When Refinancing meets Monetary Tightening: Heterogeneous Impacts on Spending and Debt via Mortgage Modifications *

Philippe Bracke †, Matthew Everitt ‡, Martina Fazio §and Alexandra Varadi ¶

Abstract

This study examines how UK mortgagors adjusted their spending and saving habits in response to the post-2021 monetary tightening, highlighting the interplay between collateral-driven borrowing and the cash-flow channel of monetary policy. Unlike in markets with long-term fixed-rate mortgages, UK mortgagors face heightened exposure to interest rate shifts due to periodic refinancing requirements. By combining transaction-level data from a financial app with loan-level records, we create a detailed and representative view of UK mortgagors' monthly balance sheets from 2021 to 2023. This allows us to explore how mortgage modifications—particularly equity extraction and term extensions—shapes household responses to rising borrowing costs. Our findings reveal stark heterogeneity: households leveraging equity extraction, enabled by nominal house price appreciation, offset higher mortgage payments and maintain or increase discretionary spending while reducing unsecured debts. Conversely, households unable or unwilling to adjust loans face significant spending cuts in response to higher rates. These results suggest that collateral-driven debt, amplified by rising property values and mortgage term extensions, can partially compensate for the cash-flow channel in driving consumption and financial behaviour during tightening cycles. This highlights the dual role of loan modifications: while mitigating immediate consumption declines, they may affect monetary policy transmission for some groups and contribute to more persistent borrowing.

Keywords: *Monetary policy; Household behaviour; Consumption; High-frequency data, Difference-in-differences; Panel data*
JEL classification: D14, E21, G51

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†Bank of England, Philippe.Bracke@bankofengland.co.uk
‡Bank of England, Matthew.Everitt@bankofengland.co.uk
§Bank of England, Martina.Fazio@bankofengland.co.uk
¶Bank of England, Alexandra.Varadi@bankofengland.co.uk

1 Introduction

A rich body of literature provides evidence for the channels of monetary policy transmission to mortgagors. Key areas of focus include the role of mortgage structures, such as fixed vs. adjustable rates (Garriga et al., 2017), the sensitivity of household financial behaviour to interest rate changes (Best et al., 2020), and the distributional effects of monetary policy (Kaplan et al., 2018). However, the existing literature has yet to comprehensively trace how changes in interest rates, transmitted through mortgage rates, affect household consumption. Recent studies on spending adjustments from cash flow changes have largely relied on less granular or incomplete measures of individual consumption (Kartashova and Zhou, 2020; Di Maggio et al., 2017).

In this study we aim to address these shortcomings, by exploring the heterogeneous impacts of interest rate fluctuations on UK mortgagors' balance-sheets during the post-2021 monetary tightening cycle. Specifically, we address two key questions: (1) How did UK mortgagors respond to the tightening cycle? (2) How do heterogeneous balance sheets shape borrowing, saving, and spending responses? We leverage a unique transaction-level dataset provided by ExactOne, an analytics service by ClearScore, which offers a budgeting and financial advice application. This dataset includes detailed information on current and savings accounts, sourced via open banking. We match this with administrative loan-level data from the Product Sales Database (PSD), a comprehensive resource covering the universe of owner-occupied mortgages in the UK. The PSD provides both quarterly flow data on new mortgages and bi-annual stock data on outstanding mortgages. By merging these datasets, we obtain near-complete and representative monthly balance sheets of UK mortgagors between 2021 and 2023. Our analysis uncovers that mortgage loan adjustments at refinancing—particularly equity extraction and term extensions—serve as crucial flexibility mechanisms through which households respond to higher borrowing costs. Term extensions often accompany equity extraction and help mitigate higher monthly payments, thereby influencing consumption patterns. This type of mortgage modification—a less radical option than switching to an interest-only loan but with similar effects—has been under-explored in the literature (Andersen et al., 2024).

As in Cloyne et al. (2019), we exploit exogenous refinancing dates as a source of variation in UK mortgagors' exposure to interest rates. Long-term fixed rate mortgages are not widely available in the UK, with fixed terms ranging from 2 to 10 years, hence households have to periodically refinance to avoid lapsing onto higher standard variable rates (Miles, 2005). Households chose their fixed-term duration before the hiking period, which started in late 2021 in the UK. This makes the timing at which they are affected by changing rates quasi-exogenous, allowing us to compare spending behaviour across households with contracts expiring at different dates. Much of the existing literature on mortgage refinancing channels focuses on the US context, where long-term fixed interest periods complicate empirical analysis of refinancing effects due to endogeneity in responses to economic conditions (Greenwald, 2018). This paper takes a different approach by looking at the UK context, where these challenges are less of a concern.

We employ a difference-in-differences event study approach to compare households who remortgaged during the policy tightening period (June 2022 - December 2023) with those who remortgaged before December 2021 and whose deals end after the end of our sample. This setup allows us to exploit the exogenous nature of contract expiry in the UK, avoiding endogeneity issues present in other contexts. Our setting is particularly interesting for investigating the permanent income hypothesis because mortgages are the largest credit line that households rely on (Best et al., 2020), but households may be unable or unwilling to extract further equity and smooth consumption due to rising rates.

Differently from the existing literature which explores the impact of the housing cycle on household finances (Kaplan et al., 2018; Bhutta and Keys, 2016; Cloyne et al., 2019), our study includes individual-level consumption and savings data. This allows us to observe the effects of changes in mortgage payments or balances and the consequences

these have on spending and debt adjustments.[1] However, we also observe a period when UK nominal property prices steadily increased since the start of the pandemic, preceding the policy tightening period. Past evidence shows a countercyclical link between borrowing, house prices, and monetary policy, with borrowing and house prices positively correlated during booms and recessions (Beraja et al., 2019). In contrast, our setup uniquely allows us to test whether interest rate tightening can dampen borrowing and spending if house prices continue to grow, examining whether collateral-driven borrowing or the cash-flow channel of monetary policy has a greater impact on mortgagors' financial behaviour.

We have five key findings, which we highlight in turn below.

First, our analysis reveals that higher mortgage payments led to a 3% drop in aggregate consumption by the third month after refinancing, with spending recovering within five months. However, this aggregate effect conceals significant heterogeneity in household responses, which arises from households' ability to adjust mortgage characteristics during refinancing, such as the mortgage balance (resulting in equity repayment or extraction) and the overall repayment term of the mortgage.

Second, we show that households who neither extract equity nor extend their mortgage term experience a significant decrease in consumption following refinancing at higher interest rates, with spending dropping persistently by 4%. This reduction is observed across most consumption categories.

Third, households who adjust their loans by extracting equity, are able to offset rising payments, maintaining or even increasing discretionary spending, particularly on non-durables and transfers, while also paying down unsecured debts. In particular, we find that equity extraction is enabled by house price appreciation between refinancing events and is more prominent amongst households entering the refinancing event with low liquidity. On average, these households increase total non-housing spending by around 10%-20%, depending on the loan modification chosen and household characteristics. These findings align with the broader literature, where the average spending response on non-durable goods from transitory income changes is around 15% - 25% (Jappelli and Pistaferri, 2010; Kaplan and Violante, 2022). Thus, we find that relying on mortgage modifications, and in particular on collateral-driven borrowing to offset a monetary tightening event, weakens the traditional monetary transmission mechanism for some groups.

Fourth, we show that equity extraction also varies with the choice for the contract fixation period. Households choosing five-year fixed term contracts are more likely to extract equity at refinancing and thus have a larger spending response during the hiking period, despite the rising rates. This result suggests that loan modifications are exploited by mortgagors who are happy to commit to longer mortgage contracts, whereas borrowers who prefer flexibility opt for a shorter 2-year contract (Bracke et al., Forthcoming).

Finally, we find that the duration of the mortgage matters substantially for the strength of this equity extraction channel. Households who are more insensitive to tightening monetary policy by exploiting equity extraction at refinancing, are able to do so if they can actively manage their increasing monthly mortgage payments by extending the terms of the loan repayment. By extending terms, households are able to extract approximately £15,000 more in the hiking period. As a result, the spending response is larger for those who are able to reduce monthly mortgage payments by extending the overall duration of their mortgage.

Putting all these results together, we show that extracting equity and adjusting mortgage terms to maintain planned spending allows households some flexibility to smooth consumption along the life cycle. This is reminiscent of Cocco (2013), who highlights the benefits of flexible mortgage products for consumption smoothing. However, our findings

[1] Foulis et al. (forthcoming) use a similar approach to estimate the state-dependent effects of monetary policy on UK mortgage borrowing and consumption over the period 2015-2024.

suggest that loan modifications may have a dual role which needs to be balanced by policymakers going forward: while mitigating immediate consumption declines, they may slow down the transmission of monetary policy slightly and contribute to financial vulnerabilities through more persistent reliance on debt.

The paper proceeds as follows. In Section 2, we describe our data sources and provide institutional context for the UK mortgage market. Section 3 details the empirical framework used to identify the heterogeneous impacts of interest rate hikes. Section 4 presents our main findings on aggregate and household-level responses, while Section 5 delves into the role of loan modifications. Section 6 concludes with a discussion of implications and potential avenues for future research.

2 Data

In this section, we outline the data sources utilised in our analysis, including detailed loan-level mortgage data and granular household spending data. By combining these datasets, we construct a comprehensive view of mortgagors' financial positions, which is essential for investigating the heterogeneous responses of households to rising interest rates and their implications for monetary policy transmission.

2.1 Background and institutional context

In response to rising inflationary pressures post-pandemic, the Bank of England initiated a series of rate hikes starting in December 2021, raising the base rate from a historic low of 0.1% to 5.25% by late 2023. This extent of monetary tightening was unprecedented in the past two decades and aimed at curbing inflation that had surged after the Covid-19 pandemic (see Figure 1).

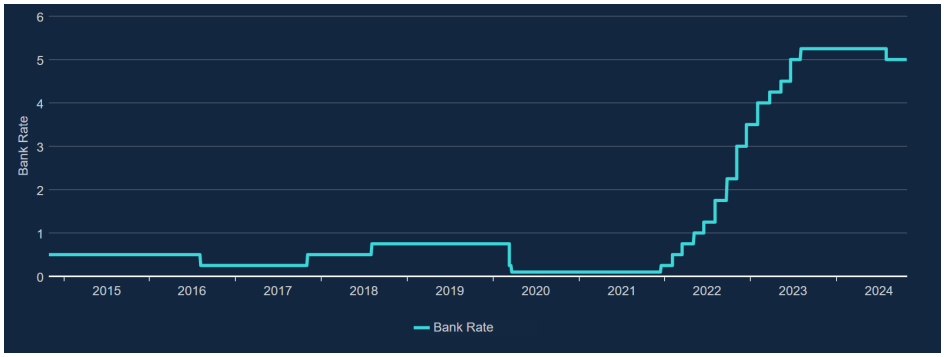


Figure 1: History of the Bank rate

Note: This figure shows the evolution of the Bank of Englands base rate from 2015 to 2024, illustrating the unprecedented pace of monetary tightening in response to rising inflation after the pandemic.

The policy tightening cycle was however preceded by robust rises in nominal house prices, a trend that picked up especially from the start of the pandemic.[2] Figure 2 shows this, with nominal house price growth only flattening somewhat during the rate hiking period, and never returning to its pre-pandemic level. We use local-authority data

[2]See here for an investigation of the drivers of fast house price growth during the pandemic, in particular shifts in household preferences towards larger properties due to remote work.

from the Office of National Statistics to update property prices in our sample, and we find that around 66% of households would have observed a gain, had new appraisals been conducted at refinancing. Furthermore, in our sample, households refinancing in the hiking period saw an average house price increase of around 26% since the previous time they refinanced.

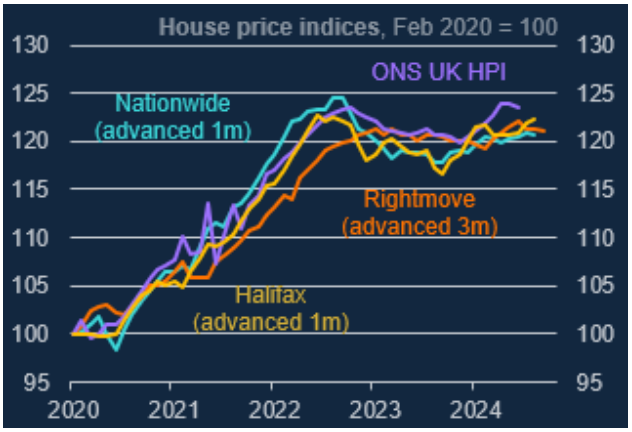


Figure 2: House Price Indices

Note: This figure shows the evolution of key house price indices from major UK sources such as the ONS, Nationwide, and Rightmove. It highlights the substantial increase in house prices before and during the policy tightening cycle, with nominal growth slowing but remaining elevated relative to pre-pandemic levels.

The UK mortgage market features contracts with fixed interest rates for an initial period - often called the 'incentive period'—after which the loan typically reverts to a higher variable rate calculated as a base rate plus a margin. This structure creates a substantial difference between the lower initial rates and the higher reversion rates, motivating borrowers to refinance at the end of the fixed-rate term to avoid substantially higher payments (Cloyne et al., 2019). The timing of these refinancing opportunities is largely predetermined by the initial choice of the fixed-rate duration, which borrowers select years in advance based on their long-term preferences and risk tolerance.

Refinancing before the contract expiration is generally discouraged due to significant early repayment charges, usually ranging from 1% to 3% of the outstanding loan balance. These penalties make it costly for borrowers to adjust their refinancing schedules in response to changing economic conditions, effectively rendering the refinancing dates exogenous to current shocks. Consequently, borrowers with different fixed-rate durations will face refinancing events at different times, creating exogenous variation that is valuable for empirical analysis. Studies have shown that the majority of households refinance either exactly when their fixed-term contract expires or shortly before or after, reinforcing the exogeneity of refinancing dates in the UK context (Best et al., 2020; Belgibayeva et al., 2024).

At the refinancing date, households can modify their loans in a number of ways which can affect the interest rate they are offered as well as their monthly mortgage payments. Firstly, they can increase borrowing via equity extraction. We will show that while a proportion of these funds are used for expenditure, some are used to consolidate (more expensive) unsecured debt and to build saving buffers. Households can also take deliberate measures to lower monthly mortgage spending and make monthly servicing of debts more affordable as a share of disposable incomes. They can switch from a capital and repayments contract to an interest only loan. Alternatively, they can choose to extend the overall amortisation period for the loan, which mechanically reduces monthly repayments at the expense

of paying higher interest rate costs over the life-time of the loan.[3] Extending terms is a more popular choice in the UK than switching to interest-only loans, with around 11% choosing the former in hiking period, and less than 1% choosing the latter in our sample. Finally, making regular overpayments during the course of the fixed term contract could also affect both the mortgage payments as well as the proportion of interest repaid.[4]

2.2 Mortgage data

For loan-level information, we use the data on the flow and the stock of mortgages collected by the Financial Conduct Authority (FCA). The flow dataset, the Product Sales Data 001 (PSD001), contains the universe of all regulated new mortgage product sales in the UK at a quarterly frequency. PSD001 covers data from April 2005 onwards. For our analysis, we focus on the period from 2021 Q1 to 2023 Q4. PSD001 includes detailed information on completed owner-occupied household mortgage originations, excluding commercial and buy-to-let loans. The data encompass various aspects of mortgage contracts, such as the loan amount, origination date, property appraisal value, interest rate during the initial fixed-rate period, whether the interest rate is fixed or variable, the end date of the initial period (i.e., when the loan reverts to a higher variable rate), whether mortgage payments include amortisation, and the total mortgage term. Borrower characteristics are also captured, including age, gross annual income (sole or joint), and borrower type (refinancer, first-time buyer, or home-mover).

The stock dataset, Product Sales Data 007 (PSD007), provides semi-annual disaggregated data on loan performance for outstanding UK mortgages. Looking at PSD007 over the same period of analysis allows us to observe the ongoing status of mortgages, including any changes in loan terms, interest rates, and repayment behaviours. In particular, we are able to recover the precise date when households refinance and the term of their new loans, when this information is not included in PSD001.[5] The two mortgage datasets are matched using available columns such as the date of origination of the loan, the name of the lender, the property postcode and the date of birth of the main borrower.

