Interest Rate Pass-Through With Adjustable Rate Mortgages*

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Abstract

Adjustable-rate mortgages (ARMs) transmit monetary policy less directly than commonly assumed. Exploiting variation in ARM rate reset timing in Portugal—where over 90% of mortgages are indexed to Euribor—during the European Central Bank's 2022–2023 tightening cycle, we show sizable household responses. Following resets, mortgage renegotiations rise by 10 percentage points, transfers to new banks by 4, partial prepayments by 5, and full prepayments by 3, offsetting roughly 17% of the payment increase implied by policy rates. These adjustments occur immediately after rate resets, consistent with selective inattention, and are more pronounced among younger, more educated, and higher-balance borrowers. Supply-side factors amplify these effects: competition intensifies as rates rise, with households at more flexible banks or in areas with greater broker presence exhibiting higher switching and prepayment activity. Our findings show that even in ARM-dominated mortgage markets, borrower behavior, market frictions, and sticky deposit rates jointly shape monetary policy pass-through.

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1 Introduction

Mortgage credit is one of the largest, and most interest rate-sensitive, components of household balance sheets, making it a primary channel through which monetary policy affects consumption and housing demand. In markets dominated by fixed-rate mortgages, monetary policy pass-through is both sluggish and asymmetric: when policy rates rise, borrowers keep below-market rates contracts and postpone moving or trading up (Fonseca and Liu (2024)); when rates fall, refinancing is slow and incomplete, muting the expansionary effects of easing (e.g., Di Maggio, Kermani, Keys, Piskorski, Ramcharan, Seru, and Yao (2017); Beraja, Fuster, Hurst, and Vavra (2019); Zhang (2022); Berger, Milbradt, Tourre, and Vavra (2024)). In contrast, adjustable rate mortgages (ARMs) are often seen as avoiding this asymmetry, since contractual rates reset automatically to market rates over the lifetime of the loan, implying a faster and more symmetric pass-through of policy changes to household cash flows (Garriga, Kydland, and Šustek (2017)).

A critical but rarely tested assumption behind the conventional view is that mortgage terms remain fixed when rates change, so that interest rate movements pass through one-for-one to mortgage payments. In practice, however, mortgage terms may adjust through borrower- or lender-initiated actions, making pass-through incomplete or state contingent even in ARM-dominated markets. Direct evidence on such actions is limited. Existing work studies refinancing and inattention under fixed-rate mortgages (e.g., Gross and Souleles (2002); Campbell and Cocco (2003); Keys, Pope, and Pope (2016); Fuster, Plosser, Schnabl, and Vickery (2019)), the impact of switching costs and bank competition (Woodward and Hall (2012); Allen, Clark, Houde, Li, and Trubnikova (2024); Agarwal, Grigsby, Hortaçsu, Matvos, Seru, and Yao (2024)), and the sluggish adjustment of deposit rates, which shapes banks' funding costs (Drechsler,

Savov, and Schnabl (2017); Bonfim and Queiró (2024)). To the best of our knowledge, this is the one of the first papers to examine how ARM borrowers respond to large increases in inflation- and policy-driven interest rates.[1]

We exploit the European Central Bank's (ECB) unprecedented tightening cycle between July of 2022 and September of 2023, during which the 12-month Euribor rose from -0.5% to over 4%. We focus on Portugal, which offers an unusually clean setting for three main reasons. First, ARMs make up over 92% of outstanding mortgage contracts (as of July 2022), and approximately one-quarter of these mortgages reset exactly once per year, creating a staggered, quasi-experimental timing of mortgage payment shocks.[2] We focus on contracts indexed to the 12-month Euribor, which reset annually, to isolate borrower responses to individual rate shocks and avoid overlapping event windows; the effects materialize more rapidly when reset intervals are shorter. Second, deposit-rate pass-through was muted during this period (Bonfim and Queiró (2024)), widening the gap between mortgage rates and returns on liquid savings and amplifying incentives to prepay. Third, mortgage contractual rates—the spread over the Euribor reference rate—are individually negotiated as in the United States. Borrowers can renegotiate with their current bank or switch to another, but they face significant frictions in doing so.

Using the universe of loan-level administrative data linked to contract amendments, bank transfers, prepayment flows, and short-term credit usage, we show that rate resets during the ECB's 2022–2023 tightening cycle triggered sharp changes to mortgage terms and balances. In the six months after a reset, the monthly probability

[1] In contemporaneous work, Elias, Gillitzer, Kaplan, La Cava, and Prasad (2025) look at the Australian context and find that ARM borrowers repay part of their mortgages when mortgages are "liquid", in the sense that they include the possibility of redrawing these early payments.

[2] We refer to mortgages with rates that reset periodically over their lifetime as adjustable rate mortgages (ARMs). In Portugal, unlike in the United States, ARMs do not include an initial fixed-rate period distinct from later reset periods. Instead, they are indexed to the 3-month, 6-month, or 12-month Euribor.

of mortgage renegotiation rose by 0.74 percentage points, switching to a new lender (i.e., transfers) by 0.26, partial prepayments by 0.36, and full prepayments by 0.14. By December 2023, these effects cumulated to 10.0 percentage points for renegotiations, 3.8 for transfers, 4.8 for partial prepayments, and 2.5 for full prepayments. This implies that borrowers whose mortgage rate reset during the tightening cycle were 19.8 percentage points more likely to respond than borrowers whose rate did not reset in the same calendar month-year. Most responses occur immediately after resets, consistent with rational or selective inattention (as in de Silva and Mei (2025) on durable purchases), although a subset of more financially sophisticated borrowers act in advance.

We find that adjustments occur across multiple margins. Transfer to other banks delivers sizable and immediate spread reductions of roughly 65 basis points and facilitate changes in contract terms, such as switching into fixed- or mixed-rate mortgages or lowering loan-to-value ratios through home revaluation.[3] Renegotiation yields smaller spread improvements of roughly 27 basis points but is more accessible to liquidity-constrained borrowers. Partial and full prepayments rise significantly, consistent with muted deposit-rate pass-through that lowers the opportunity cost of drawing down liquid savings. Beyond mortgages, overdraft usage increases sharply, and authorized credit limits expand faster than actual credit card spending, indicating greater reliance on high-cost credit to smooth consumption and build precautionary liquidity buffers.

The effects on mortgage renegotiation, transfer, and partial prepayment are largely driven by supply-side factors, namely lenders. We split households based on the behavior of their mortgage lenders toward geographically distant borrowers and find

[3]Mixed-rate mortgages in Portugal feature an initial fixed-rate period—typically 3, 5, or 10 years—followed by an adjustable rate for the remaining term of the loan.

that this variation helps explain the magnitude of the estimated effects. Borrowers of a bank are more than three times as likely to renegotiate when that bank tends to renegotiate in other regions. Likewise, borrowers whose banks exhibit high transfer activity in other regions are significantly more likely to transfer their mortgages to another bank. Mortgage brokers also contribute: greater local broker presence makes borrowers more likely to transfer their mortgages to another bank. Taken together, the evidence suggests that interest rate increases intensify bank competition in the mortgage market, limiting the pass-through of policy rates to mortgage payments.

Borrower heterogeneity also helps explain the magnitude of the estimated effects. Renegotiations and transfers are more prevalent among younger and more educated households, as well as among those with larger mortgage balances or longer maturities. Consistent with expectations, households with high debt-service-to-income (DSTI) ratios are more likely to renegotiate and less likely to deleverage.

Back-of-the-envelope calculations suggest that, in aggregate, contract adjustments and mortgage balance changes absorbed about 17% of the increase in scheduled mortgage payments during the tightening cycle that would have occurred under full monetary policy pass-through. In particular, transfers and renegotiations offset about 3% of the increase implied by policy rates. These findings show that even in an ARM-dominated market, monetary policy transmission is shaped not only by contract design but also by borrower behavior, financial constraints, and market structure.

Our findings contribute to three strands of literature. First, we add to work on the heterogeneous transmission of monetary policy through household debt portfolios by showing that, even in an ARM-dominated market, borrower actions play a central role in shaping aggregate pass-through (Garriga et al. (2017); Berger et al. (2024)). This finding relates to existing studies examining how households respond to interest rate shocks. (Abel and Fuster (2021); Berger, Milbradt, Tourre, and Vavra (2021); Berger et al.

(2024); Fonseca and Liu (2024)). Abel and Fuster (2021) examine program-driven refinancing under HARP in the United States in 2009; Berger et al. (2021, 2024) study refinancing frictions and path dependence in fixed-rate markets during easing cycles; and Fonseca and Liu (2024) analyze fixed-rate mortgage lock-in effects on household mobility when interest rates rise. Boutros, Clara, and Kartashova (2025) show that the coexistence of fixed-rate, adjustable-rate, and hybrid contracts in the Canadian market is welfare-enhancing and that the dominant contract type shapes monetary transmission. Closest to our setting, Fuster, Gianinazzi, Hackethal, Schnorpfeil, and Weber (2025) examine the German market, where mortgages typically carry a 5–15 year fixed-rate period. Following the 2022 euro area interest rate increases, they find that borrowers are attentive to rate movements and act preemptively by locking in rates through "forward mortgage" contracts—unlike in Portugal, where we observe that responses cluster after resets.

Second, we extend the literature on mortgage market competition by showing how abrupt reference-rate changes interact with search frictions and switching costs (DeFusco and Paciorek (2017)). These frictions influence whether borrowers renegotiate with their existing bank or transfer to a new one. We document that competition intensifies when interest rates rise, with more flexible banks and greater broker presence amplifying switching and prepayment activity.

Third, we contribute to the growing evidence on sluggish deposit-rate pass-through (Drechsler et al. (2017); Bonfim and Queiró (2024)) and its connection to bank profitability (Altunok, Arslan, and Ongena (2024)). Low deposit betas raise bank profitability by widening the spread between mortgage rates and returns on liquid savings. This wedge, in turn, strengthens households' incentives to deleverage. Consistent with this mechanism, we document substantial increases in partial and full prepayments as well as in mortgage transfers.

Our contribution is to examine borrower-initiated responses to rising mortgage payments in an ARM-dominated market where refinancing is not program-driven but arises organically from predictable mortgage rate resets. In Portugal, these adjustments occur mainly through within-bank renegotiation and partial prepayment, as home equity lines (HELOCs) and cash-out refinancing are rare—consistent with voluntary deleveraging under financial pressure. Rather than transmitting interest rate changes swiftly and automatically to household budgets, we show that households actively renegotiate, switch lenders, or reduce principal, thereby limiting the pass-through of monetary policy. Because these actions are tied to individual reset schedules, they alter both the timing and profile of monetary policy transmission. For policymakers, this implies that the effectiveness of rate hikes depends not only on the prevalence of ARMs but also on competitive dynamics in mortgage and deposit markets and on borrower attention to financial conditions—factors that vary widely across countries and over time.

These results echo Di Maggio et al. (2017), Flodén, Kilström, Sigurdsson, and Vestman (2021), and Ahn, Galaasen, and Maehlum (2024), who document substantial short-run consumption response to changes in mortgage payments, particularly among indebted ARM borrowers. Elias et al. (2025), on the other hand, find a muted response of consumption to increases in interest rates in the Australian context, where the majority of borrowers hold ARMs. In their context, repayments are likely to have played an important role in mitigating the effect of the increase in interest rates. The Portuguese case, however, differs from the U.S. case, where refinancing is typically triggered by rate cuts in fixed-rate markets. In Portugal, households adjust in response to mortgage payment increases, reflecting a state-contingent behavioral pass-through: sharp reactions during tightening periods—particularly at reset dates—and relative inertia in normal periods, consistent with theories of rational or selective inattention

(Cloyne, Ferreira, and Surico (2019)).

2 Data and Identification Strategy

2.1 The Mortgage Market in Portugal

The Portuguese mortgage market is characterized by the overwhelming dominance of adjustable-rate contracts.[4] As of July 2022, ARMs represented 92% of the outstanding stock of mortgages, a share far above the euro-area average. The bulk of contracts are indexed to the 3-, 6- or 12-month Euribor. As of July 2022, loans with 12-month reset frequencies represent 26% of all mortgages in the Portuguese Central Credit Register, while 3-month and 6-month resettable loans account for 29% and 42%, respectively. The 12-month index accounts for the largest share when measured by amounts outstanding, accounting for 40% of all mortgages, compared with 23% for 3-month resettable loans and 30% for 6-month resettable loans. Origination spreads are negotiated bilaterally and averaged about 150 basis points over Euribor in the period preceding the 2022–2023 tightening cycle, creating room for ex-post renegotiation.

Mortgages in Portugal are full-recourse contracts, allowing lenders to pursue borrowers' other assets and future income in the event of default. Contracts typically include clauses permitting renegotiation or transfer to another institution. Prepayment penalties are legally capped at 0.5% of the outstanding balance for adjustable-rate loans and 2% for fixed-rate loans. To foster competition during the recent rate-hike episode, the government suspended early-repayment fees on adjustable-rate mortgages for owner-occupied homes between late-2022 and

[4] As in Portugal, adjustable-rate contracts dominate in Finland, Greece, Ireland, Italy, and Spain. By contrast, in Canada and the U.K., the typical mortgage has an initial fixed rate that later resets, similar to ARMs in the United States.

December 2025, lowering pecuniary switching costs. Life- and fire-insurance coverage are not mandated by law but are routinely required by banks as conditions for mortgage approval.

Since July 2018, the Bank of Portugal has imposed borrower-based restrictions on all new housing loans: (1) a loan-to-value cap of 90% for owner-occupied purchases (lower for secondary homes and investment properties); (2) a debt-service-to-income (DSTI) ratio cap of 50%; and (3) a maximum original maturity reduced from 40 to 30 years by the end of 2022. All loans must amortize through regular principal-and-interest installments; interest-only periods and negative-amortization schedules are prohibited.

Portuguese banks fund a large share of their mortgage books with domestic retail deposits. Bonfim and Queiró (2024) document incomplete pass-through of monetary policy to deposit rates. They estimate a long-run deposit beta of 0.65 using 1997:Q4–2023:Q4 data: a 100 basis point increase in money-market rates raises new household-deposit rates by only 65 basis points after one year, compared with a euro-area average of 0.87.[5] During the 2022–2023 tightening, mortgage rates on ARMs moved one-for-one with Euribor, while deposit remuneration adjusted far more slowly. The widening gap between mortgage and deposit rates increased the opportunity cost of holding large sight balances and likely triggered the wave of partial and full prepayments we document.

These institutional features jointly shape how European Central Bank's (ECB) policy shocks reach Portuguese households. Euribor-indexed contracts ensure mechanical pass-through to scheduled payments, but low switching costs, capped (and at times waived) prepayment penalties, negotiable spreads, and muted deposit remuneration create margins for borrowers to insulate themselves once interest rate resets occur.

[5]Bonfim and Queiró (2024) also report an even lower deposit beta of 0.59 for household deposits.

