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Long-Term Debt and Short-Term Rates: Fixed-Rate Mortgages and Monetary Transmission

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Long-Term Debt and Short-Term Rates: Fixed-Rate Mortgages and Monetary Transmission

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ABSTRACT: We study the two-way relationship between fixed-rate mortgages (FRMs) and monetary policy in a panel of up to 35 countries over the last two decades. The dataset includes quarterly information on the composition of mortgage flows and stock by type of rate-fixation and monetary policy shocks cleaned of information effects. Using instrumental-variable local projections, we find both path- and state-dependency in monetary transmission. Monetary policy shapes mortgage choice, increasing (decreasing) the share of FRMs during easing (tightening) cycles. Over time, this mechanism alters the composition of the outstanding mortgage stock which, in turn, affects the central bank's ability to stabilize the economy ex-post. A greater (lower) prevalence of FRMs weakens (strengthens) monetary policy transmission to key macro-variables.

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1. Introduction

The global economy has recently emerged from the steepest and most coordinated monetary tightening cycle in decades. This episode quickly reversed a long period of historically low interest rates, as many central banks kept policy rates close to zero between 2009 and 2020. As mortgage lending rates declined, many countries witnessed an increase in the prevalence of fixed-rate mortgages (FRMs) relative to adjustable-rate ones (ARMs) during this decade (Figure 1).[1] The share of ARMs quickly picked up again during the post-pandemic tightening cycle. What is the link between monetary policy and the uptake of FRMs relative to ARMs? And to what extent does this matter for monetary transmission going forward?

This paper establishes two key findings. First, we show that monetary policy affects the composition of new mortgages: loosening (tightening) episodes can significantly increase the share of new fixed-rate (adjustable-rate) mortgages in new flows. Over time, this mechanism can significantly affect the composition of the mortgage *stock*. Second, we show that monetary policy pass-through depends on the composition of the outstanding stock of mortgages: fixed-rate mortgages weaken transmission strength and lags. Hence, monetary policy is both path- and state-dependent: changes in policy rates today affect the composition of mortgage loans going forward (path-dependency), which, in turn, determines the relative strength of monetary transmission many years down the line (state-dependency), as mortgages are long-dated contracts.[2]

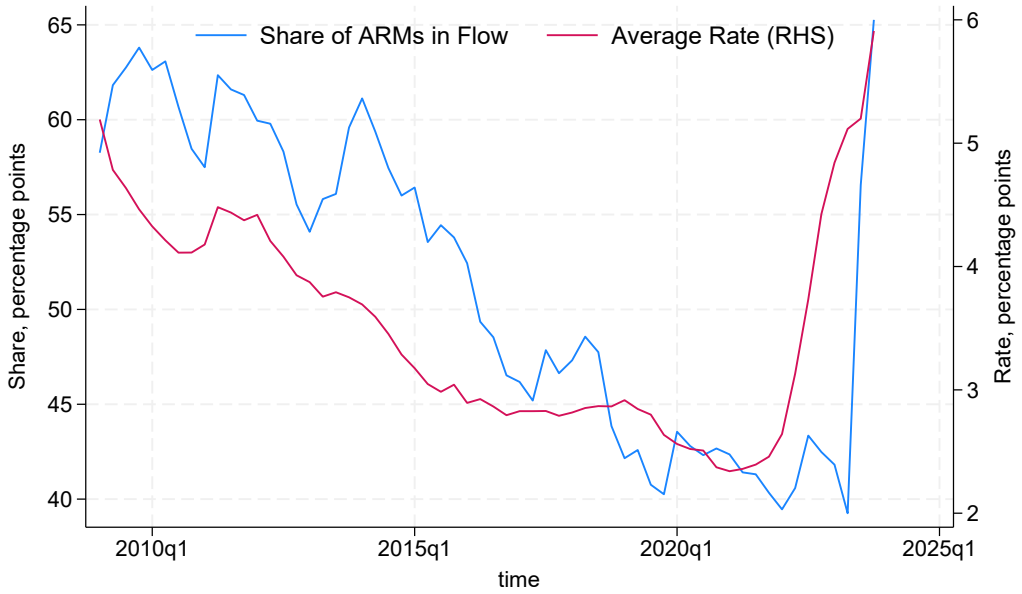
These results are based on a novel dataset, which compiles information on the structure of mortgage markets for an unbalanced panel of countries observed at a quarterly frequency for up to two decades. The dataset includes information on the composition of mortgage *flows*, such as the share of fixed- and adjustable-rate mortgages in new originations and respective interest rates for 27 advanced (AEs) and emerging market economies (EMEs). It also includes novel information on the composition of the mortgage *stock* over time for 35 AEs and EMEs.[3] The latter is, to our knowledge, the first publicly available data source providing information on the composition of outstanding loans, based on data obtained from national central banks. The dataset also contains

[1] By 2020, almost half of all mortgages outstanding across 35 advanced and emerging-market economies were FRMs, up from 40 percent in 2011 (Appendix Figure A1). Data availability precludes us from reporting the 2009 figure.

[2] The mechanism is conceptually similar to the one described by Berger et al. (2021) and Eichenbaum et al. (2022), who show that the capacity of the Fed to stimulate the US economy depends on refinancing incentives for existing FRM borrowers, which are determined by the previous path of interest rates.

[3] For country group coverage, see Appendix Table A1.

Figure 1: *Share of ARMs in new mortgage flows and average mortgage rates*



Notes: Quarterly averages across 27 countries. Shares of ARMs in flow is the average share of adjustable-rate mortgages in new originations. Average Rate is the average interest rate across new FRMs and ARMs. See see Appendix Tables A2 and A3 for coverage, definitions and sources.

country-specific monetary policy shocks based on surprises vis-a-vis analyst forecasts formulated up to the day prior to each monetary announcement cleaned of information effects, which we use to identify the causal effects of policy rate decisions on the structure of mortgage markets and the macroeconomy.

This dataset allows us to make two contributions to the literature. First, to our knowledge, this paper is the first exploring a causal link between monetary policy and the relative composition of mortgage flows. The existing literature shows that the choice of holding a fixed- or an adjustable-rate mortgage depends on relative cost of the two products, as well as on expectations of future interest rates (Badarinza et al., 2018; Koijen et al., 2009). Other aggregate circumstances also play a role. Lower inflation volatility and lower average financial literacy predict higher FRM uptake, as does the use of covered bonds and mortgage-backed securities, beyond the role of credit supply factors (Albertazzi et al., 2024). At the individual level, higher expected inflation also predicts FRM choice (Andersen et al., 2023; Botsch and Malmendier, 2023), as does future income risk (Cocco, 2013) , while a higher propensity to move increases the prevalence of ARMs (Andersen et al., 2023), albeit much variation in mortgage choice remains unexplained.

Using monetary policy shocks as instruments for changes in policy rates in an instrumental-variable local projections (IV-LP) framework (Jordà et al., 2015), we show that loosening

(tightening) episodes make fixed (adjustable)-rate mortgages relatively more popular, all else equal. Quantitatively, our results indicate that a rise (fall) of 100bpp in policy rates increases (decreases) the proportion of ARMs in the flow of new mortgages by 10 percentage points, on average (about two-thirds of the within-country standard deviation in ARM flows in our sample).

This result highlights a potential role for budget constraints in determining mortgage choice. While FRM rates are generally less responsive to monetary policy than ARM rates, borrowing costs on both mortgage types increase (decline) in response to monetary tightening (loosening). As interest rates increase, ARMs become more appealing to consumers, because these mortgages are typically cheaper than fixed-rate ones (Figure A2). By affecting debt servicing ratios and budget constraints, higher (lower) mortgage rates incentivize more (fewer) households to choose ARMs.[4] When interest rates decline and budget constraints become less binding, people tend to choose fixed-rate mortgages relatively more, even though these products are generally more expensive.[5] Our results indicate that changes in the level of interest rates are more important in determining mortgage choice than changes to the spread between FRMs and ARMs.

Our second contribution is to show that these developments can be quantitatively relevant for monetary policy transmission many years down the line. We collect novel and previously proprietary information on the relative composition of the *stock* of outstanding mortgages, for a panel of 35 advanced and emerging market economies. Using this variable in a state-dependent IV-LP framework, we show that the composition of the ex-ante mortgage stock determines the strength and speed of transmission of a change in policy rates to real private consumption. Our preferred specification indicates that six quarters after a 100bpp policy rate increase (decrease) real private consumption drops (increases) 5 percentage points more in a world with only ARMs relative to one with only FRMs, controlling for the level of mortgage debt.

These findings are qualitatively consistent with those in (Calza et al., 2013; Corsetti et al., 2022; Pica, 2021) who show that a higher share of FRMs tends to limit monetary policy transmission in the Euro area, especially where households have more debt and higher homeownership rates.[6]

[4]Indeed, Andersen et al. (2023) find that ARMs are popular not just among wealthy households, but also among low-income and high-debt borrowers, who are plausibly constrained. Bosshardt et al., 2024 show that debt servicing-to-income ratios can be binding constraints at the time of mortgage origination.

[5]This suggests a preference for FRMs over ARMs whenever the budget constraint is not binding, possibly because FRMs shield households from interest rate risk.