2.3 Spending data

The data on spending comes from analytics business ExactOne (EO), who extract anonymous transaction data from consumers who have shared their data with organisations via the Open Banking framework.[6] It then collates consumers' financial transactions and tags them according to more aggregated expenditure buckets, such as mortgages, gas bills or groceries. The key advantages of the ExactOne data are its timeliness and the data collection method, which minimises measurement and self-reporting errors due to being fully electronic and automated in real-time.

The use of transaction level data in the UK to understand households financial situation is relatively novel. A similar dataset, from a digital tool called MoneyDashboard, has been used to track households consumption patterns during the pandemic (Hacıoğlu-Hoke et al., 2021; Bourquin et al., 2020; Albuquerque and Varadi, 2024). However,

[3] In the limit, this corresponds to a switch from capital to interest repayments only, where the full notional value of the mortgage is never repaid until the house is sold.

[4] Note that most contracts allow households to repay up to 10% of the loan balance without incurring an early repayment charge during the contract fixation period. When making overpayments, households can choose between reducing their amortisation period, thus reducing interest rate costs, or reducing the loan amount, thus decreasing monthly mortgage repayments.

[5] Before April 2021, PSD001 did not include most loans refinanced with the same lender. The data only recorded newly opened accounts, whereas internal remortgages where recorded under the same account, unless there was a significant change in loan terms. While this information is now included in PSD001, it needs to be inferred from PSD007 for the previous period.

[6] Open Banking is regulated by the FCA in the UK, providing a secure and standardised way for consumers to share their financial information with authorised third parties through Application Programming Interfaces (APIs). ExactOne is an analytics service by ClearScore, which offers a budgeting and financial advice app.

the MoneyDashboard service has been discontinued in the UK, with the latest data stopping shortly before the hiking period begun, in late 2021. Similar to MoneyDashboard data, the ExactOne data includes information only on electronic cash withdrawals and payments. This prevents us from tracking how households spend their physical cash. But this is unlikely to skew our analysis given that cash payments have been steadily declining in the UK since the 2000s (Caswell et al., 2020).

We follow the basic cleaning and aggregation approach of Albuquerque and Varadi (2024). Table 1 illustrates our key aggregates of financial transactions from ExactOne, split into debits and credits. We do, however, consider more disaggregated measures of non-housing consumption, including non-durable goods, durable goods, services, groceries, bank transfers, restaurant, cash, bank charges or no tags. In terms of housing expenditure, we can observe monthly mortgage payments and where needed, rental payments (such as for shared ownership). These data allow us to explore heterogeneous effects across broader measures of household consumption.

Table 1: Aggregation of financial transactions in ExactOne data by type of funds

Incomings	**Outgoings**
Income	Non-housing consumption
Labour income	Cash (ATM)
Investment/capital income	Investment/other savings
Rental income	Rental payments
Other income/benefits	Other spending
Credit finance	Credit repayments
Credit card finance	Credit card repayments
Personal loan finance	Personal loans repayments
	Mortgage
	Bank charges/fees

Note: This table lists the different categories of financial transactions used in the analysis, including both incomings and outgoings. These classifications allow for a granular examination of household balance sheets.

For each anonymous consumer in the dataset we observe their transactions, age, gender and postal district. For each transaction we have information on the amount, whether it is a credit or debit, the date when the transaction took place, the merchant, the balance remaining in the account, a raw transaction description from the bank statement, and the automatic or manual tag that ExactOne uses to categorise the transaction into buckets. Since users could link multiple accounts, we can also observe an account reference, and the account type. Additionally, ExactOne uses specialised algorithms to derive salary income from transaction tags, including from consumers' multiple jobs as applicable. Finally, when a consumer connects their transaction data via Open Banking, ExactOne automatically downloads up to three years of back data from the linked accounts.

We take a number of additional steps to clean the data, which we explain in detail in Appendix A.3. Some transactions, however, were not tagged, which prevents us from properly identifying the type of expenditure or credit they refer to. We choose not to drop untagged debit or credit transactions, since these may be including important dynamics that we would lose otherwise. In addition, we follow Albuquerque and Varadi (2024) and treat the data as measuring the finances of the 'nuclear family', which includes individuals, their partners and their children. The aim of these financial applications is to help users with their financial wellbeing and access to credit. Hence to maximise benefit, households are encouraged to link all their family accounts for a more complete view of their budget. We would then expect the majority of users to link their accounts jointly with the other family members.

To obtain a picture of mortgagors' balance sheets, including their income, savings, debt and expenditure behavior, we match PSD001 and PSD007, with the ExactOne data using age, postal district and the monthly mortgage payment, together with the mortgage reporting period and provider, when available. We end up with over 55,000 unique remortgagors and approximately 1.6 million observations after cleaning, over January 2021 to December 2023. We remove the pandemic period since it was an exceptional time for households in terms of both credit markets and individual spending dynamics. Table 2 shows the descriptive statistics of our matched PSD-EO data.

Table 2: Descriptive statistics for the matched PSD-EO sample

Statistic	N	Mean	St. Dev.	Min	Max
Gross annual income (PSD)	1,618,291	51,392	32,469	1,817	1,999,998
Debt Service Ratio (DSR)	1,618,291	17.6	6.2	0.4	133.4
Loan-To-Value (LTV)	1,618,291	73.4	17.9	5.0	104.6
Loan-To-Income (LTI)	1,618,291	3.3	0.9	0.04	9.8
House prices	1,618,291	281,075	172,514	31,678	6,393,525
Mortgage loan	1,618,291	158,235	97,634	1,579	2,152,499
Mortgage payment	1,618,291	721	436	53	9,018
Mortgage interest rate	1,618,291	2.4	1.1	0.1	21.9
Spending excluding housing	1,618,291	4,771	4,892	269	44,879
Credit card and other repayments	1,618,291	1,092	2,433	0	256,803
Current and saving balances	1,618,291	5,379	18,413	−258,578	2,787,070

Note: This table presents summary statistics for key variables in the matched PSD-EO sample, including gross annual income, debt service ratio, loan-to-value ratio, mortgage amounts, and monthly mortgage payments. These statistics provide an overview of the financial characteristics of the mortgagors included in the dataset.

We show that the matched PSD-EO data is representative of the universe of mortgagors. Figure 3 includes key statistics from the distribution of gross income, loan balance outstanding and monthly mortgage payments in PSD, which captures the universe of all outstanding mortgages in the UK, and our matched PSD-EO sample. Appendix A.1 provides further statistics to show that the sample is also representative across the distribution of age, UK regions, loan-to-value, loan-to-income, gross income and house prices. Furthermore, Figure A.7 in Appendix A.1 shows that the percentage of those who refinance their loans in our sample is representative in the wider population of remortgagors in the UK.

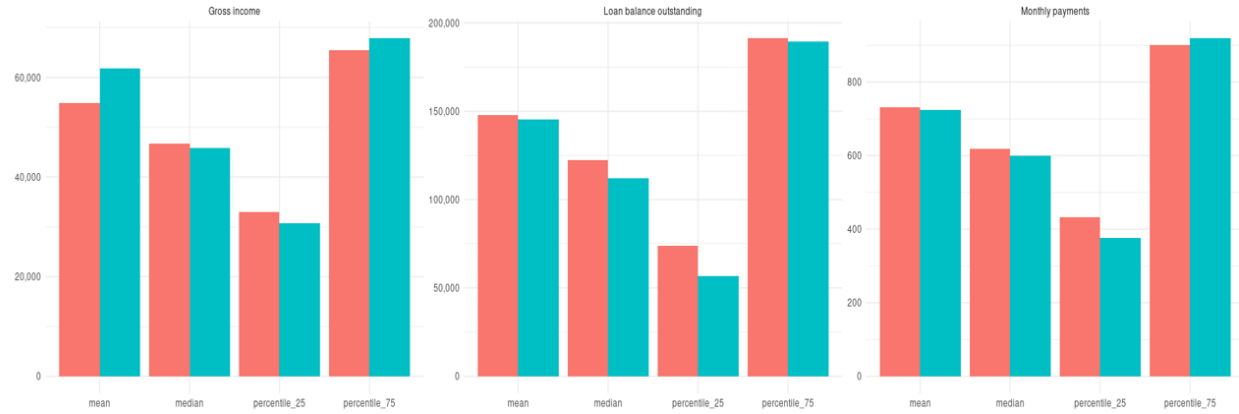


Figure 3: Representativeness of the matched PSD-EO data

Note: This figure compares the matched PSD-EO sample (in red) with the universe of mortgagors in the PSD dataset (in blue) across key financial indicators: gross income, loan balance outstanding, and monthly mortgage payments. Each panel shows the mean, median, and interquartile range (25th and 75th percentiles) for each metric. The alignment of distributions highlights the representativeness of the matched sample in reflecting the broader population of UK mortgagors.

3 Research Design

We explore variation in UK mortgagors' exposure to interest rate changes at refinancing during the hiking period that started in late 2021 in the UK. This approach follows Cloyne et al. (2019) in exploiting exogenous refinancing dates, since in the UK households have to periodically refinance to avoid lapsing onto higher standard variable rates. Different households have an incentive to remortgage at different times based on the timing of their previously originated mortgage. This setup provides rich differences in the UK mortgage market around product terms, with length of fixed-term products varying from 2 to over 10 years. It thus allows us to compare the balance sheet adjustments of mortgagors with contracts expiring at different dates.

Our main specification is a difference-in-differences (DiD) model with heterogeneous treatment and two-way fixed effects, which we estimate over January 2021 - December 2023. We estimate a dynamic equation that includes a set of monthly dummies capturing the months before and after the refinancing date and interacted with an indicator for treatment. $1_{treated,t}$ is a dummy which takes the value of 1 for mortgagors whose latest mortgages reset during the treatment period and 0 otherwise. We only focus on mortgagors who remain in the same property since the last refinancing, to ensure that the property move would not bias our results:

$$Y_{i,t} = \sum_{t=-j}^{j,t\neq reset\,month} \delta 1_{i,month=t} + \sum_{t=-j}^{j,t\neq reset\,month} \beta_t^j 1_{i,month=t} * 1_{treatment} + \omega X'_{i,t} + \alpha_i + \gamma_t + \varepsilon_{i,t} \quad (1)$$

where $Y_{i,t}$ is the outcome of borrower i in month t; $1_{i,month=t}$ captures the months around the refinancing dates, to absorb any baseline effects due to the remortgaging event itself. Effectively this term means that in addition to differencing treated and controls, we also difference out the systematic effect of refinancing on outcomes. The remaining variation then captures only the effect of refinancing during the tightening cycle. $X'_{i,t}$ includes a series of controls at an individual level, including income and loan-to-value (LTV) ratios (as proxies for borrower risk). γ_t captures time fixed effects; α_i captures household fixed effects. β_t^j measures the difference in average outcomes for mortgagors

refinancing in the treatment period relative to the control group, in a window of $[-j, j]$ months relative to the reset month. We set the baseline month for comparison to be the last month of the previous mortgage contract. This is excluded from the regression to avoid collinearity.

Our treated group comprises mortgagors who refinanced in the hiking period, more precisely, between July 2022 and December 2023. This period has been chosen to reflect the effective pass-through of Bank rate hikes to higher mortgage rates. We then compare them with a control group of mortgagors whose mortgages do not expire anytime between January 2022 and December 2023. The control group includes households on both long and short term fixes. [7] This setup allows us to keep refinancing dates between treated and control separate enough (i.e., six months apart) as to avoid any spillover effects from the remortgage itself to bias our estimates. Furthermore, our rich data allows us to compare treated and controls who make the same loan choices at refinancing. This allows us to compare households who are most similar to each other, thus reducing any potential unobserved bias that may determine choices into loan modifications.

Table 3 shows summary statistics for the main variable of interest comparing our treated and control group. Results from the event study in Equation 1 will show that across all of our specifications, the parallel trend assumption, necessary for identification, continues to hold.

Table 3: Summary statistics for treated and control groups

Statistic	Control Group			Treated Group		
	N	Mean	St. Dev.	N	Mean	St. Dev.
Gross annual income (PSD)	489,352	50,869	30,151	673,070	51,849	31,952
Debt Service Ratio (DSR)	489,352	16.8	5.8	673,070	18.7	6.5
Loan-To-Value (LTV)	489,352	73.2	17.8	673,070	73.4	17.8
Loan-To-Income (LTI)	489,352	3.2	0.9	673,070	3.3	0.9
House prices	489,352	283,346	175,632	673,070	279,027	169,751
Mortgage loan	489,352	155,880	94,579	673,070	161,001	100,268
Mortgage payment	489,352	681	400	673,070	775	474
Mortgage interest rate	489,352	2.0	0.7	673,070	2.9	1.2
Spending excluding housing	489,352	4,661	4,798	673,070	4,778	4,889
Credit card and other loan repayments	489,352	1,087	2,358	673,070	1,086	2,408
Current and saving balances	489,352	5,464	16,130	673,070	5,119	15,850
Equity extraction Y/N	489,352	0.2	0.4	673,070	0.2	0.4
Term extension Y/N	489,352	0.1	0.2	673,070	0.1	0.3
Equity extracted if Y	2,650	33,562	38,294	5,157	35,743	40,862
Month extended if Y	588	58.1	50.7	2,302	73.0	211.4

Note: This table presents summary statistics for the main variables used in the analysis, across both treated and control units.

We address any potential endogeneity challenges in our approach, in a number of ways, which we discuss in turn below.

We ensure robustness to staggered treatment. While the refinancing date is pre-determined for UK mortgagors, exposure to the treatment (interest rate hikes) varies depending on the timing of the refinancing during the economic cycle. This introduces potential bias if early-treated households are implicitly compared to late-treated households or

[7] Note: In many cases, a two year fixed term contract could include more than 24 months, as some lenders allow for a few months to complete the mortgage approval and some will fix rates until a specific end date rather than a number of years.

if control groups include households anticipating refinancing. To address this, we follow the recommendations from recent literature on staggered difference-in-differences (DiD) methods (Callaway and SantAnna, 2021; Wooldridge, 2021; Sun and Abraham, 2021), which highlight the risk of bias when treated units transition into control groups after treatment. Our control group is instead restricted to households not refinancing in the hiking period, thus they are unaffected by imminent refinancing, which avoids anticipatory behaviour or contamination of the control group. For robustness, we do allow some variations of Equation 1 where we do include the not-yet-treated in the control. However, once a user is treated, they remain in the treatment group forever, ensuring that their responses are never mixed with the behaviour of the control units after treatment.

We separate pre-determined characteristics from endogenous choices. Household characteristics are key to understanding heterogeneity in balance sheet adjustments but must be distinguished from choices made during refinancing, which may be endogenously linked to outcomes. To address this, we use pre-determined household or loan characteristics, such as house price appreciation and prior savings and income levels. For instance, house price appreciation between refinancing events is independent of refinancing dates, as discussed above, serving as an exogenous proxy for housing wealth. We also avoid anticipatory effects. More precisely, we measure household characteristics (e.g., income and savings) at least six months prior to refinancing to minimize the risk of capturing adjustments made in anticipation of refinancing. This approach aligns with the typical remortgaging timeline, where lenders contact borrowers 3-4 months before their fixed-term expiration.[8] Furthermore, we test the role of expectations about the macroeconomic environment, by assessing whether behaviours differs between households refinancing early versus later in the hiking cycle. If households are forward-looking, then they should adjust consumption when they learn about future rate increases, not only when they refinance. However, our results show spending, saving, and debt adjustments are concentrated around the refinancing date itself.

We distinguish the role of loan modifications. We differentiate between households who passively refinance and those who actively modify their loans (e.g., changing loan terms or withdrawing equity). This distinction mitigates bias from self-selection into loan modifications. Our approach includes examining spending and debt outcomes separately for households that modify their loans versus those that do not. We also employ a Probit model to explore whether financial constraints or household characteristics are correlated with loan modifications.

4 Aggregate effects and loan modifications

UK households have the option to adjust their mortgage loans at the time of refinancing. These loan modifications can include changing loan amounts by withdrawing equity or making overpayments beyond the contractual repayment amount; switching from a capital and interest repayment loan to an interest-only repayment; or extending mortgage terms at refinancing.

Table 4 shows the proportion of households taking any of these steps at the time of refinancing, before and after the hiking period. It shows a slight increase in the proportion of households making overpayments and switching to interest only at the refinancing date. A larger increase is observed in the share of households extending mortgage terms. The share extracting equity has marginally reduced, but remains by far the most popular loan modification. Overall, the share of households who have not modified their loan along any of these dimensions marginally decreased.