2.2 Data

Our data come from the Portuguese Central Credit Register, maintained by the Bank of Portugal, which records all loans to households above a reporting threshold of €50. The Credit Register provides granular loan-level information on both loan and borrower characteristics. Because of the low threshold, it captures nearly all credit relationships in Portugal. The data are reported monthly, allowing us to track household credit over time and to distinguish between actual liabilities and potential liabilities from pre-approved bank commitments.

In our main analyses, we focus on adjustable-rate mortgages (ARMs) indexed to the 12-month Euribor, which reset annually, issued for owner-occupied homes.[6] As noted above, ARMs are the dominant mortgage type in Portugal, accounting for about 92% of the stock of all contracts as of July 2022. Their share of the stock of mortgages declined during the tightening cycle—to 88% by December of 2023 and 85% by June of 2024—due to making up 76% of new contracts in July of 2022, but just 17% of new contracts in June of 2023 and 12% in December of 2024.

For each mortgage, we observe the amount outstanding (balance), installment amount, interest rate spread, reset frequency (3-, 6-, or 12-month), maturity, and loan-to-value (LTV) ratio. The data also track households' overall credit positions, including total exposure and the use of consumer credit instruments such as credit cards, overdrafts, and auto loans, as well as loan performance (nonperforming status and arrears). We can identify mortgage actions such as renegotiations, transfers, and partial or full prepayments. Property location is available at the ZIP code level for about 78% of loans. For mortgages issued by banks using internal ratings-based (IRB) models for regulatory capital (the four largest banks among the 34 institutions with

[6] As a robustness check, we analyze mortgages with 6-month reset periods. Despite differences in average borrower and loan characteristics relative to 12-month resets (see Table IA.1 in the Internet Appendix), the results are broadly consistent.

mortgage exposures), we additionally observe bank-estimated probabilities of default. At the borrower level, we observe age, gender, education, employment status, and municipality of residence.

Our final sample consists of 369,308 mortgage loans for owner-occupied properties, totaling 989,525 resets and 10,825,856 loan-month observations in the 2021-2023 period. Table 1 reports descriptive statistics for the variables used in our baseline analysis at reset (12-month Euribor contracts).[7] The typical household holds total credit of €82,450, with a mortgage balance of €76,175 and a monthly installment of €314. The average mortgage carries an interest rate spread of 1.44%, a loan-to-value ratio of 0.61, and a residual maturity of about 30 years. Among mortgage actions, renegotiations and partial prepayments are most common, followed by full prepayments and transfers. The average debtor is 41 years old, 78% are employed, and about 55% have a college degree, compared with only 30% in the Portuguese population in 2023.

2.3 Empirical Specification

We estimate event-study regressions around ARM rate reset dates to track how households adjust their mortgage—renegotiations, transfers across banks, and full or partial prepayments—over a symmetric 12-month window from six months before to six months after the reset.

Our empirical strategy relies on localized event-time regressions that trace dynamic household behavior relative to an omitted baseline event month, similar to the designs in Abel and Fuster (2021) and Berger et al. (2021). These studies show how changes in mortgage payments shape household behavior, whether through policy-induced refinancing under HARP or market-driven rate differentials.

[7] Variable definitions are provided in Table A.1 in the Appendix.

We estimate the following regression equation:

$$Y_{ilmt} = \sum_{t=-6, t\neq -3}^{5} \boldsymbol{\alpha_t} Reset_{ilmt} + \boldsymbol{\gamma} Tightening_{ilm} + \sum_{t=-6, t\neq -3}^{5} \boldsymbol{\beta_t} (Reset_{ilmt} \times Tightening_{ilm})$$
$$+ \boldsymbol{\eta} DebtorCharacteristics_{im} + \boldsymbol{\lambda} LoanCharacteristics_{lm} + \boldsymbol{\zeta} MonthYear_t + \epsilon_{ilmt}, \tag{1}$$

where i indexes households, l mortgages, m the reset month, and t the number of months before or after the reset. Y_{ilmt} is a dummy variable capturing mortgage actions: renegotiation, transfer, partial prepayment, and full prepayment. $Reset_{ilmt}$ are event-time dummies centered on the interest rate reset date ($t = 0$ is the reset month; the figures below generally omit $t = -3$). $Tightening_{ilm}$ is a dummy variable that takes the value of one if the reset occurs during the monetary policy tightening period (July 2022–December 2023), and zero otherwise. The regressions control for debtor characteristics ($DebtorCharacteristics_{im}$), including age, gender, education level, and employment status, and loan characteristics ($LoanCharacteristics_{lm}$), including mortgage balance, residual maturity, and loan-to-value ratio (LTV). Finally, the regressions include calendar-time (month-by-year) fixed effects ($MonthYear_t$) to absorb any unobserved macroeconomic fluctuations. The coefficients on the interaction term $Reset_{ilmt} \times Tightening_{ilm}$, denoted β_t, capture household responses to mortgage rate resets during the tightening period, relative both to the same event month in the pre-tightening period (January 2021–June 2022) and to households whose mortgages did not reset in the same calendar month-year. These coefficients allow us to isolate changes in household responses under a contractionary monetary policy regime.

This approach enables us to examine how households respond to predictable mortgage rate resets and whether their responsiveness is amplified or muted during

periods of monetary tightening. It also isolates anticipatory and reactive behavior before and after rate resets, particularly amid interest rate shocks. Our empirical strategy echoes Abel and Fuster (2021), who identify the causal effect of refinancing opportunities on household debt and spending using HARP eligibility. In contrast, we exploit scheduled mortgage rate resets and compare households both to themselves before the rise in interest rates and to contemporaneous households that do not reset.

We focus on mortgages with 12-month reset frequencies, as more frequent resets weaken the quasi-experimental clarity of a single event by creating overlapping windows; our analysis uses a 12-month event window centered on the reset. With 3- or 6-month ARMs, contract terms may change more often than households can realistically respond, and each adjustment is typically smaller, often falling below behavioral thresholds for action. Flodén et al. (2021) show that with 3-month ARMs, consumption responses arise mainly when borrowers face meaningful changes in disposable income over a predictable horizon, not at every reset. Moreover, households often display rational inattention or inertia in response to small, transient, or non-salient interest rate changes (see Fuster and Willen (2017); Keys et al. (2016)). By contrast, 12-month ARMs produce larger cumulative rate adjustments and more salient mortgage payment changes, making household reactions easier to detect within a defined window and providing a stronger setting for identifying causal responses to rate changes.

3 Interest Rate Shocks and Household Responses

In this section, we examine household responses to interest rate shocks triggered by rising inflation and the ECB's tightening that began in July 2022. Figure 1 plots monthly changes in mortgage contract interest rates (in blue) alongside changes in the volume

of mortgages undergoing three actions (in red): renegotiation (Panel A), transfer to another bank (Panel B), and partial prepayment (Panel C). The figure shows that, in aggregate, a sizable volume of mortgages undergo changes in contract terms and balances during the tightening, with a lag relative to contract rates.

Figure 2 presents the monthly frequency of household responses (Panel A) and their cumulative frequency (Panel B) in the 18 months before and after the tightening that began in July 2022. The red bars show that all mortgage actions became significantly more likely after July 2022. In total, 15.8% of mortgages were renegotiated in the 18 months after July 2022, compared with only 2.3% in the pre-tightening period (a difference of 13.5 percentage points). The corresponding differences are 4.4 percentage points for transfers, 6.7 for partial prepayments, and about 2.8 for full prepayments.

3.1 Monthly and Cumulative Estimates

We show a rich set of household responses to interest rate shocks, shedding light on the micro-foundations of monetary policy transmission. We identify the effects using the staggered reset schedule of 12-month ARMs. We estimate equation (1) to track behavior within a 12-month window centered on each mortgage's reset date. Figure 3 plots the β_t coefficients of the interaction terms $Reset_{ilmt} \times Tightening_{ilm}$. The figure shows that households cope with higher rates by either renegotiating mortgage terms, transferring the mortgage to another bank (i.e., switching lender), or partially and fully prepaying mortgage balances to lower future interest payments.

The probability that a household takes action rises sharply around reset dates during periods of monetary tightening, peaking at the reset and remaining elevated in the following months. In the month after reset, renegotiations increase by 1.7 percentage points (Panel (a)), transfers by 0.4 (Panel (b)), partial prepayments by 0.6

(Panel (c)), and full prepayments by 0.2 (Panel (d)). These effects taper in later months but, given the low baseline frequencies of such actions, represent substantial relative increases. Rate resets thus serve as a powerful determinant of financial decision-making, and the magnitude of the responses highlights the economic importance of household balance-sheet adjustments in shaping monetary policy transmission during tightening cycles. Overall, the probability of taking any mortgage action increases by 3 percentage points (Panel (e)) in the month after reset.

We also find some evidence of preemptive action, discussed in more detail in the next section. As shown in Figure 3, some actions (i.e., renegotiation and partial prepayment) begin to rise before rate resets, but adjustments typically peak afterward and remain elevated, suggesting that households either do not fully anticipate the payment increase or deliberately wait until higher payments are realized. This delayed response indicates that, even in an environment of rising interest rates and broad media coverage of policy changes, household financial decisions are closely tied to the immediate experience of higher repayment obligations. Such behavior is consistent with rational inattention models (e.g., Sims (2003); Mackowiak and Wiederholt (2009)), in which households optimally allocate limited attention to complex financial choices, as well as with the staggered and non-salient structure of ARM resets, which obscure the timing and magnitude of payment changes. Limited salience and perceived complexity (Keys et al. (2016)) can thus delay adjustment and mute the speed of interest rate pass-through despite the mechanical link between ARMs and market rates.

We consider mortgages with 6-month reset periods (i.e., 6-month Euribor) as a robustness check. Figure IA.1 plots the coefficients of the corresponding interaction terms. Although the estimates are less precise, the results remain broadly consistent with those obtained for 12-month resets.

Average Treatment Effect around the Rate Reset To complement the dynamic event-study results, we estimate a specification that groups event time more coarsely to capture average household behavior before and after the rate reset. We partition the window into three mutually exclusive periods: (1) event months –6 to –3 (omitted baseline); (2) event months –2 to –1 ("Immediate pre-reset"); and (3) event months 0 to +5 ("Post-reset"). The regression equation is:

$$\begin{aligned} Y_{ilmt} = {} & \boldsymbol{\alpha_1}\, Immediate\ Pre\text{-}Reset_{ilmt} + \boldsymbol{\alpha_2}\, Post\text{-}Reset_{ilmt} + \boldsymbol{\gamma}\, Tightening_{ilm} \\ & + \boldsymbol{\beta_1}\big(Immediate\ Pre\text{-}Reset_{ilmt} \times Tightening_{ilm}\big) \\ & + \boldsymbol{\beta_2}\big(Post\text{-}Reset_{ilmt} \times Tightening_{ilm}\big) \\ & + \boldsymbol{\eta}\, DebtorCharacteristics_{im} + \boldsymbol{\lambda}\, LoanCharacteristics_{lm} + \boldsymbol{\zeta}\, MonthYear_t + \epsilon_{ilmt}\,. \end{aligned} \tag{2}$$

The interactions coefficients β_1 and β_2 capture how the tightening cycle impacts household responses in the immediate pre-reset and post-reset periods, respectively, relative to the same periods before the tightening period and relative to households that do not reset in the same calendar month-year.

Table 2 reports the estimates. During the tightening cycle, the post-reset interaction effects, $Post\text{-}reset \times Tightening$, are large and statistically significant at the 1% level: the likelihood of renegotiation rises by 0.74 percentage points, transfers by 0.26, partial prepayment by 0.36, and full prepayment by 0.14. In addition, the probability of households taking any action increases by 1.6 percentage points during the tightening period relative to the pre-tightening period. These effects confirm that households actively adjust their mortgages when facing with higher payments.

In the two months preceding resets, we also observe some increases in household responses—particularly in renegotiations and partial prepayments—indicating some

anticipatory behavior. For renegotiations and partial repayments, the interaction term $Immediate\ Pre\text{-}Reset \times Tightening$ are positive and significant at the 1% level. For transfers and full prepayments the pre-reset effects are either negative or statistically insignificant, consistent with an absence of anticipatory behavior in response to rising mortgage rates. In fact, transfers are likely to take more time and therefore we do not observe any significant action before rate reset.

Taken together, these results reinforce our core finding: households do not absorb mortgage payment shocks passively. While most adjustments occur after resets, some borrowers respond in advance—often by renegotiating or deleveraging—showing that both reactive and anticipatory behaviors shape monetary policy pass-through in ARM-dominated mortgage markets.

Cumulative Effects The estimates in Figure 3 describe monthly probabilities of mortgage-related actions. As noted above, Figure 2 shows that cumulative frequencies rise substantially over time, reaching 15.8% for renegotiations, 6.4% for transfers, 11.5% for partial prepayments, and 8.6% for full prepayments in the 18 months after July 2022. These patterns motivate an alternative specification that estimates cumulative rather than monthly effects.

We collapse the data at the contract–reset window–tightening period level and estimate a modified version of equation (2), where the dependent variable indicates whether a household undertook a given action in any reset period within one of three windows relative to the reset: pre-reset (–6 to –3 months; omitted baseline), immediate pre-reset (–2 to –1 months), and post-reset (0 to +5 months). We then examine the post-tightening period—either starting in July 2022 and cumulative through June 2023 or starting in July 2022 and cumulative through December 2023—relative to the pre-tightening period (January 2021-June 2022) to track how responses evolve over

time.

Table 3 reports the cumulative treatment effects of rate resets during the tightening period. By June 2023, the likelihood of renegotiations increases by 6.8 percentage points, transfers by 2.0, partial prepayments by 3.7, full prepayments by 1.6 for households with mortgage rate resets during the tightening period relative to the pre-tightening period. In addition, households are 13.6 percentage points more likely to take any mortgage action in the post-tightening period relative to the control group. By December 2023, the likelihood of renegotiation rises by 10.0 percentage points, transfer by 3.8, partial prepayment by 4.8, and full prepayment by 2.5—magnitudes that underscore the active role households play in managing payment shocks. Overall, households are 19.8 percentage points more likely to take any mortgage action in the post-tightening period relative to the control group.

Credit Card and Personal Loan Actions To complement our analysis of mortgage-related actions, we examine how households adjust short-term debt in response to mortgage rate resets, using credit card and overdraft balances as proxies for liquidity management. Using the same specification as equation (1), we analyze changes in (1) credit card drawdowns, (2) credit card limits (authorized limit), and (3) overdraft balances. Figure 4 presents the event-time estimates for these outcomes, tracing the timing and magnitude of spending-related adjustments around mortgage rate resets.

