CENTER FOR
ECONOMIC
BEHAVIOR &
INEQUALITY

CEBI WORKING PAPER SERIES

Working Paper 04/26

CONSUMPTION RESPONSES TO RISING MORTGAGE RATES: UNPACKING THE CASH-FLOW CHANNEL OF MONETARY POLICY

Asger Lau Andersen

Andreas Jakobsen

Mads Rahbek Jørgensen

Niels Johannesen

ISSN 2596-447X

CEBI
Department of Economics
University of Copenhagen
www.cebi.ku.dk

Consumption responses to rising mortgage rates: Unpacking the cash-flow channel of monetary policy*

Asger Lau ANDERSEN
Andreas JAKOBSEN
Mads Rahbek JØRGENSEN
Niels JOHANNESEN

March 27, 2026

Abstract

When market interest rates are rising, do mortgage borrowers make consumption decisions based on current cash-flows—what they are paying on their mortgage today—or expected future cash-flows—what they expect to pay after the next mortage rate reset? We address these questions in the context of the dramatic rise in interest rates in 2022 and present two key findings. First, comparing households with the same adjustable-rate mortgages but different reset timing, we find no significant effect of current cash-flows: each additional dollar of mortgage payments reduces spending by only 1 cent and liquid buffers absorb most of the increased expenditure. Second, comparing households with different exposure to future resets, we find a large effect of expected future cash-flows: each additional dollar of expected mortgage payments reduces current spending by more than 15 cents. Overall, the evidence is consistent with forward-looking households who reduce spending and increase savings in anticipation of future increases in their mortgage payments and use liquid buffers to smooth spending.

JEL-Codes: D12, D14, E21, E43, E52.

Keywords: Consumption, Saving, Cash-flow effect, Monetary policy, Mortgage

*Asger Lau Andersen is at University of Copenhagen and Centre for Economic Behavior (asger.lau.andersen@econ.ku.dk). Andreas Jakobsen is at Danske Bank and Copenhagen Business School (anja@fi.cbs.dk). Mads Rahbek Jørgensen is at Danske Bank and University of Copenhagen (mads.jorgensen@econ.ku.dk). Niels Johannesen is at Oxford University Centre for Business Taxation and University of Copenhagen (niels.johannesen@sbs.ox.ac.uk). We are grateful to seminar audiences at University of Bristol, University of Nottingham, Imperial College and Oxford University for helpful comments and suggestions. The activities of CEBI are financed by the Danish National Research Foundation, Grant DNRF134. Declarations of interest: none

1 Introduction

A key channel of monetary policy transmission is the cash-flow channel: the pass-through of policy rates to market rates and thus to homeowners' mortgage payments. In many countries, the majority of mortgage loans have adjustable rates that are reset at regular intervals, for instance every year or every five years. This means that monetary policy shocks often affect mortgage payments with a significant time lag; however, they may potentially have an immediate impact on household behavior by shifting expectations about what mortgage payments will be after the next reset. The strength and the timing of monetary policy transmission to aggregate consumption through the cash-flow channel therefore depends crucially on household responses to changes in current as well as expected future mortgage payments.

Standard theory of household consumption and savings provides some guidance on these questions. On the one hand, the permanent income hypothesis predicts that households with sufficient liquidity should adjust spending in response to shocks that change expectations about future mortgage payments and smooth spending through fully expected changes in current mortgage payments (Friedman 1957; Ando and Modigliani 1963; Hall 1978). On the other hand, another class of models find that households whose spending is constrained by a low level of liquidity may respond strongly to changes in current mortgage payments and perhaps not at all to changes in expectations about the future (Zeldes, 1989; Deaton, 1991; Carroll, 1997). The broader empirical household finance literature documents a range of settings where households exhibit a high sensitivity to current cash-flows, even when they are fully anticipated (e.g. Kueng, 2018).

In this paper, we study household responses to the strong surge in interest rates in the first half of 2022 and the pass-through to mortgage rates in the following years. Our laboratory is Denmark where the interest rate on adjustable-rate mortgage loans with 5-year interest fixation periods soared sharply from around 0% to around 3% in a few months. This dramatic increase implied that mortgage payments on such loans more than doubled when rates were reset for large groups of households in 2023-2024. Our analysis uses transaction data, highly granular loan data and other customer data from Danske Bank, the largest retail bank in Denmark, which allows us to track mortgage payments, household spending, and savings in deposits and securities across customers with different exposure to the surge in interest rates.

This setting allows us to unpack the cash-flow effect of monetary policy by estimating, with distinct quasi-experimental designs, the response to fully anticipated changes in *current mortgage payments* holding constant expectations about future cash-flows and the response to changes in *expected future mortgage payments* holding constant current cash-flows, In both cases, we aim to shut down other channels of monetary policy, such as wealth effects and labor market effects.

The first quasi-experiment identifies the effect of an increase in current mortgage payments on household spending, saving and investment decisions. It compares two groups of households who are essentially identical in terms of ex ante observable characteristics. Both groups had adjustable-rate mortgage loans with a 5-year interest fixation period when they entered the period with surging market interest rates; however, past timing differences in home purchase and financing decisions creates variation in the exact time at which mortgage rates were reset to a higher level. Through a four-year window from April 2020 to March 2024, we thus compare a treatment group whose mortgage rate reset during the window, in April 2023, and a control group whose mortgage rate reset after the window, in April 2024. The key identifying assumption is that the two groups are similarly exposed to other channels of monetary policy, including the effect on expected medium-term and long-term mortgage costs. Under this assumption, the effect of the change in current mortgage payments is identified as the differential behavioral change of the treatment group at the reset in April 2023.

The results suggest that the anticipated increase in current mortgage payments had little or no effect on household spending. For every dollar the treatment group's monthly mortgage payments increased at reset, they reduced monthly spending by only 1 cent relative to the control group, a very low and statistically insignificant marginal propensity to consume of around 0.01 (confidence interval: [-0.04, 0.07]). To sustain spending through the substantial increase in mortgage payments, they drew down balances on deposit and current accounts (around 75 cents on the dollar). We find no significant effects on other margins: stock market investment, employment income, and non-mortgage loans.

The second quasi-experiment identifies the effect of an increase in expected future mortgage payments on the same financial decisions. It compares two groups of households who are similar in terms of observable characteristics but differ in their exposure to the looming pass-through of higher market rates to mortgage payments because of past mortgage financing choices. Specifically, we compare a treatment group with 5-year adjustable-rate mortgage loans due to reset in April 2023 or April 2024, and a control group with fixed-rate mortgage loans originating in the same period as the adjustable-rate loans of the treatment group. This analysis focuses on the period *before reset* where current mortgage payments are fixed for both groups, but where the treatment group is exposed to a sharp increase in expected future mortgage payments.

The results suggest that the shock to expected future mortgage payments had a significant negative effect on household spending. To express the estimate as a marginal propensity to consume, we use market forecasts of future mortgage rates to construct, for each household and for each month prior to reset, a time-varying measure of the expected increase in mortgage payments at reset. The results imply that for every dollar the treatment group's monthly mortgage payments were expected to increase at reset, they reduced monthly spending by around 16 cents in the period prior to reset. By reducing spending, but also by reducing financial investments and raising employment income, the treatment group significantly increased balances on deposit and current accounts (around 60 cents on the dollar of expected future increases) in anticipation of the mortgage rate reset.

We probe the robustness of the results in a range of additional tests. First, the results are generally robust to changing the set of non-parametric controls. Second, the results remain when we exclude households that extract equity or make changes to the mortgage loan features (e.g. change the interest rate fixation period or move into interest-only) at the time of reset. Third, the results on spending responses to expected future payments are robust to an alternative design that relies on variation in mortgage loan size *within* the sample of households with adjustable rate mortgages for identification. This addresses a potential identification concern of our main design, namely that selection into adjustable vs fixed rate loans is determined by unobservable characteristics (e.g. risk preferences) that may have a separate impact on household behavior through the sample period. Remarkably, this alternative design, although it exploits an entirely different source of variation, delivers the same estimate of the propensity to reduce current spending in response to higher expectations about future mortgage payments (16 cents on the dollar).

Overall, the results align well with standard theory for unconstrained households. The households in our sample lower spending significantly and increase their buffer of liquid assets when a shock to market rates raises expectations about future mortgage payments. However, they make no further spending adjustments but draw on liquid buffers when the shock to market rates passes through to current mortgage payments. Presumably, this reflects that Danish households with adjustable-rate mortgage are relatively liquid: average deposit balances in our sample equal almost one year of spending or more than three years of mortgage payments at the higher reset rates. When we focus on the least liquid subsample, we find larger spending cuts as expectations about future mortgage payments rise (25 cents on the dollar of expected future increases), suggesting that they do more to increase their liquid buffer in anticipation of the reset, but no significant change in spending when current mortgage payments reset.

Our findings have important practical implications for monetary policy. Most importantly, they suggest that household consumption adjusts quickly to a new interest rate environment, even if the pass-through to existing loan payments takes months or years to materialize. Specifically, our analysis reveals that mortgage borrowers are forward-looking and adjust their spending before loan payments actually change. Rather than waiting for payment adjustments to occur, they respond to rising expectations about future mortgage payments, modifying their consumption in anticipation of higher costs.

Our paper contributes to a limited but growing literature that uses granular microdata to study the propagation of monetary policy through the cash-flow channel. Closely related to our analysis of current mortgage payments, Di Maggio et al. (2017) study spending and leverage responses to mortgage rate reset in an environment where interest rates are falling, so that reset implies an increase in disposable income. Contrary to our finding that spending barely responds to current mortgage payments, they find significant increases in car purchases at the time of reset. Other recent contributions to this literature include Galaasen et al. (2024) and Floden et al. (2021) who find significant consumption responses to monetary policy shocks without distinguishing responses to actual vs expected changes to cash-flows and Druedahl et al. (2022) who study spending responses to advance notices from banks about the rate at which mortgages will be reset.

Compared to this set of papers, our paper stands out in two ways. First, we identify the consumption effects of shocks to expectations about future mortgage payments, in addition to but separately from the effects of anticipated changes in current payments.[1]This is important for theory as well as for practical monetary policy. Second, we study spending responses to rising rates whereas the existing literature largely consider settings where rates are falling. Given recent evidence documenting in the context of tax refunds that cash-flow effects need not be symmetric (Baugh et al., 2021), this feature may explain the apparent conflict between Di Maggio et al. (2017) who find that spending increases when mortgage rates reset to a lower level and our finding that spending does not change when they reset to a higher level. Third, our measures of spending, deposits, investment and employment income are close to comprehensive. This enables us to directly estimate the marginal propensity to consume and also recover the full array of household responses to rising interest rates with estimates that, at least approximately, respect the adding-up properties coming from the intertemporal budget constraint.