To distinguish between the effects of loan modifications on our outcome variables, we run Equation 1 only on the sample of mortgagors who did not make any loan adjustments. We then gradually allow other adjustments to take

[8] See here for more details on the remortgaging process in the UK.

Table 4: Proportion of households who adjust their loans at refinancing

Loan Adjustment	Pre-Hiking Period	Hiking Period
% Extracting equity	23.2%	22%
% Switching to interest-only	0.7%	0.85%
% Making overpayments	5.1%	5.4%
% Extending terms	8.5%	11%
% Extending terms & extracting equity	5.2%	5.8%
% Not modifying their loan	73%	72%

Note: This table reports the share of households refinancing each month, who are engaging in different types of loan adjustments. It compares refinancing behaviour before the hiking period and during the policy tightening cycle.

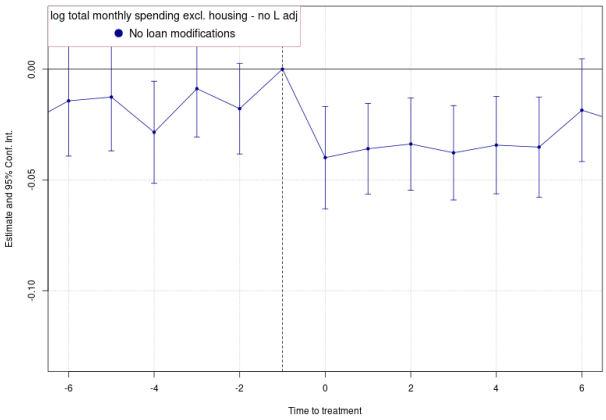
place and compare the outcomes. We find that equity extraction and mortgage term extensions are the most important dimensions of adjustment, and these are amplified by house price appreciation between refinancing events.

4.1 Aggregate effects without loan modifications

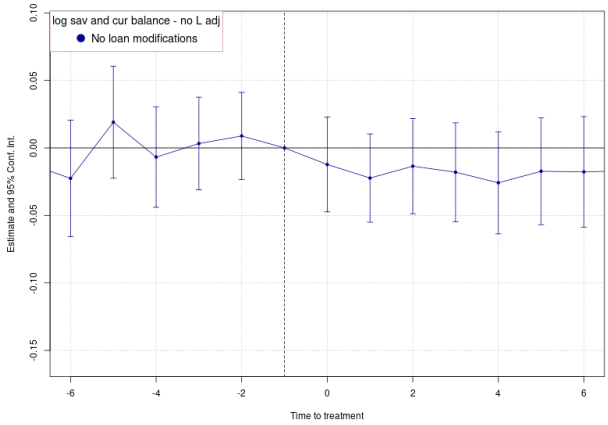
We examine the response of the average household to cash-flow changes (unanticipated or otherwise) in Figure 4. To ensure estimates are not biased by endogenous household choices in response to the refinancing event, we start by looking at households who do not undertake any voluntary loan modifications, which accounts for around 70% of our sample. The figure shows that average non-housing spending decreases significantly on impact, with a large effect persisting for six months after the event. Refinancing in the hiking period leads to a 4% drop in spending compared to controls who refinance prior to the hiking period and who also do not adjust their loans. This effect is in response to monthly mortgage payments increasing by around £150 as a result of the hiking cycle (equivalent to a 20% rise in mortgage payments).

These households cannot or do not respond to the shock by adjusting along other dimensions of their balance sheet, for example by accessing their saving balances or reducing repayments of unsecured loans. Despite the expected nature of the event of refinancing at higher rates, households only adjust their spending margin in response to the event, in contrast to standard macroeconomic models which would predict adjustments along all balance sheet dimensions. This finding aligns with previous empirical evidence. Andersen et al. (2024) find that homeowners' consumption drops in response to a negative and anticipated disposable income shock, driven by the beginning of the amortisation period on previous interest-only mortgages. Using both empirical evidence and theoretical modelling, Vihriälä (2023) finds that liquidity-constrained households with self-control issues exhibit overconsumption during periods of free mortgage-repayment flexibility, followed by a sharp drop when the flexibility ends.

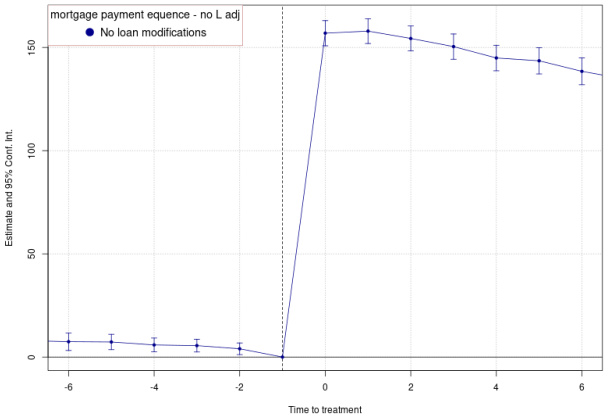
We can exploit the detailed nature of our data to dig deeper into which categories of consumption are subject to adjustments. Figure 5 shows that almost all dimensions of spending are affected, including cash withdrawals. Expenditures in non-durable, durable, services and bank transfers between households and businesses all shrink by around 3% - 9%. The most surprising response is however on groceries spending, which decrease by 5% and remains significantly reduced throughout the sample. One explanation may be that on average, households seek cheaper grocery baskets, as a result of the higher cost of living driven by the inflationary period following the pandemic. Indeed, there is evidence from the Office of National Statistics that UK households adjusted their grocery shopping



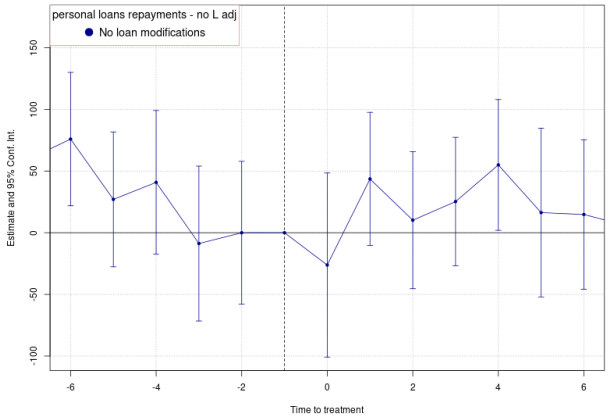
(a) Total non-housing spending



(b) Total saving balances



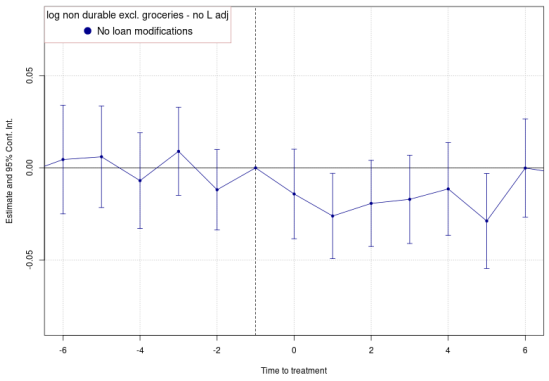
(c) Monthly mortgage payment



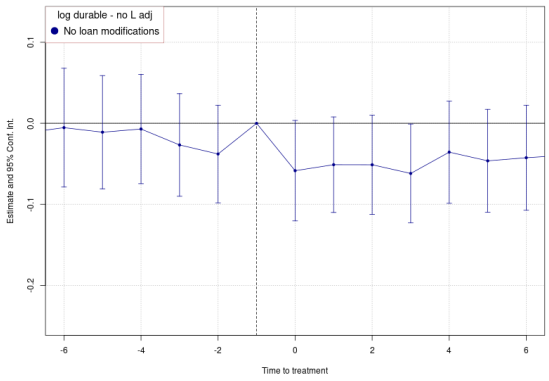
(d) Unsecured loan repayments

Figure 4: Household responses to the hiking cycle without loan modifications

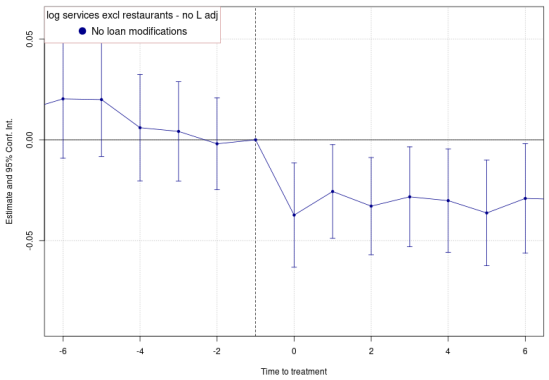
Note: This figure plots the average responses of households that did not adjust their mortgage loans at refinancing, estimated using Equation 1 on the matched Product Sales Database - ExactOne data. The horizontal axis represents time to treatment - i.e the months relative to the refinancing event in the hiking period (denoted as t=0), with negative values indicating months before the event and positive values indicating the months after. The figure includes 95% confidence intervals. Neither control nor treated units do not adjust their loan terms actively at refinancing.



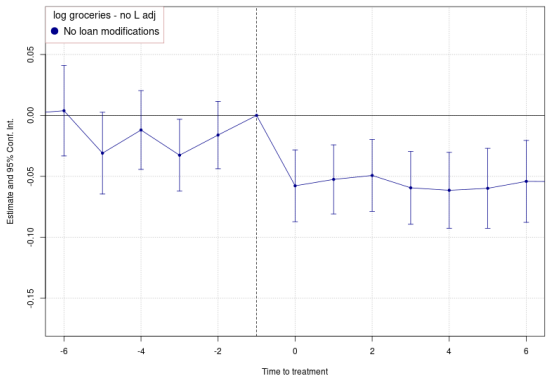
(a) Non-durable (excl. groceries)



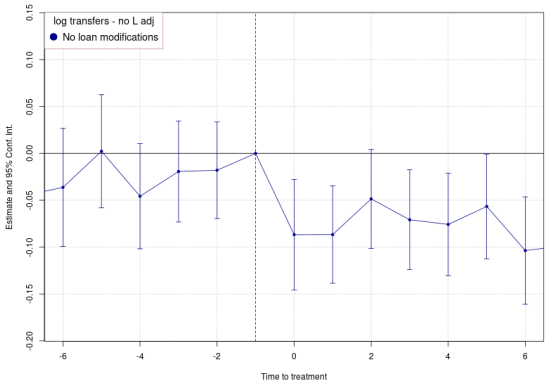
(b) Durable



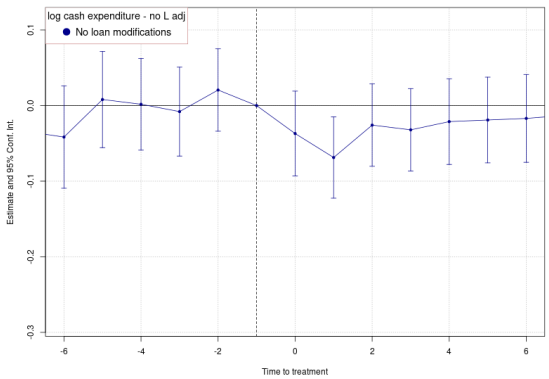
(c) Services excl. restaurant



(d) Groceries



(e) Transfers



(f) Cash

Figure 5: Average consumption category responses to the hiking cycle for households without loan modifications

Note: This figure illustrates the average responses in consumption categoriesnon-durable goods, durable goods, services, groceries, and cash withdrawalsfor households that did not adjust their loans at refinancing during the hiking period. The layout replicates that of Figure 4. The horizontal axis represents time to treatment - i.e the months relative to the refinancing event in the hiking period (denoted as t=0), with negative values indicating months before the event and positive values indicating the months after.

and essential spending habits during the cost of living crisis by switching to cheaper budget options for their groceries or increasingly using discount retailers.[9] While we do not find evidence of retail switching in our daily disaggregated data, it is possible that households purchased cheaper consumption baskets from the same retailer, without reducing quantities.

The effects discussed in this subsection highlight that households appear to adjust spending only at the refinancing date, rather than when learning about future rate increases. If the Permanent Income Hypothesis (PIH) held, we would expect households to react earlier, smoothing consumption across the policy rate hiking cycle. However, as shown in Appendix A.4, households refinancing later in the hiking cycle, despite facing larger mortgage payment increases, show a similar spending response to those refinancing earlier. This indicates that refinancing, rather than anticipated rate hikes, triggers consumption adjustments.

4.2 Smoothing cash-flow effects via mortgage loan modifications

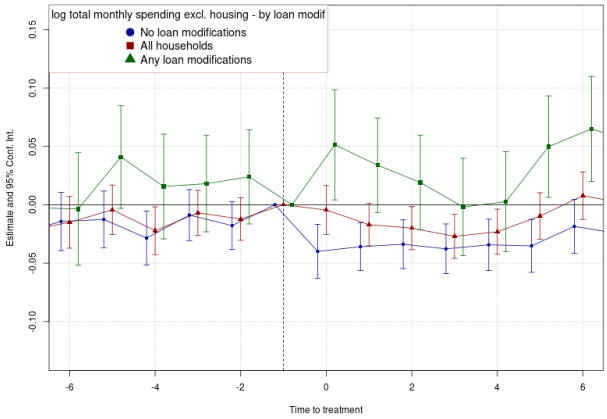
In the previous section we showed that households not undertaking any voluntary loan modifications at the refinancing date cut spending in the following months. A natural question emerges on how and whether loan adjustments have helped households weather the impact of the interest rate hikes and its effects on monthly mortgage payments. To examine this, we compare the subset of households in the previous section (i.e., those not adjusting their loan terms at refinancing) with those who undertake at least one loan modification, which includes around 30% of our sample.

Figure 6 shows a split of households in our data by loan modifications. There is a clear divergence in responses between those who modified their loan at refinancing (green line) and those who did not (blue line). Modifying loans at least across one dimension, leads to a 5% rise in spending on impact, compared to similar controls who also adjust their loan terms. This response is an aggregate across all types of loan modifications—i.e., those meant to reduce overall debt burden, such as overpayments, as well as those increasing overall debt burden, such as mortgage term extensions and equity withdrawals. Approximately 6% of all treated households make overpayments at the refinancing date. The average overpayment is £2030 or two and a half times the average monthly mortgage payment pre-refinancing. Removing overpayments would amplify the results, but it would provide an incomplete picture of all possible loan adjustments at refinancing. In Appendix A.4 we illustrate the impact of removing overpayments from the set of loan modifications.

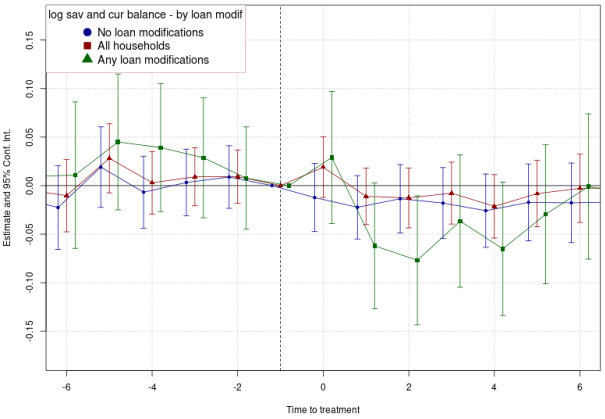
Furthermore, we observe total saving balances decreasing for those undertaking loan modifications, with a persistent rise in unsecured loan repayments. We argue that overpayments are driving the results on the former (as we show in Appendix A.4), while equity withdrawals are responsible for the latter.

Next, we examine the impact of refinancing in the hiking period on our aggregate data, shown in red in Figure 6. While we still observe a reduction in total non-housing spending, the aggregate response is more muted and less long-lasting than for households with no loan modifications. This suggests that loan modifications have important aggregate effects, by dampening the overall response to the monetary tightening cycle. Even more so, in Appendix A.4.4, we show that both the aggregate results and those split by loan modifications in Figure 6 hold for real values of spending, savings and unsecured debt. We thus conclude that mortgage contract modifications at refinancing are an important channel via which households handle mortgage cash-flow shocks. In the following sections, we investigate the mechanisms through which these loan adjustments impact households' response.

