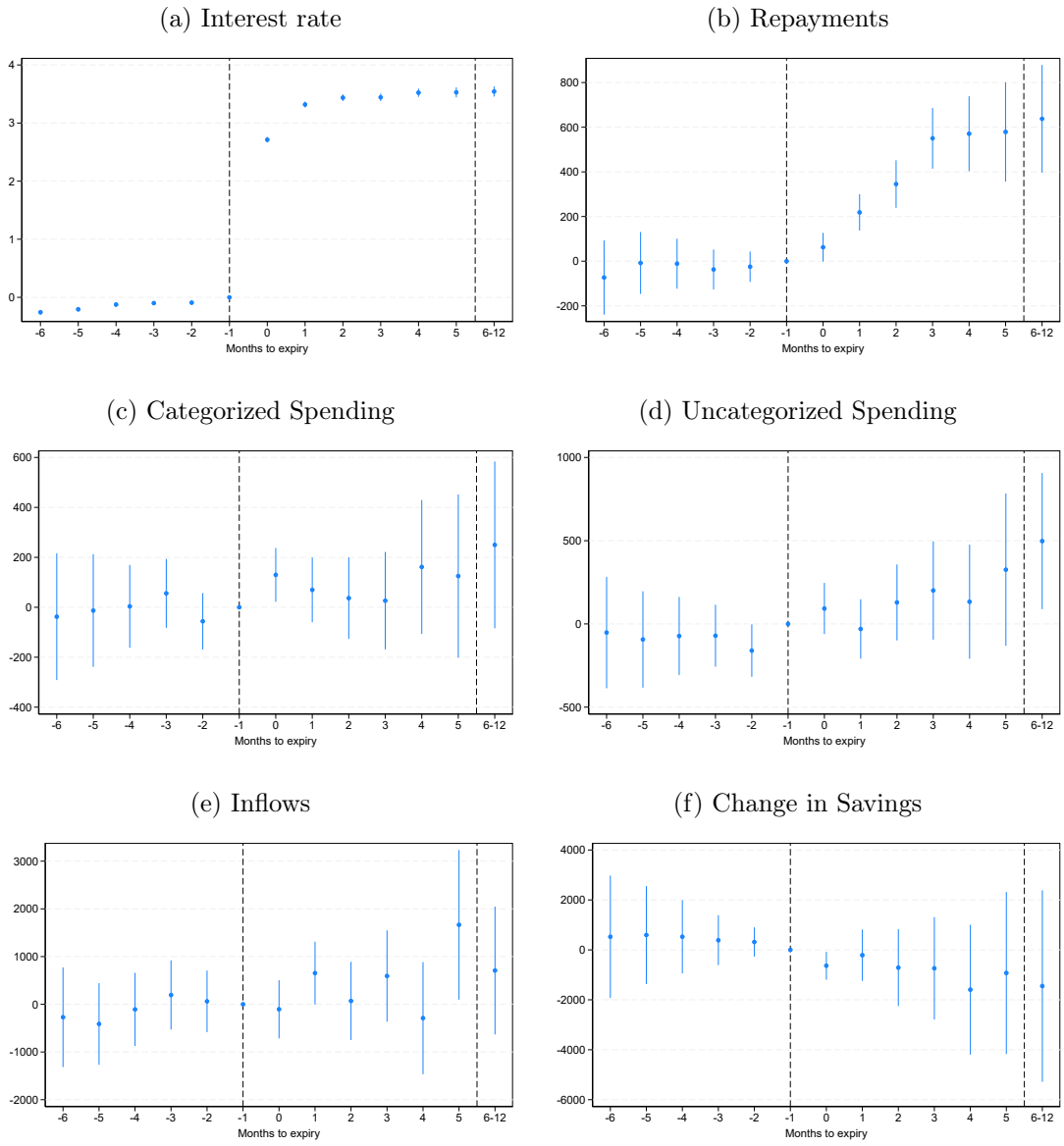
Figure A6: Event Study: Mortgagors vs. Non Mortgagors