[1]Relatedly, Fuster et al. (2026) show that households prepare for future changes in mortage rates through refinancing decisions.

We also contribute to the broader empirical household finance literature on how spending and saving decisions are shaped by changes in the economic environment. A central question concerns the effect of anticipated cash-flows, positive or negative, on household consumption. The findings are mixed with some papers documenting a high sensitivity to anticipated cash-flows (Parker, 1999; Souleles, 1999; Kueng, 2018) and others finding no such sensitivity (Browning and Collado, 2002; Hsieh, 2003). Our small and precise estimate of the marginal propensity to consume out of current mortgage payments places our paper in the latter camp. Our finding is consistent with arguments that households are more likely to smooth large cash-flows (Browning and Collado, 2002) and negative cash-flows (Baugh et al, 2021).

The paper proceeds in the following way. Section 2 lays out the institutional setting. Section 3 describes the data sources and the variables and provides summary statistics. Section 4 explains the empirical design for current mortgage payments and reports the results. Section 5 explains explains the empirical design for expected future mortgage payments and reports the results. Section 6 analyzes heteregoneity in household behavior while Section 7 probes the robustness of the findings and Section 8 concludes.

2 Background

2.1 The Danish mortgage market

Households in Denmark typically finance home purchases through long-term mortgages with a duration of up to 30 years. Danish mortgage banks fund these loans by issuing covered bonds backed by the pool of loans. The banks act as intermediaries between borrowers and bond investors and carry the credit risk in case of borrower default. However, mortgages are full recourse, the legal process in case of foreclosure is fast and low-cost, and default rates are very low. Households can borrow up to 80% of the property value with bond-financed mortgage loans. They can top up beyond the 80% mark with other types of collateralized loans, but these are typically more expensive, as mortgage lenders have a senior claim on the collateral in the event of borrower default.

As in the United States, the traditional Danish mortgage loan is a 30-year fixed-rate mortgage (FRM) with no prepayment penalty, but adjustable-rate mortgages (ARM) have become a highly popular alternative since their introduction in the 1990s. Adjustable-rate loans also have terms up to 30 years, but the interest rate is adjusted at regular, predefined intervals, typically of 1, 3 or 5 years. Both FRM and ARM loans come with an option of interest-only payments for a limited period.

Based on comprehensive administrative micro-data, Table 1 shows aggregate statistics for households with a mortgage in Denmark at the end of 2021. Of the 1.1 million households with a mortgage, roughly half had an ARM, and a quarter had an ARM with a five-year interval between rate adjustments (ARM5). ARM5 borrowers held 30% of total household debt in 2021 (mortgage debt as well as other types) and paid about 20% of total household interest payments, reflecting that interest rates were generally lower on ARM5 loans than on FRM loans.

For both FRM and ARM loans, the interest rate paid by the borrower is determined directly by the yield on the bonds issued to finance them. Interest rates are therefore determined solely by market conditions and the choice of loan type and do not depend on individual borrower characteristics.[2] For FRM loans, the interest rate is determined at origination and stays constant during the term of the loan. FRM borrowers have the option to prepay at either face or market value, however, and can thus refinance to a lower rate if market rates fall.

For ARM borrowers, the interest rate adjustments during the loan's term are determined by bond market conditions at the time of the adjustment. About 2 months prior to the adjustment date, banks issue new bonds to refinance the loans, and the new interest rate is then calculated as the yield on the new bonds. ARM borrowers must decide whether to keep or refinance their loans about 3 months before the adjustment. At that time, the bank will typically send a letter to the borrower informing them about the upcoming adjustment, the bank's expectations for the new interest rate, and their options for refinancing.

2.2 The interest rate shock in 2022

Figure 1 shows the evolution in interest rates on new ARM5 loans issued by Realkredit Danmark, the mortgage credit branch of Danske Bank. Interest rates on ARM5 loans were close to zero throughout 2021 but then rose sharply in the first half of 2022, as central banks raised policy rates to combat mounting inflationary pressures caused by supply chain disruptions following the Covid-19 pandemic and the onset of the war in Ukraine. By the end of 2022, they had increased by more than 3 percentage points.

Figure 1 also shows Danske Bank's forecast, made 12 months earlier, for the ARM5 interest rate in each month. The forecast series illustrates two important points: First, the one-year-

[2] Banks redirect interest and principal payments from borrowers to bond holders. On top of these, they also charge an administrative fee from borrowers to cover their own costs. The fee is proportional to loan balances and may depend on the loan-to-value ratio and loan characteristics, but is otherwise independent of borrower characteristics.

ahead forecasts for 2022 are only slightly increasing and far below actual realized rates, demonstrating that the steep increase came as a surprise to professional analysts. Second, the forecasts closely track current rates with a one-year lag, indicating that at any point during this period, forecasters expected the interest rate 12 months in the future to remain close to its current level. For example - and particularly important for our purposes - the bank's expectation in early 2023 was that interest rates would remain at roughly the same elevated level over the next year—an expectation that ultimately proved accurate.

3 Data

Data sources. The analysis uses customer data from Danske Bank, the largest retail bank in Denmark. The data includes loan-level data on mortgages and other loans with detailed information about loan characteristics and payments of interest and fees. It also includes transaction-level data on consumer expenditures made through card payments and bill payments, as well as on cash withdrawals.

Analysis period. Our analysis covers the 48-month period from April 2020 to March 2024. This period covers two key events: the rise in market interest rates in the first half of 2022 and the reset of rates of 5-year ARMs in April 2023. The sample period includes some of the Covid-19 pandemic, which had a profound impact on spending patterns (Andersen et al, 2022).

Sample. We conduct the analysis at the household level and use loan information to delineate four samples. First, a sample whose 5-year adjustable mortgage rate was reset in April 2023. Second, a sample whose 5-year adjustable mortgage rate was reset in April 2024. These 5-year ARM loans generally originated 5 or 10 years before the reset in April 2023 and April 2024, respectively.[3] Finally, two samples with fixed-rate mortgage loans originating in the same period as the adjustable-rate mortgage loans in the first two samples.

We impose two additional sample restrictions to address the concern that spending measures based on transaction data from a single bank are incomplete when households spend through multiple banks (Baker, 2018). We aim to exclude households who mainly use other banks than Danske Bank by requiring that households have at least five spending transactions through

[3]Danske Bank designates a specific date each year to adjust rates on all ARM loans sceduled for reset. In 2023 and 2024, that date was April 1. The first sample thus consists of households who financed their home with a 5-year ARM in the period March 2013 - February 2014 or in the period March 2018 - February 2019. The second sample consists of households who financed their home with a 5-year ARM in the period March 2014 - February 2015 or in the period March 2019 - February 2020.

Danske Bank per month throughout the analysis period, and that their unique bank account designated for transactions with the public sector is held at Danske Bank. Finally, we exclude business customers because their personal balance sheets are difficult to disentangle from those of their businesses. After applying these sample restrictions, we are left with around 10,000 households with ARM loans and around 25,000 households with FRM loans.

Exogenous effect of reset. Some households change their mortgage loan type at the time of the interest rate reset. They may opt for a loan with a fixed rate or a 1-year adjustable rate or they may choose to make their loan interest-only. Conceptually, we consider changes in the loan type as potentially endogenous responses to the reset. We think of the *exogeneous* effect of reset as the change in mortgage payments a household would experience absent any active change of loan type, i.e. if it would continue with its existing ARM5 loan after the reset. To measure this, we project the contractual payments on the loans that the household holds as of December 2021 and compute the exogenous effect as the change in projected payments at the time of reset. For households who do not alter their loans between December 2021 and the time of reset, this coincides with the actual change in mortgage payments at reset.

Outcomes. We use the customer data from Danske Bank to construct a number of household-level outcomes. First, we measure monthly *mortgage payments* with information from the loan dataset. The measure includes mortgage interest payments as well as fees related to the mortgage loan. Second, we measure monthly consumer *spending* by summing payments made with cards and bills as well as cash withdrawals while excluding transaction categories such as tax payments and debt service that we do not consider spending. Our approach follows existing papers that construct spending measures from bank transaction data (e.g., Ganong et al., 2019; Andersen et al., 2023, 2024).[4] Third, we measure *net saving in deposits* as the change in balances on all current accounts and deposit accounts from the beginning to the end of the month. Fourth, we measure *net investment in securities* as net flows into securities investment accounts from current and deposits accounts. Our measure includes flows to and from investment accounts at Danske Bank as well as the two main online investment platforms in Denmark. Fifth, we measure the change in *other loan balances* as the change in balances on all loans accounts other

[4]In Figure A1 in the Online Appendix, we compare our spending measure to a survey-based measure of consumption constructed by Statistics Denmark. Our measure suggests a somewhat higher average level of spending. This may be partly due to the methodological differences, but also reflects that our sample of homeowners is not representative of the overall population. Reassuringly, the composition of spending across categories is roughly similar across the two measures.

than mortgage loans from the beginning to the end of the month. Sixth, we measure *income* by summing over incoming flows categorized as income by the banks' classifier. Importantly, income flows are measured after tax is withheld by employers and therefore – as interest payments are tax deductible – mechanically affected by the increase in mortgage payments at reset.

Frequency. While we measure all outcomes at the monthly level, we conduct the empirical analysis at the quarterly level using the monthly average within the quarter as outcome. This procedure reduces the noise relative to estimations at the monthly frequency and retains the interpretation of the estimates as changes in monthly flows.

Summary statistics. Table 2 shows summary statistics for each of the four samples: households with an ARM5 loan with reset in April 2023 (Column 1) and April 2024 (Column 2) originating 5 or 10 years before and households with an FRM originating in the same periods (Columns 3-4). The two ARM samples are highly comparable in terms of age, balance sheet structure, income and spending, geographical location and family structure. This is intuitive given that they have selected the same type of mortgage loan at almost the same point in time. The FRM samples are somewhat different in terms of observable characteristics. Specifically, the FRM households are younger, have smaller balance sheets and higher income, are less likely to live in the Copenhagen region and are more likely to have children under 18 years. The differences motivate the use of a battery of control variables in the regressions below.

4 Current cashflows

The goal of our first analysis is to estimate responses to the increase in current mortgage payments occurring at the time of the mortgage rate reset. While theory suggests that households with no significant liquidity constraints should smooth spending in response to fully anticipated changes in payments, many empirical studies show that household spending exhibits a high sensitivity to cash-flows, even when they are fully anticipated (e.g. Kueng, 2018).

4.1 Empirical design

Our design relies on quasi-random differences in the timing of mortgage rate reset following the shock to market interest rates in 2022. Specifically, we compare the *treatment group* with ARM5 loans resetting in April 2023 to the *control group* with ARM5 loans resetting in April 2024. Assuming that the two groups would have remained on similar behavioral trajectories absent the difference in reset dates, we interpret any divergence around April 2023 as the effect of the differential change in current mortgage payments.