[6]A closely-related literature identifies the cash-flow channel of monetary policy using household-level data for specific countries: see Di Maggio et al. (2017) for the US, Jappelli and Scognamiglio (2018) for

We extend these results in two key dimensions. First, we expand the cross-sectional coverage substantially, including countries outside the Euro Area. Beyond ensuring external validity of the result, a broader cross sectional dimension allows disentangling the effects of debt levels from those of the composition of the mortgage stock, and studying the role of asymmetry. Second, we provide a more precise quantification of how the *changing composition* of the mortgage stock within individual countries over time affects transmission strength and response lags. Due to data limitations, the literature generally relies on cross-sectional variation in the share of ARMs in stock, which is assumed to be broadly constant over time (Corsetti et al., 2022; Pica, 2021). We show that the stock of ARMs can change substantially over time, and that within country-variation in this variable is important in explaining differential responses to monetary policy shocks.

This paper proceeds as follows. The following section describes the dataset, defining key mortgage market variables and detailing across countries. Section 3 describes the construction of monetary policy shocks and the empirical framework. Section 4 discusses results for both path and state-dependent effects of monetary policy, and Section 5 briefly concludes.

2. Mortgage data: flows, stocks and interest rates

A key contribution of this paper is the development of a comprehensive dataset covering information on mortgage fixation for a large set of countries over a period of about two decades. This section describes the data and provides descriptive statistics.

The dataset is an unbalanced panel covering a wide set of advanced economies (AEs) and emerging market economies (EMEs), observed at a quarterly frequency for a period of about 15 years, on average. Appendix Table A1 lists the sample of countries. Variables and sources are listed in Table A2.

Among others, two key variables we collect in this dataset are the prevalence of adjustable-rate mortgages in the *flow* of new mortgages and their relative prevalence in the *stock* of outstanding mortgages. We harmonize publicly available data on the composition of new mortgage flows for 27 economies. Data sources and definitions are described in Appendix table A3. While data on flows of new mortgage originations is publicly available for most countries in our sample, data on the composition of the outstanding mortgage stock is not, as most central banks do not publish a breakdown of

Italy, and Flodén et al. (2021) for Sweden.

the outstanding loan stock by fixation period.

To our knowledge, the companion dataset to this paper is the first publicly available data source detailing the composition of the outstanding mortgage stock over time for a broad cross-section of countries. Table A4 details the sources used to construct this variable, and adds some country-specific details. Data is measured at a quarterly frequency and we follow most countries for a period of about 15 years.

A key challenge in the development of this dataset is the definition of what constitutes a fixed-rate mortgage: a loan with fixation period of 3 or 5 years may be considered "fixed" in one country and "adjustable" in another. We choose to harmonize the definition of FRMs to include only mortgages whose rate does not reset for at least 12 months. Hence, an adjustable-rate mortgage is a mortgage which resets within 12 months or less. This classification applies to both the flow and the stock of loans, albeit for flows the definition is based on status at origination, while for stocks the definition is based on residual maturity. This choice is based on data availability: most central banks only collect data on loan composition based on this classification, both for the stock and for the flows of new loans. This is an admittedly short fixation horizon and thus this definition is likely to substantially underestimate the share of adjustable-rate mortgages in our sample. For example, mortgages due to have a rate reset within 2-5 years from origination are classified as FRMs. Nevertheless, this definition is consistent over time, allowing us to correctly capture within-country trends. Moreover, the use of a common definition allows cross-country comparisons which would otherwise be impossible, if we adopted a country-specific definition.

Table A5 details this and other mortgage market characteristics. It includes a snapshot of the share of FRMs in the flow new mortgages, share of FRMs in the outstanding loan stock, average fixation periods at origination, and availability of a free-prepayment option for fixed-rate loans.

The relative prevalence of fixed and adjustable rate mortgages varies significantly across time and countries in our sample. This is true for both the flows of new mortgages and the outstanding stock; these variables are related, but not necessarily equivalent, for a three reasons. First, mortgages are long-dated liabilities: even a very high share of new ARM originations may take decades to translate in a large amount of ARMs in stock, and vice versa. Second, the characteristics of new originations can be highly volatile within individual countries (Figure A3), so even persistent trends in flows can revert relatively quickly. Third, given the differences in definition (origination vs. residual

maturity), flows and stocks do not necessarily map onto one another over time. This because a loan which is classified as FRM at origination (because its rate resets in more than 12 months) may eventually be classified as an ARM for the purpose of the mortgage stock, once it reaches the end of its reset period. As a result of these three factors, some countries may witness very high shares of new FRM originations for a few years, in relative terms, without seeing any significant changes in the composition of the stock of loans (Figure A4). One key example is the United States around the early 2000s, where the share of new ARMs in originations increased substantially for a few years, but the overall composition of the stock remained broadly stable. In other countries, instead, the volatility of flows can translate in steep changes in the volumes of outstanding loans within a few years (e.g., United Kingdom).

One common trend in our sample is the steep decline in new ARM originations after 2009 (Figure 1). The share of ARMs in new originations falls steadily throughout this decade, in parallel with the historical decline in interest rates. More recently, ARMs gained popularity, in parallel with the dramatic increase in interest rates during the post-pandemic hiking cycle.

These developments cannot be easily attributed to the spread in borrowing costs between the two types of mortgages: the difference in interest rates charged on new FRMs and ARMs remained broadly constant between 2010 and 2020 and narrowed down to virtually zero, on average, since 2020 (Figure A2).[7] By compiling and harmonizing novel data on the share of ARMs in stock, we are able to show that these developments have a significant bearing on the composition of outstanding mortgages, over time. The share in ARMs in stock declined slowly but steadily in many countries over the past decade (Figure A1).

3. Methodology

This section describes how we identify exogenous monetary policy shocks, based on deviations of actual policy rates from analyst expectations collected just before the policy decision. It also describes how we use these shocks to study the effects of changes in policy rates on the relative composition of mortgage flows and the role that the changing composition of the mortgage *stock* plays in the transmission of policy rates to the real economy.

[7]Lending rates for FRMs/ARMs are defined as average interest rates on newly issued FRMs in any given quarter, following the respective definitions outlined in Appendix table A3.

3.1. Monetary policy shocks

The literature on high-frequency identification of exogenous monetary policy changes relies on intra-day changes of a set of market interest rates around the time of a monetary policy announcement. The window is typically set within several minutes, typically 30, to assure that the only major news affecting market rates is the announcement itself.[8] Unfortunately, this literature has only produced shocks for a small set of countries, in part because many countries, particularly smaller advanced economies or emerging markets, don't have sufficiently liquid trading across the yield curve to make such narrow trading bands meaningful. A panel dataset which includes monetary policy shocks for a broad set of countries is the Macro History Database, used for example in Jordà et al. (2015). This database exploits the traditional trilemma of monetary policy to identify exogenous changes in local policy rates, based on changes in interest rates in the peg currency. As pegs are relatively uncommon in our sample, we cannot exploit the same intuition.

Instead, we rely on a different approach, closer in spirit to high-frequency identification of monetary policy shocks. We measure monetary policy *surprises*, by comparing the actual policy rate decision taken by central banks with professional forecasters' ex-ante expectations of the same policy rate decisions.[9] In recent work, Sandri et al. (2024) construct monetary policy surprises for a wide group of emerging markets by relying on forecasts collected by Bloomberg.[10] We follow the same approach (also used in IMF, 2024), to define monetary policy *surprises* as the difference between actual monetary policy announcements and the average forecasts submitted to Bloomberg by professional analysts up to the day prior to the corresponding announcement. The dataset of monetary surprises includes an unbalanced panel of 16 countries with independent monetary policy in addition to 19 countries in the Euro Area or pegged to the euro, starting as early as 1998, observed at a monthly frequency.[11]

In a second step, we follow Bauer and Swanson (2023) (BS23, henceforth) and purge monetary policy surprises from recent economic news and local equity market dynamics

[8] See Brennan et al., 2024 and Bauer and Swanson, 2022, for recent examples and a review of the literature and methods.

[9] This approach has been used for some time in the case of emerging markets, see Meyer de P. (2006) or Pescatori (2018) for the case of Chile, exactly because of the drawbacks mentioned in the previous paragraph.

[10] Deb et al. (2023) also construct surprises based on deviations of actual and forecasted policy rates, but the forecasts of interest rates they use lag announcements up to several months.

[11] Series for EMs are based on data used in Sandri et al. (2024), kindly shared by the authors. In rare cases where there was more than one announcement per month — less than 2 percent of the sample -– policy rate surprises are averaged at the monthly level and the date for the last announcement is retained.

to account for the "central bank reacting to information" effect. BS23 argue that orthogonalizing measures constructed from high-frequency data with respect to past economic news, which are themselves predictive of changes in expectations about monetary policy and key macro-variables, can help resolve the often puzzling estimated reactions to monetary policy in the literature for the United States. As regressors, they use past monthly surprises of: (i) GDP, (ii) core CPI, (ii) unemployment, (iii) payrolls, and (iv) an index that summarizes all releases; and actual changes in: (i) expected core CPI, (ii) core CPI itself, (iii) the stock market index, (IV) the yield curve slope and (v) commodity prices.

While some of the control variables used by BS23 are not available for all countries in our sample, we follow a similar approach to obtain orthogonal monetary policy *shocks*. We regress Bloomberg policy rate surprises for each country and each announcement on the two prior quarterly real GDP growth surprises (typically occurring within 6 months prior to each announcement), the 6 prior monthly inflation surprises (again typically occurring within 6 months prior to each announcement), and the change in the national stock price index over the 6 months prior to the announcement (see Appendix A.1 for more details).