We find clear evidence of liquidity adjustments following rate resets during the tightening cycle. Authorized credit limits (Panel (a)) grow by about 10 percentage points in the reset month (time 0), while actual credit card usage (Panel (b)) grows by about 5 percentage points, indicating that households expand credit access—likely to meet obligations or smooth consumption. Credit card limits and drawdowns remain

elevated by at least three months after reset. In addition, overdraft usage rises by 2 percentage points in month after the reset (time 1), and remains elevated in subsequent months. These patterns are consistent with the cash-flow channel of monetary policy: higher mortgage rates reduce disposable income for indebted households, prompting greater reliance on high-cost credit instruments (see Di Maggio et al. (2017); Flodén et al. (2021)).

The increased reliance on short-term credit suggests that, although renegotiations, transfers, and prepayments partially mitigate payment shocks, they do not fully insulate household balance sheets. A greater dependence on short-term debt may heighten fragility and future default risk.

3.2 The Role of the Supply-Side

Our analysis has so far given limited attention to the relative importance of household (demand-side) behavior versus bank (supply-side) behavior. We now examine how supply-side factors—specifically differences across banks and intermediation channels—affect household responses to mortgage rate resets. The key question is whether heterogeneity in bank competition or mortgage broker presence amplifies or dampens the mortgage-level adjustments we document.

We construct a measure of each bank's propensity for renegotiations, transfers, and prepayments; the prepayment propensity serves as an indicator of competitiveness in deposit-rate setting. Specifically, we calculate the rate at which borrowers from the same bank—but geographically distant from the focal household, as well as in a different age group, and different mortgage balance group—undertake these actions. While borrower selection into banks may partly reflect similarities in observable characteristics, we mitigate this concern by focusing on borrowers who differ by

region, age, and loan balance.

Specifically, we define geographically distant borrowers as those residing in another district ("distrito").[8] Age groups are defined as <35, 36–45, 46–55, and >55 years old. Balance groups are defined according to the median at rate reset. For each household in a given district, we compute the rate at which clients of the same bank—located in different districts, age groups, and balance—renegotiate, transfer, or prepay their mortgages in the prior six months. These supply-side measures proxy for the bank's overall strategy toward each mortgage action, as well as for the competitiveness of its deposit rates as reflected in prepayment behavior. We estimate equation (1) for each mortgage action separately for households with owner-occupied ARMs whose banks are above and below the median for each action.

Figure 5 shows how household responses vary with our supply-side measures. The results indicate pronounced differences across banks. At high-shift banks—those actively adjusting contracts elsewhere—households are substantially more likely to renegotiate mortgages, transfer, and make partial prepayments after a rate reset. The difference is most pronounced for renegotiation, where responsiveness rises immediately and persists in the post-reset period. These findings highlight the central role of supply-side factors in enabling household adjustment, echoing evidence in Keys et al. (2016) and Berger et al. (2024) on the influence of lender competition and refinancing frictions. Even in an ARM-dominated market, contractual flexibility is not purely mechanical but depends critically on lender behavior.

Mortgage Brokers We next examine the role of mortgage brokers, who facilitate borrower–lender matching and mitigate search and information frictions. We split the sample by mortgage broker availability in the household's municipality ("concelho")

[8]Portugal has 18 districts, ranging from about 100,000 residents to just over 2 million. Districts are larger than U.S. counties.

and re-estimate equation (1) for above- versus below-median number of brokers.

Figure 6, Panel (b)), shows that households in areas with higher broker presence are more likely to transfer the mortgage (i.e., switch lender) following rate resets. This highlights the role of brokers in lowering switching costs and enhancing competition in the mortgage market. In contrast, broker presence does not influence mortgage renegotiations with the existing lender (Panel (a)). In this case, brokers are not compensated, and outcomes are instead shaped by established bank–client relationships and customer retention policies. While brokers do not increase renegotiation, they intensify competition by easing transfers, consistent with prior evidence on intermediation reducing search frictions (e.g., Woodward and Hall (2012)) and market structure and borrower–broker interactions in shaping monetary policy transmission (Berger et al. (2021, 2024).

3.3 Heterogeneity

While prior analyses have focused on average effects, heterogeneity in financial flexibility and the cost of (in)action likely shape both the magnitude and nature of household responses. In this subsection, we examine how responses to mortgage rate resets vary across borrower profiles. Specifically, we re-estimate the specifications from Table 2 for subgroups defined by age, education, and DSTI ratios. This allows us to assess whether certain households are more responsive—or more constrained—when facing higher mortgage payments.

Age Figure 7 shows significant heterogeneity in responses by borrower age groups. Younger households are substantially more responsive to rate resets, particularly through renegotiation and transfers. This likely reflects higher leverage and lower income, which increase both the salience and potential gains from adjusting mortgage

terms. By contrast, households over 55 years old exhibit much smaller, or even muted, responses through renegotiation and transfer, consistent with lower financial exposure and reduced perceived benefits from adjustment. Households aged 55 and older exhibit stronger responses in the form of partial—and especially full-prepayments—likely reflecting higher liquid savings.

Education Figure 8 shows a strong positive relationship between educational attainment—primary, secondary, tertiary—and household responsiveness to policy shocks. Households with college degrees are far more likely to take active steps after a reset, whereas those with primary (or no formal education) exhibit only modest adjustments. This heterogeneity is consistent with differences in financial literacy, information-processing capacity, and confidence explaining complex financial decisions such as the response to mortgage rate increases.

Debt Service-to-Income Ratio Figure 9 examines heterogeneity by household DSTI ratio, using the median to split the sample. Unlike the sharp variation by age or education, differences across DSTI groups are modest. High-DSTI households are somewhat more likely to renegotiate but far less likely to make partial prepayments. This pattern is consistent with financially constrained borrowers adjusting through low-cost channels while struggling to undertake balance-sheet improvements that require liquidity outflows (Beraja et al. (2019)). Renegotiation typically requires little or no upfront cash and may even be initiated by lenders to limit delinquency risk, whereas partial prepayment depends on cash buffers—resources that high-DSTI households often lack despite strong incentives to deleverage when rates rise. In addition, we find no difference in transfer responses between high- and low-DSTI households, consistent with the notion that high-DSTI borrowers face stronger

incentives to switch lenders but possess limited bargaining power to do so.

We present additional heterogeneity results by mortgage balance and residual maturity in Figure IA.2 and Figure IA.3 in the Internet Appendix. Households with larger balances exhibit stronger responses in renegotiation and partial prepayment, while mortgages with longer residual maturities display greater responsiveness, particularly through renegotiation and transfer. These patterns are consistent with the idea that mortgages with larger balances and longer maturities have payments that are more sensitive to interest rate increases.

3.4 Contract Terms around Renegotiation and Transfer

In this subsection, we examine how contract characteristics evolve around mortgage renegotiation and transfer. To shed light on the mechanisms behind mortgage actions, we track changes in the six months before and after these events, conditional on their occurrence. Our empirical design is an event study centered on the month of renegotiation or transfer:

$$\begin{aligned} Y_{ilmt} = & \sum_{t=-6, t\neq -3}^{5} \boldsymbol{\alpha_t} Event_{ilmt} + \boldsymbol{\gamma} Tightening_{ilm} + \\ & \sum_{t=-6, t\neq -3}^{5} \boldsymbol{\beta_t} Event_{ilmt} \times Tightening_{ilm} + \boldsymbol{\zeta} Loan_l + \epsilon_{ilmt}, \end{aligned} \tag{3}$$

where i indexes households, l mortgages, m the event month, and t the number of months relative to the event (month of renegotiation or transfer is zero). The dependent variable Y_{ilmt} is a monthly household-level outcome: mortgage spread, loan-to-value (LTV) ratio, home value, or interest rate regime. We omit the event month -3 and include mortgage contract fixed effects to isolate within-contract changes. $Tightening_{ilm}$ is a dummy variable that takes the value of one if the event

occurs during the tightening period (July 2022–December 2023), and zero otherwise. The interaction term $Event_{ilmt} \times Tightening_{ilm}$ captures how tightening alters the dynamics of mortgage terms around the mortgage adjustment event.

Figure 10 present the estimates. Panels (a) and (b) show that mortgage spreads fall sharply in the event month for both renegotiations and transfers. This pattern indicates that borrowers secure better pricing either through direct renegotiation (Panel (a)) or by switching to more competitive lenders (Panel (b)). Transfers deliver sizable and immediate spread reductions of roughly 65 basis points and often involve changes in contract terms, such as switching into fixed- or mixed-rate mortgages or lowering loan-to-value ratios through home revaluation. Renegotiations yield smaller spread improvements—about 27 basis points—but remain more accessible to liquidity-constrained borrowers. Finally, the interaction term for tightening periods is slightly positive for both renegotiations and transfers, suggesting limited borrower bargaining power when interest rates are rising.

Figure IA.4 in the Internet Appendix plots inbound and outbound transfer volumes alongside conditional offered rates—measured relative to a reference lender—for different mortgage types. We find that lenders offering lower rates consistently attract greater inbound transfers, particularly for mixed-rate mortgages. This pattern indicates that borrower switching is highly sensitive to interbank price differentials and that competitive pricing is a key mechanism driving reallocation flows during monetary tightening. Overall, these results underscore the importance of supply-side factors in shaping pass-through, showing that even in a predominantly ARM-based market, lender heterogeneity in pricing strategies influences both the magnitude and direction of mortgage transfers.

Panels (c) and (d) show that LTV ratios decline around renegotiations and transfers, but with different dynamics. Renegotiations exhibit a gradual and sustained drop,

consistent with faster deleveraging and home revaluations as shown in Panel (e). In contrast, transfers display a sharp, concentrated reduction in the event month, reflecting the updated appraisals required for refinancing as shown in Panel (f).

Figure 11 tracks transitions from ARMs into fixed- and mixed-rate contracts following mortgage renegotiations and transfers. Around renegotiations, the share of fixed-rate mortgages remains essentially unchanged, irrespective of monetary policy stance. Transfers, however, display significant increase in fixed-rate adoption during the tightening period, consistent with a strategic shift toward interest-rate insulation. For mixed-rate mortgages, uptake is modest around renegotiations but much larger around transfers during tightening periods—roughly ten times the estimates for fixed rates. In fact, Table 4 in the Internet Appendix indicates that transfers are associated with a change from ARM (12-month Euribor) to mixed-rate mortgage.

In short, mortgage actions—renegotiations and transfers—extend beyond repricing to also include changes in leverage, collateral valuation, and interest-rate regime. In addition, these adjustments broaden and intensify during monetary tightening, with across-bank transfers enabling larger and more structural modifications than (within-bank) renegotiations.

3.5 Back-of-the-Envelope Calculation of the Effects Across the Borrower Population

Up to this point, we have analyzed household behavior at the micro level. We now turn to the aggregate consequences, focusing on how mortgage-related actions shape the transmission of monetary policy through the mortgage market. Specifically, we compare the path of mortgage payments absent any adjustment with the actual path once actions are taken.

Figure 12 plots the trajectories of monthly payments for ARM borrowers, normalized to an index value of 1 in July 2022. The figure distinguishes six groups of households: those that renegotiate, transfer, partially prepay, fully prepay, take multiple actions, or take no action. While payments rise sharply for all groups due to the automatic Euribor-linked reset, trajectories diverge once borrower behavior is considered. The "No Action" group experience the steepest and most sustained increase, reflecting near-complete mechanical monetary policy pass-through. By contrast, households that act—especially through prepayment, transfer, or multiple adjustments—face smaller increases in mortgage payments, indicating that deleveraging and contract modifications materially reduce their exposure to interest rate shocks.

To assess the aggregate impact, Table 4 compares actual payments with those that would have occurred due to automatic Euribor-linked resets (i.e., with no mortgage action or under full mechanical pass-through of interest rates during the tightening). We then decompose the total reduction in mortgage payments by household response, with each column summing to 100%, for several subperiods. Renegotiations account for about 2.3% of the reduction, transfers for 13.7%, and partial prepayments for roughly 14.1% in the period July 2022 to December 2023. In addition, multiple actions have a sizable contribution to the reduction in mortgage payments at about 23.4%. Finally, we find that the largest contribution comes from households that fully repaid their mortgages at about 46.5%.

4 Conclusion

This paper provides new evidence on how contract adjustment and prepayment shape monetary policy transmission in an adjustable-rate mortgage (ARM)-dominated

market. Exploiting the European Central Bank's 2022–2023 tightening and the staggered mortgage rate reset schedule of 12-month Euribor-linked mortgages in Portugal, we show that resets act as powerful catalysts for mortgage adjustments and deleveraging. Cumulative responses include increases of 10 percentage points in renegotiations, 4 in lender switching, 5 in partial prepayments, and 3 in full prepayments, with transfers and renegotiations delivering significant spread reductions and loan-to-value (LTV) ratio reductions. Together, these actions absorbed about 17% of the payment increase during the tightening cycle that would have occurred under no mortgage action (i.e., under full contractual interest rate pass-through).

Household responses are concentrated post-rate reset, consistent with selective inattention, and differ systematically by borrower profile, loan characteristics, and supply-side factors. Younger, more educated, and high-mortgage balance borrowers are most responsive, while high-debt-service-to-income ratio households rely on low-cost channels such as renegotiation. Lender behavior and mortgage broker presence significantly increase transfers and prepayments, highlighting how higher interest rates intensify lender competition. Sluggish deposit-rate pass-through further amplified deleveraging incentives by lowering the opportunity cost of using liquid savings to repay mortgage balances.

For policymakers, these findings imply that while ARMs ensure faster and more symmetric monetary policy transmission than fixed-rate mortgages, they do not guarantee full monetary policy pass-through. The magnitude and timing of monetary policy transmission are shaped by market frictions, competitive dynamics, and borrower attention. Policies that strengthen competition, lower switching costs, enhance financial literacy, and address deposit-rate stickiness would amplify household adjustments to payment shocks. However, such measures would dampen

and delay the pass-through of the monetary tightening, while enhancing household resilience during tightening cycles. More broadly, our results underscore that aggregate pass-through elasticity in ARM markets is not fixed by contract design but is state-contingent and behavior-driven, jointly shaped by household agency and market institutions.