The comparison of two cohorts of ARM borrowers arguably controls for other channels through which higher interest rates and broader changes in the macro-economic environment affected household behavior in the period. First, the two groups are highly similar in terms of observable characteristics such as age, income and balance sheets, suggesting that labor market effects and wealth effects are equally similar. Second, the two groups have selected the exact same type of mortgage loans (albeit at a slightly different point in time), suggesting that they have comparable risk preferences and similar expectations about mortgage costs over the medium and long run. Third, expectations about future mortgage payments are similar for the two groups: the mortgage rate of the treatment group reset at around 3.5% in April 2023 and, as shown in Figure 1, the market expectation at that time was that the mortgage rate would reset at a similar level in April 2024, which turned out to be accurate. The only salient difference between the two groups is the timing of the increase in mortgage payments, which reflects a minor difference in the timing of loan origination 5-10 years earlier.

4.2 Descriptive evidence

We begin with a descriptive analysis of the dynamics in our two main outcomes - mortgage payments and spending - in the time period around April 2023. Figure 2 shows raw averages of these variables for the group of households with an ARM5 loan resetting in that month (the treatment group) and the group with an ARM5 loan resetting one year later, in April 2024 (the control group). Panel (a) shows that monthly mortgage payments roughly double in April 2023 for the average household in the treatment group, from just over DKK 3,000 per month to more than DKK 6,000, while they remain constant for the control group. [5].

As shown in Panel (b), monthly spending is almost perfectly aligned across the treatment and control group throughout the analysis period. There is significant variation in the level of spending across months, due to differences in the number of days, the number of weekends and public holidays, but this variation is remarkably similar across the two groups. Strikingly and most importantly for our purposes, there are no visible signs that the spending of the treatment group changes differentially in April 2023 when their mortgage payments double.

[5] The slight increase in the months before reset for the treatment group reflects that a minority of households hold other mortgage loans in addition to their ARM5 loans. Some of these have shorter interest rate fixation periods and are therefore affected by the increase in current market rates before April 2023

4.3 Spending dynamics

We conduct a formal investigation of the dynamic spending responses to the mortgage rate reset by estimating the following difference-in-differences model for the period from 2020q2 to 2024q1:

$$y_{i,t} = \alpha_i + \gamma_t + \sum_{q \neq 2023q1} \big((\beta_q ARM23_i + \boldsymbol{X}_i \boldsymbol{\delta}_q) \cdot \mathbb{1}(t = q) \big) + \epsilon_{i,t} \tag{1}$$

where $y_{i,t}$ is the average monthly outcome (e.g., spending) for household i in quarter t, α_i is a household fixed effect, γ_t is a time fixed effect, $ARM23_i$ is a dummy for belonging to the group with reset in April 2023, $\mathbb{1}(t = q)$ is an indicator for quarter q, and $\boldsymbol{X}_i$ is a vector of controls evaluated in December 2021. The controls are categorical variables indicating birth year (5-year interval), gross income (quintile group), total debt (quintile group), total bank deposits (quintile group), and area of residence (11 regions). The β estimates from this model capture the differential development in the outcome for households in the treatment group since the reference period (2023q1) relative to households in the control group with similar observable characteristics.[6]

Figure 3 shows estimated β coefficients with average monthly spending as the outcome. The estimates are generally small and statistically insignificant with no apparent change after 2023q2. The two groups are on parallel spending trajectories both before and after the interest rate reset for the treatment group, suggesting that the treatment group did not significantly change spending in response to the sharp increase in current mortgage payments.

4.4 Other response margins

To explore how households sustained spending through the surge in mortgage payments, we provide DiD estimates for a broader set of response margins in Column 1 of Table 3. We obtain these estimates by estimating a parsimonious version of equation (1) where the full vector of quarterly indicators is replaced by a single indicator for post-treatment quarters. This model delivers a single β estimate that captures the average monthly response for the treatment group relative to the control group after 2023q2.

The results indicate that the monthly mortgage payments of the treatment group increased differentially by around DKK 3,300 while their spending decreased differentially by only around DKK 40. We find small and statistically insignificant changes in net investment, income and

[6]Note that the model is estimated on quarterly data, but since all outcomes are constructed as average *monthly* values within each quarter, the β estimates also capture monthly effects. For example, β_{2023q2} captures the monthly effect on the outcome averaged over April, May, and June 2023.

other loan balances. The only other significant response margin is a monthly differential decrease in deposit balances of around DKK 2,600. Jointly, the estimates are not far from respecting the adding-up properties implicit in the intertemporal budget constraint, suggesting that we are not missing any important response margins.[7]

4.5 Marginal effects

Finally, we express the DiD estimates as marginal effects, i.e., the change in the outcome variable per 1 DKK exogenous increase in current mortgage payments. For this purpose, we implement the following instrumental variables framework:

$$y_{i,t} = \alpha_i + \gamma_t + \lambda \cdot \Delta payment_i^{exo23} \cdot post_t + \sum_{q \neq 2023Q1} \big((\boldsymbol{X}_i \boldsymbol{\delta}_q) \cdot \mathbb{1}(t = q) \big) + \epsilon_{i,t} \tag{2}$$

where $post_t$ is an indicator for quarters after the mortgage rate reset in April 2023. The key explanatory variable is $\Delta payment_i^{exo23}$, which captures the increase in monthly mortgage payments occurring at reset in April 2023, absent any refinancing. For the control group of households with loans resetting in April 2024, this is zero by construction. The λ coefficient captures the effect on the outcome per 1 DKK increase in current mortgage payments in an average month after April 2023.

To isolate the variation in $\Delta payment_i^{exo23}$ related to the quasi-random differences in the timing of reset, we instrument it with $ARM23_i$, the indicator for belonging to the group with reset in April 2023 (as opposed to April 2024). The reduced-form version of the IV model thus corresponds to a standard difference-in-differences analysis between the two groups. Any variation in $\Delta payment_i^{exo23}$ within the treatment group, created by differences in loan amounts, does not contribute to the identification of λ.

We report estimates of the marginal effects in Column (2) of Table 3. For mortgage payments, we obtain a coefficient of 0.98, suggesting that refinancing by the treatment group around reset had a negligible impact on actual mortgage payments. As a reference point, if all households in the treatment group kept their existing ARM5 contracts completely unaltered through the reset, the estimated coefficient would be unity by construction. Hence, our estimate suggests that the treated households offset the contractually scheduled increase in mortgage payments

[7] Specifically, the additional expense on mortgage payments ($\approx$ DKK 3,300) is partly offset by a decrease in spending (DKK $\approx$ 50), by an increase in income ($\approx$ DKK 200) and by an increase in other loan balances ($\approx$ DKK 50), but compounded by an increase in net investment ($\approx$ DKK 150). This suggests a net monthly impact on deposits of around DKK 3150, which is not far off of our estimate of around DKK 2,600.

by 2 cents on the dollar through refinancing.[8]

For spending, we estimate an insignificant marginal effect of -0.01, which can be interpreted as an MPC out of exogenous changes in current mortgage payments of 0.01. The estimate is relatively precise with an upper bound of the confidence interval around 0.07. For net investment, income and other loan balances, the marginal effects are also small and statistically insignificant while marginal effect for deposit balances suggests that this margin absorbed more than three quarters of the increased mortgage payments.[9]

5 Expected future cashflows

The goal of this analysis is to estimate responses to shocks to expected future mortgage payments. Such shocks occur for ARM borrowers when market rates surge before the actual reset of the rate on their own loans. While theory suggests that households should make behavioral adjustments when expectations change, empirical evidence confirming such behavior remains limited.

5.1 Empirical designs

Figure 1 illustrates that the sharp increase in current market interest rates in the first half of 2022 was accompanied by an equally large increase in market expectations about future rates. Our main empirical design exploits the asymmetric exposure to this expectation shock across adjustable-rate borrowers, who were suddenly facing reset at a much higher rate, and fixed-rate borrowers, who are effectively insured against increasing mortgage rates. Specifically, we compare a *treatment group* of households with ARM5 loans resetting in April 2023 or April 2024 to a *control group* of households with fixed-rate mortgages originating in the same period as the treatment group. We focus on the period *before reset* where current mortgage payments were fixed for both groups, but where the treatment group became exposed to the sharp increase in expected future mortgage payments in the beginning of 2022.

Our difference-in-difference estimators assume that the two groups would have remained on

[8] Most refinancing was in the form of switches to ARM1 loans on which the interest rate in April 2023 was, incidentally, almost identical to that of ARM5 loans. This allowed households believing the surge in mortgage rates to be temporary to avoid locking in a perceived high interest rate for 5 years, but it did not mitigate the immediate impact of the interest rate shock on mortgage payments.

[9] Again, the estimates are roughly consistent with the intertemporal budget constraint. The additional expense on mortgage payments (≈ 0.98 DKK per 1 DKK exogenous increase) is partly offset by a decrease in spending (≈ 0.01), by an increase in income (≈ 0.07) and by an increase in other loan balances (≈ 0.01), but compounded by an increase in net investment (≈ 0.05). This suggests a net monthly impact on deposits of 0.94 per 1 DKK exogenous increase in mortgage payments, which is reasonably close to our estimate of around 0.76.

similar behavioral trajectories throughout the sample period absent the surge in expected future interest rates for the treatment group, and we interpret any divergence in the first half of 2022 as the effect of the differential exposure to expected increases in future mortgage payments. The key concern about our main design is selection into adjustable vs fixed rate loans on unobervable characteristics (e.g. risk preferences) that could have their own separate impact on household behavior through the sample period. We address that concern with an alternative design that relies on variation in mortgage loan size *within* the sample of households with adjustable rate mortgages for identification.

5.2 Descriptive evidence

Figure 4 shows the raw averages in monthly mortgage payments (Panels a-b) and spending (Panels c-d) for the two treatment groups (green and blue lines) and the two control groups (gray lines) in the period from 2020q2 until the last quarter before the mortgages of the treatment groups reset. As shown in Panels (a)-(b), mortgage payments are significantly lower for the treatment group than for the control group, reflecting the general cost advantage of ARM loans over FRM loans in the preceding decade. The main thing to notice, however, is that monthly mortgage payments are stable for *both* groups during the whole period, despite the sharp increase in market interest rates on new loans in the first half of 2022, reflecting the lagged pass-through of market rates to mortgage payments.