Specifically, we run the following regression for each country c, announcement on day a and count of prior RGDP or inflation announcements $-j$:

$$r_a^c - \mathbb{E}r_a^c = \alpha^c + \sum_{j=1}^{2} \beta_j^c \left(RGDP_{a,-j}^c - \mathbb{E}RGDP_{a,-j}^c \right) + \sum_{j=1}^{6} \gamma_j^c \left(\pi_{a,-j}^c - \mathbb{E}\pi_{a,-j}^c \right) + \delta S_{a-181,a-1}^c + \epsilon_a^c \qquad (1)$$

Where $r_a - \mathbb{E}r_a$ are the surprises measured as the difference between the actual announced policy rate and the mean analyst forecasts from Bloomberg. $RGDP_{a,-1} - \mathbb{E}RGDP_{a,-1}^c$ and $RGDP_{a,-2} - \mathbb{E}RGDP_{a,-1}^c$ are two surprises prior to announcement a in RGDP growth, where surprises comprise the difference between the actual release value for real GDP and the mean of analyst forecasts available from Bloomberg;$\pi_{a,-1...-6} - \mathbb{E}\pi_{a,-1...-6}^c$ are six surprises prior to announcement a in monthly inflation, defined as done for RGDP, also from Bloomberg; and $S_{a-181,a-1}$ is the change in the national stock price index on the day prior to each policy announcement relative to its value 180 days earlier.[12]

The resulting residuals can be thought of as measures of monetary policy *shocks* that are independent from (orthogonal to) past surprises of real GDP and inflation, and actual changes in the stock market. In other words, these shocks measure the unexplained component of monetary policy surprises, or the component of monetary policy announce-

[12] All our results are robust to the use of simple surprises, rather than orthogonalized shocks.

ments cleaned of information effects. The shocks are positively correlated (0.58) with shocks identified with high-frequency data from the literature for 5 major economies (see Appendix Figure A5). Finally, shocks are aggregated to the quarterly frequency, to align them with the rest of our dataset.[13]

3.2. Path and state dependent effects of monetary policy

Our empirical approach relies on using exogenous monetary policy shocks to estimate the effects of monetary policy on mortgage markets; and in turn how the changing composition of mortgage markets over time affects the transmission of monetary policy to other outcomes. We do this using two different specifications.

First, to study the effects of monetary policy on mortgage *flows*, we apply a standard instrumental-variable local projection (IV-LP) to our panel dataset, following Jordà et al., 2015:

$$y_{c,t+h} - y_{c,t-1} = \alpha^h + \beta_1^h \widehat{Deltarate_{c,t}} + \sum_{l=0}^{3} \beta_l^h X_{c,t-l} + \sum_{l=1}^{4} \rho_l^h \Delta y_{c,t-l} + \varepsilon_{c,t+h}^h \quad (2)$$

Where $y_{c,t+h} - y_{c,t-1}$ is the cumulative change in outcomes y between quarter $t-1$ and quarter $t+h$ with $h = 0, ..., 8$. Outcomes include the share of ARMs in new mortgage originations, interest rates on ARMs and FRMs, or the yields on government bonds.[14]

$Deltarate_{c,t-1}$ is the key variable of interest, measuring the (lagged) change in country c policy rate.[15] As the change in policy rates is obviously endogenous to the outcomes we are interested in studying, we instrument it with country-specific monetary policy shocks constructed as described in subsection 3.1. The vector $X_{c,t-l}$ contains contemporaneous and 3 lags of (log) changes in real GDP, CPI, nominal house prices, real private consumption, and household debt. In addition, equation (2) controls for four lags of (log) changes in the dependent variable.

In a second set of results, we study how monetary policy transmission to aggregate outcomes *depends* on a country's ex-ante degree of mortgage fixation. To do so, we

[13] Whenever a given currency is pegged to a major pegging currency, we use monetary policy shocks for the major pegging currency as a measure of monetary policy shocks for the pegged currency. See Appendix A.1 for more details.

[14] We also study other macroeconomic outcomes, such as real GDP, real private consumption, among others, to show that this specification delivers expected responses to outcomes usually studied in the literature.

[15] For example, this is the upper bound of the Federal Funds target rate for the Federal Reserve, or the main refinancing rate for the European Central Bank.

augment equation (2) with an interaction term, aimed at capturing the state-dependent (differential) effects of a change in policy rates depending on the relative prevalence of ARMs in the outstanding debt-to-GDP stock. Specifically, we use an IV-LP model of the form:

$$\begin{aligned} y_{c,t+h} - y_{c,t-1} =& \alpha^h + \beta_1^h \widehat{Deltarate_{c,t} \times ARMdebt_{c,t-1}} + \beta_2^h \widehat{Deltarate_{c,t}} \\ &+ \beta_3^h ARMdebt_{c,t-1} + \sum_{l=0}^{3} \beta_l^h X_{c,t-l} + \sum_{l=1}^{4} \rho_l^h \Delta y_{c,t-l} + \theta_t^h + \gamma_c^h + \varepsilon_{c,t+h}^h \end{aligned} \tag{3}$$

Where $y_{c,t+h} - y_{c,t-1}$ are cumulative changes in real GDP, real private consumption, durables consumption, and real house prices. Everything else is defined as in equation (2), except for the introduction of an interaction term, which allows changes in monetary policy to have a different effect on outcomes depending on the ex-ante levels of a state variable *ARMdebt*. In this equation, β_1 is the main coefficient of interest, measuring the differential effect of 100bpp change in policy rates for each percentage point increase in *ARMdebt* measured one quarter before the monetary policy intervention. *ARMdebt* is the share of adjustable-rate mortgages in the *stock* of debt, rescaled to be expressed as a proportion of a country's household debt-to-GDP ratio.[16]

We rescale the share of ARMs by household debt-to-GDP ratios because the importance of ARMs for monetary transmission depends crucially on how much households borrow and on how many households have a mortgage in the first place.[17] For example, if only a small percentage of the population had a mortgage, monetary transmission through the cash flow channel of monetary policy (Di Maggio et al., 2017; Flodén et al., 2021) could be muted even if the entire mortgage stock was comprised of adjustable-rate loans, as fewer households would feel the effects of changing interest rates in their monthly debt servicing ratios. Conversely, even small increases in the share of ARMs in stock may have important implications for monetary policy transmission, in a setting where mortgage debt is more prevalent.

While our preferred specification combines the two variables—the share of ARMs out of the stock of mortgages and the level of debt-to-GDP—, we also provide results for models in which the two variables are included separately, and a horse-race model with two included simultaneously. Following Jordà et al., 2015 we use Driscoll-Kraay

[16] In countries where the ARM share is expressed as share of total mortgages the variable *ARMdebt* is likely to understate the share of adjustable-rate mortgages in the debt-to-GDP ratio, since mortgage debt is always a subset of household debt.

[17] Pica (2021) makes a similar point on homeownership rates.

standard errors with 3 lags, which are robust to cross-sectional dependence and autocorrelation.[18]

4. Results

This section presents results for the two areas of focus of the paper: path and state-dependent effects of monetary policy. First, we compare our findings to those in the existing literature on mortgage choice, showing that short-run cost minimization is highly correlated with the choice of mortgage fixation, in our sample. Second, we show how monetary policy affects the relative composition of mortgage flows, via its role in shaping mortgage interest rates. Finally, we show how these changes in mortgage flows can affect monetary policy transmission many years down the line, since the composition of the mortgage stock has implications for the relative strength of monetary transmission. We conclude the section with a brief and more tentative discussion of asymmetry, and the role of refinancing options.

4.1. Taking stock of the literature: interest rates, spreads and mortgage choice

What drives mortgage choice across countries and over time? The literature on ARM choice is relatively small. Existing contributions highlight how, beyond individual circumstances such as life-cycle considerations and moving propensity (Andersen et al., 2023), the time series and cross-sectional variation in the relative prevalence of ARMs is positively correlated with the spread between FRM and ARM rates (Badarinza et al., 2018) and negatively correlated with expectations of future rates, or inflation (Andersen et al., 2023; Botsch and Malmendier, 2023; Koijen et al., 2009).