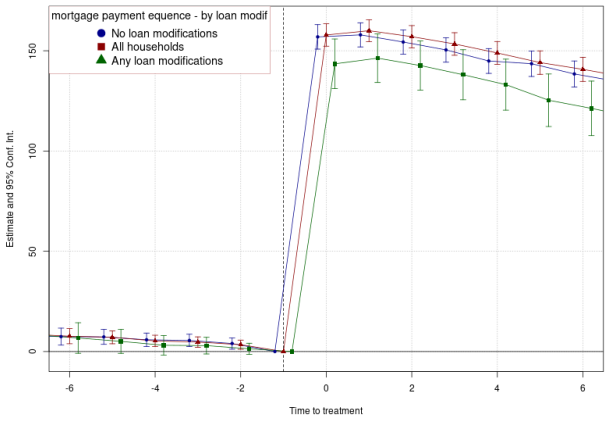
[9] See here for more details on this evidence.



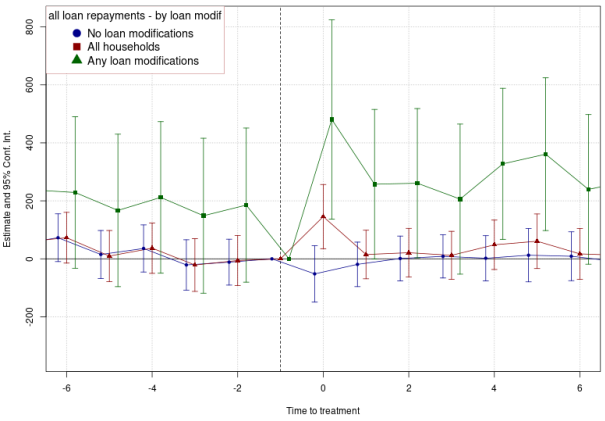
(a) Total non-hous spending



(b) Total saving balances



(c) Monthly mortgage payment



(d) Unsecured loan repayments

Figure 6: Impact of mortgage loan adjustments

Note: This figure shows the average impact of loan adjustments on key financial outcomes across four panels: (a) total non-housing spending, (b) total saving balances, (c) monthly mortgage payment, and (d) unsecured loan repayments. The figure compares three groups of households: those with no loan modifications, those with any loan modifications, and the overall sample. Outcomes include total non-housing spending, saving balances, mortgage payments, and unsecured loan repayments. The layout replicates that of Figure 4.The horizontal axis represents time to treatment - i.e the months relative to the refinancing event in the hiking period (denoted as t=0), with negative values indicating months before the event and positive values indicating the months after.

5 Mechanisms of mortgage loan modifications

In this section, we analyse the ways in which loan modifications can help households smooth the negative cash-flow effects arising from refinancing onto higher rates during the hiking cycle. We also analyse the drivers behind households' use of these modifications.

Table 4 highlights that equity extraction is the most common loan modification among refinanciers, with approximately 22% of the sample (both treated and controls) borrowing more at refinancing. Another significant modification is extending the loans amortisation term, which is notably more prevalent among households extracting equity. Specifically, 25% of treated households who extracted equity also extended their loan terms, compared to just 6% of treated households who did not extract equity. Given these facts, our analysis focuses on equity extraction and its combination with term extensions. We examine how financial constraints (e.g., collateral or liquidity constraints) and loan choices (e.g., fixed-rate term length and loan term extensions) influence these behaviours.

As a first step, we briefly review the impact that equity extraction has on households' responses to the hiking cycle. We find that equity extraction induces similar balance sheet adjustments, in terms of sign and magnitude, as the results for all loan modifications observed in Figure 6. This is expected, given that the most common loan modification is equity extraction. In Appendix A.4.3 we show these results in detail, splitting households between those who do and do not extract equity. As expected, the positive spending response to the refinancing event in the hiking period comes exclusively from equity extractors, who spend more on average than the similar control group (also extracting equity). Equity extraction in the hiking period leads to a 10% rise in spending on impact compared to control units. This difference in spending may be explained by inflation, as we show in Appendix A.4.5. Moreover, the spike in consumption is accompanied by a similar response in saving balances and unsecured debt repayments. This indicates that equity extraction does not only support spending amid rising mortgage payments, but also helps households rebuild saving balances and repay more expensive debt, thus consolidating their balance sheets.

Despite the positive effects of equity extraction on households, these benefits are short-lived and fade soon after refinancing. A deeper look at more granular spending categories (Figure A.14 in the Appendix) reveals that the primary response is concentrated in non-durable goods and bank transfers, which often indicate investments in savings or housing, such as payments for building work or home improvements. This suggests that households extract equity mainly for specific investment purposes or to maintain certain levels of non-essential spending. In contrast, those not extracting equity reduce spending across all spending categories.

5.1 Who extracts equity?

We next examine what drives this self-selection into equity extraction by exploring how individual household characteristics and economic factors correlate with it. Equity extraction is a choice at the refinancing event only, with housing wealth locked in over the duration of the fixed contract. Large transaction costs prevent households from refinancing before the fixed contract expiration date. To understand the probability of extracting equity we rely on a Probit model, shown in Equation 2:

$$P(Equity\ Extraction = 1 \mid X) = \Phi(\beta_0 + \beta_1 X_1 + ... + \beta_k X_k) \tag{2}$$

$$\Phi(z) = P(Z \leq z), Z \sim N(0,1), \tag{3}$$

where we use the cumulative standard normal distribution function $\Phi(.)$ to model the binary dependent variable, which

takes the value of 1 if a treated household extracts equity in response to the hiking period and 0 otherwise. The Probit coefficients β capture the change in the z-value associated with a one-unit change in our covariates X. Our vector of covariates includes a dummy for all the possible loan adjustments mentioned above and household characteristics. We compute the following variables prior to refinancing: income quantiles, saving balances quantiles, quantiles of monthly mortgage repayments changes. We aim to capture how the financial situation of households prior to the refinancing event is correlated with loan modification choices at the refinancing. We also include the following variables, which are computed in changes relative to the previous refinancing event: change in LTV notch and property prices changes. All other variables (such as those related to mortgage flexibility) capture changes that the household can only take advantage at during the refinancing event.

Table 5 shows that on average, a mortgagor refinancing in the hiking period, has around a 22% mean probability of extracting equity. Equity extraction is positively correlated with financial characteristics such as the strength of house price gains between refinancing events, higher income and lower savings. Equity extraction also correlates with other loan modifications such as extending mortgage terms or choosing longer contract fixation periods. In the next section we investigate each of these drivers of equity extraction in more detail, using Equation 1 to obtain causal effects.

Table 5: Probability of Extracting Equity for Treated Households (Probit Model)

	Marginal Effect	**Std. Error**	**P-value**
Prop. price increase since last remo.: Up to 25% rise	-0.159***	0.01	0.00
Prop. price increase since last remo.: 25%-50%	0.158***	0.01	0.00
Prop. price increase since last remo.: 50%-100% rise	0.071***	0.01	0.00
Contract fixation: 5 years	0.049***	0.00	0.00
Contract fixation: 2 years	0.029***	0.00	0.00
Change in mortgage payment Q1	-0.049***	0.00	0.00
Change in mortgage payment Q2	-0.012***	0.00	0.00
Change in mortgage payment Q4	0.02***	0.00	0.00
Change in mortgage payment Q5	0.03***	0.00	0.00
Overpayment at the remo. event	-0.005**	0.00	0.03
Switch to i. only	0.033***	0.01	0.00
Mortgage term extension	0.232***	0.00	0.00
Income at remo. Q1	-0.023***	0.00	0.00
Income at remo. Q2	-0.01***	0.00	0.00
Income at remo. Q4	0.007***	0.00	0.00
Income at remo. Q5	0.011***	0.00	0.00
Saving balances Q1	0.011***	0.00	0.00
Saving balances Q2	0.01***	0.00	0.00
Saving balances Q4	-0.006***	0.00	0.00
Saving balances Q5	-0.008***	0.00	0.00
Mean across sample	0.22		

Note: This table presents results from a Probit regression estimating the likelihood of equity extraction at refinancing (see equation 2 in the main text. Marginal effects and standard errors are reported.

5.2 Drivers of equity extraction: house prices and constraints

The decision to extract equity at refinancing depends both on financial constraints and on house price dynamics. This subsection explores these two key drivers. We start with property price appreciation, which enhances borrowing capacity by increasing the value of collateral. We then move on to heterogeneity across income and savings, and show that households with limited liquidity or low income can tap into home equity as a financial buffer.

5.2.1 House price appreciation as a driver of equity extraction

Table 5 shows that equity extraction is up to 38% more likely in circumstances where the property price has increased substantially since the last remortgaging event. This suggests a strong collateral-driven motive which is somewhat independent of the policy tightening cycle. Households can only take advantage of property price changes at the refinancing event, since the costs of remortgaging during the fixation period of the loan are substantial. The larger the housing wealth gain since the last refinancing, the more likely households are to extract some of that wealth and channel it into consumption.

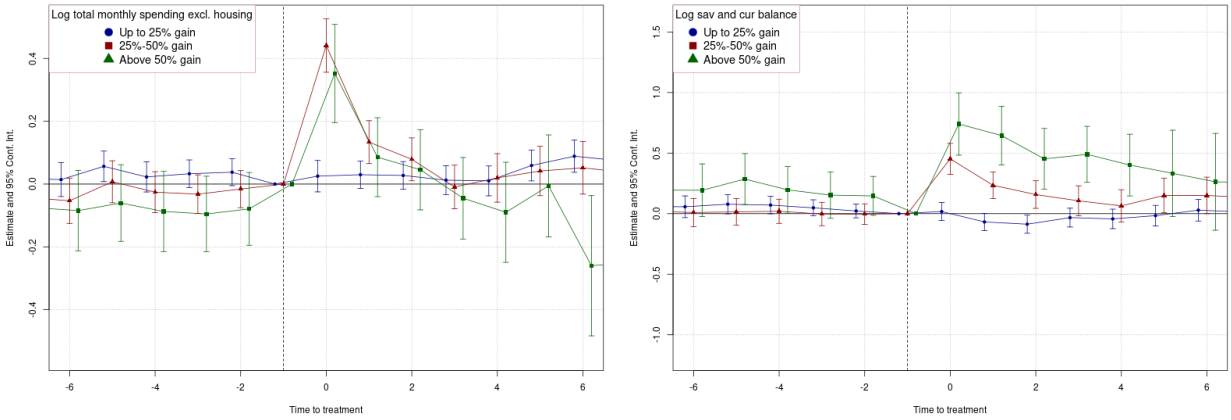
Collateral-driven borrowing has remained important in this policy tightening cycle despite the rising rates. As we show in Figure 2, the hiking period in 2022-2023 was preceded by strong house price growth, particularly during the pandemic, which meant that many households experienced nominal house price appreciation between refinancing events. This supported their decision to extract equity at the refinancing date despite rising rates.

Indeed, the relevance of nominal, rather than real, house prices for household choices has been documented in the literature. For instance, Bracke and Tenreyro (2021) use administrative data from the UK to show that it is current and past nominal house prices that are relevant for housing market activity and sale prices. Cloyne et al. (2019) find that a 1% increase in house prices leads to an approximate 0.24% increase in household borrowing when refinancing. While the authors do not link these results to spending, they provide evidence that household finances respond strongly to nominal house price gains. In our sample we find that around 45% of all refinanciers extracting equity have seen an appreciation in their house price since the last refinancing event. However, amongst equity extractors, house price appreciation has been stronger for the treated group refinancing in the hiking period, compared to controls refinancing before 2022. Indeed, controls observed a mean property gain of 17% when remortgaging, compared to an average gain of 26% enjoyed by the treated group.

Figure 7 shows that the positive spending and savings responses we see for households extracting equity, are driven by nominal house price gains. Households who experience a house price appreciation above 25% observe a large spending response and a persistent build up of saving balances. Expenditure increases across most categories, as shown in Appendix A.4.7, with larger adjustments in durable, non-durable and cash withdrawals. In contrast, observing property price gains between 0%-25% leads to muted impacts, with these households channelling equity extraction into repaying more expensive unsecured debts, rather than spending (see Appendix A.4.7 for further details).

While housing wealth boosts equity extraction, rising interest rates acts as a countervailing force, reducing the impact that equity extraction has on household finances. In Appendix A.4.6 we examine treated households extracting equity based on their interest rate exposure at refinancing. We show that the positive spending effects decreases with the size of the interest rate rise at refinancing. A doubling of the interest rate change from 100bps to 200bps, decreases the spending response in half, although it remains positive and significant. This finding highlights the interplay between two competing forces: collateral-driven borrowing fuelled by property price gains which encourages equity withdrawal, and the cash-flow and interest rate channels of monetary policy, which discourage borrowing by

raising interest costs.



(a) Total non-housing spending

(b) Saving balances

Figure 7: Impact of equity extraction by house appreciation

Note: This figure shows how spending and saving behaviours vary by the level of house price appreciation experienced by mortgagors who extract equity at refinancing. The layout replicates that of Figure 4. The horizontal axis represents time to treatment - i.e the months relative to the refinancing event in the hiking period (denoted as t=0), with negative values indicating months before the event and positive values indicating the months after.

5.2.2 Liquidity constraints when households can extract equity

Table 5 shows that equity extraction is positively correlated with individual characteristics. For instance, households in the highest quantiles of income or the lowest quantiles of saving balances are more likely than the median household to extract equity.

In this subsection, we examine heterogeneity across income and savings. There is a rich literature on the behaviour of wealthy hand-to-mouth borrowers—i.e., those who have substantial illiquid assets, such as property equity, but have low illiquid savings to be able to react to negative shocks (e.g. Kaplan et al. (2020), Kaplan et al. (2018), Greg Kaplan and Weidner (2014)). Despite their wealth, these households tend to have high marginal propensity to consume and are more responsive to income than to interest rate shocks (Aguiar et al., forthcoming). We add to this literature in two ways. First, we show that it is savings and housing wealth, rather than income, that drive spending adjustments during the monetary tightening. Second, we find that housing wealth, via equity extraction, is used by poorer hand-to-mouth households to build up their saving balances and by richer hand-to-mouth to consolidate their debts. Hence, while income does not matter for consumption adjustments, it matters for other dimension of the balance sheet.

We show these results in Figure 8, where we focus on treated households who extract equity, and who fall in either the top or bottom quartiles of income or savings prior to the refinancing date. We then compare them with controls with similar characteristics in terms of equity extraction, income or savings. Panels (a), (c) and (e) show that equity extractors with high savings behave comparably in the hiking period to similar controls refinancing before.

Panels (b), (d) and (f) show a contrasting picture for equity extractors entering the hiking period with low savings. Both high and low income households use housing equity withdrawal to support significant (20%) increases in spending relative to controls. This suggests the presence of constraints imposed by low liquidity, rather than income, which

prevented these households from consuming optimally during the hiking period. Income distribution is more relevant for adjustments across savings and unsecured debt. Low income liquidity constrained households channel some equity extraction into rebuilding higher saving balances. High income liquidity constrained repay unsecured loans at a faster rate.

Table 5 shows a positive correlation between increases in mortgage payments at the refinancing event and the likelihood of equity extraction. This suggests that households facing rising debt servicing costs may resort to secured borrowing, which tends to be cheaper than alternative forms of credit, to manage liquidity constraints and smooth consumption. In this context, equity extraction acts as a financial buffer, enabling households to offset higher monthly payments while stabilising other areas of their balance sheets, such as unsecured debt repayments and savings.

5.3 Other loan modifications and mortgage choices

In addition to equity extraction, households facing higher refinancing costs can adjust various other mortgage terms to better manage repayment burdens. This subsection examines two critical loan modifications that equity extractors use: selecting longer fixed-rate contracts to lock in current interest rates and extending the mortgage term to reduce monthly payments. We show how these strategies shape equity extraction decisions and amplify borrowing capacity.

5.3.1 Longer contract fixation contracts as a driver of equity extraction

Table 5 shows that being on a longer contract fixation period, of around five years, is more strongly correlated with equity withdrawals compared to shorter, two year fixation contracts.