Panels (c)-(d) show evidence of a differential decrease in the spending of the treatment groups around the surge in interest rate expectations in the first half of 2022. ARM5 borrowers with reset in April 2023 initially have slightly higher average spending than the corresponding FRM borrowers in the control group, but the gap between the two groups is largely eliminated in the course of 2022 (Panel c). ARM5 borrowers with reset in April 2024 initially have lower average spending than their control group of FRM borrowers, and the gap between the two groups widens in the course of 2022 (Panel d).

5.3 Spending dynamics

As in the previous section, we investigate the dynamic spending responses to the expectation shock more formally in a difference-in-differences framework. The sample period is 2020q2-2024q1, but treated households with reset in April 2023 (and the corresponding control group) are only included in the period 2020q2-2023q1 so that the estimates are not contaminated by the reset. We estimate the following model:

$$y_{i,t} = \alpha_i + \gamma_t + \sum_{q \neq 2021q4} \big((\beta_q ARM_i + \boldsymbol{X}_i \boldsymbol{\delta}_q) \cdot \mathbb{1}(t = q) \big) + \epsilon_{i,t} \tag{3}$$

The key explanatory variable is ARM_i, which is an indicator for having an adjustable-rate mortgage with reset in April 2023 or April 2024. All other variables, including the controls, are the same as in equation (1).

Figure 5 shows the estimated β coefficients with monthly spending as the outcome. With few exceptions, the estimates in the pre-shock period are statistically insignificant and there is no discernible trend, supporting the assumption that the treatment and control groups would have continued on parallel spending trajectories absent the expectations shock. Coinciding with the expectations shock, a wedge opens up with the treatment group gradually reducing their spending relative to the control group. This suggests that the treatment group cut down on spending and started building a liquid buffer in anticipation of the expected future increase in mortgage payments.

Figure 6 shows the estimates from an alternative difference-in-differences framework that identifies from variation in mortgage size *within* the sample of adjustable-rate borrowers and thus addresses the selection problem discussed above. Intuitively, as borrowers with the same mortgage product pay the same interest rate, the change in mortgage payments at reset is proportional to the size of the mortgage. We can thus estimate the effect of the increasing expectations about future mortgage rates by comparing households with large exposure (ARM loan balance above median) to households with small exposure (ARM loan balance below median). We implement this design by estimating equation (3) for the sample of ARM borrowers while replacing ARM_i with $LargeARM_i$, which indicates an ARM loan balance (evaluated end-of-year 2021) above the sample median. The estimates – while less precise than the baseline – are consistent with Figure 5: The two groups appear to be on parallel spending trajectories prior to the expectations shock and then diverge, with the more exposed group gradually reducing spending relative to the less exposed group.

5.4 Other response margins

We provide static DiD estimates for a broader set of response margins in Column 3 of Table 3. Almost by design, there is no differential change in the mortgage payments of the treatment group coinciding with the surge in expected future interest rates.[10] Nonetheless, they reduce

[10] While the sample period is designed to exclude the resets, changes in mortgage payments can, in principle, occur for both ARM and FRM at any time if they choose to refinance their loans.

their monthly spending by around DKK 540 relative to the control group. Moreover, they differentially reduce their investments by around DKK 1,040 and increase their income by around DKK 260. As a result, the deposit balances of the treatment group increase by almost DKK 2,000 per month relative to the control group.[11].

5.5 Marginal effects

Finally, we express the difference-in-differences estimates as marginal effects, i.e. the change in the outcome variable per 1 DKK exogenous increase in expected future mortgage payments. For this purpose, we implement the following instrumental variables model:

$$y_{i,t} = \alpha_i + \gamma_t + \lambda \cdot E_t[\Delta payment_i^{exo}] + \sum_{q \neq 2021q4} \big((\boldsymbol{X}_i \boldsymbol{\delta}_q) \cdot \mathbb{1}(t = q) \big) + \epsilon_{i,t} \tag{4}$$

where $E_t[\Delta payment_i^{exo}]$ is a measure of the quarter t expectation of the (exogenous) increase in mortgage payments at the upcoming reset.[12] We instrument this variable with $ARM_i \cdot E_t[\Delta r_{reset}]$. Here, ARM_i denotes the binary indicator for belonging to the treatment group with ARM5 loans resetting in April 2023 or April 2024, while $E_t[\Delta r_{reset}]$ denotes Danske Bank's forecast for the change in the interest rate at the upcoming reset date. The instrument gets time variation from changes in the bank's forecast, and cross-sectional variation from households' treatment status only. The instrumentation implies that identification comes exclusively from comparing average adjustable-rate and fixed-rate borrowers before and after the expectation shock in the spirit of the difference-in-differences estimator. Variation in $E_t[\Delta payment_i^{exo}]$ stemming from variation in household loan balances within the treatment group does not contribute to the identification of λ in equation 4.

We provide estimates of the marginal effects in Column (4) of Table 3. The estimates suggest that adjustable-rate borrowers reduced monthly spending by around 0.16 per DKK 1 expected increase in future monthly mortgage payments. The analogous estimates for the reduction in

[11] The estimates are roughly consistent with the intertemporal budget constraint. The decrease in spending ($\approx$ DKK 540), the decrease in net investment ($\approx$ DKK 1,040) and the increase in income ($\approx$ DKK 260) add up to DKK 1,840, which is close to our estimate of around DKK 1,950

[12] We construct this measure by combining information about each household's loans as of December 2021 with the bank's forecasts about the change in the ARM5 interest rate at the relevant upcoming reset. Specifically, for ARM5 borrowers with loans resetting in April 2023, we construct $E_t[\Delta payment_i^{exo}]$ as the change in monthly payments that household i would have experienced in April 2023, absent any refinancing and assuming that the bank's forecast in quarter t for the interest rate in April 2023 had turned out accurate. For ARM5 borrowers with loans resetting in April 2024, it is constructed in completely parallel fashion, only using forecasts for the interest rate change in April 2024. For the households in the control group of FRM borrowers, $E_t[\Delta payment_i^{exo}]$ is equal to zero by construction.

investments is 0.27 and for the increase in income around 0.05. The resulting increase in deposit balances is around 0.58 per DKK 1 expected increase in future monthly mortgage payments.[13]

6 Heterogeneity

Theory highlights that household responses to changes in cash-flows may vary systematically with household characteristics. Most notably, households with little liquidity may reduce consumption more strongly in response to an adverse change in cash-flows because they lack liquid reserves to smooth consumption. However, other characteristics may matter too. For instance, highly levered households may respond more strongly because the change in cash-flows is more salient; households with a high share of spending on food may respond less strongly because food is a necessity item; and older households may respond more strongly because a given shock must be smoothed over a smaller number of years.

To understand the mechanisms underlying the mean spending responses reported above, we provide MPC estimates for 10 subsamples. Specifically, we split the sample by (i) *liquidity* using an indicator of having deposit balances above DKK 75,000; (ii) *debt-to-income* using an indicator of having housing debt in excess of two times the annual income; (iii) *loan-to-value* using an indicator of having housing debt in excess of 0.6 of the property value; (iv) *grocery share* using an indicator of incurring more than 20% of total expenditures in grocery stores; (v) *age* using an indicator of age being above 60.

The results are illustrated in Figure 7. As shown in Panel (a), none of the subsamples has an estimated marginal propensity to consume out of current mortgage payments above 0.05 and none of the estimates are statistically significant. Perhaps most surprisingly, the point estimate for the low-liquid group is almost exactly zero; however, the estimates are imprecise and we cannot reject MPCs below around 0.14. As shown in Panel (b), all the subsamples exhibit a sizeable and statistically significant marginal propensity to consume out of expected future mortgage payments. We find the largest point estimate of around 0.25 for the low-liquidity group, suggesting that households with less ex ante liquidity are willing to make deeper cuts in spending to build liquidity buffers in anticipation of expected future increases in mortgage payments.

We also break down spending responses by spending categories in Figure 8. To facilitate comparisons across categories, the estimates are scaled with ex ante monthly spending within

[13] The estimates are reasonably close to adding up: the decrease in spending (≈ 0.16) and investment (≈ 0.27) and the increase in income (≈ 0.05) suggest a total monthly impact on deposit balances of 0.48, which is close to our estimate of 0.58.

the category. As shown in Panel (a), none of the spending categories exhibit a statistically significant reduction in response to the anticipated change in current mortgage payments and the estimated changes are generally below 5% of the ex ante level. As shown in Panel (b), there is significant variation in spending responses to increases in expected future mortgage payments across spending categories. The responses tend to be smaller in categories generally considered to be inelastic such as supermarkets, utilities, health, and transport and larger in durable consumption categories such as furniture and department stores.

7 Robustness

Finally, we report the results from a series of robustness tests that vary the set of controls in the regressions as well as the sample restrictions.

First, Figure 9 illustrates how the estimated responses vary with the set of controls. Starting from a parsimonious specification that only includes household and time fixed effects, we sequentially add non-parametric controls for ex ante income and balance sheet components, and demographics. Finally, we also increase the granularity of the non-parametric controls replacing quintiles with deciles. As shown in Panel (a), the estimated responses to changes in current cashflows are remarkably robust to the set of controls. This likely reflects that the treatment and control groups in this exercise – adjustable-rate borrowers with reset in April 2023 and April 2024, respectively – are highly balanced on covariates, as documented in Table (2). As shown in Panel (b), the estimated responses to changes in expected future cashflows are somewhat more sensitive to the set of controls. In particular, the most parsimonious specifications that fail to control for the material differences in age and geography deviate substantially from the baseline.

Second, Figure 10 illustrates how the estimates change when we impose more stringent sample restrictions. As shown in Panel (a), spending and investment responses to changes in current cashflows are consistent across all samples, but the change in deposits becomes smaller when we drop households that extracted equity or refinanced their mortgage around the reset. As shown in Panel (b), the estimates are generally highly robust to harsher sample restrictions. This is intuitive, since in this analysis, the mortgage rate resets do not occur within the sample period by design.

8 Concluding remarks

This paper analyzes the transmission of monetary policy to consumption operating through the cash-flow effect of changes in mortgage payments. Using highly granular data transaction and mortgage data from a major Danish bank, we study how households responded to the historically sharp increase in interest rates in 2022-2023.

Exploiting differences in exposure to the rise in mortgage rates among otherwise-similar households, we find that households reduce spending swiftly in response to expectations about higher payments in the future: Relative to fixed-rate borrowers, households with adjustable-rate mortgages resetting in 2023-2024 cut back on spending already in 2022 when interest rates began to rise, i.e. as much as two years before the impact on their own payments would materialize. With current mortgage payments initially unchanged, the cut in spending helped these households build up of liquid buffers to prepare for the future hike in payments.