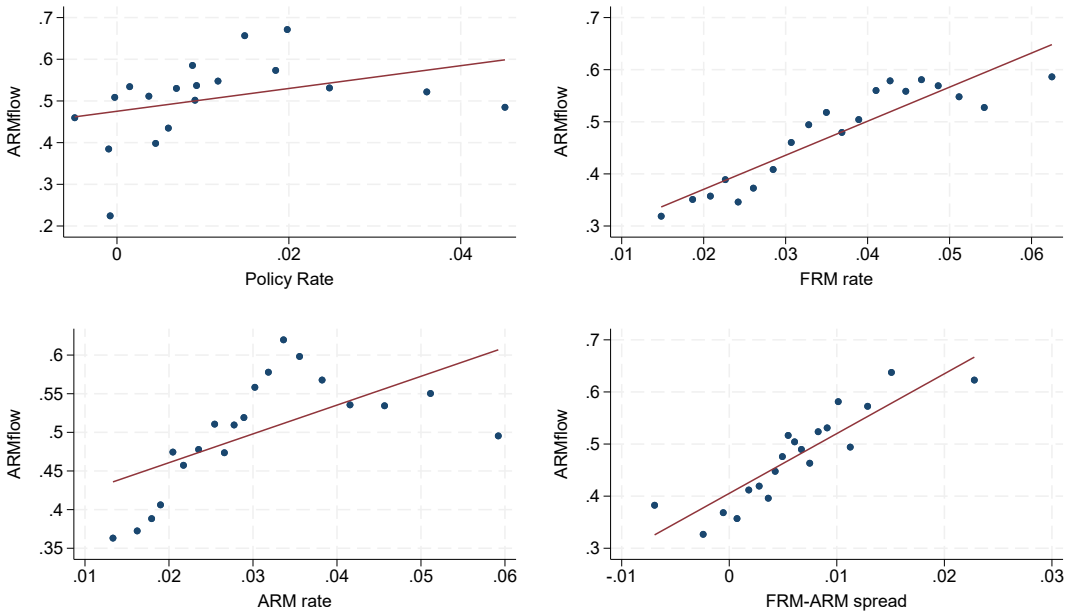
Our dataset considerably expands the cross-sectional dimension, relative to existing studies.[19] Simple time-series correlations in Figure 2 suggest that, indeed, the level of borrowing costs may be an important determinant of the relative prevalence of fixed vs. adjustable-rate mortgages over time. On average, the share of adjustable-rate mort-

[18] We also test an alternative specification which includes robust standard errors clustered at the quarter level and show that the significance of the IRFs is robust to this choice.

[19] Andersen et al. (2023) and Koijen et al. (2009) focus only on cross sectional variation among Danish households and on time series variation in US data, respectively. Badarinza et al. (2018) expands the analysis in Koijen et al., 2009 by focusing on nine countries, all advanced economies. In this subsection, the panel is composed of 27 advanced and emerging market economies, for which we collect information on the flow of new mortgage originations.

gages in new mortgage flows correlates weakly with policy rates over time (panel a), but strongly with average interest rates on new fixed-rate mortgages (panel b), with the spread between rates on fixed-rate and adjustable-rate mortgages (panel c) and, albeit non-linearly, with ARM rates (panel d).

Figure 2: *Correlation between the share of new adjustable-rate mortgages and the level of interest rates (within country)*



Notes: This figure presents results of a linear regression of the share of ARMs in the flow of new mortgages as a dependent variable, and different interest rates on the right-hand side. Clockwise: policy rates (a); rates on fixed rate mortgages (b); spread between fixed and adjustable rate mortgages(c); rates on adjustable rate mortgages (d). Each dot represents an average across 50 data points around the interval shown and the line represent the linear fit. Country fixed-effects are included. The panel includes 26 advanced and emerging market economies. For details see Appendix Table A1

Table 1 runs a similar regression model as in Badarinza et al. (2018), Table 5. This is a test of how flows of new ARMs relate to two key variables: the current spread between FRM and ARM rates (*spread*), and the difference between current FRM rates and a measure of *expected* future ARM rates. Following Badarinza et al. (2018) we construct this second measure as the difference between FRM rates observed at any given point in time and the average ARM rates observed over the *previous* year.[20] We refer to this second variable as *risk premia*, following Koijen et al. (2009).

Badarinza et al. (2018) use these two variables to test whether the dominant model of mortgage choice is one aimed at minimizing current interest cost or one driven by ex-

[20]Koijen et al. (2009) use this variable as a measure of the difference between current FRM cost and expected future ARM cost. Under a model of adaptive expectations, recently observed ARM rates are a good proxy for near-term expectations of future ARM rates.

pectations of future rates/risk premia. Under a dominance of current cost minimization, the coefficient on the *spread* should be positive, significant, and larger than the coefficient associated with *risk premia*; if instead expectations of future developments in rates matter more for mortgage choice, the opposite should be true. Their results, based on a sample of 9 countries, suggest that the short-run cost minimization trumps the role of expectations of future rates.

We test these predictions in our sample, which broadens the sample used in Badarinza et al. (2018) by including 27 advanced and emerging-market economies for which we are able to collect time-varying information on the composition of new mortgage flows. Columns 1-3 in Table 1 present a similar model to the one in Table 5 of Badarinza et al. (2018). Consistently with their findings, current FRM-ARM *spread* is positively correlated with the share of ARMs in new originations (column 1). This seems reasonable, as a larger spread today implies that FRMs are relatively more expensive than ARMs, hence ARMs should become more appealing, all else held equal. Similarly, higher *risk premia* are positively correlated with the flows of ARMs (column 2) in isolation, albeit when controlling for current spreads they lose significance and turn negative (in column 3). Similar to the findings in Badarinza et al. (2018), this suggests that short-run interest rate minimization is dominant, in this sample.

In column 4, we move one step beyond Badarinza et al. (2018) and test how these correlations hold when controlling for the contemporaneous *level* of borrowing costs, beyond the relative difference in pricing (or expected pricing) between mortgage products. This is because, if short-run cost-minimization is the relevant model predicting mortgage choice (or, put differently, the relative tightness of household budget constraints is a key determinant of mortgage choice), it is likely that the *level* of interest rates will be a key predictor of the relative composition of mortgage flows. Typically, FRMs are more expensive than ARMs (Figure A2), as banks charge a positive spread for providing households insurance against interest rate risk. Hence, when mortgage rates are higher, households may demand more adjustable-rate mortgages simply because the cost of fixed-rate loans becomes unaffordable relative to their monthly budgets. In fact, people may even face a binding budget constraint and be forced to choose ARMs as interest rates increase.[21]

In column 4, we test this intuition and show that the level of borrowing costs (proxied

[21]Indeed, Bosshardt et al., 2024 show that many potential borrowers were pushed above underwriting debt-to-income thresholds as interest rates rose, which generated a substantial decline in home purchasing activity in 2022 and 2023, especially among low-income groups.

by the rate on newly issued FRMs) is significantly correlated with ARM flows beyond current FRM-ARM spread and risk premia. Higher (lower) borrowing cost correlates with a higher share of ARMs (FRMs) in new mortgage originations, holding macroeconomic developments and relative pricing constant.

The findings in Table 1 are overall consistent with the notion that households decide on whether to borrow mortgages under adjustable rates using a cost-minimization rationale and that the level of borrowing costs plays a key role in these decisions, although results so far are merely associations and should not be interpreted causally. The next section explores formally how monetary policy affects interest rates, spreads and mortgage choice.

Table 1: *Interest spreads, risk premia, and the share of new adjustable-rate mortgages*

	(1)	(2)	(3)	(4)
VARIABLES	ARMflow	ARMflow	ARMflow	ARMflow
Spread	8.191***		9.141***	8.752***
	(0.559)		(1.067)	(1.210)
Risk premia		6.213***	-0.979	-3.237***
		(0.472)	(1.124)	(1.125)
FRM rates				3.149***
				(0.851)
Observations	1,354	1,354	1,354	1,354
R-squared	0.907	0.902	0.907	0.908
Time FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Notes: Spread is defined as (FRMrates - ARM rates). Risk premia is the difference between current FRM rates and the avg ARM rate over the previous year. FRM rate is the average mortgage rate on new FRM loans at any given point in time. Controls include (log) nominal house prices, CPI, real GDP, real private consumption, household debt levels. Country and quarter FE included. Heteroskedasticity-robust SEs are clustered at the quarter level.

4.2. Path dependency: monetary policy and mortgage choice

Koijen et al. (2009) and Badarinza et al. (2018) discuss how the relative pricing of mortgage products and expectations about the future affect mortgage choice. Yet, neither addresses directly the role of monetary policy in shaping these decisions. This section explores how monetary policy affects mortgage fixed and adjustable rates, the relative spread between the two, and the share of ARMs in new mortgage originations.

Figure 3 displays results of equation (2), or the response of various interest rates and of ARM flows to a change in policy rates, instrumented with well-identified monetary policy shocks.

Mortgage rates react almost instantaneously to a change in monetary policy rates. Rates on fixed-rate mortgages increase (decrease) by 0.5pp, for each percentage point rise (fall) in policy rates. The response of FRM rates over time is similar to the response of long-term government bonds, consistent with findings in Kaminska et al. (2021). ARM rates respond more to changes in monetary policy, increasing almost one-on-one with the change in policy rates. The responses in ARM rates are similar to changes in the yields on short-term government bonds, to which these mortgages are typically indexed. All rates revert back to their initial level after about 4-6 quarters. [22]

Since ARM rates respond more than FRM rates to changes in monetary policy, the spread between FRMs and ARMs declines (increases) by about 0.5pp for each percentage point increase (decline) in policy rates. Given that relative pricing across mortgage products is an important factor in determining mortgage choice (Badarinza et al., 2018), a decline (increase) in FRM-ARM spreads following tightening (loosening) could in principle make ARMs less (more) appealing. In contrast with this prior, the share of ARM flows increases (declines) significantly following monetary tightening (loosening), in this sample. Figure 3 shows that ARM flows increase (decrease) significantly after monetary tightening (loosening): a one percentage point increase (decline) in policy rates increases (lowers) the relative prevalence of ARMs in new originations by 10 percentage point after one year, on average. This is a large effect, as it corresponds to about two thirds of a within-country standard deviation in ARM flows in this sample.