Notes: This figure shows estimated coefficients δ_k (pre-event) and γ_k (post-event) from Equation (9) excluding individuals whose average net incoming transfers are above the 95th percentile. All flows shown are at monthly rates. *Cumulative change in account balance* is the sum of *income* and *all other net inflows* less the sum of *repayments* and *spending*. *Measured spending* is the sum of non-durable, durable and services (including rent) spending categorized by the credit bureau; *unmeasured spending* is the sum of other spending-related outflows (ATM withdrawals, miscellaneous card payments, credit card repayments and gambling). Measured spending account for around 60 percent of total spending. Standard errors are clustered at the person level and two standard error bands are shown.

Summary: After excluding individuals with large net incoming transfers, 85 per cent of the increase in repayments were financed by mortgagors reducing their bank account balances.

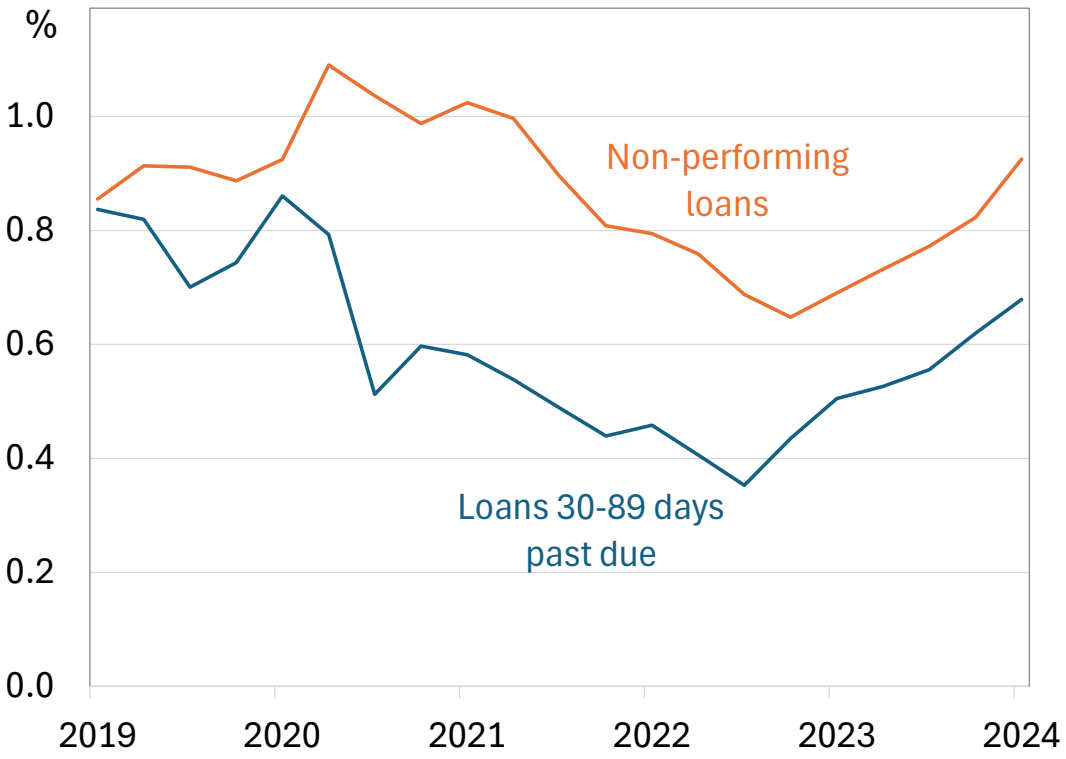
Figure A7: Event Study: Fixed Rate Mortgage Expiries