Consistent with this idea, we find that the anticipated increases in mortgage payments did not have any additional impact on spending once they materialized: Comparing adjustable-rate borrowers with interest rates resetting in 2023 vs 2024, we find no difference in spending dynamics between the two groups around April 2023 when the former group saw a pronounced increase in their mortgage payments. Instead, the shock to cash-flows was fully absorbed by reduced saving in liquid assets.

These findings offer important insights for monetary policy, and in particular the speed of its transmission: Although it can take several years for changes in policy rates to fully pass through to actual mortgage payments, our results indicate that the effect on consumption occurs much more quickly. In particular, our analysis shows that households do not wait for their loan payments to adjust before altering their spending. Instead, they respond quickly to changes in expected future interest rates, adjusting consumption in anticipation of higher payments rather than in reaction to their eventual realization.

The results of our analysis are consistent with standard theories of forward-looking and unconstrained households using liquid buffers to smooth consumption in the presence of fluctuations in disposable income.

References

[1] Andersen, A. L., Hansen, E. T., Johannesen, N., and Sheridan, A. (2022). Consumer responses to the COVID-19 crisis: Evidence from bank account transaction data. *Scandinavian Journal of Economics*, 124(4), 905-929.

[2] Andersen, A. L., Jensen, A. S., Johannesen, N., Kreiner, C. T., Leth-Petersen, S., and Sheridan, A. (2023). How do households respond to job loss? lessons from multiple high-frequency datasets. *American Economic Journal: Applied Economics*, 15(4), 1-29.

[3] Andersen, A. L., Johannesen, N., and Sheridan, A. (2024). Dynamic Spending Responses to Wealth Shocks: Evidence from Quasi Lotteries on the Stock Market. *American Economic Review: Insights*, 6(3), 434-452.

[4] Ando, A., and Modigliani, F. (1963). The" life cycle" hypothesis of saving: Aggregate implications and tests. *American Economic Review*, 53(1), 55-84.

[5] Baker, S. R. (2018). Debt and the response to household income shocks: Validation and application of linked financial account data. *Journal of Political Economy*, 126(4), 1504-1557.

[6] Baugh, B., Ben-David, I., Park, H., and Parker, J. A. (2021). Asymmetric consumption smoothing. *American Economic Review*, 111(1), 192-230.

[7] Browning, M., and Collado, M. D. (2001). The response of expenditures to anticipated income changes: panel data estimates. *American Economic Review*, 91(3), 681-692.

[8] Carroll, C. D. (1997). Buffer-stock saving and the life cycle/permanent income hypothesis. *Quarterly Journal of Economics*, 112(1), 1-55.

[9] Deaton, A. (1991). Saving and liquidity constraints. *Econometrica*, 59(5), 1221-1248.

[10] Di Maggio, M., Kermani, A., Keys, B. J., Piskorski, T., Ramcharan, R., Seru, A., and Yao, V. (2017). Interest rate pass-through: Mortgage rates, household consumption, and voluntary deleveraging. *American Economic Review*, 107(11), 3550-3588.

[11] Di Maggio, M., Kermani, A., and Palmer, C. J. (2020). How quantitative easing works: Evidence on the refinancing channel. *Review of Economic Studies*, 87(3), 1498-1528.

[12] Druedahl, J., Jensen, E. B., and Leth-Petersen, S. (2022). The intertemporal marginal propensity to consume out of future persistent cash-flows: Evidence from transaction data (No. 13/22). CEBI Working Paper Series.

[13] Flodén, M., Kilström, M., Sigurdsson, J., and Vestman, R. (2021). Household debt and monetary policy: Revealing the cash-flow channel. *Economic Journal*, 131(636), 1742-1771.

[14] Friedman, M. (1957). The permanent income hypothesis. In A theory of the consumption function (pp. 20-37). Princeton University Press.

[15] Fuster, A., Gianinazzi, V., Hackethal, A., Schnorpfeil, P., and Weber, M. (2026). The response of debtors to rate changes. NBER Working Paper No. 34752.

[16] Galaasen, S., Maehlum, M., and Ahn, S. (2024). The Cash-Flow Channel of Monetary Policy-Evidence from Billions of Transactions. Available at SSRN 5089327.

[17] Hall, R. E. (1978). Stochastic implications of the life cycle-permanent income hypothesis: theory and evidence. *Journal of Political Economy*, 86(6), 971-987.

[18] Hsieh, C. T. (2003). Do consumers react to anticipated income changes? Evidence from the Alaska permanent fund. *American Economic Review*, 93(1), 397-405.

[19] Kaplan, G., Moll, B., and Violante, G. L. (2018). Monetary policy according to HANK. *American Economic Review*, 108(3), 697-743.

[20] Kueng, L. (2018). Excess sensitivity of high-income consumers. *Quarterly Journal of Economics*, 133(4), 1693-1751.

[21] Parker, J. A. (1999). The reaction of household consumption to predictable changes in social security taxes. *American Economic Review*, 89(4), 959-973.

[22] Souleles, N. S. (1999). The response of household consumption to income tax refunds. *American Economic Review*, 89(4), 947-958.

[23] Zeldes, S. P. (1989). Consumption and liquidity constraints: an empirical investigation. Journal of Political Economy, 97(2), 305-346.

Figure 1. Actual and forecasted mortgage interest rates. The figure shows actual and forecasted interest rates on new adjustable-rate mortgage loans with a 5-year interest fixation period: the actual rate in month m (blue solid line) and the market forecast of the rate in month m made one year earlier in month m-12 (red dotted line). Actual rates are from Danmarks Nationalbank and market forecasts are from Danske Bank.

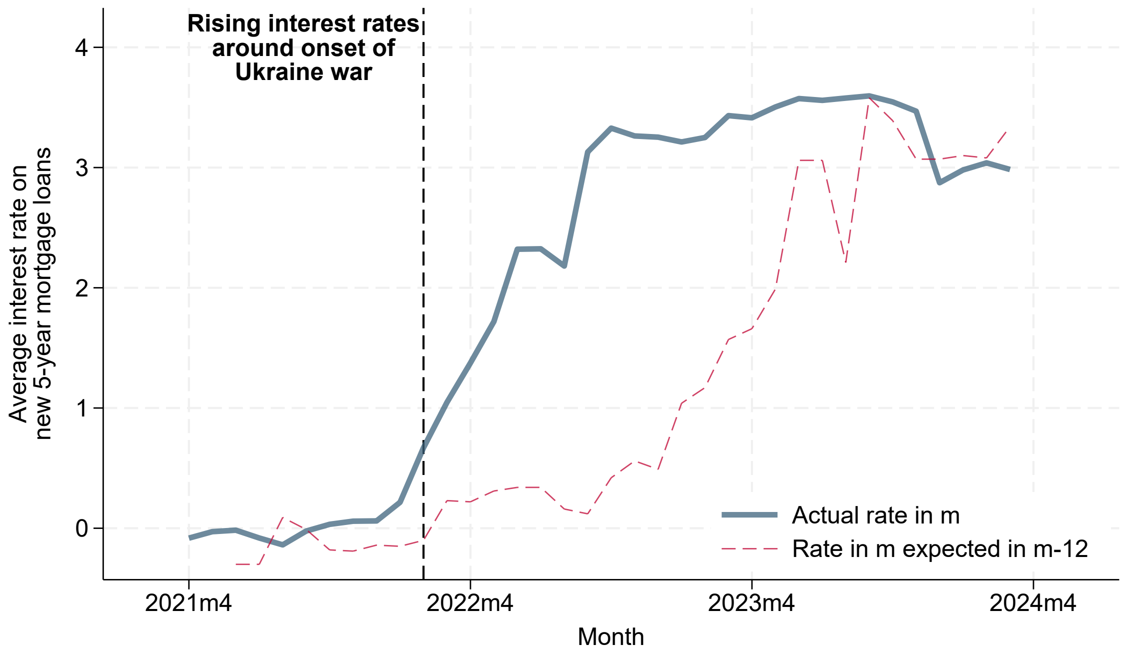
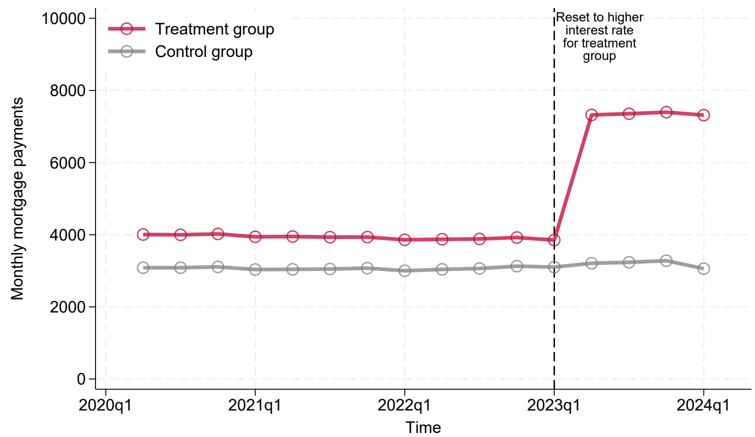
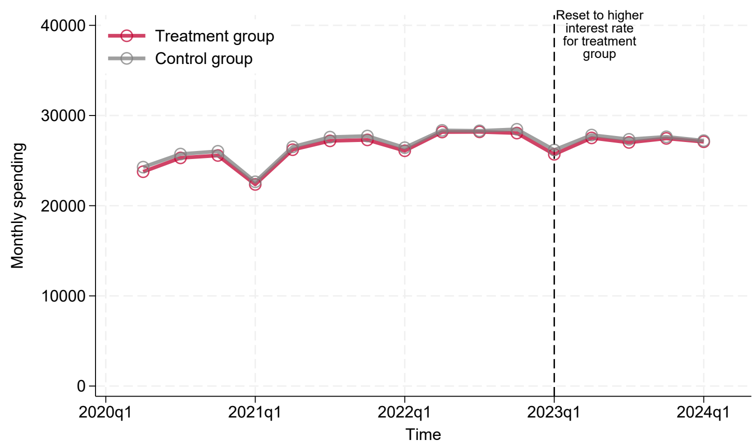


Figure 2 – Current cash-flows (descriptive evidence). The figure shows raw sample averages of monthly mortgage payments (Panel a) and spending (Panel b) for households with an ARM5 loan resetting in April 2023 (”Treatment group)” or in April 2024 (”Control group”).



(a) Mortgage payments



(b) Spending

Figure 3 – Current cash-flows (DiD estimates). The figure shows dynamic DiD estimates of the effect of the increase in current mortgage payments at reset on monthly spending. The estimates correspond to the β parameters in model 1 with monthly spending as the outcome. Each estimate captures the differential change in spending since 2023q1 for the treatment group of households with ARM5 loans resetting in April 2023 vs. the control group of households with ARM5 loans resetting in April 2024.