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Table 1: Summary statistics

	(1) Mean	(2) Std. Dev.	(3) P10	(4) Median	(5) P90
Mortgage Characteristics					
Amount Outstanding (€)	76,175	69,495	22,287	60,906	140,000
Installment (€)	314	500	99	241	578
Spread (%)	1.441	0.585	1.000	1.250	2.040
Maturity (month)	353	112	186	384	468
LTV	0.608	0.219	0.256	0.675	0.828
Renegotiation (%)	0.8	9.0	0.0	0.0	0.0
Transfer (%)	0.3	5.5	0.0	0.0	0.0
Partial Prepayment (%)	0.9	9.3	0.0	0.0	0.0
Full Prepayment (%)	0.4	6.7	0.0	0.0	0.0
Any Action (%)	2.6	16	0.0	0.0	0.0
Household Credit Positions					
Total Credit (€)	82,450	77,774	24,157	66,420	149,564
Credit Card (€)	702	1,823	0	30	1,841
Overdrafts (€)	32	719	0	0	0
Personal Credit (€)	4,543	13,427	0	0	13,676
Overdue Credit/Total Credit	0.002	0.033	0.000	0.000	0.000
Borrower Characteristics					
Age (years)	41.47	9.30	30.00	40.00	54.00
Male	0.544	0.498	0.000	1.000	1.000
Higher Education	0.487	0.500	0.000	0.000	1.000
Employed	0.780	0.414	0.000	1.000	1.000

This table presents mean, standard deviation, 10th percentile (P10), median, and 90th percentile (P90) for the variables used in the analysis. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023. Our final sample consists of 369,308 mortgage loans for owner-occupied properties, totaling 989,525 resets and 10,825,856 loan-month observations. The reported statistics include the mean, standard deviation, 10th percentile (P10), median, and 90th percentile (P90). All summary statistics are calculated at the time of the interest rate reset. Variable definitions are provided in Table A.1 in the Appendix.

Table 2: Interest Rate Reset and Household Responses

	(1) Renegotiation	(2) Transfer	(3) Partial Repayment	(4) Full Repayment	(5) Any Action
$Immediate\ Pre-reset$	0.042***	-0.008**	0.013	-0.008*	0.043***
	(0.008)	(0.003)	(0.008)	(0.004)	(0.013)
$Post-reset$	0.055***	0.098***	0.008	0.308***	0.478***
	(0.010)	(0.005)	(0.008)	(0.014)	(0.013)
$Tightening$	-0.050*	-0.066***	-0.043***	-0.075***	-0.234***
	(0.027)	(0.013)	(0.013)	(0.019)	(0.059)
$Immediate\ Pre-reset \times Tightening$	0.222***	-0.035**	0.193***	-0.015	0.373***
	(0.050)	(0.017)	(0.033)	(0.010)	(0.088)
$Post-reset \times Tightening$	0.744***	0.258***	0.363***	0.138***	1.569***
	(0.103)	(0.039)	(0.042)	(0.026)	(0.195)
Observations	10,825,856	10,825,856	10,825,856	10,825,856	10,825,856
Adjusted R^2	0.009	0.004	0.009	0.003	0.016

This table reports regression estimates based on equation (2). The dependent variable in each column is a mortgage action in each reset (event) month: a dummy variable for renegotiation, a dummy variable for transfer, a dummy variable for partial prepayment, a dummy variable for full prepayment or a dummy variable for any action. The explanatory variables of interest are a dummy variable for the *Immediate Pre-reset* window (months –2 to –1), a dummy variable for the *Post-reset* window (months 0 to +5), and the omitted *Pre-reset* window (months -6 to -3); month 0 corresponds to the reset month. *Tightening* is a dummy variable that takes the value of one between June 2023 and December 2024. All regressions control for loan characteristics (term-to-maturity, amount outstanding, LTV ratio), debtor characteristics (age group, gender, education level, employment status, and residence municipality), and calendar month-year fixed effects. Debtor and loan characteristics are measured at the time of the interest rate reset. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023. Standard errors are clustered at the municipality and month-year levels.

Table 3: Cumulative Household Responses

	(1) Renegotiation	(2) Transfer	(3) Partial Prepayment	(4) Full Prepayment	(5) Any Action
			Jan 2021 - Jun 2023		
$Immediate\ Pre-reset \times Tightening$	0.700***	-0.186***	0.931***	-0.679***	0.799***
	(0.032)	(0.019)	(0.051)	(0.028)	(0.069)
$Post-reset \times Tightening$	6.775***	1.996***	3.712***	1.561***	13.556***
	(0.154)	(0.063)	(0.151)	(0.053)	(0.280)
Observations	1,816,636	1,816,636	1,816,636	1,816,636	1,816,636
Adjusted R^2	0.038	0.017	0.019	0.016	0.068
			Jan 2021 - Dec 2023		
$Immediate\ Pre-reset \times Tightening$	0.761***	-0.248***	0.584***	-0.986***	0.188**
	(0.050)	(0.025)	(0.050)	(0.033)	(0.082)
$Post-reset \times Tightening$	10.000***	3.832***	4.800***	2.537***	19.812***
	(0.223)	(0.101)	(0.170)	(0.067)	(0.354)
Observations	1,816,636	1,816,636	1,816,636	1,816,636	1,816,636
Adjusted R^2	0.060	0.031	0.027	0.024	0.114

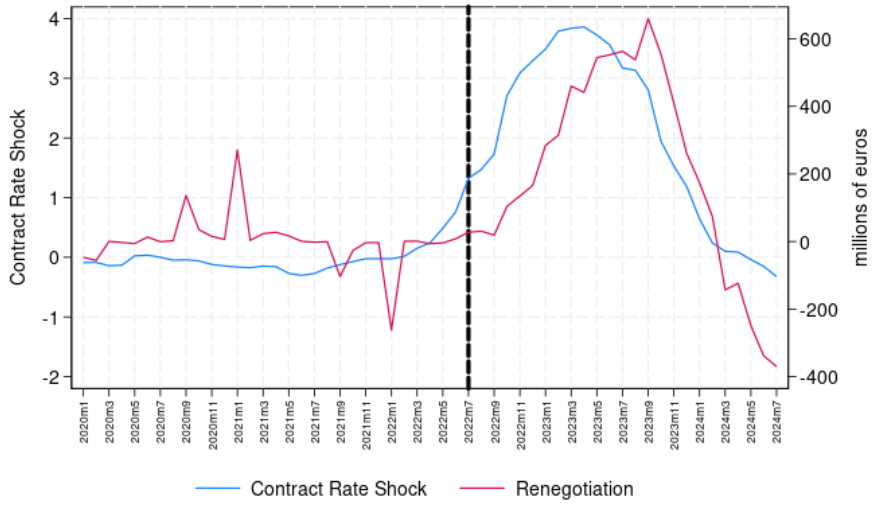
This table reports regression estimates using data collapsed at the contract–reset window–tightening period level. The dependent variable in each column is a mortgage action in each reset (event) window: a dummy variable for renegotiation, a dummy variable for transfer, a dummy variable for partial prepayment, a dummy variable for full prepayment or a dummy variable for any action. The explanatory variables of interest are a dummy variable for the *Immediate pre-Reset* window (months –2 to –1), a dummy variable for the *Post-reset* window (months 0 to +5), and the omitted *Pre-reset* window (months -6 to -3); month 0 corresponds to the reset month. *Tightening* is a dummy variable that takes the value of one between June 2023 and December 2024. All regressions control for loan characteristics (term-to-maturity, amount outstanding, LTV ratio), and debtor characteristics (age group, gender, education level, employment status, and residence municipality). Debtor and loan characteristics are measured at the time of the interest rate reset. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023. Standard errors are clustered at the municipality level.

Table 4: Aggregate Effects

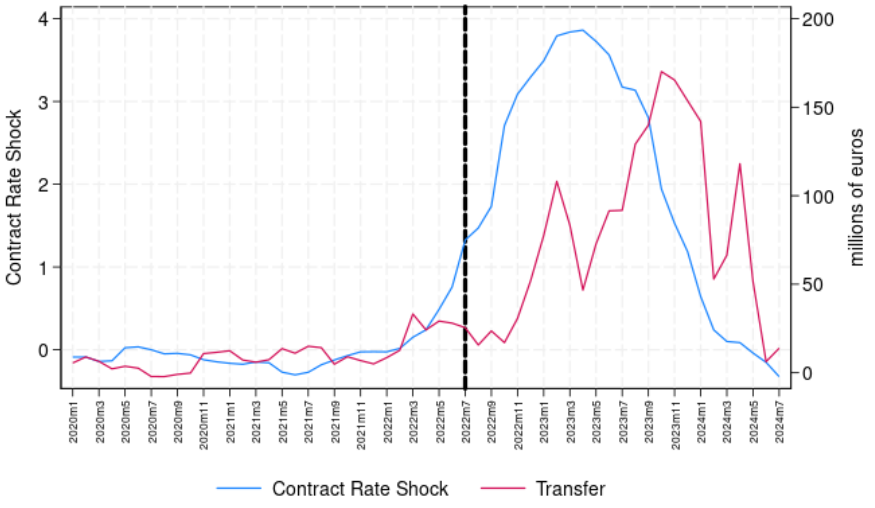
	(1)	(2)	(3)	(4)
Period	Jul - Dec 2022	Jan - Jun 2023	Jul - Dec 2023	Jul 2022 - Dec 2023
		Payment Shock Absorbed		
Action	7.21	15.49	25.41	17.30
		Contribution of Payment Shock Absorbed		
Renegotiation	2.62	2.23	2.29	2.31
Transfer	10.13	13.28	14.62	13.73
Partial Repayment	15.3	13.8	13.98	14.07
Full Repayment	48.47	48.84	44.97	46.51
Multiple Actions	23.48	21.84	24.13	23.37

This table presents aggregate estimates (in percentage) of how much mortgage actions reduce the increase in scheduled mortgage payments that would have occurred in their absence between July 2022 and December 2023. The table also shows the relative contribution (in percent) of each action: renegotiation, transfer, partial prepayment, full prepayment and multiple actions. The contribution of each action is calculated as the difference between scheduled payments and actual payments divided by total reduction in mortgage payments. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023.

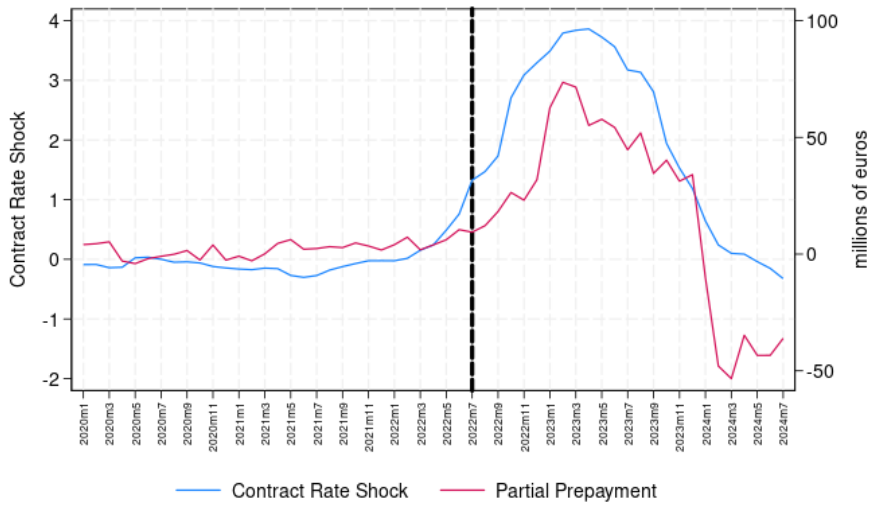
Figure 1: Interest Rate Shocks and Household Responses



(a) Renegotiation



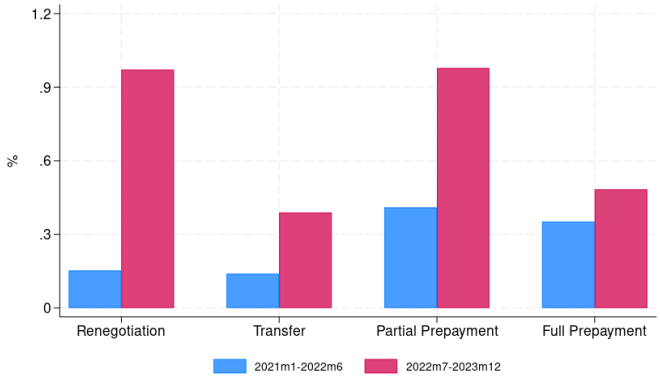
(b) Transfer



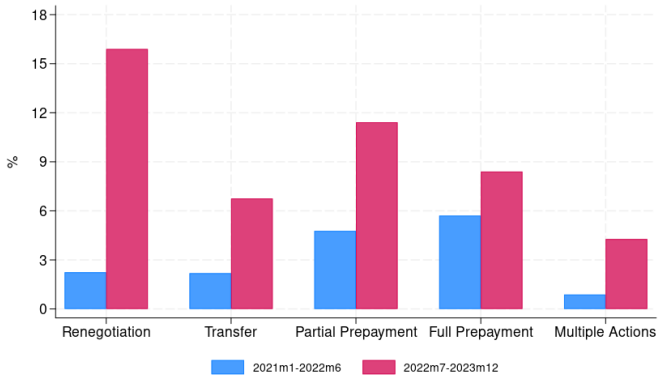
(c) Partial Prepayment

This figure shows the mean change in the mortgage contract rate for 12-month resettable ARMs that reset in each calendar month over the period between January 2020 and July 2024. It also shows the yearly change in the total amount (in millions of euro) of mortgage loans that undergo each action: renegotiation with the current bank (Panel A), transfer to another bank (Panel B), and partial prepayment (Panel C). The black dashed line marks the beginning of the tightening cycle in July 2022, when the ECB raised its key policy rates for the first time in 11 years. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023.

Figure 2: Monthly and Cumulative Frequency of Household Responses



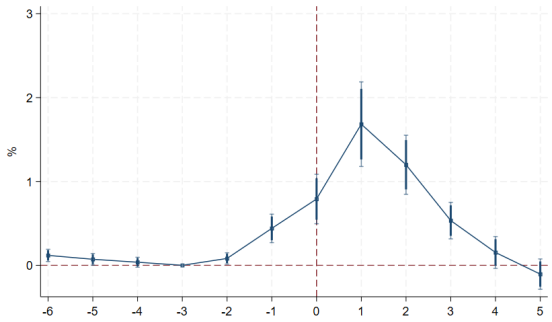
(a) Monthly Frequency



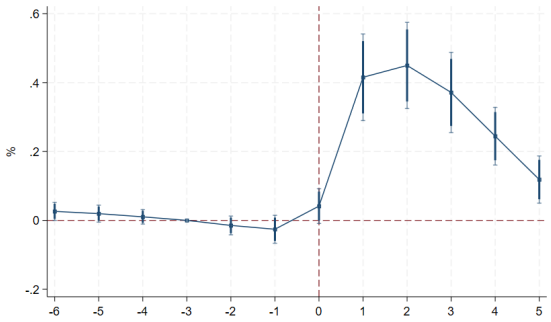
(b) Cumulative Frequency

This figure shows, separately for the January 2021–June 2022 (pre-tightening period) and July 2022–December 2023 (tightening period), both the monthly and cumulative frequencies of household mortgage actions, including mortgage renegotiations, transfers, partial prepayments, full prepayments, and multiple actions. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023.