Notes: Each panel reports expiry cohort-averaged event study coefficients from the Sun and Abraham cohort-specific event study model. The control cohort is unexpired fixed rate loans observed to have at least three months to expiry. Estimation is at a monthly frequency and a pooled estimate for the period 6-12 months ahead is used because the sample size decreases with time. The first expiring cohort is July 2022 and the final expiring cohort is March 2024. Observations outside the period 6 months prior and 12 months post expiry are dropped. Panel (a) shows the the interest rate on the expiring fixed rate loan; Panel (b) shows repayments on all mortgages held by an individual with an expiring fixed rate loan; Panel (c) shows the sum of non-durable, durable and services spending categorized by the credit bureau; Panel (d) shows other spending-related outflows (ATM withdrawals, rental payments, miscellaneous card payments, credit card repayments); Panel (e) shows the sum of income and all other net inflows, and; Panel (f) shows the cumulative change in bank account balances. Standard errors are clustered at the person level.

Summary: For the average expiring fixed rate loan that reset to variable rate status, the interest rate rose by about 3 percentage points and repayments rose by about $600. There is little evidence of a change in spending.

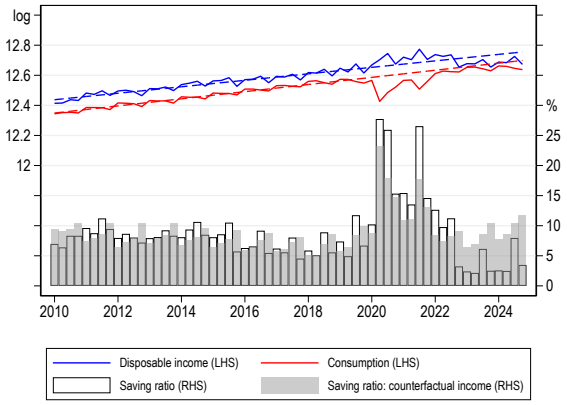
Figure A8: Arrears and Non-Performing Mortgages
Share of Total Credit Outstanding



Notes: Non-performing loans are loans that have been recognised as either impaired or 90 days past due. Loans 30-89 days past-due but not impaired are loans that are at least 30 days past-due but less than 90 days past-due, whether or not the loan is well secured or impaired . *Source*: APRA.

Summary: Arrears and non-performing loans accounted for less than 1 per cent of outstanding credit during the period in which required repayments on variable-rate loans increased.

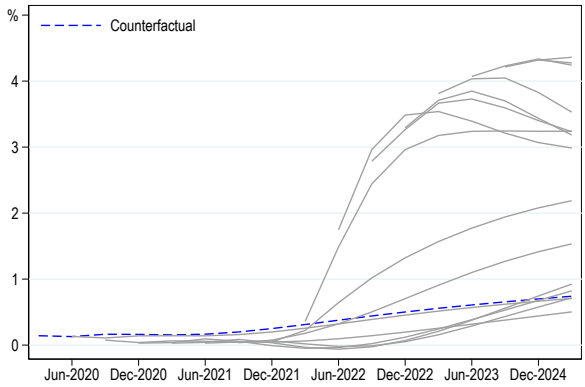
Figure A9: Household Consumption, Disposable Income and Saving



Notes: The figure shows log real household final consumption expenditure, log real household disposable income and the household saving ratio from the National Accounts (ABS Cat. 5206). Household disposable income is net of interest payments. Data are quarterly and seasonally adjusted. Counterfactual trends for consumption and disposable income assume a log-linear trend from 2010-2019. Grey bars show the saving ratio using actual consumption and counterfactual disposable income.

Summary: Lower consumption during the pandemic accounts for 63 percent of the increase in the household saving ratio in 2020-2021 relative to 2019.

Figure A10: Actual and Counterfactual Monetary Policy



Notes: The figure shows the expected path of nominal interest rates at each date and the counterfactual path. Data are forward rates from RBA Statistical Table F17. The counterfactual path assumes interest rates remained at the values expected in 2020Q2, until 2024Q1. After 2024Q1, the counterfactual path is equal to the actual path at all dates.

Summary: Market interest rate expectations began to rise relative to the counterfactual path in late 2021.