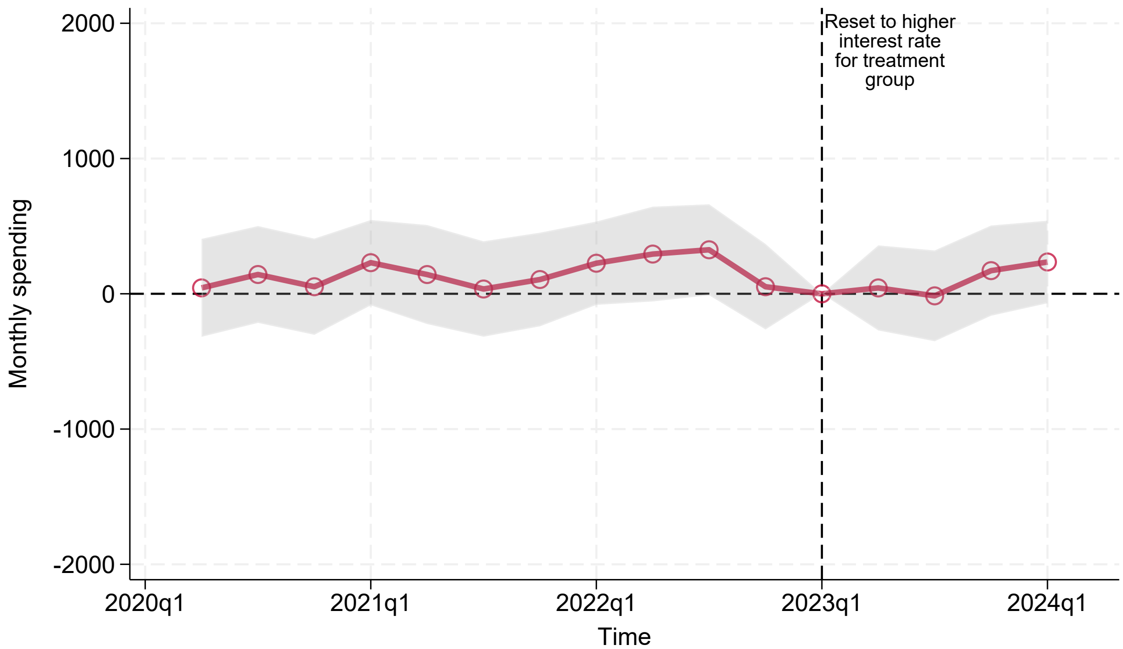
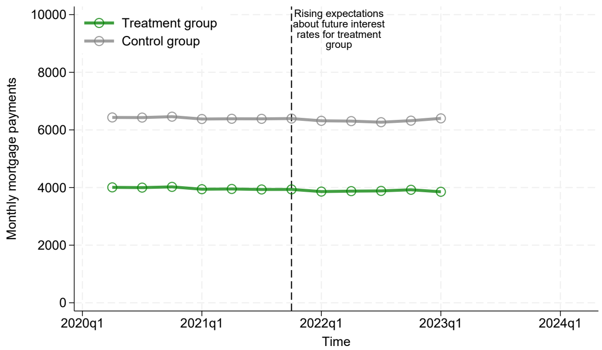
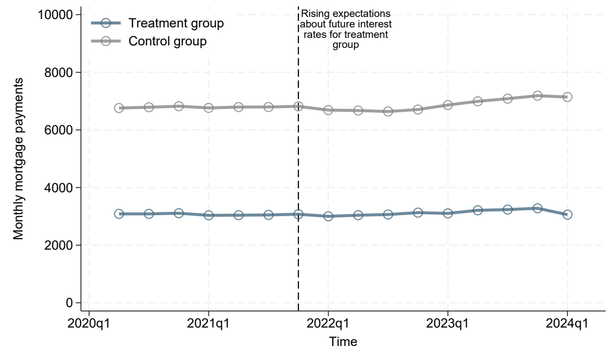


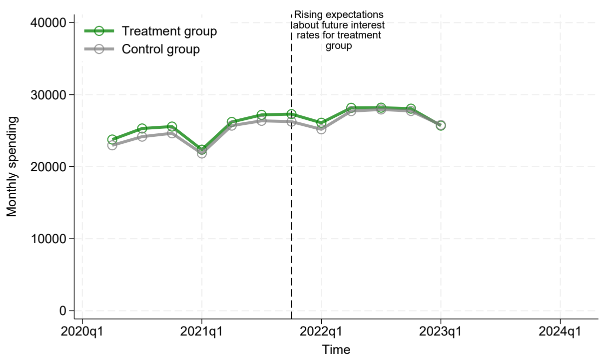
Figure 4 – Expected future cash-flows (descriptive evidence). The figure shows raw sample averages of monthly mortgage payments (Panel a) and spending (Panel c) for the treatment group of households with ARM5 loans resetting in April 2023 and the corresponding control group with FRM loans. It also shows raw sample averages of monthly mortgage payments (Panel b) and spending (Panel d) for the treatment group of households with ARM5 loans resetting in April 2024 and the corresponding control group with FRM loans.



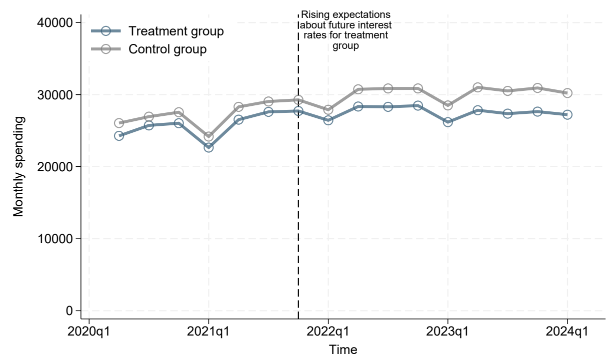
(a) Mortgage payments (ARM23 vs FRM23)



(b) Mortgage payments (ARM24 vs FRM24)



(c) Spending (ARM23 vs FRM24)



(d) Spending (ARM24 vs FRM24)

Figure 5 – Expected future cash-flows (DiD estimates). The figure shows dynamic DiD estimates of the effect of the increase in expected future mortgage payments at reset on monthly spending. The estimates corresponds to the β parameters in model 3 with monthly spending as the outcome. Each estimate captures the differential change in spending since 2021q4 for the treatment group of households with ARM5 loans resetting in April 2023 or April 2024 vs. the corresponding control groups of households with FRM loans. Households in the treatment group with reset in April 2023 (and the households in the corresponding control group) are dropped in all periods after 2023q1 so that the treatment groups consists exclusively of households whose ARM loans have not yet reset.

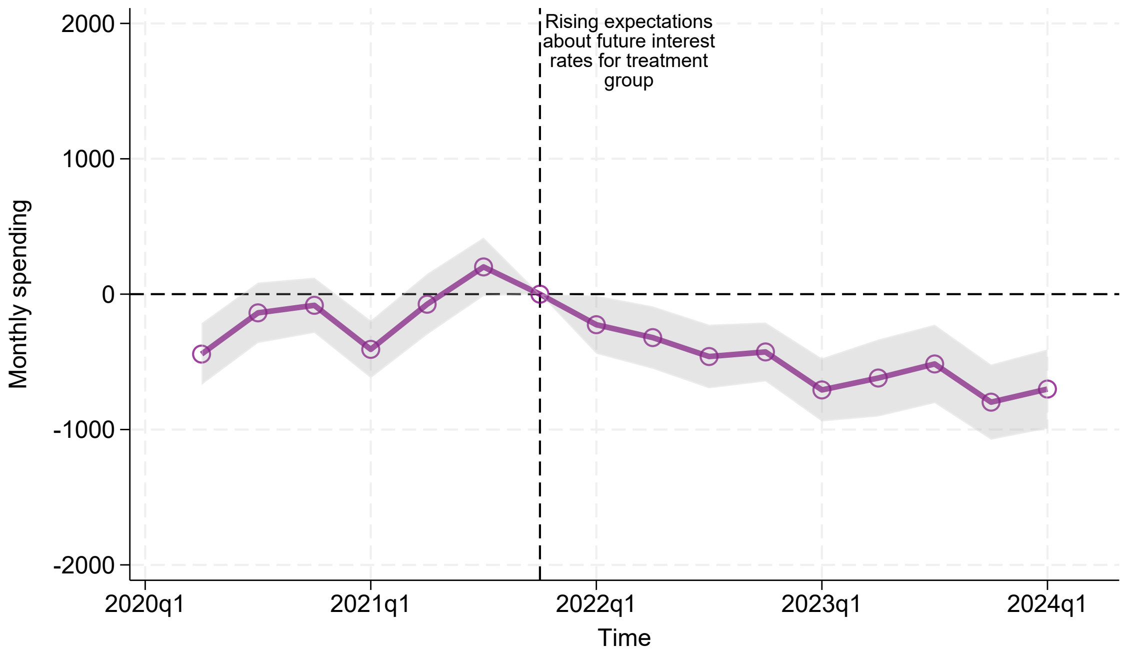
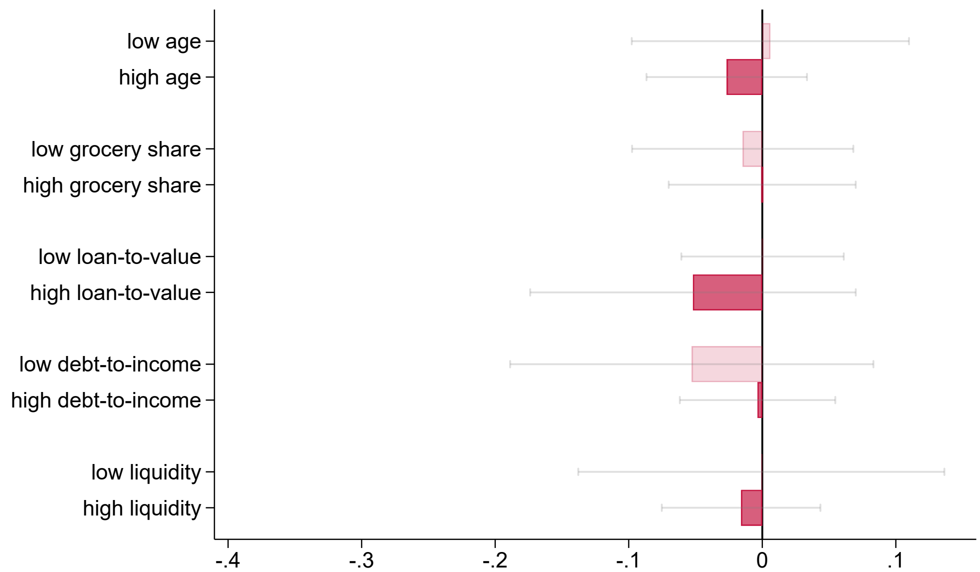
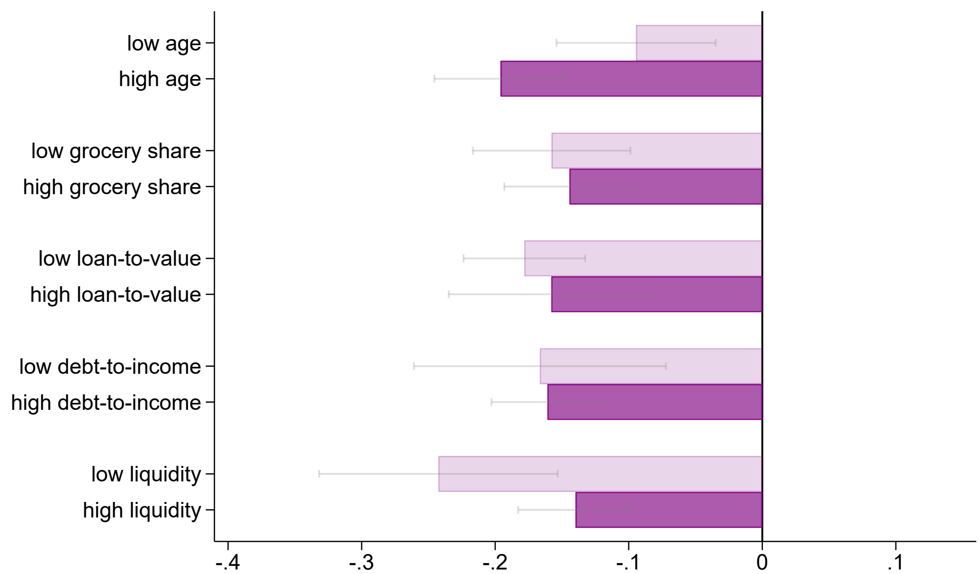