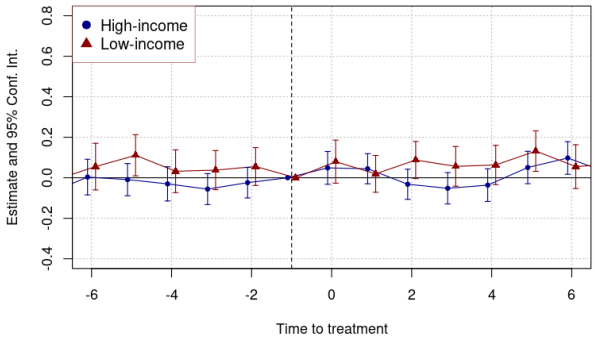
We next examine whether refinancing onto a 2-year or a 5-year fixed rate contracts leads equity extractors to behave differently.[10] Households on 5-year contracts face less frequent opportunities to extract equity from their home and they are thus, on average, more likely to experience larger house price increases when they do eventually refinance. Table 6 reports the frequency of equity extraction among households on a 2- vs 5- year contract, showing a slightly larger share among the 5-year fixes. More remarkably, households on longer term contracts experience a larger average house price appreciation, with a larger share of this subset experiencing positive nominal house price growth between refinancing dates.

Table 6: Comparison of 2-Year and 5-Year Contracts

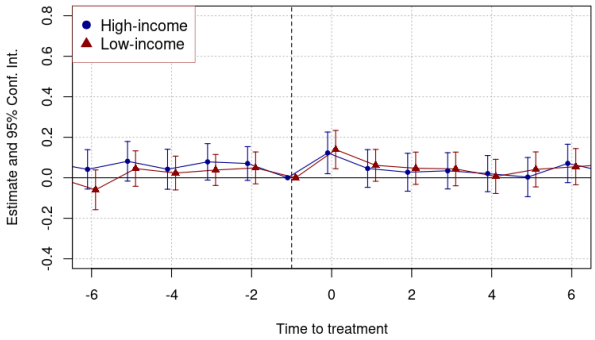
Households extracting equity	2-Year Contract	5-Year Contract
Share	21.8%	24.2%
Share of contracts experiencing nominal house price appreciation	32%	45%
Average nominal house price appreciation	8.6%	11.8%

Then, we investigate whether the borrowing, spending and saving responses of treated households depend on the length of their contract fixation length. We select a control group that matches the contract duration of the treatment. As most households on a 2-year contract will be treated in the hiking period, we change our specification slightly to allow the not-yet treated to be used as controls.

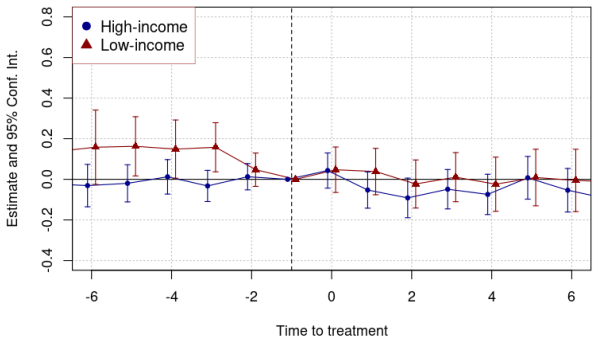
[10] We choose these two contract lengths as they are among the most popular in the UK. We only look at households who refinance from similar length contract.



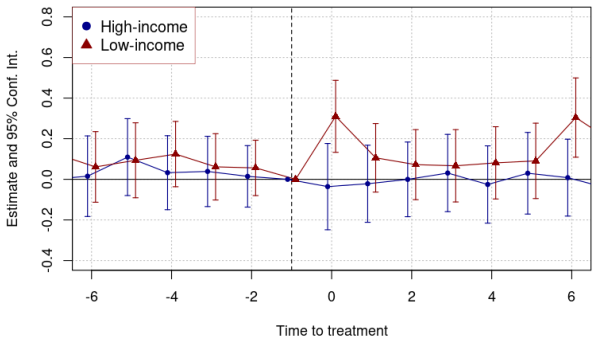
(a) Non-housing spending - high savings



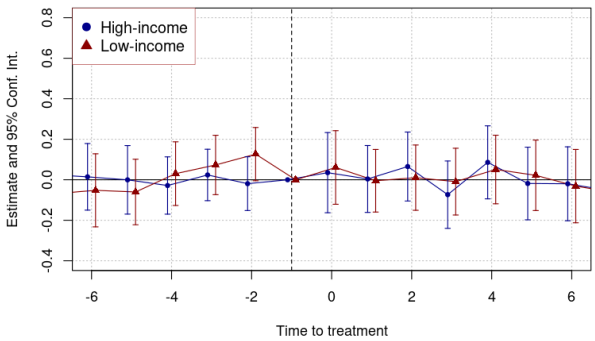
(b) Non-housing spending - low savings



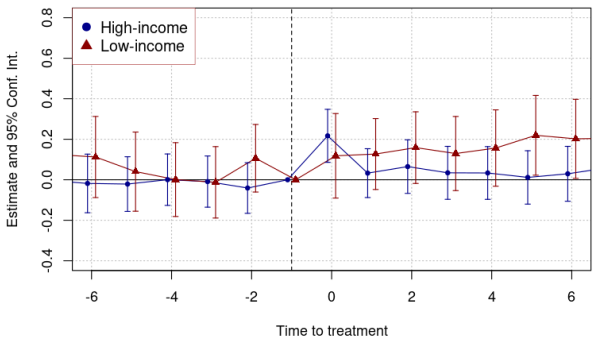
(c) Saving balances - high savings



(d) Saving balances - low savings



(e) Unsecured debt repayments - high savings

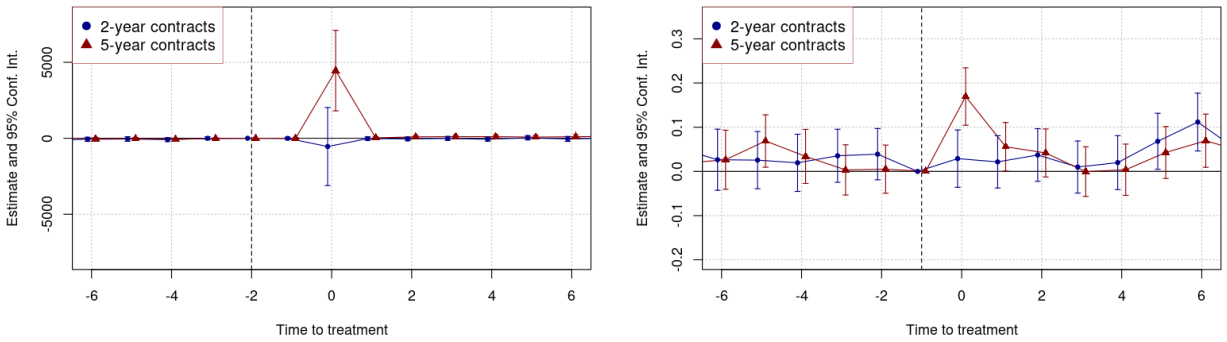


(f) Unsecured debt repayments - low savings

Figure 8: Impact of wealth and savings on households extracting equity

Note: This figure examines the heterogeneous effects of equity extraction on households, segmented by savings levels (high vs. low). Panels (a) and (b) depict changes in non-housing spending; panels (c) and (d) show changes in saving balances; panels (e) and (f) illustrate adjustments in unsecured debt repayments. The layout is consistent with that of Figure 4. The horizontal axis represents time to treatment - i.e the months relative to the refinancing event in the hiking period (denoted as t=0), with negative values indicating months before the event and positive values indicating the months after.

Figure 9a compares the amount of nominal equity extracted by households on different contract lengths during the hiking period versus similar controls before the hiking period. Longer contract fixation length is associated with larger equity extraction in the hiking period. This increased borrowing is reflected in higher spending. Figure 9b shows that only households on a 5-year fix increase their spending upon extracting equity, while we find no effects for households on a 2-year contract. These results suggests further that households on longer term contracts tend to take larger advantage of house price gains between refinancing events, by borrowing more and using it to support consumption during the hiking period.



(a) Nominal equity extraction

(b) Log of total non-housing spending

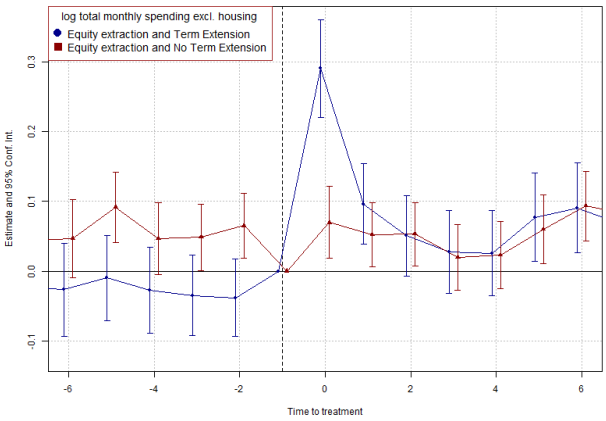
Figure 9: Role of contract fixation length for households extracting equity

Note: This figure examines the link between equity extraction and the choice of contract fixation length. Treated units are households refinancing on two or five year fixes in the hiking period (from a similar contract length) who also extract equity. Controls are households refinancing onto similar contracts as treated and extracting equity, all before December 2021. The layout is consistent with that of Figure 4. The horizontal axis represents time to treatment - i.e the months relative to the refinancing event in the hiking period (denoted as t=0), with negative values indicating months before the event and positive values indicating the months after.

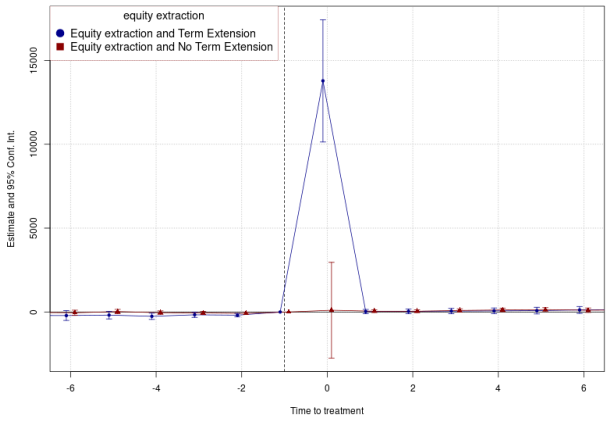
5.3.2 Amplifying equity extraction via the mortgage term extension channel

Table 5 shows that extending terms makes households nearly 45% more likely to extract equity. By borrowing more against the property value, households are increasing their monthly mortgage repayments, over and above what is implied by the higher refinancing rate driven by the policy tightening cycle. To reduce monthly mortgage payments, households in the UK can extend the period over which they repay their loans, thus increasing the overall interest repayments but reducing monthly debt repayments. This strategy can make mortgage payments more manageable.

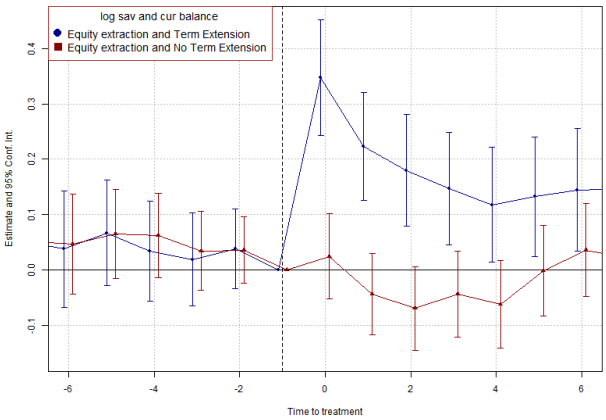
We find that mortgage term extensions amplify equity extraction. Households extracting equity increase spending response on impact by nearly 20% when they also extend terms, compared to around 5% when they do not (Figure 10 (a)). This effect is driven by higher equity withdrawal when mortgage term extensions are in place. In fact, by extending terms, households are able to extract approximately £15,000 more in the hiking period compared to the average equity extractor in the control group. Put differently, we observe that term extensions lead to higher borrowing, which is then channelled into higher spending and saving balances, and more unsecured debt consolidation. These results suggest that mortgage term extensions are used by equity extractors to manage the consequences of higher borrowing on their monthly mortgage payments, making higher debt more sustainable. In essence, households trade the cost of paying more interest over the life time of the loan, for the benefit of smoothing the effects of the shock during the hiking period.



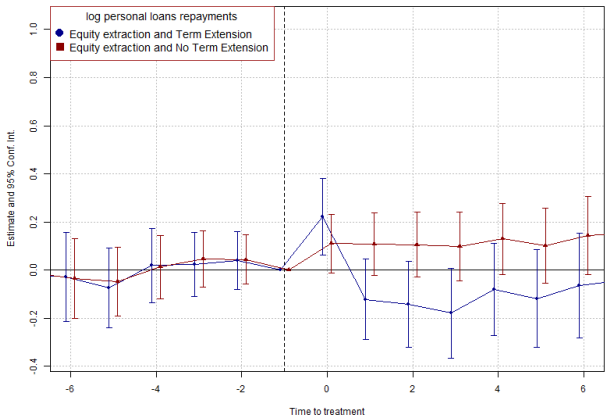
(a) Total non-housing spending for equity extractors



(b) Equity extraction



(c) Saving balances



(d) Unsecured loan repayments

Figure 10: Impact of mortgage term extensions

Note: This figure examines the link between equity extraction and the choice of mortgage term extension. Treated units are households extracting equity during the hiking period, and either extending or not extending mortgage terms. Controls are households refinancing before December 2021 and extracting equity. The layout is consistent with that of Figure 4. The horizontal axis represents time to treatment - i.e the months relative to the refinancing event in the hiking period (denoted as t=0), with negative values indicating months before the event and positive values indicating the months after.

6 Conclusion

This paper provides new insights into the transmission of monetary policy via the mortgage channel, focusing on how UK households adjusted their balance sheets during the monetary tightening cycle that began in 2021. Using a unique dataset combining transaction-level spending and saving data with detailed mortgage information, we examine the heterogeneous responses of households to rising interest rates at refinancing. Our results highlight the crucial role of mortgage loan modifications—specifically equity extraction and term extensions—in shaping how households manage higher borrowing costs and their subsequent spending, saving, and debt repayment behaviours.

We find that households who do not modify their mortgage loans at refinancing experience a significant and persistent decline in spending following higher monthly mortgage payments. Conversely, households who adjust their loans—especially through equity extraction—can offset these effects, maintaining or even increasing discretionary spending and consolidating unsecured debt. Importantly, the ability to extract equity is amplified by nominal house price gains, highlighting the relevance of collateral-driven borrowing. Furthermore, term extensions enable households to smooth cash-flow shocks from higher interest rates, reinforcing their capacity to borrow and spend even in a tightening environment.

These results are directly relevant to recent debates about the implications of monetary policy, not only for understanding its micro-level transmission but also because they amplify the aggregate effects of interest rate changes (Cloyne et al., 2020; Yellen, 2016). While some key channels of heterogeneity, such as differences in income or intertemporal substitution, have been incorporated into macroeconomic models (Greenwald, 2018; Kaplan et al., 2018; Hedlund et al., 2017), others have received less attention. For instance, our findings emphasise the importance of heterogeneity in savings, housing equity and other mortgage flexibility, which significantly influence households' sensitivity to interest rates.

Our analysis reveals that the flexibility provided by mortgage modifications—though beneficial for individual households—may weaken the traditional monetary transmission mechanism for some groups, particularly those with greater access to housing equity or the ability to modify loan terms. This suggests that the aggregate effects of monetary policy may vary depending on the structural features of the mortgage market and the distribution of household balance sheets.

Our analysis focuses on a unique period of persistent monetary tightening, providing new evidence on how households cope with rising interest rates following a phase of strong nominal house price appreciation. Future research could investigate whether mortgage term extensions and equity extractions lead to greater debt persistence over the life cycle and how this impacts households' future financial outcomes. Additionally, our analysis so far leverages only a subset of the rich transaction-level data available, leaving room for further exploration of how households adjust their daily granular spending and financial decisions amidst evolving economic conditions.