This finding could potentially highlight a role played by budget constraints, in addition to short-run cost minimization. Tightening increases the *level* of borrowing costs on all mortgage products, not just ARMs. Even as the spread between FRMs and ARMs declines, interest rates on FRMs increase significantly following tightening, making them more expensive than before. Moreover, FRMs in general carry higher interest rates than ARMs at any given point in time, as banks charge a premium to shield consumers from interest rate risk (Figure A2).

As a result, consumers may have a stronger incentive to choose ARMs after monetary

[22] Appendix figure B1 provides a reality check on the model and on monetary policy shocks, plotting the results of equation (2) using other macroeconomic aggregates as outcomes. Responses in GDP, house prices, household debt levels and real private consumption all have the expected signs and significance.

tightening, as these mortgages remain relatively more affordable than FRMs.[23] This is in principle consistent with a cost-minimization framework, where consumers choose mortgage products based on a simple rule, aimed at minimizing mortgage payments in the short run. Yet, it can also reflect the behavior of rational borrowers facing a binding budget constraint, which forces them to choose the cheaper of two mortgage products following tightening episodes.[24]

Conversely, as borrowing costs decline following monetary loosening, affordability concerns become less prominent making the ARM option relatively less attractive. Our empirical framework does not allow us to tease out the exact channels behind this result. However, the fact that FRM originations increase after loosening episodes, despite rising FRM-ARM spreads and despite the fact that FRM remain overall more expensive than ARMs, cannot be easily explained by short-run cost minimization. Instead, this result suggests a general preference for FRMs over ARMs whenever the budget constraint is less binding, possibly because FRMs shield households from interest rate risk.[25]

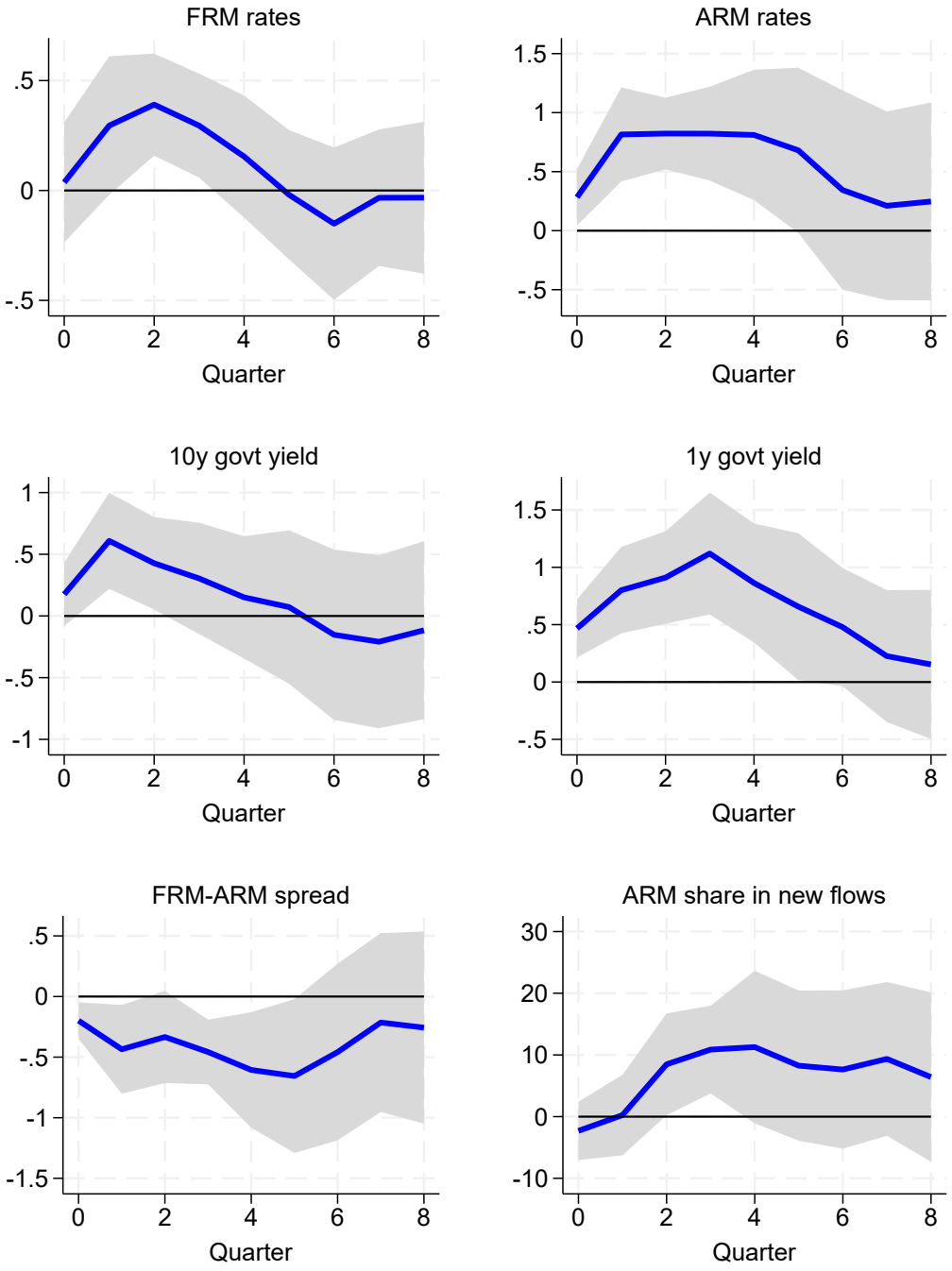
Over time, these changes can significantly affect the composition of the outstanding mortgage *stock*, within individual countries. A 100bpp increase (decline) in policy rates increases (reduces) the share of ARMs in stock by about 4 percentage points within 12 quarters, with the effect persisting for up to 20 quarters (Appendix Figure B2). This effects corresponds to about 50 percent of a within-country standard deviation in this sample.

[23]The FRM-ARM spread declines on average by about 0.5pp on average following a 1pp increase in policy rates (Figure 3). However, the average spread between FRMs and ARMs in our sample at any given point in time is about 1pp (Figure A2). This suggests that, on average, FRMs would remain 0.5pp more expensive than ARMs following a 1pp tightening episode.

[24]Indeed, Andersen et al. (2023) show that ARMs are relatively more popular among borrowers who are plausibly liquidity-constrained.

[25]Bosshardt et al. (2024) argue that regulatory limits on debt servicing ratios became binding constraints for US borrowers following the post-pandemic tightening episode. While they do not find evidence that US borrowers reacted to shifting DTI constraints by choosing relatively more ARMs on the margin, this mechanism can be quantitatively relevant in countries where ARMs are generally more prevalent.

Figure 3: *Monetary policy, interest rates and mortgage choice*



Notes: This figure shows the results of equation (2), using different dependent variables. Top to bottom, left to right: rates on new FRMs; rates on new ARMs; yields on 10y government bonds; yields on 1y government bonds; spread between FRM-ARM rates; and flow of newly originated ARMs. Controls include four lags of (log) changes in the dependent variable, nominal house prices, CPI , GDP, real private consumption, and household debt levels and four lag of changes in the FRM-ARM spread. Country and quarter FE included. Shaded areas represent 90 percent confidence intervals based on Driscoll-Kraay SE with 3 lags. Kleibergen-Paap Wald F statistic in first stage is equal or greater than 34. See Appendix Table A7 for the first stage regressions.

4.3. State dependency: monetary policy and stock of adjustable-rate mortgages

The previous subsection shows that the recent path of monetary policy affects the extent to which new mortgages are predominantly fixed or adjustable-rate. This sub-section considers the implications of these changes for the relative strength of monetary policy transmission to consumption, GDP and other macroeconomic aggregates.

The left column in Figure 4 plots results of equation (3) using real house prices, real private consumption and durables consumption and real GDP as dependent variables. The blue lines on the left column plot the coefficient β_1 in equation (3), or the marginal effect of 100bpp change in policy rates for each percentage point increase in the state variable *ARMdebt*. This state variable measures the ex-ante share of outstanding ARMs (expressed as a proportion of household debt-to-GDP ratios), at any given point in time.

Figure 4 highlights how monetary policy transmission to some key aggregate variables is significantly weaker (stronger) when the stock of ARMs is lower (higher). For example, the same 100bpp tightening (loosening) of policy rates leads to a decline (increase) in real private consumption which is about 0.05 percentage points larger for each additional percentage point increase in the share of ARMs as a proportion of GDP. These differential effects are noticeable after six quarters, while differential effects in durables consumption are noticeable after two quarters. The differential effect on real GDP is quantitatively comparable with the response in consumption.

The differential responses plotted in figure 4 show the marginal effect of the changing stock of ARMs expressed as a share of household debt-to-GDP ratios, hence these results potentially combine two separate mechanisms. The first is the role that mortgage rate resets play *in isolation* in determining pass-through to consumption for a given level of household indebtedness: the literature refers to this mechanism as the cash flow channel of monetary policy (Di Maggio et al., 2017; Flodén et al., 2021). The second is the effect that household debt-to-GDP ratios themselves play in affecting transmission of monetary policy to aggregate outcomes. These effects could go beyond the role of a simple cash flow channel, for example because more indebted households may be more sensitive to changes in interest rates, in general, and more likely to respond to collateral and wealth effects related to house price developments (Calza et al., 2013; Cloyne et al., 2020). Ex ante, one would expect the cash flow channel to be more relevant for household spending and aggregate activity, than for house prices. On the other hand, the level of household debt relative to GDP could be important both for aggregate activity and for

house prices, since rising interest rates may affect home purchasing activity, as well as house valuations of existing homeowners, thereby affecting their spending through wealth and collateral effects(Mian et al., 2013).