Figure 6 – Expected future cash-flows (alternative DiD estimates). The figure shows an alternative set of dynamic DiD estimates of the effect of the increase in expected future mortgage payments at reset on monthly spending. The estimates corresponds to the β parameters in model 3 with monthly spending as the outcome. Each estimate captures the differential change in spending since 2021q4 for an alternative treatment group of households with "large" ARM5 loans resetting in April 2023 or April 2024 (i.e. ex ante loan balances above sample median) vs. an alternative control group of households with "small" ARM5 loans resetting in April 2023 or April 2024 (i.e. ex ante loan balances below sample median). Households with reset in April 2023 are dropped in all periods after 2023q1 so that the treatment group consists exclusively of households whose ARM loans have not yet reset.

Figure 7 – Heterogeneity. The figure shows DiD estimates of the MPC out of current mortgage payments (panel a) and the MPC out expected future mortgage payments (panel b) for various subsamples. The subsamples are defined with reference to the following ex ante characteristics (i.e. measured in 2021): *age*: average household age above or below 60 years; *grocery share*: grocery spending accounts for more or less than 20% of total expenditure; *loan-to-value*: total housing debt is above or below 60% of the property value; *debt-to-income*: total housing debt is above or below 200% of the household income: *liquidity*: total deposit account balances is above or below DKK 75,000.

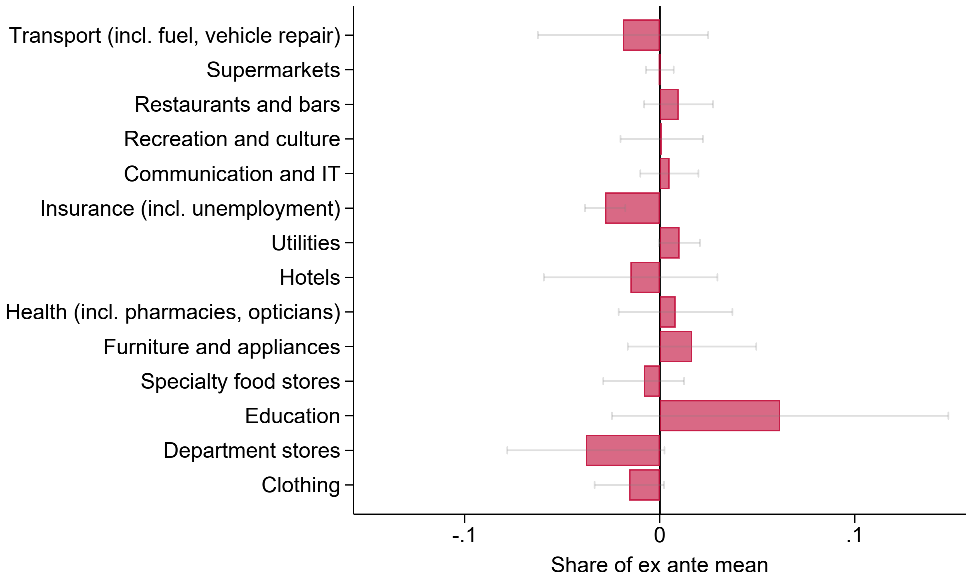


(a) MPC out of current cashflows

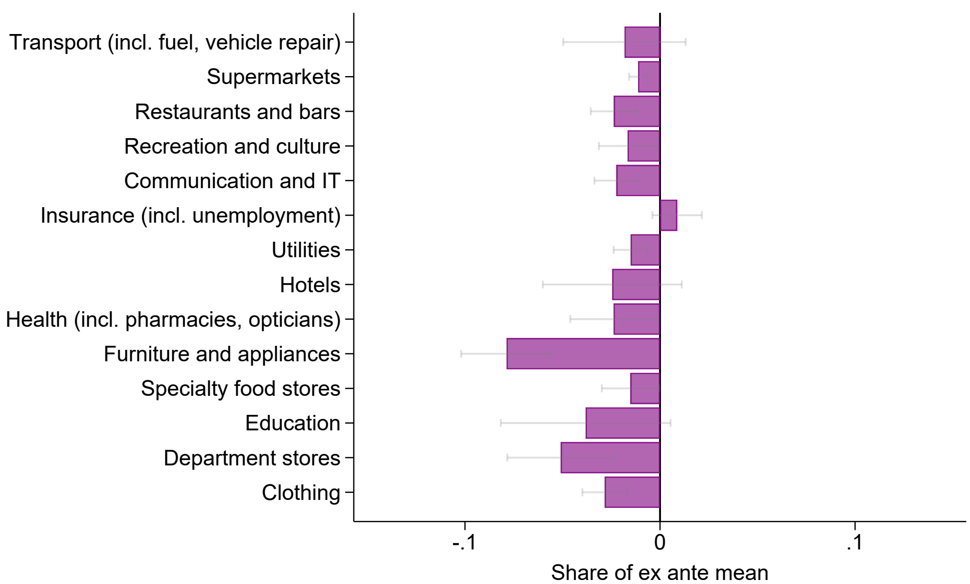


(b) MPC out of expected future cashflows

Figure 8 – Spending categories. The figure shows DiD estimates of the effect on categories of spending of the increase in current mortgage payments at reset in April 2023 (Panel a) and of the increase in expected future mortgage payments in 2022q1 (Panel b). Each DiD estimate corresponds to the β parameter in the parsimonious version of model 1 (Panel a) or model 3 (Panel b) when the outcome is monthly spending in a particular category scaled by the average ex ante monthly spending in this category in the whole sample.

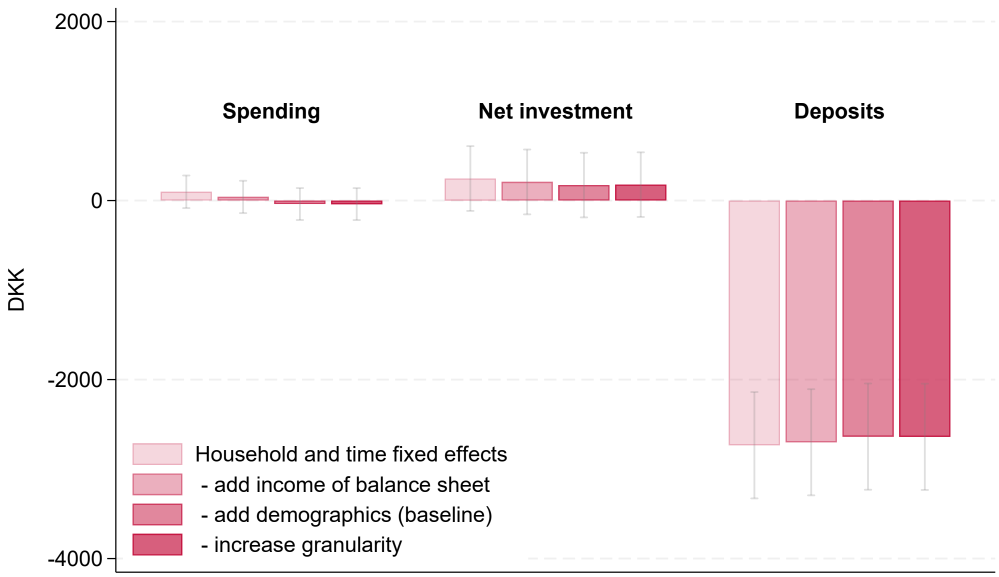


(a) Current cashflows

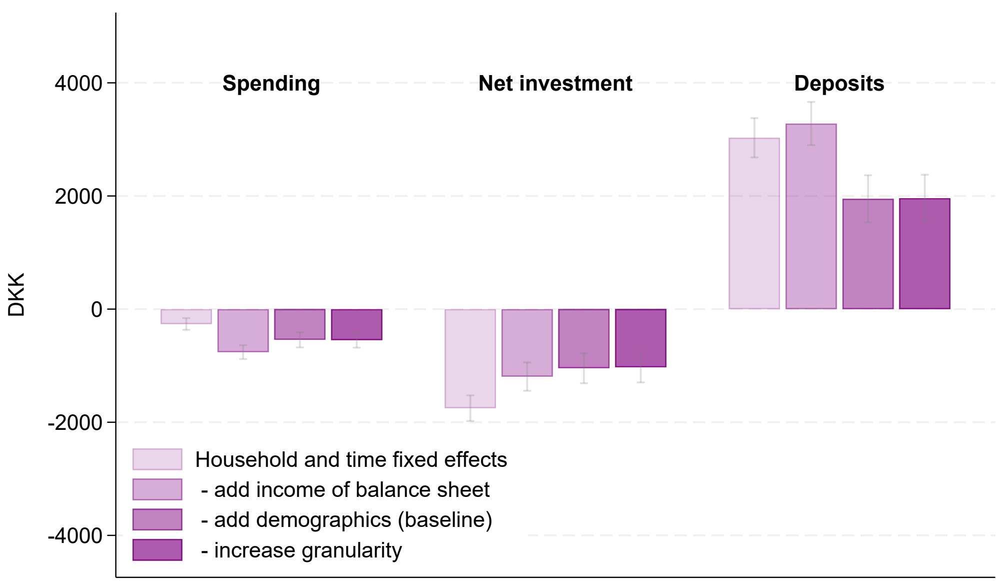


(b) Expected future cashflows

Figure 9 – Robustness (controls). The figure illustrates the robustness of the baseline estimates to using different sets of control variables. Each of the reported DiD estimates corresponds to the β parameter in the parsimonious version of model 1 (Panel a) or model 3 (Panel b) when the outcome is spending, net investment or the change in deposits. The first model only includes household and time fixed effects (lightest shading), the second model includes income and balance sheet controls (second-lightest shading), the third model includes demographic controls and corresponds to the baseline (second-darkest shading), and the fourth model increases the granularity of the controls by using deciles rather than quartiles of the continuous covariates (darkest shading).