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A Appendices

A.1 Data statistics

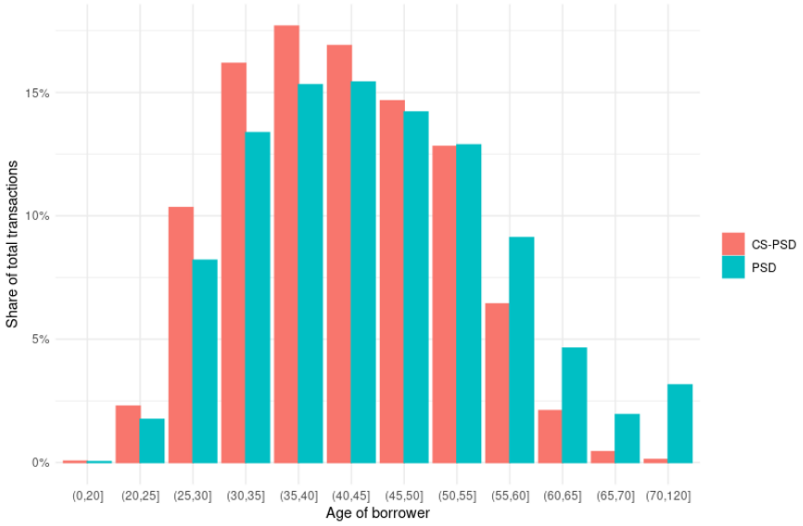


Figure A.1: Macthed PSD-EO data: Borrower age

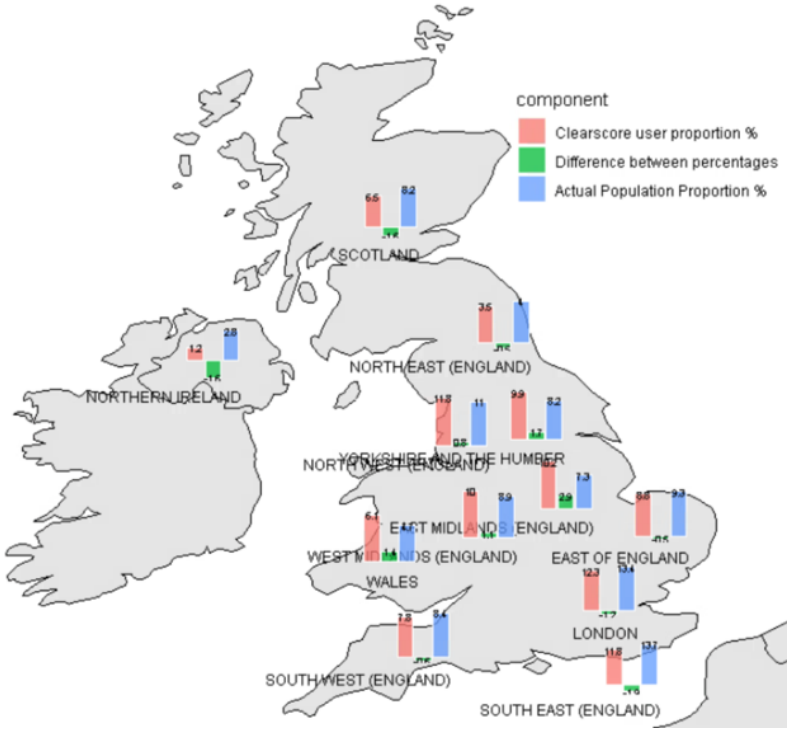


Figure A.2: Macthed PSD-EO data: Regional Distribution

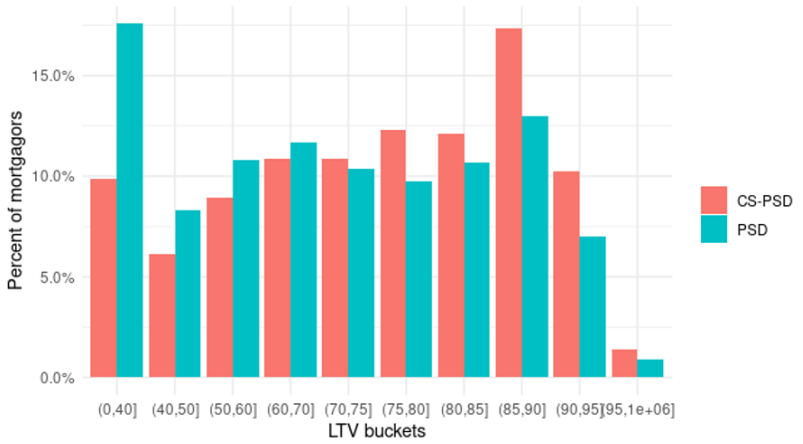


Figure A.3: Macthed PSD-EO data: LTV Distribution

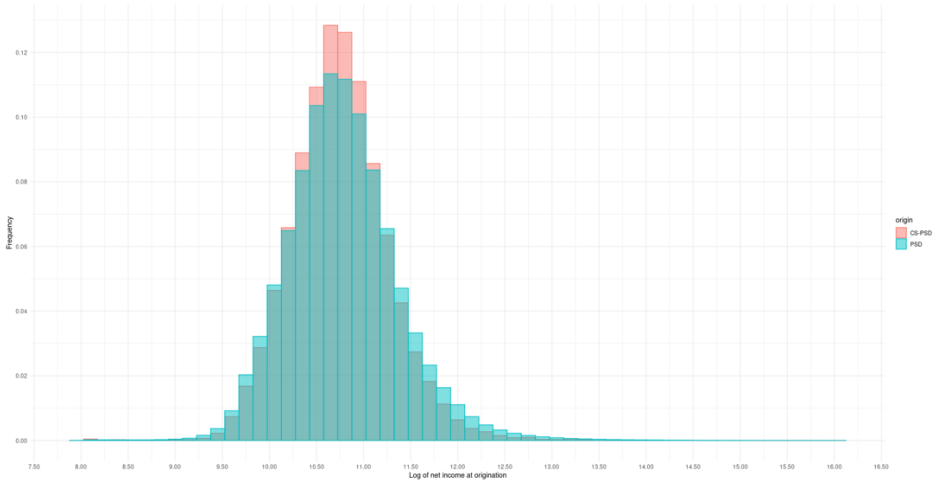


Figure A.4: Macthed PSD-EO data: Income Distribution

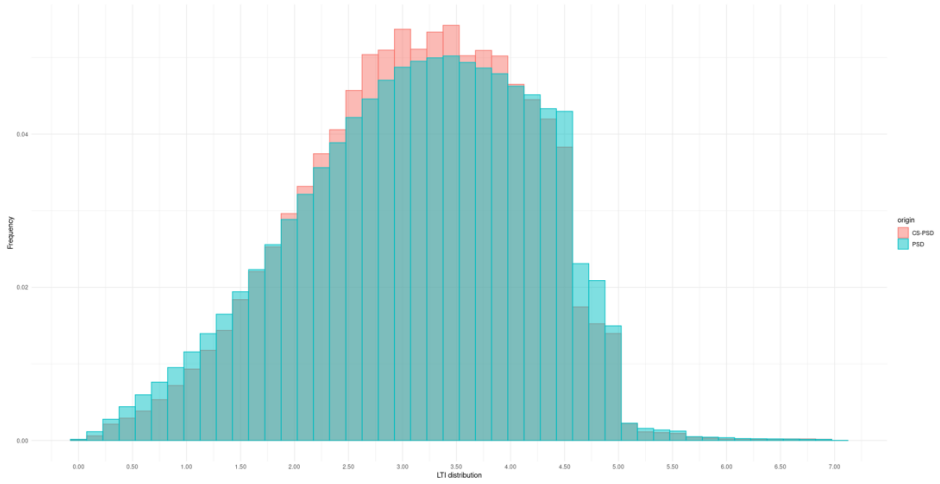


Figure A.5: Macthed PSD-EO data: LTI Distribution

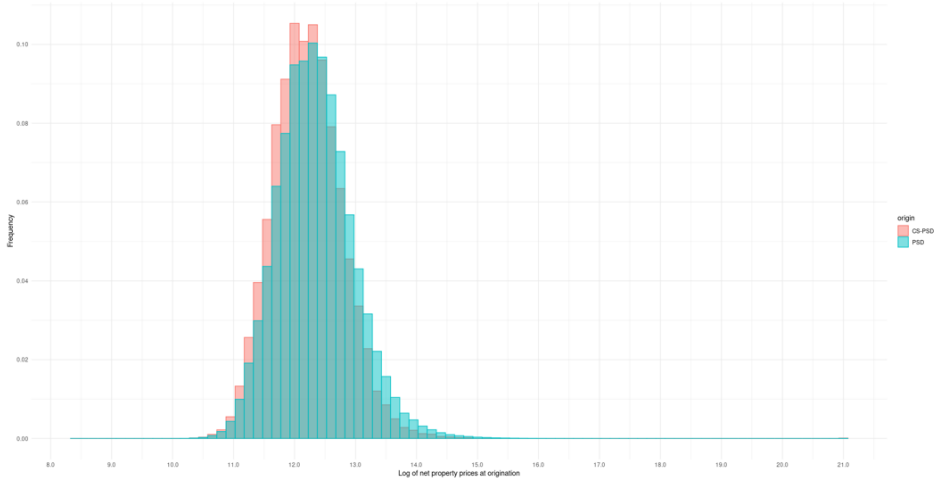


Figure A.6: Macthed PSD-EO data: House Price Distribution

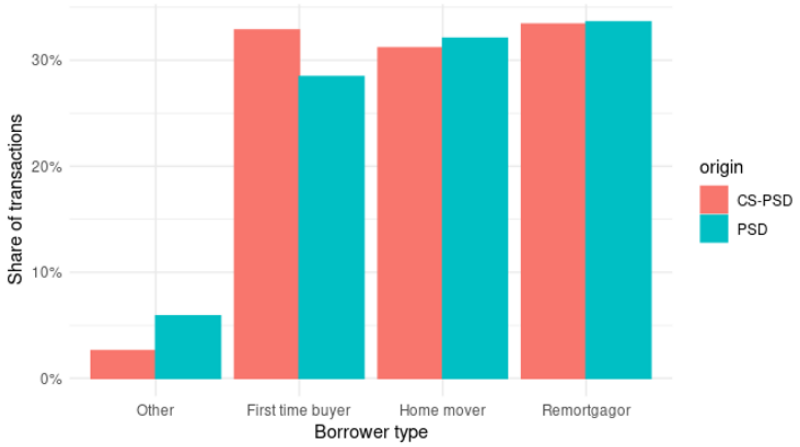


Figure A.7: Macthed PSD-EO data: Borrower type

We also compare savings rates in the matched PSD-EO data with aggregate statistics.

Figure A.8: Savings rates

Figure A.9: (a) Mortgagors vs All Households

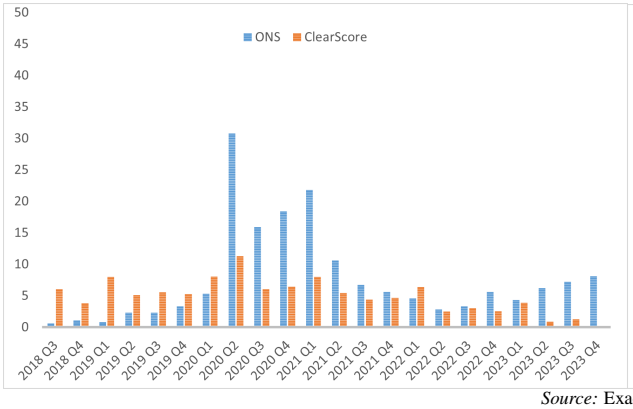
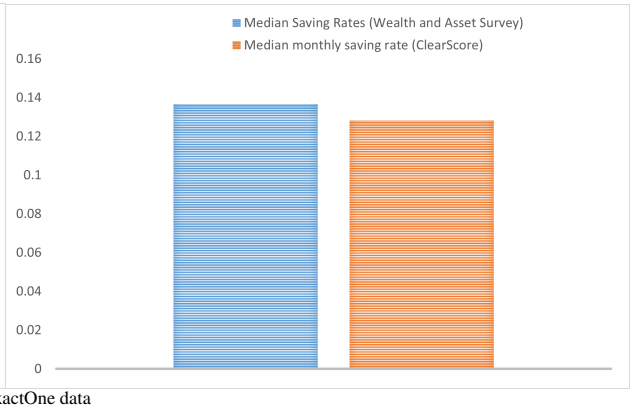


Figure A.10: (b) Mortgagors: PSD-EO vs WAS, Wave 7



Source: ExactOne data

A.2 Spending categories

Our data is very granular in terms of household transactions, with daily entries for every expenditure item that the user purchases or receives into their account. To make the data more manageable, we aggregate purchases items into the following categories: non-durable excl. groceries, groceries, durable, services excl. restaurants, cash expenditure, bank charges, business expenditure, untagged transactions and bank transfers. This split follows OECD expenditure categorisation. Table 7 illustrates the key transaction types under our main consumption categories.

Table 7: Components of main spending categories

Non-durable spending	Fuel, Clothing, Energy, Bills, Children Expenditure, Medical bills, Pet care, Gifts, Books, Accessories, Online store, General Retail
Durable	Home DIY or Repairs, Electronics, Appliences, Jewellery, Furniture, Software, Garden Cycling, Musical Equipment, Art, Vehicle purchase, Lighting
Groceries	Food, Groceries, Household, Supermarket Purchases
Services excl. restaurants	Enjoyment, Council payments, Insurance, TV and Media, Transport, Holidays (incl. hotels and flights), Taxi, Hobbies or Activities, Services and Repairs, Donations, Hairdressing, Health, Course and school fees, Childcare, Other service provides
Restaurants	Takeaway, Dining and Drinking, Lunch or Snacks
Bank charges	Interest Rate and Bank Charges, Account Fees, FX Fees, Penalty Charges, Money Transfer Fees

A.3 Additional data cleaning details

In this part of the Appendix we explain a few additional data-cleaning steps that we implement before the analysis.

ExactOne (EO) data cleaning steps at the user level. First, we want is to ensure that the observed household-level spending and mortgage data accurately represent mortgagors financial behaviour, rather than misclassifying internal account transfers or other recurring large payments. To remove transfers between the same users, we use a simple method:

1. we take transactions which are tagged "No Tag" and "Transfers", for each transaction date;
2. we count how many times we see a "Credit" and "Debit" transaction for the same transaction amount in GBP (£);
3. we then mark pairs of the same GBP, occurring for both credits and debits for the same user in different accounts on the same day;
4. we remove each pair of credit and debit from the respective accounts.

Identifying additional mortgage payments in EO. Whilst transactions in EO are tagged, the tagging is not always complete. We use the EO debit tags "Mortgage payment" and "Mortgage or Rent" as our starting point; however, we think these tags do not capture all mortgages in the dataset. (There are 121,000 users who have a mortgage according to their credit report, but we cannot find a mortgage in their transactions. Additionally, 45,000 users have less than 10 mortgage transactions in the whole period.)

To address this gap, we implement a method to reclassify series of payments that we are confident are mortgages for mortgagors identified by EO. In the UK, the average homebuyer spends 20% of their income on mortgage payments.[11]

[11] See Table 38 from the Office of National Statistics

As an example, in December 2023, purchasing a property for £286,000 at a rate of 5.05% with 75% LTV would give a mortgage payment of £1,262. As housing costs are one of the highest payments made by mortgagors monthly, we start with a dataset of the largest debit transactions for households in the EO data.

To do this, we gather the three largest transactions from users, along with metadata such as the amount, the merchant, and the transaction description. We then group individual mortgage-related debits into series, each represented as a single row in our dataset. Each series is characterized by the following features: Modal/Average/Median amount, Standard deviation/coefficient of variation, Merchant, associated Bank code, Transaction description, Time of month paid (beginning, middle, end), Round ratio (i.e., the proportion of "round" payments such as £15.00 to payments with pence, such as £15.55), Current purpose tag, Distinct months paid, and Longest length of continuous monthly payments. Using these features, we divide the dataset into three subsets for classification:

1. Training set, which includes:
    - series explicitly tagged as mortgage payments (e.g., descriptions containing "mortgage" or "mtg");
    - series associated with merchants known to be mortgage providers;
    - users identified as non-mortgagors in their credit files.
2. Test set used to validate the classification model;
3. Unclassified set, which includes series with unclear tags (e.g., "No Tag") that may represent mortgage payments.

We train a random forest model with 300 trees and a maximum depth of 10, using the training set, which consists of 450,000 non-mortgage and 150,000 mortgage series. The top features that predict our payments are: whether the merchant is a known mortgage lender, the round ratio, and the length of the payment series. Model performance is strong, with accuracy, precision, and recall of 96%, 82%, and 86%, respectively.

Finally, we use the trained model to classify the unclassified series, adding approximately 80,000 series to our original set of mortgage payments. This brings the total number of identified mortgage series in the EO dataset to around 220,000.