To tease out these separate mechanisms, the right-hand column of figure 4 presents a horse-race model between the share of ARMs in stock and household debt-to-GDP ratios. We do this by augmenting equation (3) with two separate interaction terms.

Figure 4 shows household-debt-to GDP ratios matter for the relative strength of monetary policy transmission to durables consumption, which declines more in response to a tightening in policy rates depending on ex-ante debt levels in the economy. This potentially reflects the greater reliance of durables' consumption on credit, which would determine a steeper drop (increase) in spending on these items as interest rates increase (decline). On the other hand, the share of ARMs as a proportion of total mortgages is relevant for transmission to GDP and both measures of private consumption. This is consistent with the notion that the relative prevalence of ARMs affects monetary transmission predominantly through the cash-flow channel, or the role that interest rate resets play in affecting existing homeowners' disposable income flows via interest rate resets on existing mortgages. The greater the prevalence of ARMs in stock, the more consumers will feel the effects of a change in policy rates in their monthly budgets, which will affect their spending propensity in general. As interest rates increase (decline), an economy with more ARM borrowers is likely to witness a steeper drop (increase) in overall consumption.

Quantitatively, the coefficients plotted in figure 4 suggest that, for a given level of household debt, the same 100bpp policy rate increase will be 0.05pp more effective in reducing real private consumption 6 quarters ahead for each percentage point increase in the share of ARMs in stock.[26] These estimates are meaningful, as they correspond to exactly one standard deviation in cumulative real private consumption changes at 6 quarters, in this sample. A simple back-of-the-envelope calculation based on these coefficients suggests that, for a given level of household debt-to-GDP, the same 100 basis points increase (decrease) in policy rates induces a consumption response that is 5 percentage points stronger in a world with 100 percent ARMs relative to one with only FRMs.

These effects are likely to be particularly pronounced during tightening cycles, when refinancing incentives are limited (Berger et al., 2021; Eichenbaum et al., 2022). An

[26]The differential response in real GDP is about half of this magnitude (0.02 percent).

asymmetric specification suggests that, indeed, FRMs are a greater impairment to transmission during a tightening relative to a loosening phase, especially if free prepayment options are available to borrowers.[27]

5. Conclusions

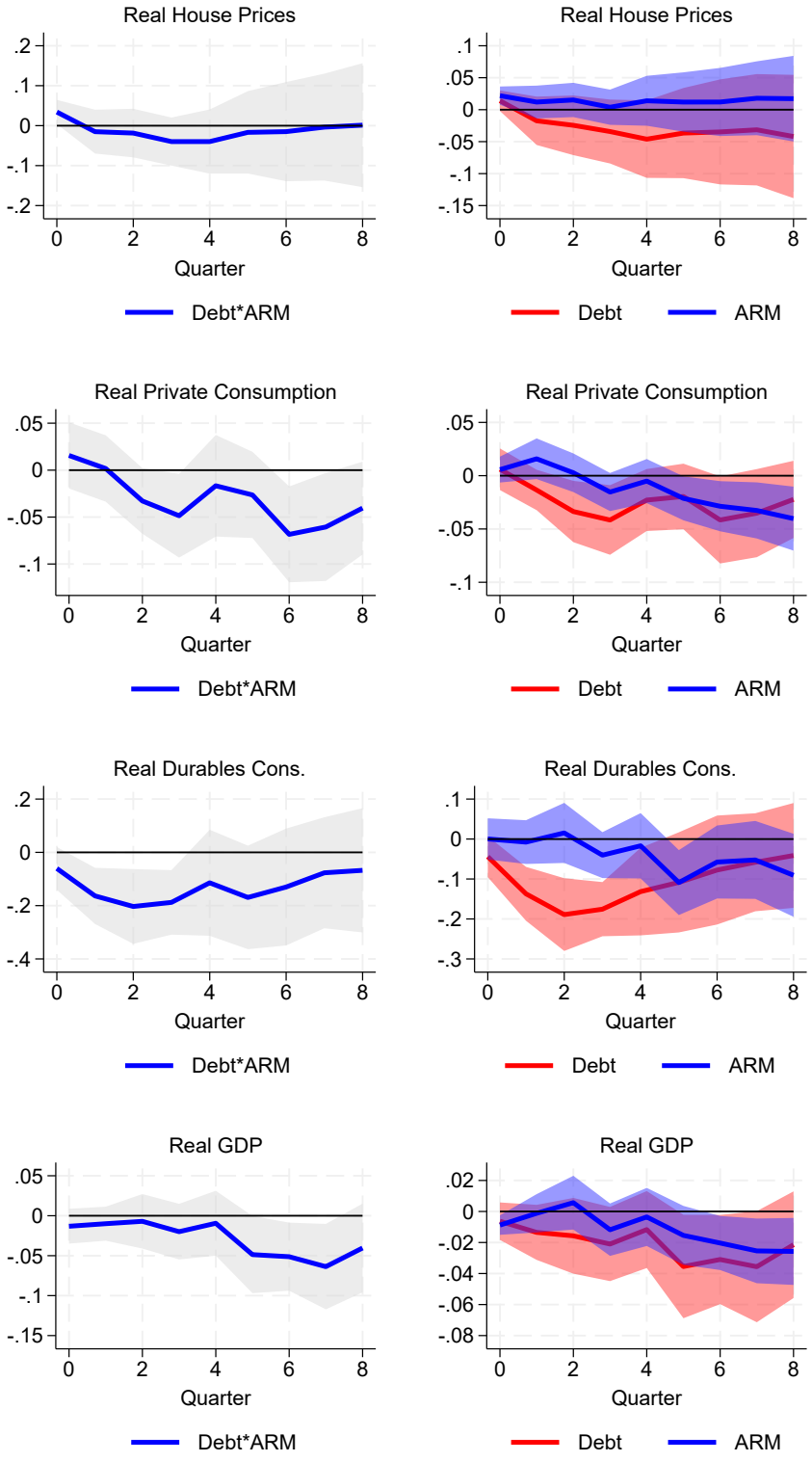
We establish two key findings. First, monetary policy affects the relative take up of fixed- and adjustable-rate mortgages: monetary tightening increases the share of new adjustable-rate mortgages, while loosening generally see an increase in the relative prevalence of fixed-rate mortgages in the flow of new mortgages. This potentially reflects the role monetary policy plays in modulating the tightness of household budget constraints, which are in turn key for the choice of mortgage fixation. Over time, prolonged loosening (tightening) cycles can significantly shift the composition of the outstanding mortgage stock within a given country towards less (more) ARMs. Indeed, in the long period of ultra-low interest rates which followed the Global Financial Crisis, the share of FRMs in stock increased substantially, across countries.

Second, we show that the ex-ante composition of the outstanding mortgage stock is a significant factor in determining the relative strength of monetary policy transmission to the real economy. Our findings indicate that monetary policy is state-dependent: the same change in policy rates affects consumption significantly more when ARMs are more prevalent, controlling for the stock of debt.

Combined, these results suggest that fixed-rate mortgages induce both path and state-dependency in monetary policy decisions. A prolonged loosening phase induces households to take on cheap fixed-rate loans; this, in turn, reduces the monetary authority's ability to stabilize the economy ex-post.

[27] See Appendix B.1.

Figure 4: *Monetary policy transmission and stock of adjustable-rate mortgages*



Notes: This figure plots the coefficient β_1 in equation (3), using different dependent variables. The left column presents results with ARM share rescaled by debt to GDP; the right column presents coefficients for each interaction term separately. Controls include four lags of (log) changes in nominal house prices, CPI , GDP, real private consumption, household debt levels. Country and quarter FE included. Shaded areas represent 90 percent confidence intervals based Driscoll-Kraay SE with 3 lags. Kleibergen-Paap rk Wald F statistic in first stage is equal or greater than 12.9.