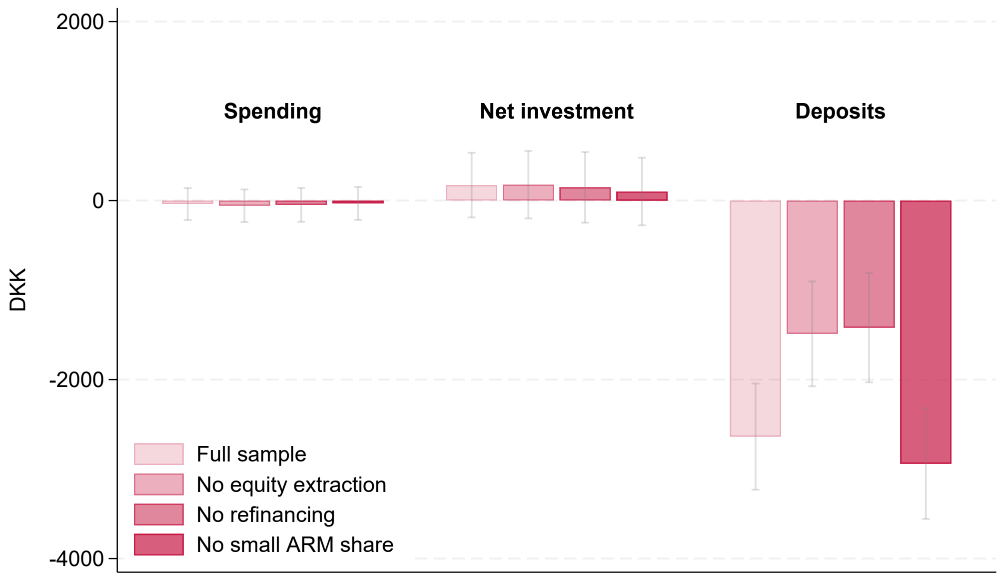


(a) Current cashflows

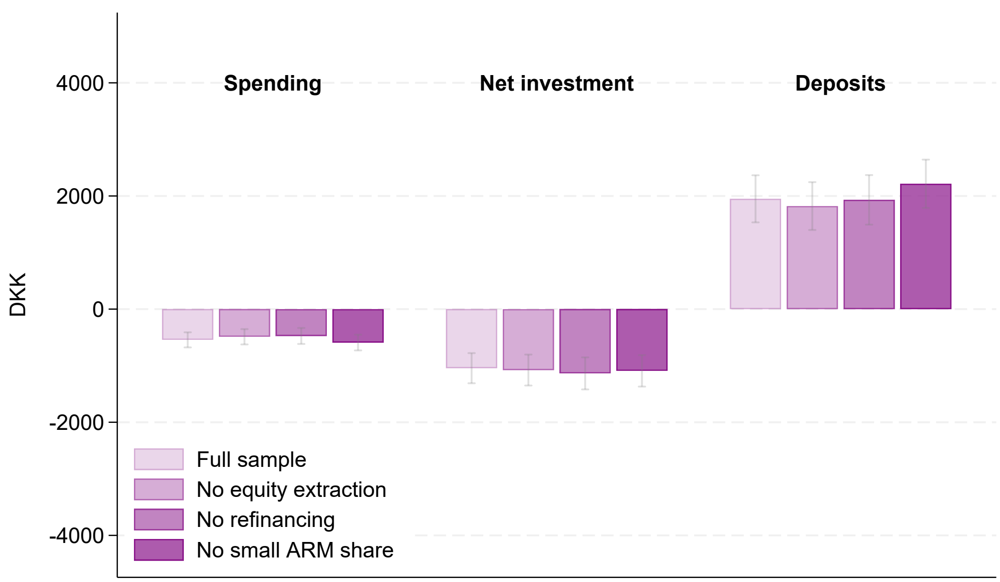


(b) Expected future cashflows

Figure 10 – Robustness (sample). The figure illustrates the robustness of the baseline estimates to various sample restrictions. Each of the reported DiD estimates corresponds to the β parameter in the parsimonious version of model 1 (Panel a) or model 3 (Panel b) when the outcome is spending, net investment or the change in deposits. The first model only includes the full sample (lightest shading), the second model excludes households that extract equity at the time of the reset (second-lightest shading), the third model excludes households that switch to another mortgage product at the time or reset (second-darkest shading), and the fourth model excludes household for which the ARM loan constitutes a small share of their total mortgage loans (darkest shading).



(a) Current cashflows



(b) Expected future cashflows

Table 1. Mortgage borrowers by type of loan The table shows aggregate statistics for the universe of households with mortgage loans in Denmark as of December 2021: all households with a mortgage, regardless of type (Column 1), all households with an adjustable-rate mortgage (ARM) of any type (Column 2), households with an adjustable-rate mortgage with a five-year interest fixation period (ARM5) (Column 3). All statistics are own calculations based on matched individual-level data from administrative registers.

	(1) All households with mortgages	(2) Households with adjustable-rate mortgages, any fixation period (ARM)	(3) Households with adjustable-rate mortgages, 5-year fixation period (ARM5)
No. of households	1,123,985.0	520,427.0	262,297.0
Total debt, bn. DKK	2,134.5	1,150.7	638.6
Mortgage debt, bn. DKK	1,817.7	967.4	562.4
Total interest payments, bn. DKK	32.6	12.8	7.0
Mortgage interest payments, bn. DKK	23.6	8.5	5.0

Table 2. Summary statistics The table shows means values for a range of observable characteristics, for each of the four samples used in the analysis: households with an ARM5 loan with interest rate reset in April 2023 and originating 5 or 10 years before (ARM-2023, Column 1), households with an ARM5 loan with interest rate reset in April 2024 and originating 5 or 10 years before (ARM-2024, Column 2), households with a FRM loan originating in the same period as the ARM-2023 sample (FRM-2023, Column 3), households with a FRM loan originating in the same period as the ARM-2024 sample (FRM-2024, Column 4).

	(1) ARM5 -2023	(2) ARM5 - 2024	(3) FRM -2023	(4) FRM - 2024
Age	62.5	64.2	53.9	54.1
Household size	2.0	2.0	2.2	2.4
Annual income (DKK)	442,129	442,758	464,040	505,695
Annual spending (DKK)	311,664	316,194	302,038	334,854
Annual mortgage payment (DKK)	47,751	37,154	77,388	82,027
Annual net investment (DKK)	17,416	21,394	13,809	18,832
Deposits (DKK)	266,781	309,515	215,361	230,934
Property value (DKK)	3,866,100	4,011,550	2,922,442	3,600,115
Other loan debt (DKK)	14,453	12,848	16,266	18,864
Copenhagen region (%)	44	45	33	39
Number of households	5,764	4,512	4,461	20,194

Table 3. The effect of current mortgage payments The table shows responses on a range of margins to changes in current mortgage payments (Columns 1-2) and expected future mortgage payments (Columns 3-4). Specifically, the table displays DiD estimates (Column 1) and IV estimates of marginal effects (Column 2) of a surge in current mortgage payments. The estimates are identified from a comparison of households with ARM5 loans, of whom some have mortgage rate reset in April 2023 (”treatment group”) and others have reset in April 2024 (”control group”). The table also displays DiD estimates (Column 3) and IV estimates of marginal effects (Column 4) of an increase in expected future mortgage payments. The estimates are identified from a comparison of households with ARM5 loans resetting in April 2023 or April 2024 (”treatment group”) and households with FRM loans originating in the same time period (”control group”)

	Current cashflows		Expected future cashflows	
	DiD estimates Average effect DKK per month	**IV estimates** Marginal effect per DKK passive change in mortgage payments	**DiD estimates** Average effect DKK per month	**IV estimates** Marginal effect per DKK passive change in mortgage payments
Mortgage payments	3,348***	0.977***	15	-0.003
	(41)	(0.010)	(16)	(0.006)
Spending	-39	-0.012	-543***	-0.162***
	(91)	(0.028)	(68)	(0.020)
Net investment	173	0.048	-1,044***	-0.268***
	(184)	(0.056)	(136)	(0.037)
Income	203	0.072	262**	0.051
	(170)	(0.052)	(104)	(0.032)
Other loans	40	0.011	-9	-0.028***
	(46)	(0.014)	(32)	(0.009)
Deposits	-2,638***	-0.763***	1,950***	0.579***
	(303)	(0.092)	(212)	(0.059)

ONLINE APPENDIX

Table A.1: Spending measures The table compares a measure of consumption constructed by Statistics Denmark based on a household survey to our measure of spending based on transaction data. The differences in the level and composition of spending may reflect both differences in sample and methodology. We note that "Housing and utilities" excludes rents and imputed rents, "Transport" excludes the purchase of vehicles, and "Other" excludes financial services. Moreover, spending in the estimation sample includes cash withdrawals.

		Statistics Denmark		**Estimation sample**	
		Monthly (1,000 DKK)	Share (percent)	Monthly (1,000 DKK)	Share (percent)
(1)	Food etc.	3.8	19.2	0.7	2.8
(2)	Clothing	1.0	4.8	1.5	5.7
(3)	Supermarkets and department stores		-	6.0	23.5
(4)	Subtotal (1)-(3)	4.8	24.0	8.2	32.0
(5)	Housing and utilities	3.2	16.0	3.9	15.2
(6)	Furniture and appliances	1.5		1.4	5.3
(7)	Transport	1.9	9.6	0.4	1.5
(8)	Information and communication	1.3	6.6	1.5	6.1
(9)	Recreation and culture	2.3	11.7	2.4	9.6
(10)	Restaurants	1.1	5.3	1.1	4.1
(11)	Insurance	1.6	8.1	1.9	7.4
(12)	Other	2.2	11.3	4.8	18.8
	Total (4)-(12)	19.9		25.5	