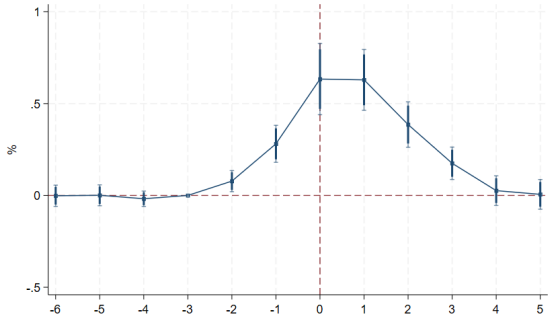
Figure 3: Household Responses to Interest Rate Shocks



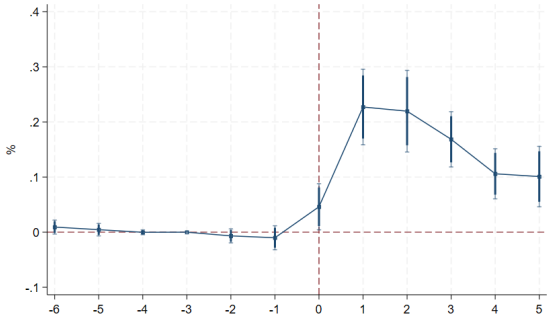
(a) Renegotiation



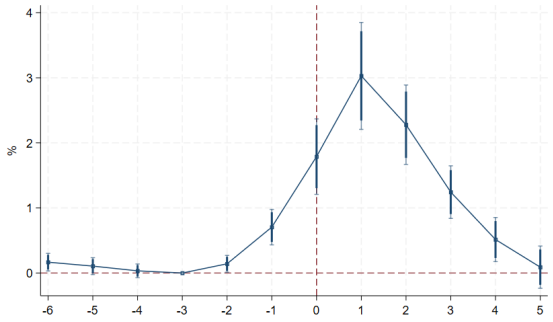
(b) Transfer



(c) Partial Prepayment



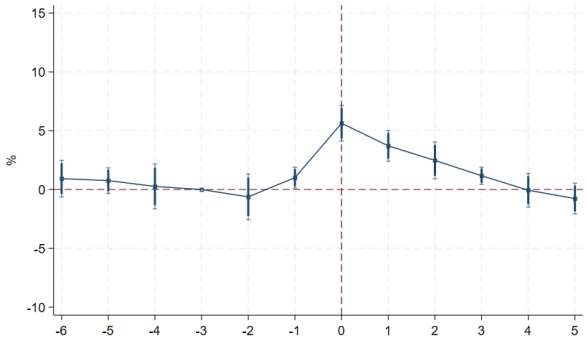
(d) Full Prepayment



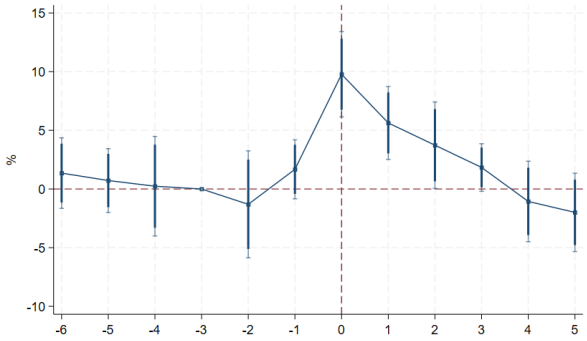
(e) Any Action

This figure presents the point estimates along with the 90% and 95% confidence intervals of β_t in equation (1). The dependent variable in each panel is a mortgage action in each reset (event) month: a dummy variable for renegotiation (Panel (a)), a dummy variable for transfer (Panel (b)), a dummy variable for partial prepayment (Panel (c)), a dummy variable for full prepayment (Panel (d)) or a dummy variable for any action (Panel (e)). All regressions control for loan characteristics (residual maturity, amount outstanding, loan-to-value ratio), debtor characteristics (age group, gender, education group, employment status, and municipality), and calendar month-year fixed effects. Debtor and loan characteristics are measured at the time of the mortgage rate reset. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023. Standard errors are clustered at the municipality and month-year levels.

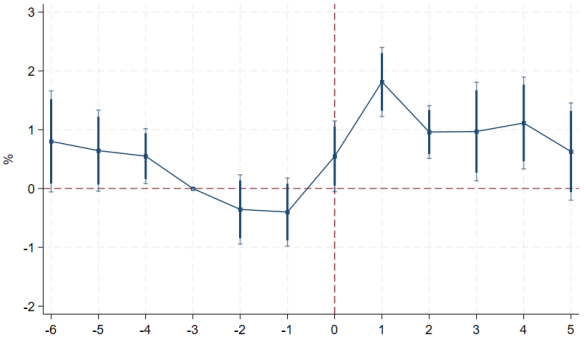
Figure 4: Interest Rate Shocks and Short-Term Debt



(a) Credit-Card Drawndown



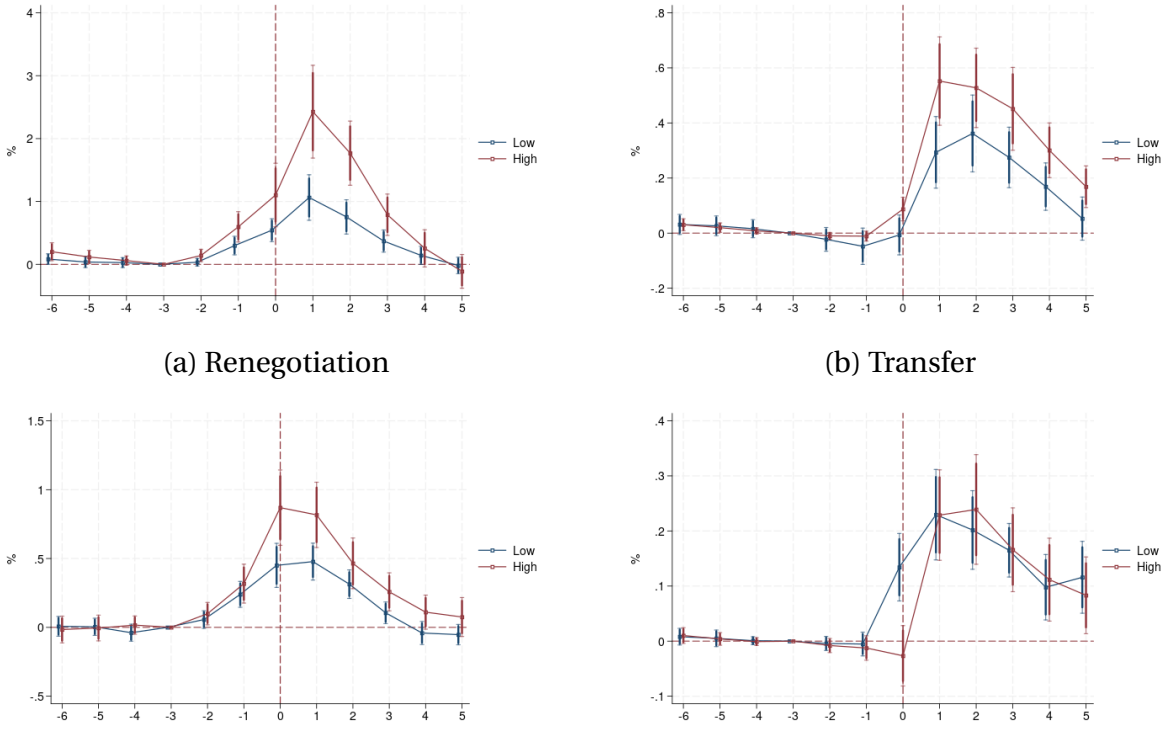
(b) Credit-Card Limit



(c) Overdrafts

This figure presents the point estimates along with the 90% and 95% confidence intervals of β_t in equation (1). The dependent variable corresponds to the log amount of credit card drawdown (Panel (a)), the log amount of credit card limit (Panel (b)), and the log amount of used overdrafts (Panel (c)). All regressions control for loan characteristics (residual maturity, amount outstanding, loan-to-value ratio), debtor characteristics (age group, gender, education group, employment status, and municipality), and calendar month-year fixed effects. Debtor and loan characteristics are measured at the time of the mortgage rate reset. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023. Standard errors are clustered at the municipality and month-year levels.

Figure 5: Supply-Side Effects



(a) Renegotiation

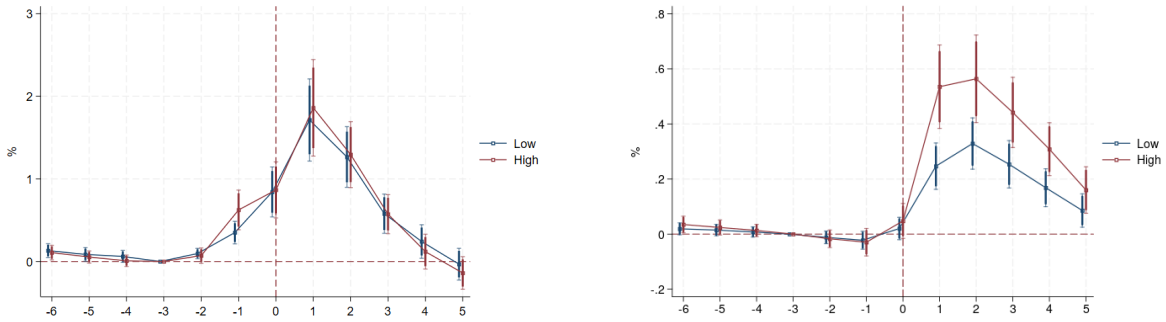
(b) Transfer

(c) Partial Prepayment

(d) Full Prepayment

This figure presents the point estimates along with the 90% and 95% confidence intervals of β_t from equation (1), estimated separately for subsamples of mortgages with below-median (low) and above-median (high) bank-level shift values. The bank-level shift is the rate at which the household's bank is acting with households from different age-mortgage balance groups, located outside of the focal household's region (district). The rate is calculated as the number of mortgage contracts that were renegotiated, transferred (inbound), partially prepaid, or fully prepaid, divided by the total number of contracts for each bank. The dependent variable in each panel is a mortgage action in each reset (event) month: a dummy variable for renegotiation (Panel (a)), a dummy variable for transfer (Panel (b)), a dummy variable for partial prepayment (Panel (c)), a dummy variable for full prepayment (Panel (d)) or a dummy variable for any action (Panel (e)). All regressions control for loan characteristics (residual maturity,amount outstanding, loan-to-value ratio), debtor characteristics (age group, gender, education group, employment status, and municipality), and calendar month-year fixed effects. Debtor and loan characteristics are measured at the time of the interest rate reset. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023. Standard errors are clustered at the municipality and month-year levels.

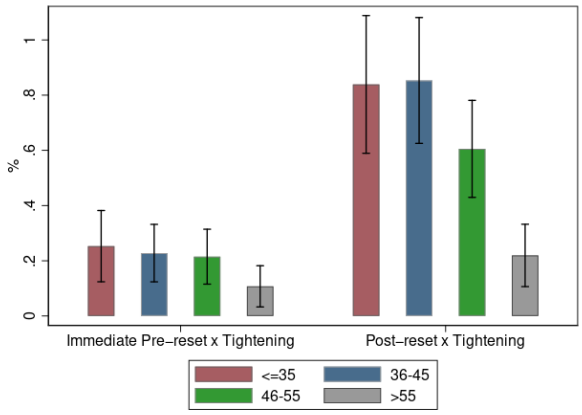
Figure 6: The Role of Mortgage Brokers



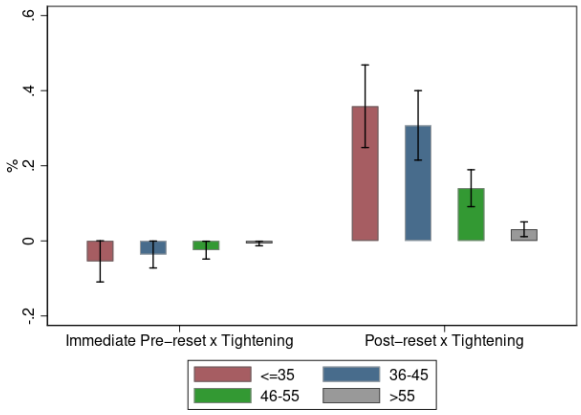
(a) Renegotiation (b) Transfer

This figure presents the point estimates along with the 90% and 95% confidence intervals of β_t from equation (1), estimated separately for subsamples of mortgages held by households resident in municipalities with below-median (low) and above-median (high) number of mortgage brokers. The dependent variable in each panel is a mortgage action in each reset (event) month: a dummy variable for renegotiation (Panel (a)) or a dummy variable for transfer (Panel (b)). All regressions control for loan characteristics (residual maturity, amount outstanding, loan-to-value ratio), debtor characteristics (age group, gender, education group, employment status, and municipality), and calendar month-year fixed effects. Debtor and loan characteristics are measured at the time of the interest rate reset. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023. Standard errors are clustered at the municipality and month-year levels.