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A. Appendix A: Data

Table A1: *Country Groups Composition for Advanced and Emerging Markets*

Advanced Economies	**Emerging Markets**
Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom, United States	Chile, Colombia, Hungary, Malaysia, Mexico, Poland, South Africa

Table A2: *Variables and Sources*

Interest Rates	**Source**
Policy Interest Rate	Bloomberg
Monetary Policy Shocks	Bloomberg
Housing Variables	
Residential House Price	Bank of International Settlements (BIS)
Credit Variables	
Household Credit to GDP	BIS
Share of Fixed Rate Mortgages: Flow and Stock	European Central Bank (ECB), National Central Banks
Interest Rates on new mortgages: FRMs and ARMs originations	Haver Analytics, European Central Bank (ECB), National Central Banks
Yields on government bonds	Haver Analytics, OECD, Bloomberg
Other General Economic Indicators	
GDP (Constant and Current Prices)	World Economic Outlook
Headline CPI	World Economic Outlook
GDP per Capita (Constant Prices)	World Economic Outlook
Private Consumption, Durables Consumption (Constant Prices)	World Economic Outlook, Haver Analytics

Table A3: *Flow of Adjustable-Rate Mortgages*

Country	Coverage	FRM if Entire Fixation	Source
Australia	2019:Q3–2023:Q2	> 12 months	Australian Bureau of Statistics
Austria	2003:Q1–2023:Q2	> 12 months	ECB
Belgium	2003:Q1–2023:Q2	> 12 months	ECB
Canada	2013:Q1–2023:Q2	> 12 months	Bank of Canada
Denmark	2003:Q1–2023:Q2	> 12 months	ECB
Estonia	2011:Q1–2023:Q2	> 12 months	ECB
Finland	2003:Q1–2023:Q2	> 12 months	ECB
France	2003:Q1–2023:Q2	> 12 months	ECB
Germany	2003:Q1–2023:Q2	> 12 months	ECB
Greece	2007:Q1–2023:Q2	> 12 months	ECB
Ireland	2003:Q2–2023:Q2	> 12 months	ECB
Italy	2003:Q1–2023:Q2	> 12 months	ECB
Korea	2013:Q1–2023:Q2	Duration of contract	Bank of Korea
Latvia	2014:Q1–2023:Q4	> 12 months	ECB
Lithuania	2015:Q1–2023:Q4	> 12 months	ECB
Luxembourg	2008:Q2–2023:Q2	> 12 months	ECB
Malta	2008:Q1–2023:Q3	> 12 months	ECB
Netherlands	2003:Q1–2023:Q2	> 12 months	ECB
New Zealand	2021:Q2–2023:Q2	> 12 months	Reserve Bank of New Zealand
Poland	2011:Q2–2023:Q2	> 12 months	ECB
Portugal	2009:Q2–2023:Q2	> 12 months	ECB
Slovak Republic	2009:Q1–2023:Q4	> 12 months	ECB
Slovenia	2008:Q2–2023:Q3	> 12 months	ECB
Spain	2003:Q1–2023:Q2	> 12 months	ECB
Sweden	2005:Q3–2023:Q2	> 12 months	ECB
United Kingdom	2007:Q1–2023:Q2	> 12 months	Financial Conduct Authority
United States	1999:Q2–2023:Q2	Duration of contract	Federal Housing Finance Agency

Note: Countries for which entire fixation is denoted by "duration of contract" are countries for which a breakdown of the new loans by 12 months fixation period is not currently available. In these cases, FRMs are all those loans which are not floating at any given quarter, irrespectively of entire fixation period. Rate resets of floating rate loans may be subject to contracted limits and gradual phasing-in. ECB data: the FRM is defined as the of new loans to households for house purchase with an initial rate fixation period bigger than one year in total new loans from MFIs to households.

Table A4: *Stock of Adjustable-Rate Mortgages*

Country	Coverage	FRM if Residual Fixation	Source
Austria	2010:Q2–2023:Q2	> 12 months	ECB
Belgium	2010:Q2–2023:Q2	> 12 months	ECB
Canada	2000:Q2–2023:Q2	> 12 months	Bank of Canada
Chile	2005:Q1–2023:Q2	Duration of contract	Banco Central de Chile
Colombia	2008:Q2–2023:Q1	Duration of contract	Superintendencia Financiera de Colombia
Czech Republic	2013:Q1–2023:Q2	> 12 months	ECB
Denmark	2013:Q4–2023:Q1	> 12 months	Danmarks Nationalbank
Estonia	2010:Q2–2023:Q3	> 12 months	ECB
Finland	2010:Q2–2023:Q2	> 12 months	ECB
France	2010:Q2–2023:Q2	> 12 months	ECB
Germany	2010:Q2–2023:Q2	> 12 months	ECB
Greece	2010:Q2–2023:Q2	> 12 months	ECB
Hungary	2017:Q1–2023:Q2	> 12 months	Magyar Nemzeti Bank
Ireland	2010:Q2–2023:Q2	> 12 months	ECB
Israel	2011:Q2–2023:Q2	Duration of contract	Bank of Israel
Italy	2010:Q2–2023:Q2	> 12 months	ECB
Japan	2015:Q2–2022:Q1	> 12 months	Bank of Japan
Korea	2013:Q1–2023:Q2	Duration of contract	Bank of Korea
Latvia	2011:Q4–2023:Q4	> 12 months	ECB
Lithuania	2010:Q2–2023:Q4	> 12 months	ECB
Luxembourg	2010:Q2–2023:Q2	> 12 months	ECB
Malta	2011:Q3–2023:Q2	> 12 months	ECB
Mexico	2016:Q2–2023:Q2	Duration of contract	Banco de Mexico
Netherlands	2010:Q2–2023:Q2	> 12 months	ECB
New Zealand	2004:Q4–2023:Q2	> 12 months	Reserve Bank of New Zealand
Norway	2013:Q4–2023:Q2	> 3 months	Statistics Norway
Poland	2011:Q2–2021:Q4	Duration of contract	Financial Supervision Authority (KNF)
Portugal	2010:Q2–2023:Q2	> 12 months	ECB
Slovak Republic	2010:Q2–2023:Q4	> 12 months	ECB
Slovenia	2010:Q2–2023:Q3	> 12 months	ECB
South Africa	2009:Q2–2023:Q1	Duration of contract	South African Reserve Bank
Spain	2012:Q1–2023:Q2	> 12 months	ECB
Sweden	2003:Q4–2023:Q2	> 12 months	Haver Analytics
United Kingdom	2007:Q1–2022:Q4	> 12 months	Financial Conduct Authority
United States	2013:Q1–2023:Q1	Duration of contract	Federal Housing Finance Agency

Note: Unless otherwise specified, loan classification is based on current fixed/floating status, rather than status at origination. Countries for which residual fixation is denoted by "duration of contract" are countries for which a breakdown of the outstanding stock by 12 months residual fixation is not currently available. In these cases, FRMs are all those loans which are not floating at any given quarter, irrespectively of residual fixation. Rate resets of floating rate loans may be subject to contracted limits and gradual phasing-in. ECB data: denominator is defined as total outstanding loans to households (including, but not limited to, mortgages). Chile: all mortgages are inflation-indexed and are thus classified as floating. Denmark: loans from domestic mortgage banks, market value. Israel: classification based on characteristics at origination; mortgages which are inflation–adjusted are classified as floating irrespectively of fixation period. United Kingdom: Residential loans to individuals: percent floating in outstanding.

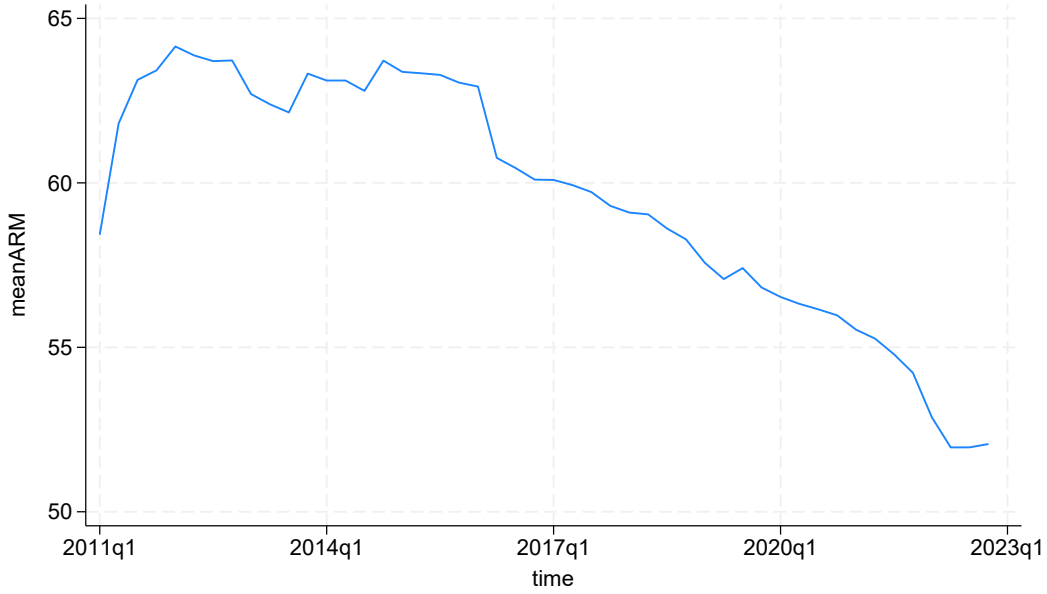
Table A5: *Housing Finance Characteristics*