Matching EO with administrative mortgage data (PSD). The set of identified mortgages provides approximately 8 million mortgage payments across 220,000 users. To link these payments to the administrative PSD data, we first group EO payments into series by user and reporting period. Mortgages in the PSD are reported semi-annually, so we assume that users make consistent monthly mortgage payments within each six-month reporting period. For each period, we prioritise the series with the greatest number of distinct monthly payments.

To perform the matching, we join EO and PSD mortgage data using postcode area and user birth year and month. Each EO loan typically links to an average of 5 potential PSD loans. To identify the best match for each user, we use a scoring formula based on multiple factors:

- number of reporting periods the match is seen;
- relative error between reported PSD mortgage payment and payment made in EO;
- whether the merchant in ExactOne matches the Lender in the PSD.

For example, a match observed across five reporting periods with no relative error and a matching merchant and lender is assigned a high confidence score. Conversely, mismatches may arise due to various issues, such as misclassified mortgage tags in EO (e.g., loans or rent mistaken as mortgage payments), buy-to-let properties, or discrepancies in postcodes or dates of birth. We successfully match 200,000 users to loans in the PSD, with 52% of these matches involving merchants that align between the two datasets. As expected, matches with aligned merchants exhibit smaller payment differences, validating the robustness of the matching process. Matches where the merchant does not align are not necessarily incorrect, because some lenders operate under different trading names or the original merchant may be obscured in some transaction descriptions.

A.4 Additional results

This section presents supplementary results that complement the findings discussed in the main text. While the core analysis is contained in the primary sections of the paper, references to specific parts of this appendix are made where additional detail supports the interpretation of key results. The first two parts of this section provide extended analysis related to topics discussed in Section 4, focusing on aggregate trends and broader macroeconomic dynamics. The remaining parts delve deeper into the mechanisms explored in Section 5, offering further evidence on household responses, borrowing behaviour, and loan adjustments during refinancing.

A.4.1 Comparing household responses early and late in the hiking cycle

The Permanent Income Hypothesis (PIH) suggests that forward-looking households should adjust consumption when they learn about future rate increases, not only when they refinance. In contrast, our findings thus far indicate that spending responses are concentrated around the refinancing date itself, rather than being spread over the hiking cycle. To explore this further, we compare refinancing households early and late in the hiking cycle, focusing on borrowers who do not undertake any loan modifications, consistent with the analysis in Section 4.

Figure A.11 divides households into two groups: those refinancing early in the hiking cycle (2022) and those refinancing later (2023), when policy rates reached their peak of 5.25%.[12] As expected, refinancing later in the cycle is associated with a larger increase in monthly mortgage payments due to higher prevailing interest rates. However, the magnitude of the spending response is strikingly similar between the two groups, both on impact and in the following months.

This similarity in consumption adjustment, despite differences in the size of the refinancing shock, suggests that households respond primarily at the refinancing date, rather than in anticipation of future rate increases. In other words, late-treated householdswho had more time to adjust their balance sheetsdo not seem to have smoothed consumption ahead of refinancing. This behaviour contradicts the PIH, indicating that households in our sample react more to immediate cash-flow constraints triggered by refinancing than to forward-looking interest rate expectations.

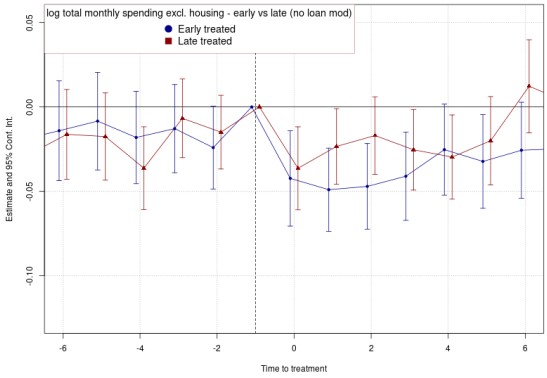
A.4.2 Impact of removing overpayments

We show in Figure A.12 the impact of removing overpayments on spending and saving balances. While the average spending effect increases marginally, saving balances become statistically insignificant. This suggests two findings. First, some households are actively using their balances to make overpayments at the refinancing date in the hiking

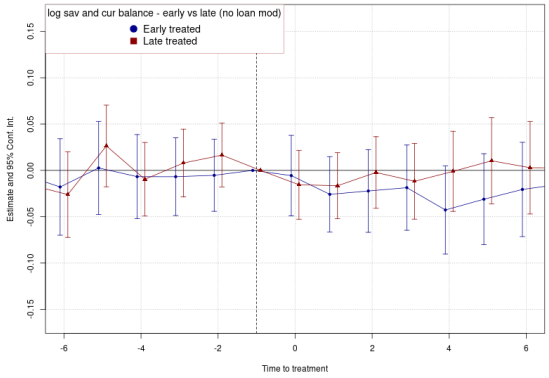
[12] The results remain robust to alternative definitions of early versus late refinancing, such as using March 2023 as the cut-off date.

Figure A.11: The sensitivity of household behaviour to the timing of refinancing

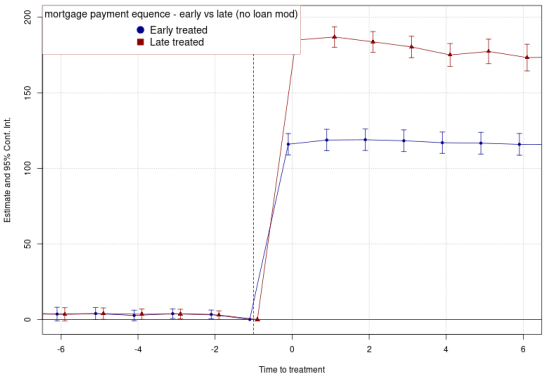
(a) Total non-hous spending



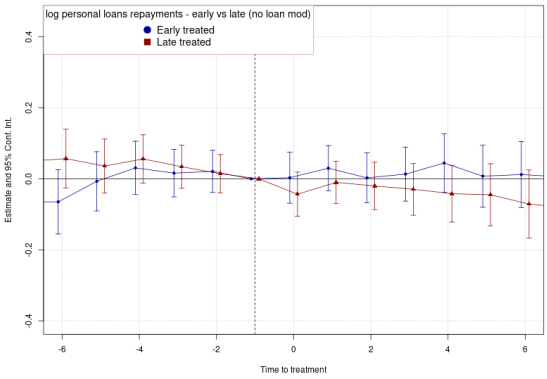
(b) Total saving balances



(c) Monthly mortgage payment



(d) Unsecured loan repayments



period, to a larger extent than controls refinancing before. Second, the positive spending effect remains, which suggests that loan modifications such as equity withdrawals and term extensions are exclusively important for supporting expenditure in the hiking period.

A.4.3 Impact of equity extraction on consumption smoothing and debt consolidation

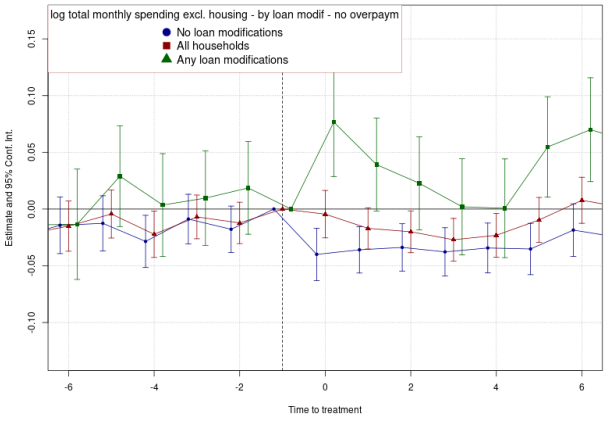
This subsection provides additional results on the role of equity extraction during the hiking period, complementing the main text analysis in Section 4 and Section 5. We examine how equity extraction affects household balance sheets by comparing spending, saving balances, and debt repayments between equity extractors and non-extractors.

As shown in Figure A.13, equity extraction is associated with a 10% increase in spending on impact compared to similar control households refinancing before the hiking cycle. This spending response coincides with increases in saving balances and unsecured debt repayments, suggesting that equity extraction facilitates both consumption smoothing and balance sheet consolidation. By withdrawing home equity, households manage to offset the effects of rising mortgage payments while rebuilding financial buffers and reducing high-cost debt.

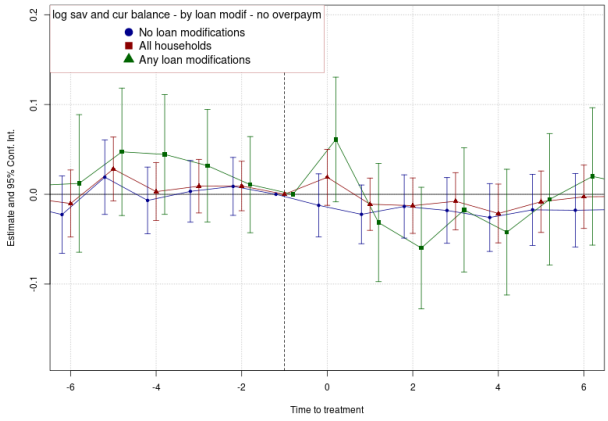
Despite the positive effects of equity extraction on households, they are short-lived and vanish soon after refinanc-

Figure A.12: Average impact of loan modifications, excluding overpayments

(a) Total non-hous spending



(b) Total saving balances



ing. To investigate this, we dig deeper into the more granular spending categories to examine how households have utilised equity extraction. We find, as shown in Figure A.14 in Appendix, that equity extractors adjusts only two dimensions of spending: non-durable and bank transfers, with the latter dominating the response in terms of magnitude. Bank transfers are indicative of investments, either in savings accounts or housing investments, such as payments for building work or home improvements. This suggests that households extract equity either to cover expenses for very specific reasons, or to utilise for daily non-essential spending included in non-durable goods (since cash, groceries, and other services remain unchanged). This is suggestive of consumption smoothing. While households extract equity for investment purposes, they also do it to finance non-essential but not durable expenditure, that would otherwise may be cut. In contrast, households not extracting equity reduce spending across all categories, consistent with results from Figure 5.

A.4.4 The role of inflation in aggregate and across households with and without loan modifications

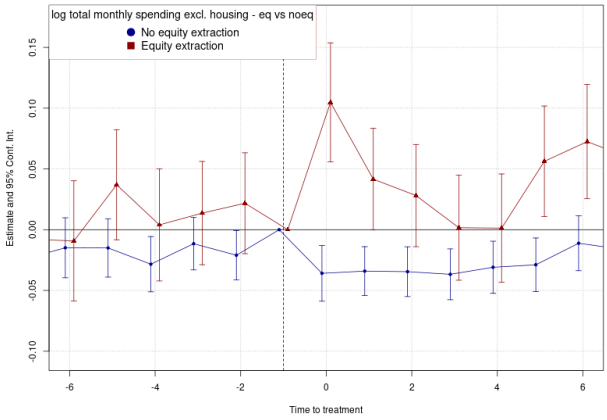
This subsection provides additional analysis exploring whether inflation contributed to the observed spending increases in aggregate and across loan modifications, complementing Figure 6 in Section 4. Figure A.15 shows that our nominal results Figure 6 hold in real terms as well. More specifically, households undertaking at least one loan modification still increase spending in real terms as well as unsecured debt repayment, compared to controls. In contrast households without loan modifications cut real spending, relative to controls, suggesting a desire to reduce balance sheets over and above the impact on inflation. These results show that higher mortgage repayments, as a result of the hiking period, can have real consequences on households' behaviour. Similarly, aggregate responses also remain consistent with those in Figure 6.

A.4.5 The role of inflation on equity extraction

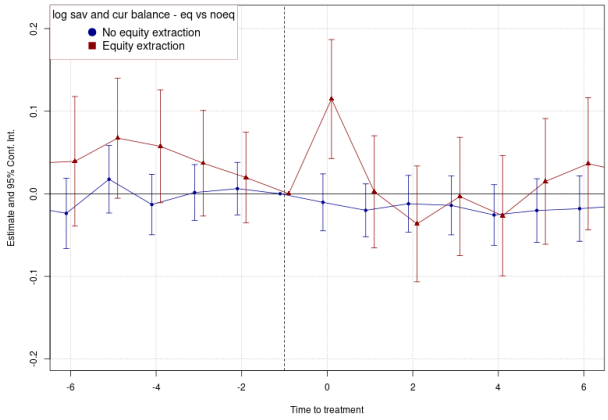
This subsection provides additional analysis exploring whether inflation contributed to the observed spending increases among equity extractors during the hiking period, complementing the main text discussion in Section 4. Given that

Figure A.13: Impact of equity extraction

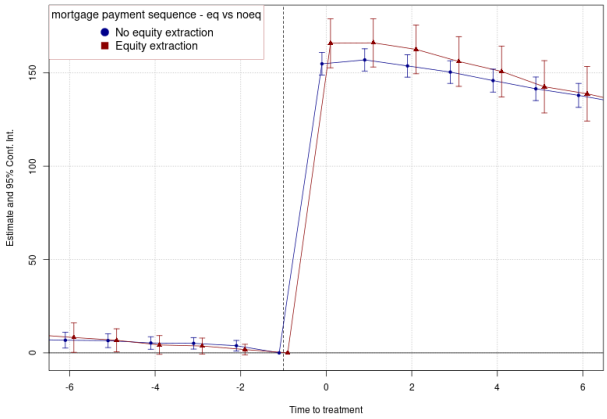
(a) Total non-hous spending



(b) Total saving balances



(c) Monthly mortgage payment



(d) Usecured loan repayments

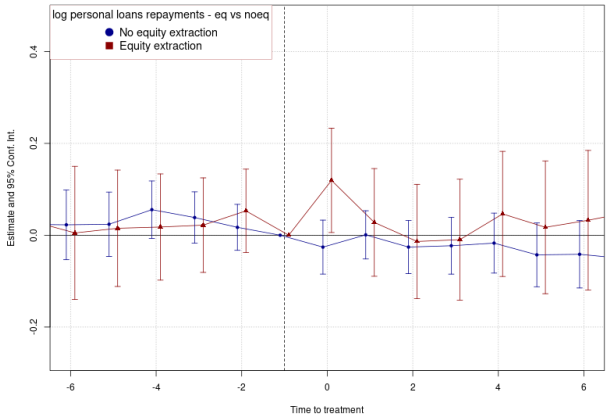
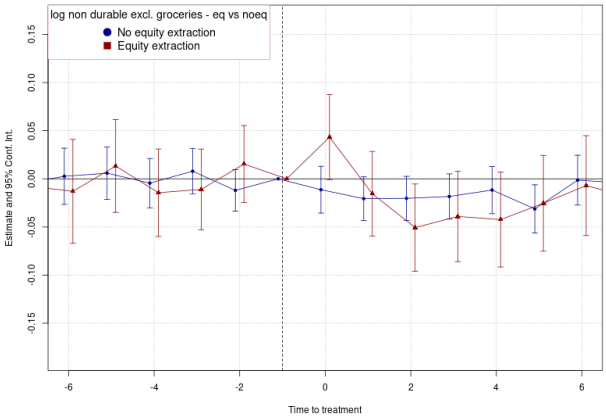
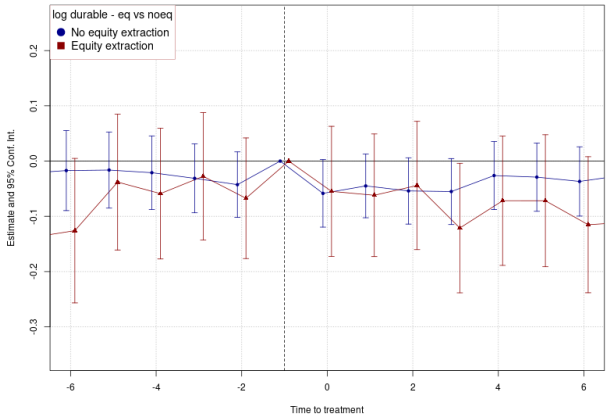