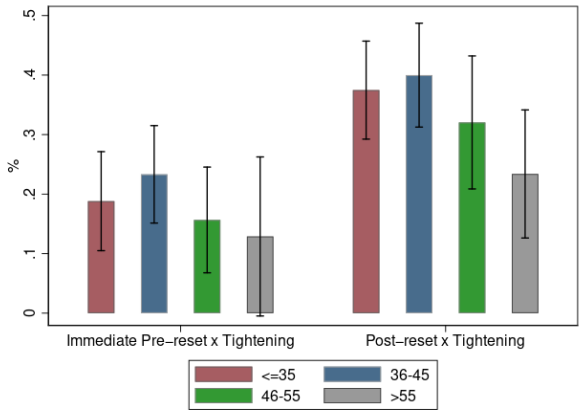
Figure 7: Interest Rate Shocks and Household Responses: Age



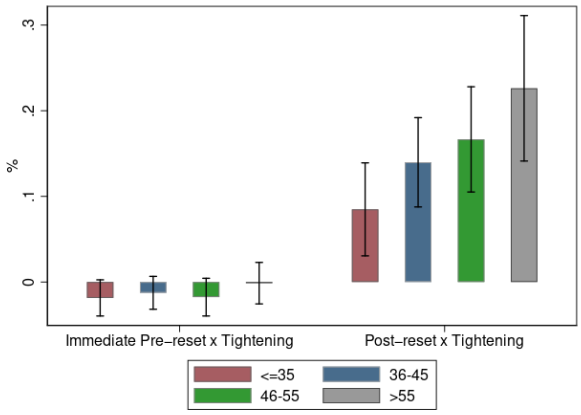
(a) Renegotiation



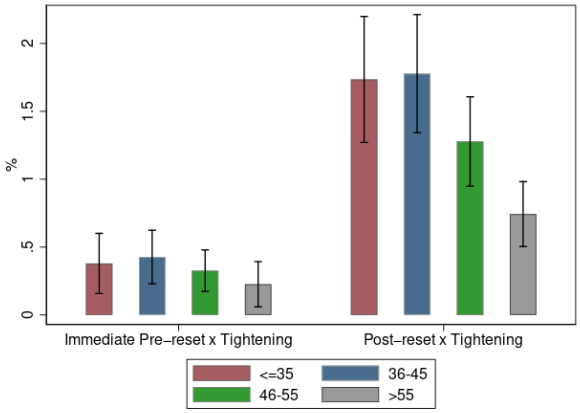
(b) Transfer



(c) Partial Prepayment



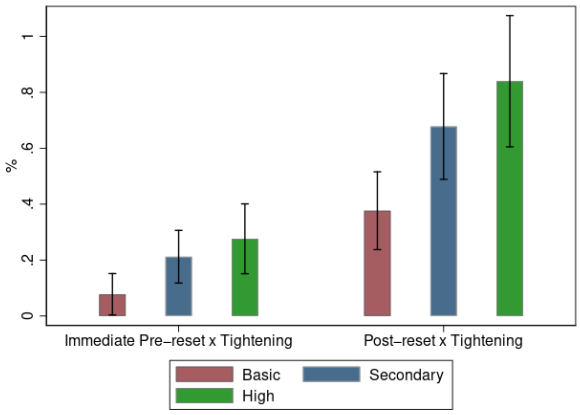
(d) Full Prepayment



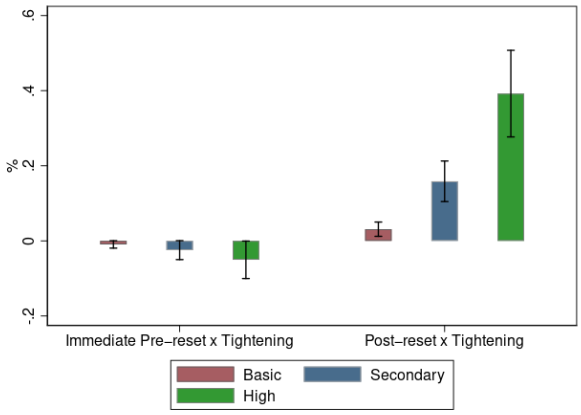
(e) Any Action

This figure presents the point estimates along with the 90% and 95% confidence intervals of β_1 and β_2 from equation (2), estimated separately for subsamples of households aged 35 years or younger, 35 to 45 years, 45 to 55 years, and above 55 years. The dependent variable in each panel is a mortgage action in each reset (event) month: a dummy variable for renegotiation (Panel (a)), a dummy variable for transfer (Panel (b)), a dummy variable for partial prepayment (Panel (c)), a dummy variable for full prepayment (Panel (d)) or a dummy variable for any action (Panel (e)). All regressions control for loan characteristics (residual maturity,amount outstanding, loan-to-value ratio), debtor characteristics (age group, gender, education group, employment status, and municipality), and calendar month-year fixed effects. Debtor and loan characteristics are measured at the time of the interest rate reset. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023. Standard errors are clustered at the municipality and month-year levels.

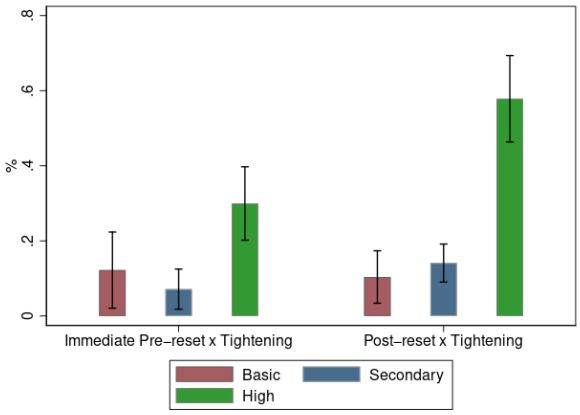
Figure 8: Interest Rate Shocks and Household Responses: Education



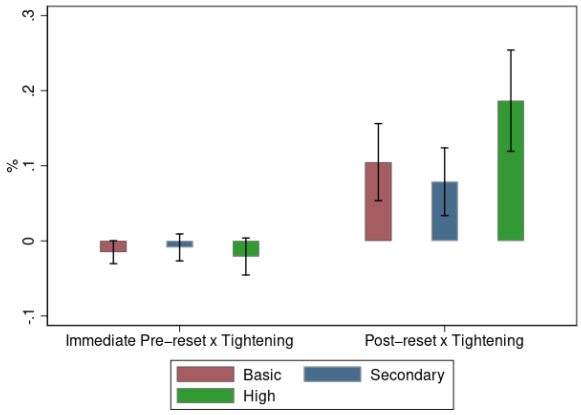
(a) Renegotiation



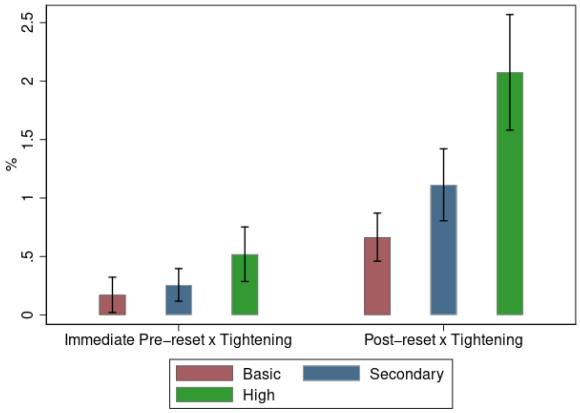
(b) Transfer



(c) Partial Prepayment



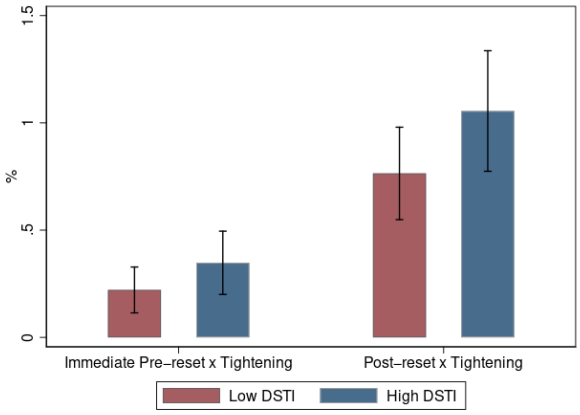
(d) Full Prepayment



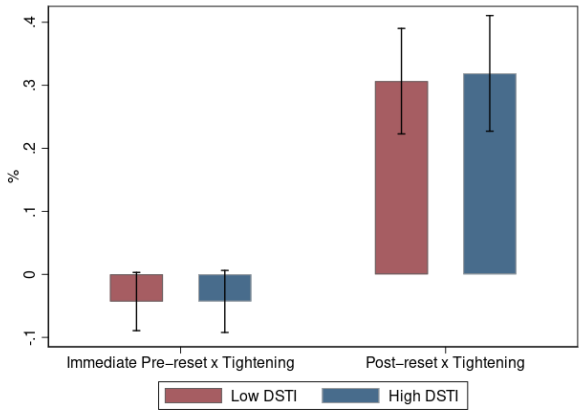
(e) Any Action

This figure presents the point estimates along with the 90% and 95% confidence intervals of β_1 and β_2 from equation (2), estimated separately for subsamples of households with primary or no education (Primary), secondary education (Secondary), and tertiary education (Tertiary). The dependent variable in each panel is a mortgage action in each reset (event) month: a dummy variable for renegotiation (Panel (a)), a dummy variable for transfer (Panel (b)), a dummy variable for partial prepayment (Panel (c)), a dummy variable for full prepayment (Panel (d)) or a dummy variable for any action (Panel (e)). All regressions control for loan characteristics (residual maturity,amount outstanding, loan-to-value ratio), debtor characteristics (age group, gender, education group, employment status, and municipality), and calendar month-year fixed effects. Debtor and loan characteristics are measured at the time of the interest rate reset. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023. Standard errors are clustered at the municipality and month-year levels.

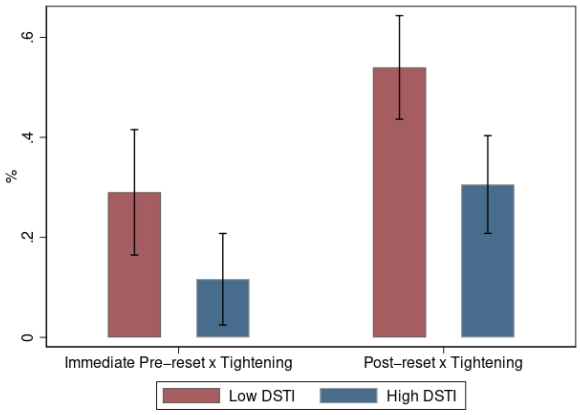
Figure 9: Interest Rate Shocks and Household Responses: Debt Service-to-Income



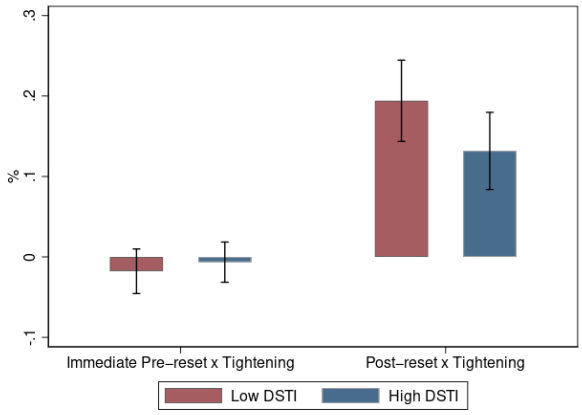
(a) Renegotiation



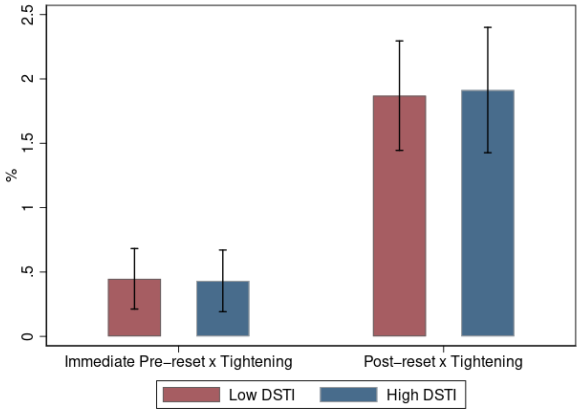
(b) Transfer



(c) Partial Prepayment



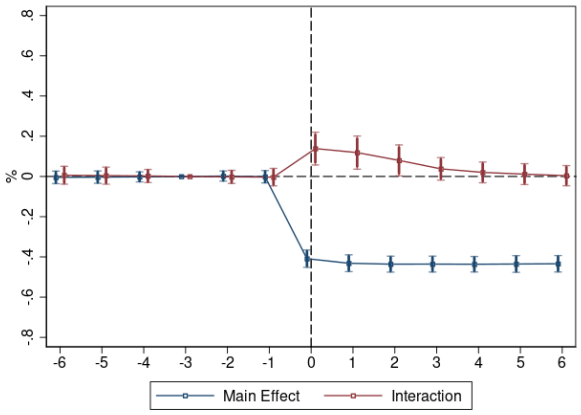
(d) Full Prepayment



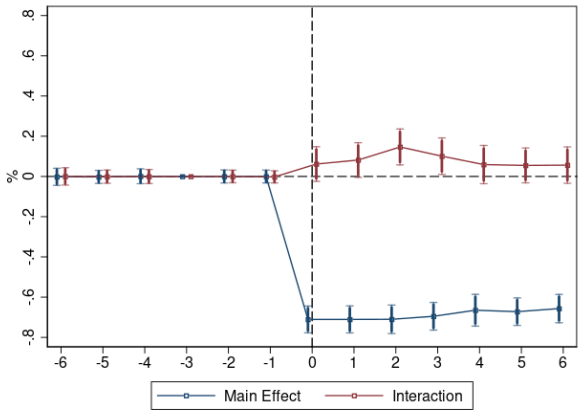
(e) Any Action

This figure presents the point estimates along with the 90% and 95% confidence intervals of β_1 and β_2 from equation (2), estimated separately for households with below-median (low) and above-median (high) debt service-to-income (DSTI) ratio. The dependent variable in each panel is a mortgage action in each reset (event) month: a dummy variable for renegotiation (Panel (a)), a dummy variable for transfer (Panel (b)), a dummy variable for partial prepayment (Panel (c)), a dummy variable for full prepayment (Panel (d)) or a dummy variable for any action (Panel (e)). All regressions control for loan characteristics (residual maturity,amount outstanding, loan-to-value ratio), debtor characteristics (age group, gender, education group, employment status, and municipality), and calendar month-year fixed effects. Debtor and loan characteristics are measured at the time of the interest rate reset. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023. Standard errors are clustered at the municipality and month-year levels.

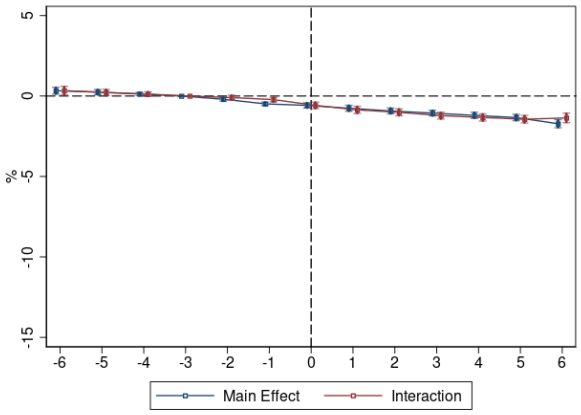
Figure 10: Change in Spread, LTV and Home Value around Renegotiation and Transfer