Figure A.14: Impact of equity extraction on granular spending categories

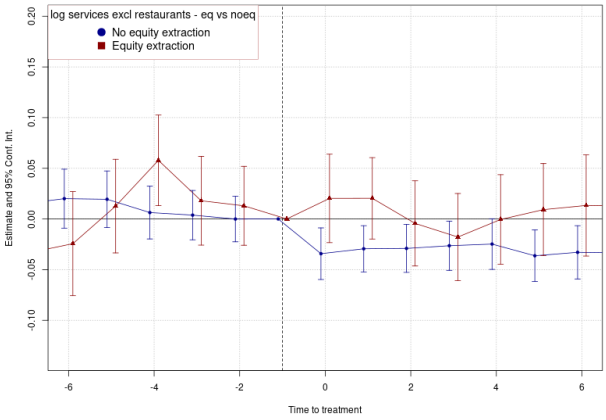
(a) Non-durable excl. groceries



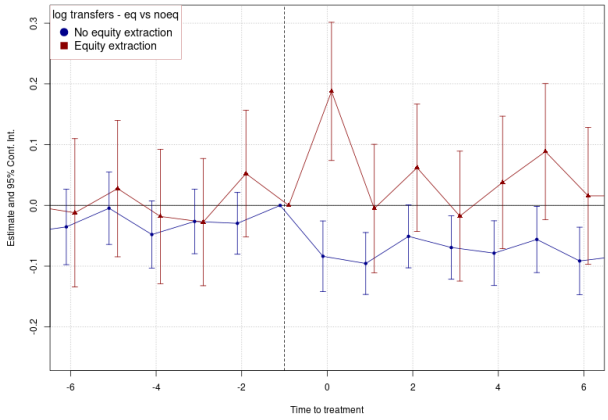
(b) Durable



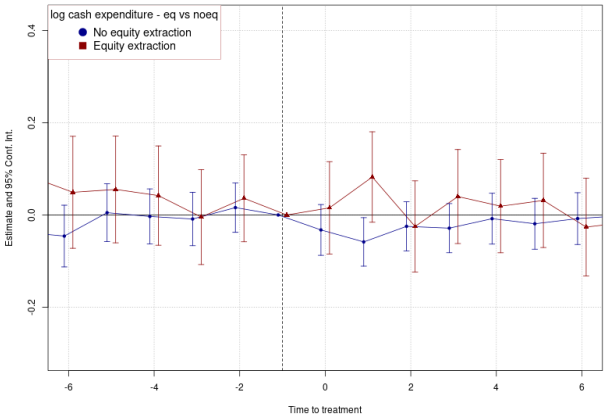
(c) Services excl. restaurants



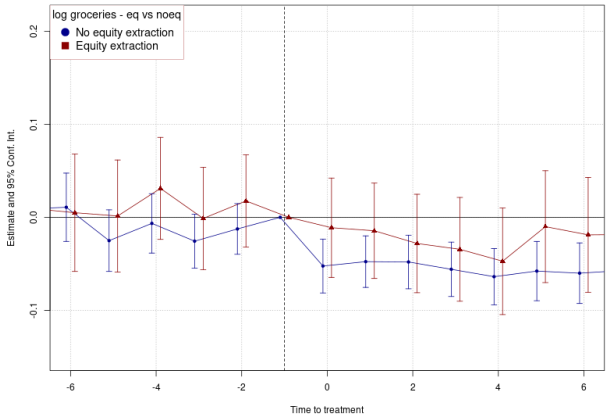
(d) Bank transfers

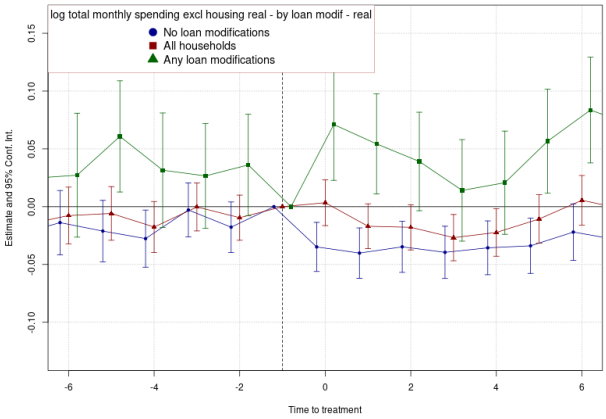


(e) Cash

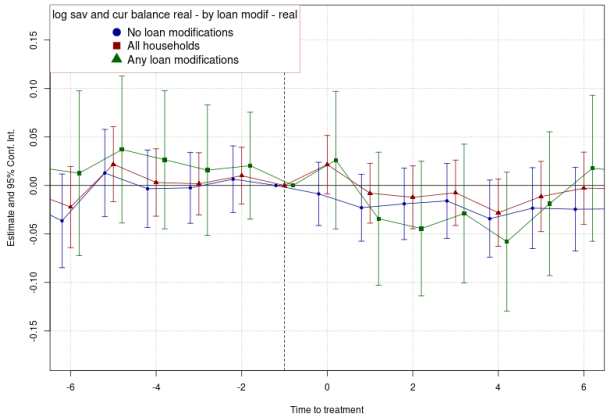


(f) Groceries

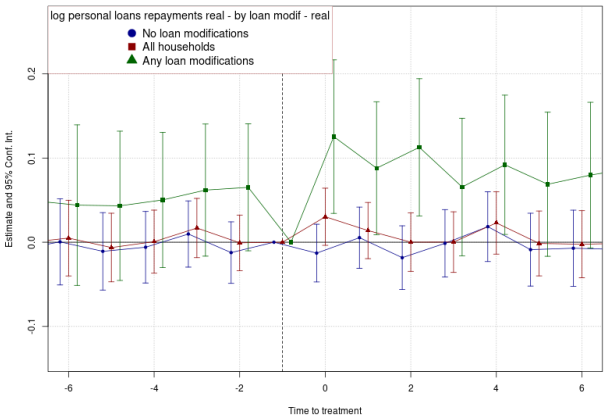




(a) Real total non-hous spending



(b) Real total saving balances



(c) Real unsecured loan repayments

Figure A.15: Impact of mortgage loan adjustments in real terms

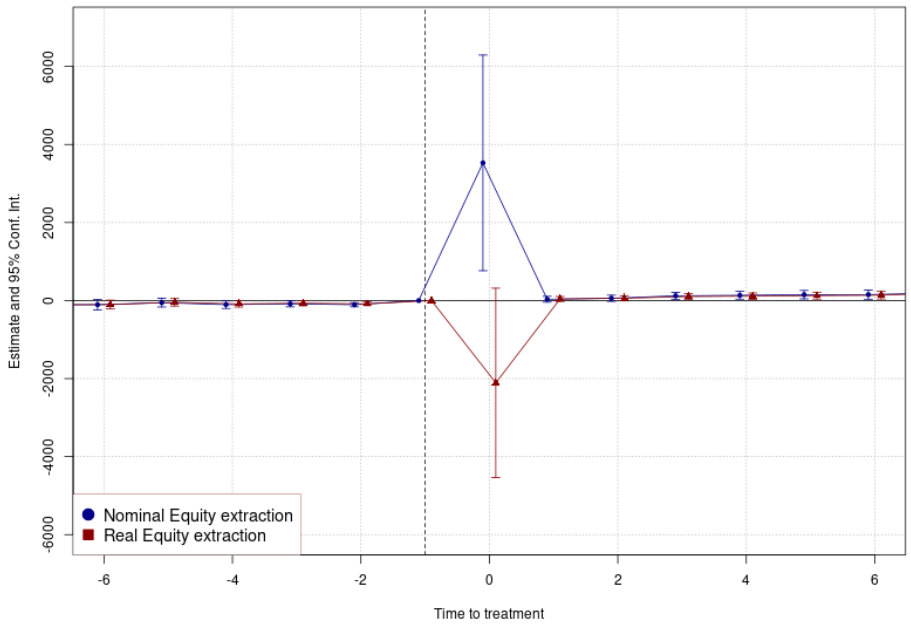
Note: This figure shows the average impact of loan adjustments on key financial outcomes in real terms. The figure compares three groups of households: those with no loan modifications, those with any loan modifications, and the overall sample. The horizontal axis represents time to treatment - i.e the months relative to the refinancing event in the hiking period (denoted as t=0), with negative values indicating months before the event and positive values indicating the months after.

average UK inflation surpassed 9% in 2022, households may have extracted more equity to offset the rising cost of living.

Figure A.16 compares equity extraction amounts in nominal and real terms for households refinancing during the hiking period versus those refinancing earlier. While nominal equity withdrawals were higher among households refinancing in the hiking period, this difference disappears when adjusted for inflation. This suggests that households likely extracted more equity in response to higher living costs.

However, the specific goods and services funded by equity extraction may have experienced inflation rates above the average Consumer Price Index (CPI) measure we use to deflate nominal values. For example, if equity extractors primarily financed housing-related investments, such as home improvements or renovations, they faced substantially higher price increases. Construction-related expenditures in the UK experienced nearly 25% annual inflation in 2022, far exceeding the average inflation rate of consumer goods.[13]

Figure A.16: Equity extraction in the hiking period



A.4.6 The role of interest rate exposure

An important consideration is how households responses to refinancing vary with their exposure to rising interest rates. While the main text establishes that higher interest rates reduce the likelihood of extracting equity, it remains relevant to explore whether households who extract equity despite facing higher rates adjust differently.

Figure A.17 examines this by splitting treated households extracting equity based on their interest rate exposure at refinancing. We account for changes in household circumstances, including income and loan-to-value (LTV) adjustments, by controlling for these factors through individual fixed effects in Equation 1. This allows us to isolate the

[13] See data from the Office of National Statistics.

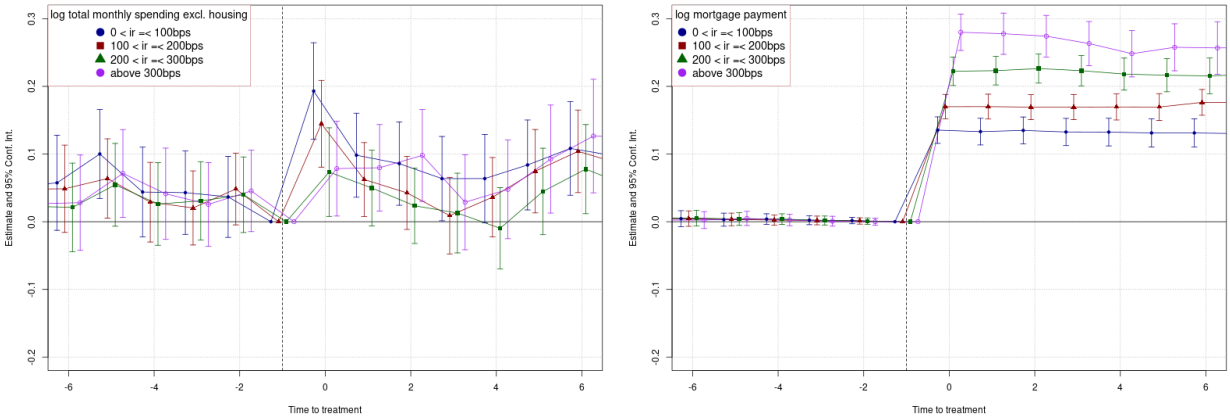
remaining variation in interest rates driven by the hiking period itself.

We show that interest rate exposure generates heterogenous outcomes for spending and mortgage payments. Equity extractors refinancing at a rate that is only up to 100bps higher than previously, change their non-housing spending by 19%. This response drops to 14% if the interest rate differential is between 100-200bps, and to 7% if the differential exceeds 200bps. This suggests a non-linear sensitivity to changes in the refinancing rate, with the largest responses above 200bps. These step changes are also visible for monthly mortgage payments, albeit they are linear. Every additional 100bps adds on average an additional 4-5pp burden to monthly mortgage payments.

Figure A.17: Impact of changes in interest rates since last refinancing event on equity extraction

(a) Total non-housing spending

(b) Changes in mortgage payments

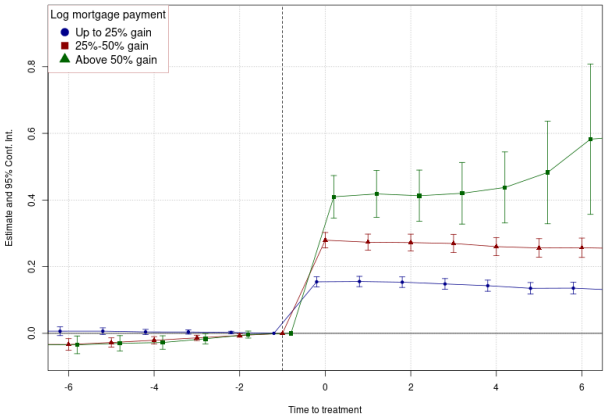


A.4.7 Impact of house price appreciation on spending categories

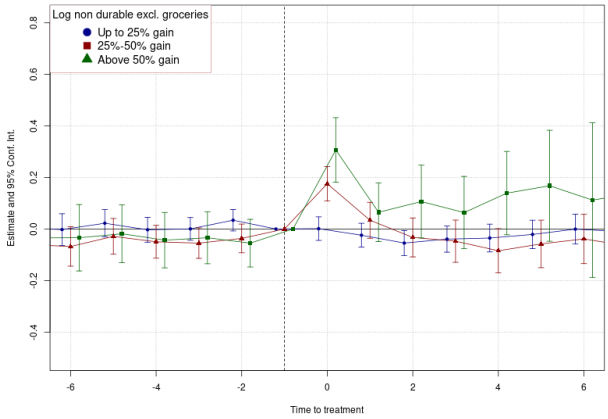
This part of the Appendix examines how spending patterns vary with different levels of house price appreciation between refinancing events. Figure 7 breaks down spending into key categories, highlighting that the positive consumption response is concentrated among households experiencing nominal house price gains above 25%. These households show significant increases in non-durable goods, durable goods, and cash withdrawals, suggesting both investment-related spending and consumption smoothing. In contrast, households with property price gains between 0% and 25% show muted spending responses, using equity extraction primarily for debt consolidation rather than consumption.

Figure A.18: Average responses to the hiking period for households without loan modifications

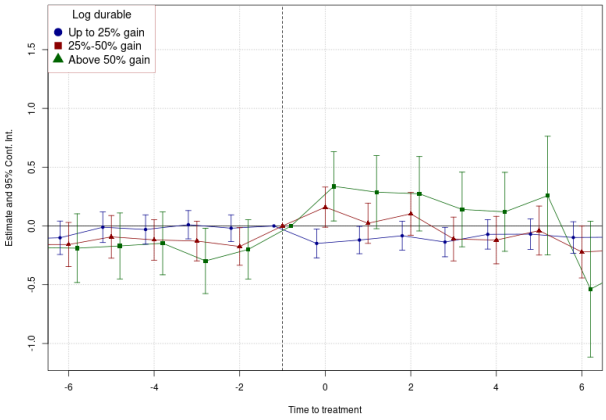
(a) Monthly mortgage payment



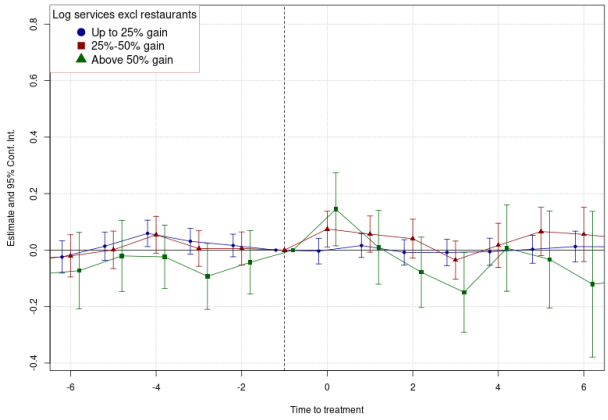
(b) Non-durable excl. groceries



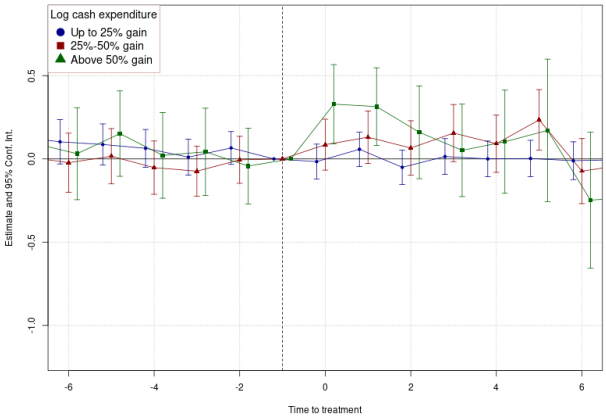
(c) Durable



(d) Services excl. restaurants



(e) Cash



(f) Unsecured loan repayments