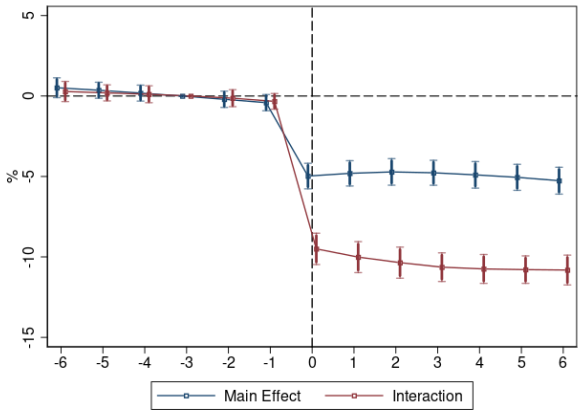
(a) Spread: Renegotiation



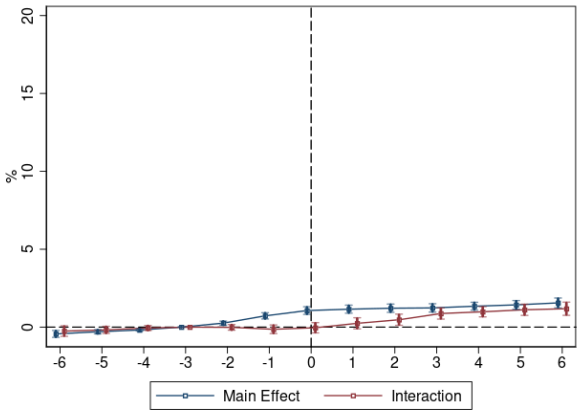
(b) Spread: Transfer



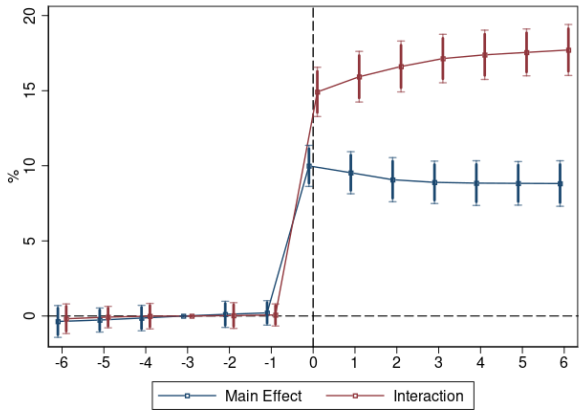
(c) LTV: Renegotiation



(d) LTV: Transfer



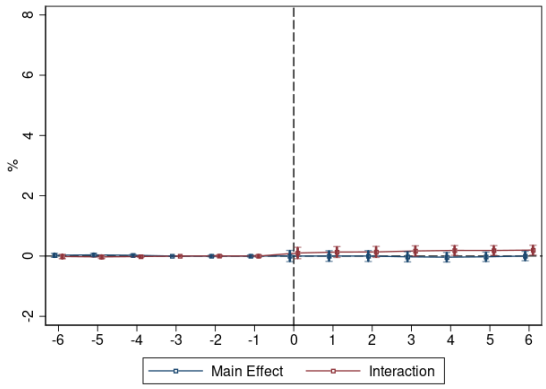
(e) Home Value: Renegotiation



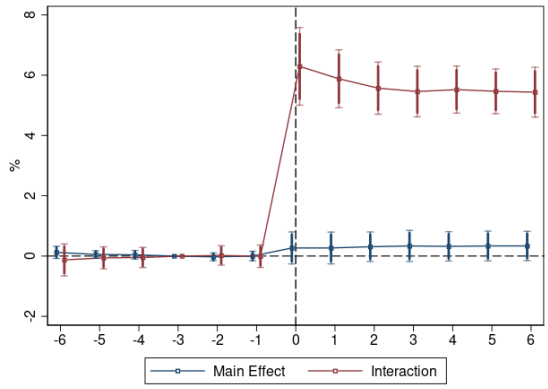
(f) Home Value: Transfer

This figure presents the point estimates along with the 90% and 95% confidence intervals of γ_t in equation (3) based on two samples: mortgage that are renegotiated with the current lender and mortgages that are transferred to a new lender with the same interest rate regime (i.e., 12-month resettable). The dependent variable in Panels (a) and (b) is the mortgage spread. The dependent variable in Panels (c) and (d) is the loan-to-value ratio (LTV). The dependent variable in Panels (e) and (f) is the home value. All regressions control for loan fixed effects. The sample consists of 12-month resettable ARM issued for an owner-occupied property in Portugal with renegotiation or transfer to a new lender between January 2021 and December 2023. Standard errors are clustered at the contract and month-year levels.

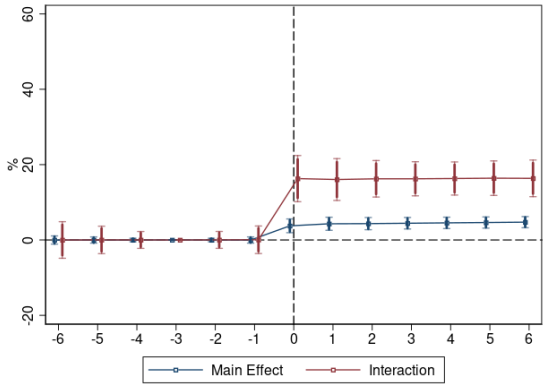
Figure 11: Change in Rate Regime around Renegotiation and Transfer



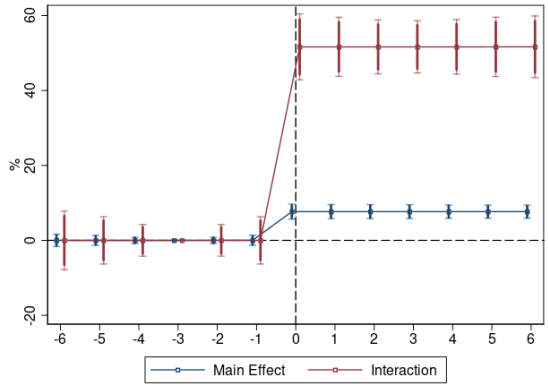
(a) Fixed rate: Renegotiation



(b) Fixed rate: Transfer



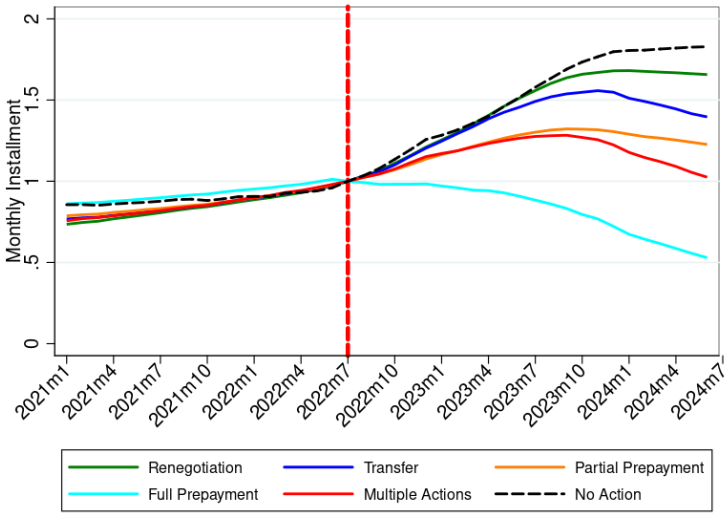
(c) Mixed rate: Renegotiation



(d) Mixed rate: Transfer

This figure presents the point estimates along with the 90% and 95% confidence intervals of γ_t in equation (3) based on two samples: mortgage that are renegotiated with the current lender and mortgages that are transferred to a new lender. This figure presents the point estimates along with the 90% and 95% confidence intervals of γ_t in equation (3) based on two samples: mortgage that are renegotiated with the current lender and mortgages that are transferred to a new lender with the same interest rate regime (i.e., 12-month resettable). The dependent variable in Panels (a) and (b) is a dummy for fixed rate mortgage. The dependent variable in Panels (c) and (d) is a dummy for mixed rate mortgage. All regressions control for loan fixed effects. The sample consists of 12-month resettable ARM issued for an owner-occupied property in Portugal with renegotiation or transfer to a new lender between January 2021 and December 2023. Standard errors are clustered at the contract and month-year levels.

Figure 12: Household Responses and Mortgage Installment Trajectories



This figure illustrates the mortgage installment payment trajectories (indexed to 1 in July 2022) for households that have renegotiated, transferred, partially prepaid, fully prepaid, taken multiple actions, or taken no action on their mortgages during the period from July 2022 to June 2024. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023.

Appendix

Table A.1: Variable definitions

Mortgage Characteristics	
Amount outstanding	Mortgage amount outstanding (in euros).
Installment	Mortgage installment payment (in euros).
Spread	Mortgage loan spread (in percentage).
Maturity	Term-to-maturity of a mortgage loan (in months).
LTV	Loan-to-value, calculated as mortgage loan amount divided by the value of the mortgaged property.
DSTI	Debt-service-to-income ratio, calculated as household's total monthly debt payments divided by by monthly income.
Renegotiation	Dummy variable that takes the value one if there is a renegotiation of a mortgage with the current lender and zero otherwise, excluding renegotiations due to noncompliance.
Transfer	Dummy variable that takes the value one if a mortgage is transferred to a new lender and zero otherwise.
Partial prepayment	Dummy variable that takes the value one if there is a partial prepayment of a mortgage and zero otherwise.
Full prepayment	Dummy variable that takes the value one is there is a full prepayments of a mortgage and zero otherwise.
Household Credit Positions	
Total credit	Total credit outstanding of the household.
Overdraft	Amount of overdrafts of the household.
Credit card drawdown	Amount of credit card drawdown of the household.
Credit card limit	Amount of credit card limit of the household.
Borrower Characteristics	
Age	Household age in years; age buckets are further created based on the following categories: $<=$35 years; 35-45 years; 45-55 years: $>$ 55 years).
Male	Dummy variable that takes on the value one for males and zero otherwise.
Education	A set of dummy variables that identify the educational background of the individual (no schooling/primary, secondary, and tertiary).
Tertiary education	Dummy variable that takes the value of one for individual with tertiary education, and 0 otherwise.
Employment status	A set of dummy variables that identify the employment status of the individual; student, retired, employed, self-employed, unemployed, and out of the job market.
Employed	Dummy variable that takes the value of one for households that are employed and zero otherwise.
Municipality	A set of dummy variables that identify the individual's municipality of residence.

Internet Appendix to

"Interest Rate Pass-Through With Adjustable Rate Mortgages"

Table IA.1: 6-month versus 12-month Contracts

	(1) 6-month	(2) 12-month	(3) dif.	(4) p-value
Mortgage Characteristics				
Mortgage Outstanding (€)	45,647	79,130	-33,484	0.000
Installment (€)	272	342	-70	0.000
Spread (%)	1.226	1.485	-0.260	0.000
Maturity (month)	200	339	-139	0.000
LTV	0.324	0.567	-0.243	0.000
Renegotiation (%)	0.1	0.7	-0.6	0.000
Transfer (%)	0.1	0.2	-0.2	0.000
Partial Prepayment (%)	0.7	0.8	-0.1	0.000
Full Prepayment (%)	0.5	0.6	-0.1	0.000
Any Action (%)	1.3	2.2	-0.9	0.000
Household Credit Positions				
Total Credit (€)	5,2835	87,385	-34,550	0.000
Credit Card (€)	797	757	40	0.000
Overdrafts (€)	50	49	1	0.462
Personal Credit (€)	3753	4768	-1015	0.000
Overdue Credit/Total Credit	0.008	0.002	0.006	0.000
Borrower Characteristics				
Age (years)	50.66	42.63	8.03	0.000
Male	0.540	0.550	-0.011	0.000
Higher Education	0.348	0.489	-0.141	0.000
Employed	0.650	0.771	-0.121	0.000

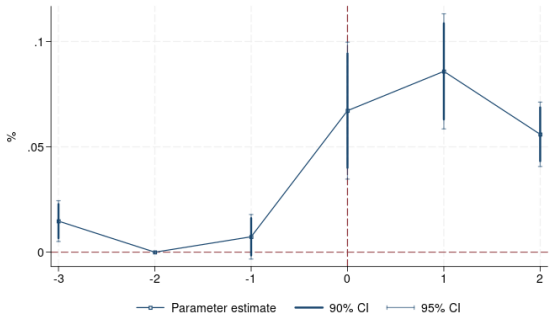
This table compares the mean characteristics of 6-month and 12-month resettable ARMs issued for owner-occupied properties in Portugal between January 2021 and December 2023. The table also reports the difference in mean and the corresponding p-value. Variable definitions are provided in Table A.1 in the Appendix.

Table IA.2: Changes in Interest Rate Regime around Transfer

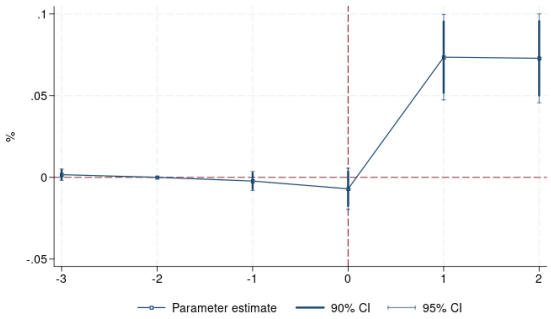
	Obs	Percent
Interest Rate Regime		
FRMs	958	4.45
MRMs	9,204	42.73
3-month ARMs	980	4.55
6-month ARMs	4,776	22.17
12-month ARMs	5,571	25.86
Other	52	0.24

This table shows the frequency distribution of interest rate regime changes — fixed-rate mortgage (FRM), mixed-rate mortgage (MRM), and adjustable-rate mortgage (ARM) — around the time of the mortgage transfer. The sample consists of 12-month resettable ARM issued for an owner-occupied property in Portugal with a transfer to a new lender between January 2021 and December 2023.

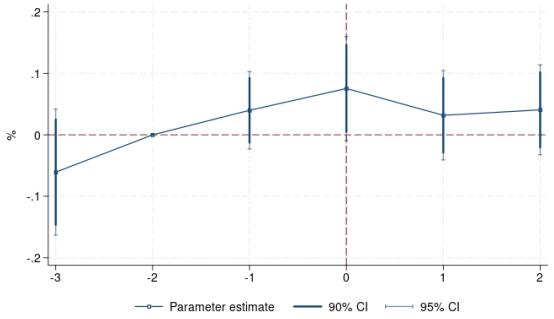
Figure IA.1: Household Responses to Interest Rate Shocks: ARMs with 6-month Rate Resets



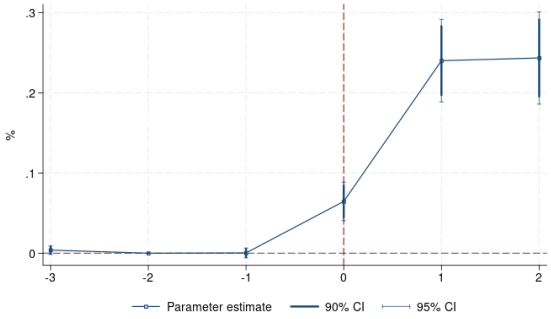
(a) Renegotiation



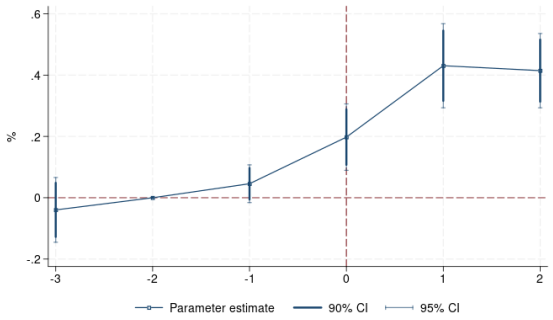
(b) Transfer



(c) Partial Prepayment



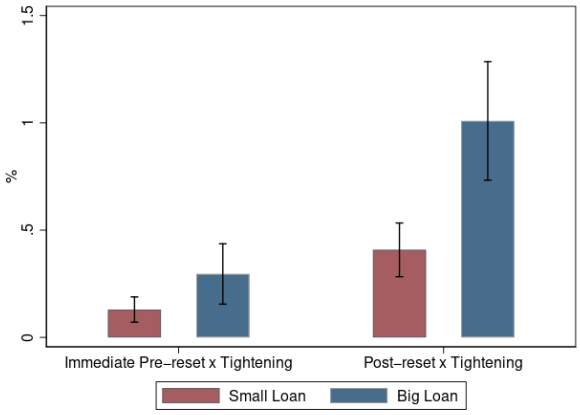
(d) Full Prepayment



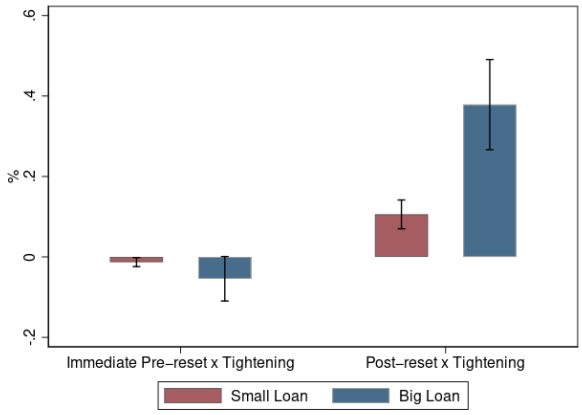
(e) Any Action

This figure presents the point estimates along with the 90% and 95% confidence intervals of β_t in equation (1). The dependent variable in each panel is a mortgage action in each reset (event) month: a dummy variable for renegotiation (Panel (a)), a dummy variable for transfer (Panel (b)), a dummy variable for partial prepayment (Panel (c)), a dummy variable for full prepayment (Panel (d)) or a dummy variable for any action (Panel (e)). All regressions control for loan characteristics (residual maturity, amount outstanding, loan-to-value ratio), debtor characteristics (age group, gender, education group, employment status, and municipality), and calendar month-year fixed effects. Debtor and loan characteristics are measured at the time of the mortgage rate reset. The sample consists of all 6-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023. Standard errors are clustered at the municipality and month-year levels.

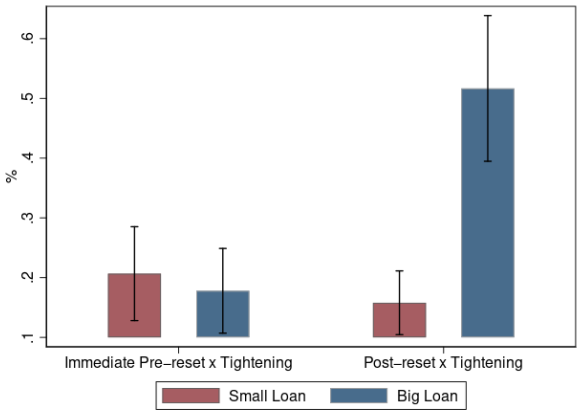
Figure IA.2: Interest Rate Shocks and Household Responses: Amount Outstanding



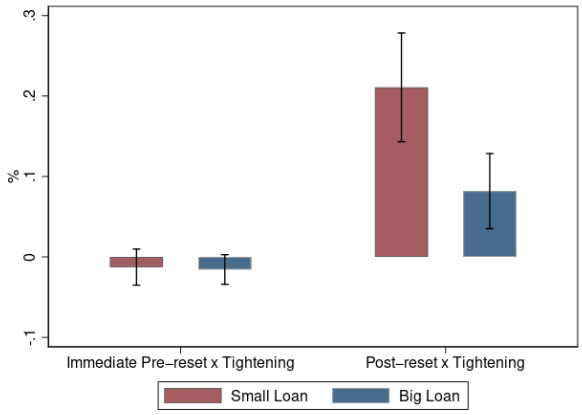
(a) Renegotiation



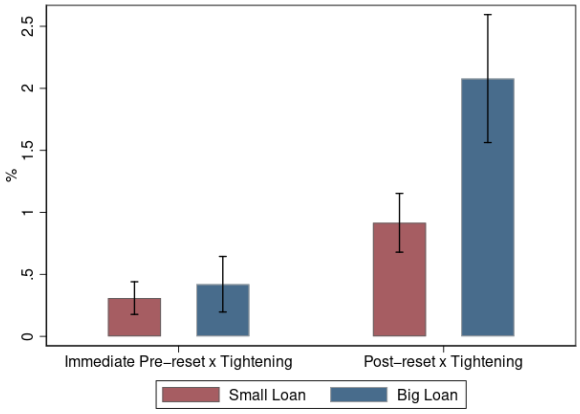
(b) Transfer



(c) Partial Prepayment



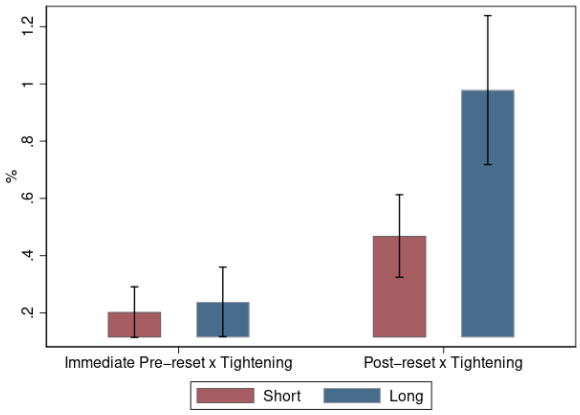
(d) Full Prepayment



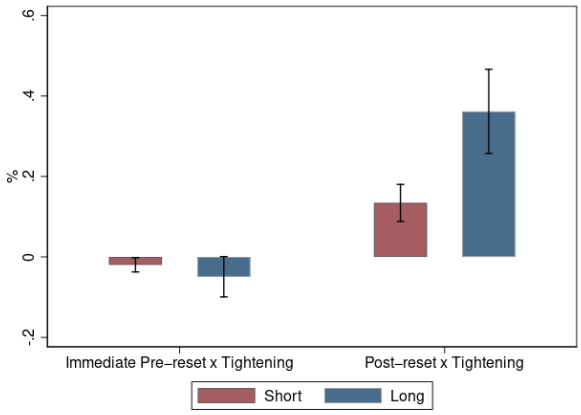
(e) Any Action

This figure presents the point estimates along with the 90% and 95% confidence intervals of β_1 and β_2 from equation (2), estimated separately for households with below-median (low) and above-median (high) mortgage amount outstanding. The dependent variable in each panel is a mortgage action in each reset (event) month: a dummy variable for renegotiation (Panel (a)), a dummy variable for transfer (Panel (b)), a dummy variable for partial prepayment (Panel (c)), a dummy variable for full prepayment (Panel (d)) or a dummy variable for any action (Panel (e)). All regressions control for loan characteristics (residual maturity,amount outstanding, loan-to-value ratio), debtor characteristics (age group, gender, education group, employment status, and municipality), and calendar month-year fixed effects. Debtor and loan characteristics are measured at the time of the interest rate reset. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023. Standard errors are clustered at the municipality and month-year levels.

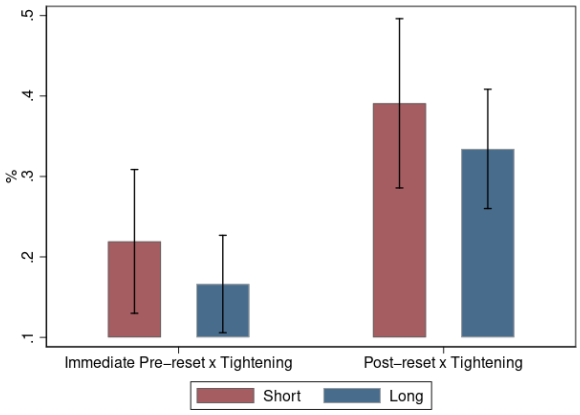
Figure IA.3: Interest Rate Shocks and Household Responses: Residual Maturity



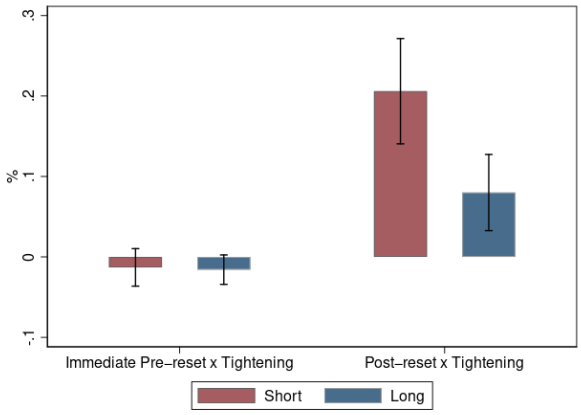
(a) Renegotiation



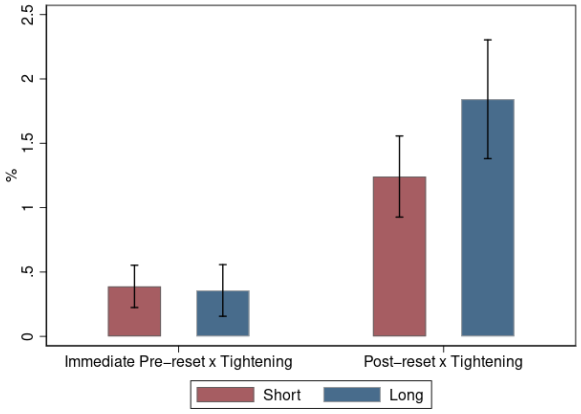
(b) Transfer



(c) Partial Prepayment



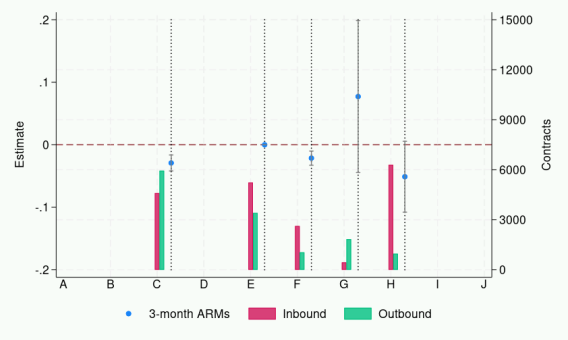
(d) Full Prepayment



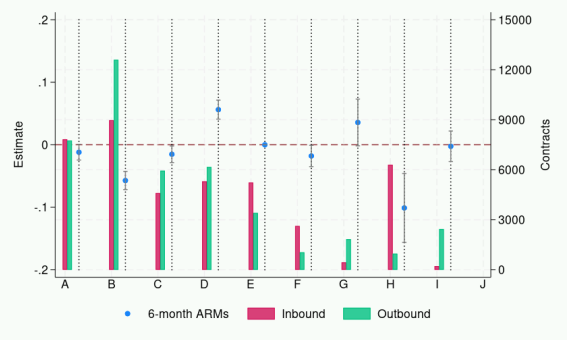
(e) Any Action

This figure presents the point estimates along with the 90% and 95% confidence intervals of β_1 and β_2 from equation (2), estimated separately for households with below-median (short) and above-median (long) mortgage residual maturity. The dependent variable in each panel is a mortgage action in each reset (event) month: a dummy variable for renegotiation (Panel (a)), a dummy variable for transfer (Panel (b)), a dummy variable for partial prepayment (Panel (c)), a dummy variable for full prepayment (Panel (d)) or a dummy variable for any action (Panel (e)). All regressions control for loan characteristics (residual maturity,amount outstanding, loan-to-value ratio), debtor characteristics (age group, gender, education group, employment status, and municipality), and calendar month-year fixed effects. Debtor and loan characteristics are measured at the time of the interest rate reset. The sample consists of all 12-month resettable ARMs issued for owner-occupied properties in Portugal, with at least one interest rate reset occurring between January 2021 and December 2023. Standard errors are clustered at the municipality and month-year levels.

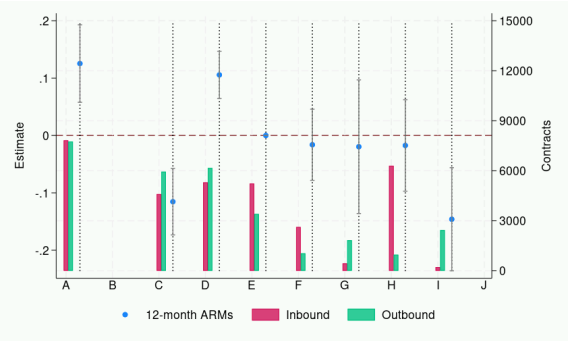
Figure IA.4: Winners and Losers: Mortgage Transfer Flows and Offered Rate



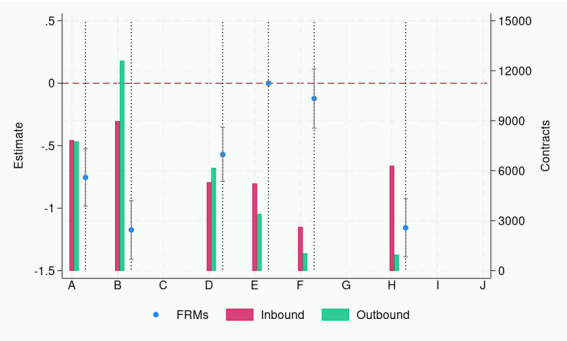
(a) Rates Offered on 3-Month ARMs



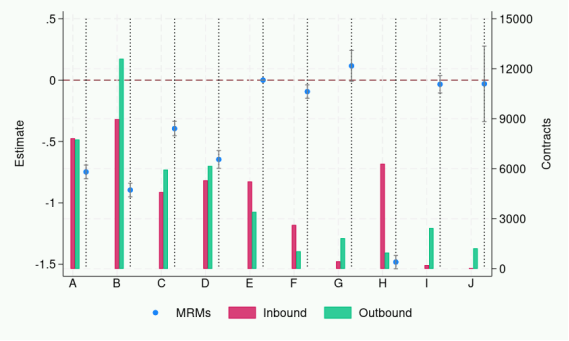
(b) Rates Offered on 6-Month ARMs



(c) Rates Offered on 12-Month ARMs



(d) Rates Offered on FRMs



(e) Rates Offered on MRMs

This figure presents the relationship between lender's mortgage inflows/outflows around the time of the mortgage transfer and their quoted interest rates, identifying competitive winners and losers in the market. It shows inbound (red bars) and outbound (green bars) mortgage transfer flows by bank (right axis), along with point estimates (blue dots) and 95% confidence intervals (vertical lines) of the conditional offered rate by bank, reported relative to the reference bank E. Estimates control for loan characteristics (term-to-maturity, amount outstanding, loan-to-value ratio), borrower characteristics (age group, gender, education level, employment status, municipality of residence), and transfer year–month fixed effects. Results are presented separately for inbound 3-month ARMs, 6-month ARMs, 12-month ARMs, FRMs, and MRMs. Negative coefficients indicate lower offered rates than the reference bank for otherwise comparable loans and borrowers. Rate estimates use inbound transfers only.