Country	Share of Fixed Rate Mortgages (Flow)	Share of Fixed Rate Mortgages (Stock)	Household Debt to GDP (Ratio)	Typical Fixation Period (Years)	Availability of Free FRM Prepayment
Australia	4.6	-[a]	112.0	3	No
Austria	52.8	48.1	48.3	5	No
Belgium	90.6	92.0	60.7	10	No
Canada	75.3	63.9	102.7	5	Yes
Chile	-	0[b]	46.5	-	-
Colombia	-	83.0	28.6	15	-
Czech Republic	-	21.0	33.5	20	Yes
Denmark	57.5	39.8	84.8	-	Yes
Estonia	8.0	7.6	32.9	5	No
Finland	2.0	8.5	65.4	5	No
France	96.1	93.2	66.2	5	No
Germany	82.2	91.7	55.0	5	No
Greece	63.1	28.2	45.3	5	No
Hungary	-	81.8	18.6	-	No
Ireland	93.9	52.9	25.8	5	No
Israel	–	25.9	44.0	5	No
Italy	33.6	58.5	41.7	5	Yes
Japan	–	26.0[c]	68.4	10	Yes
Korea	80.9	34.9	100.4	-	No
Latvia	8.2	12.5	15.1	-	No
Lithuania	3.4	10.1	21.2	5	No
Luxembourg	48.3	68.6	67.2	5	No
Malta	42.6	18.3	48.8	5	No
Mexico	-	99.6	16.6	30	Yes
Netherlands	79.0	92.3	93.4	5	No
New Zealand	78.6	40.6	94.4	-	No
Norway	-	4.9	77.3	5	No
Poland	59.7	2.3[c]	26.5	5	No
Portugal	25.5	20.0	61.5	5	Yes
Slovak Republic	95.4	88.4	47.0	5	No
Slovenia	93.5	64.8	22.0	5	No
South Africa	–	1.5	34.3	-	No
Spain	72.2	35.5	53.0	5	No
Sweden	16.4	46.6	87.6	-	No
United Kingdom	94.5	85.5	83.5	5	No
United States	95.2	95.3	74.8	30	Yes

[a] Data is available but the time series was deemed too short to be used.
[b] In Chile all mortgages are inflation-indexed and are thus classified as floating.
[c] 2022:Q1.
[d] 2021:Q4.

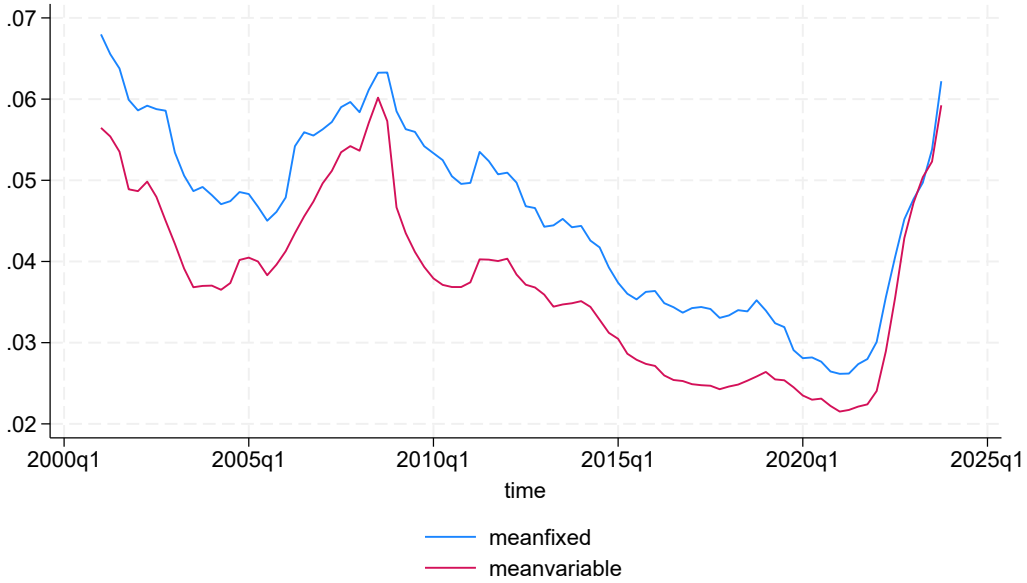
Sources: Bank for International Settlements; country authorities; European Central Bank; national Central Banks; Haver; Federal Housing Finance Agency.
Notes: Data is collected for 2022:Q4 unless otherwise specified.

Figure A1: *Share of ARMs in mortgage stock outstanding, average*



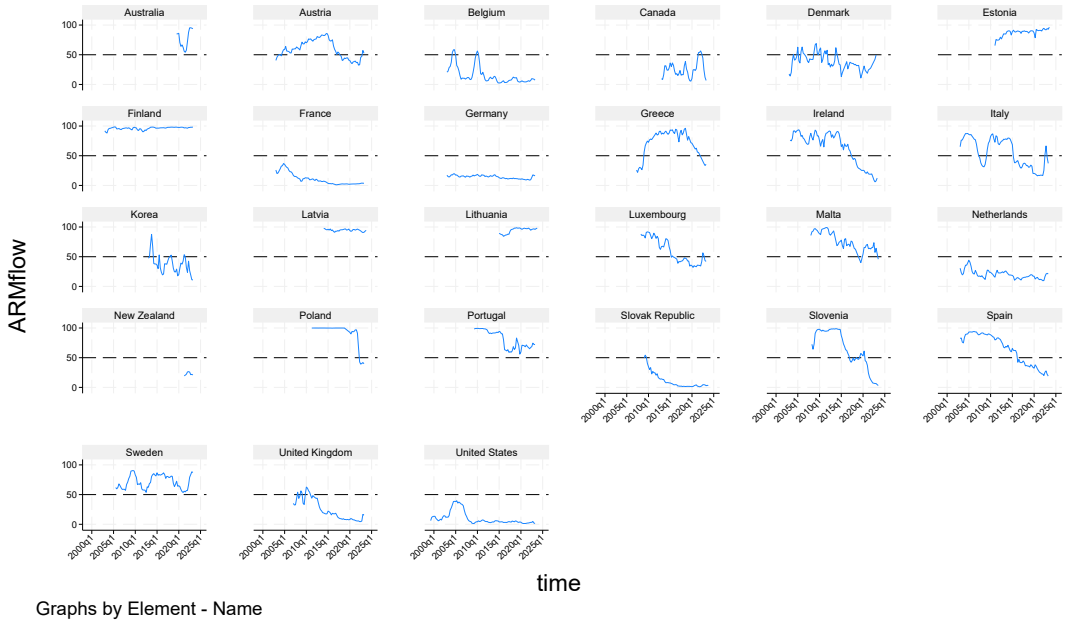
Notes: Share of adjustable rate mortgages as a proportion of the outstanding mortgage stock. Average is calculated across all countries for which data is available at any given quarter (see Appendix table A4). Source: authors' calculations on National Central Banks' data.

Figure A2: *Average rates on newly originated FRMs and ARMs*



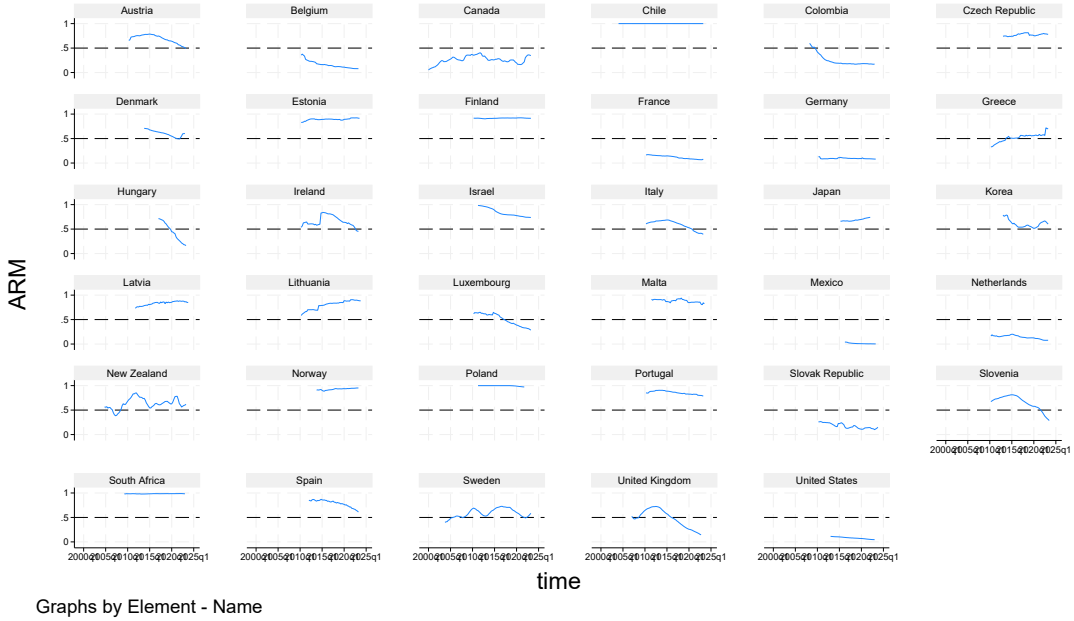
*Notes:*Average interest rates on newly issued fixed and adjustable-rate mortgages. Authors' calculation on Haver and National Central Bank's data.

Figure A3: *ARM flow over time*



*Notes:*Flows of new adjustable-rate mortgages as a proportion of all mortgages issued in a given quarter. Source: authors' calculation on National Central Bank's data.

Figure A4: *ARM in stock over time*



*Notes:*Stock of adjustable-rate mortgages as a proportion of all outstanding mortgages (for definitions see Appendix table A4). Authors' calculation on National Central Bank's data.

A.1. Monetary policy shocks: more details

To account for "the central bank reacting to information" channel (Bauer and Swanson, 2023), monetary policy shocks are constructed by orthogonalizing Bloomberg-sourced monetary policy surprises using two prior GDP surprises, 6 prior inflation surprises and the change in the national stock price index over the 6 months prior to the announcement. Specifically, we construct these regressors as follows:

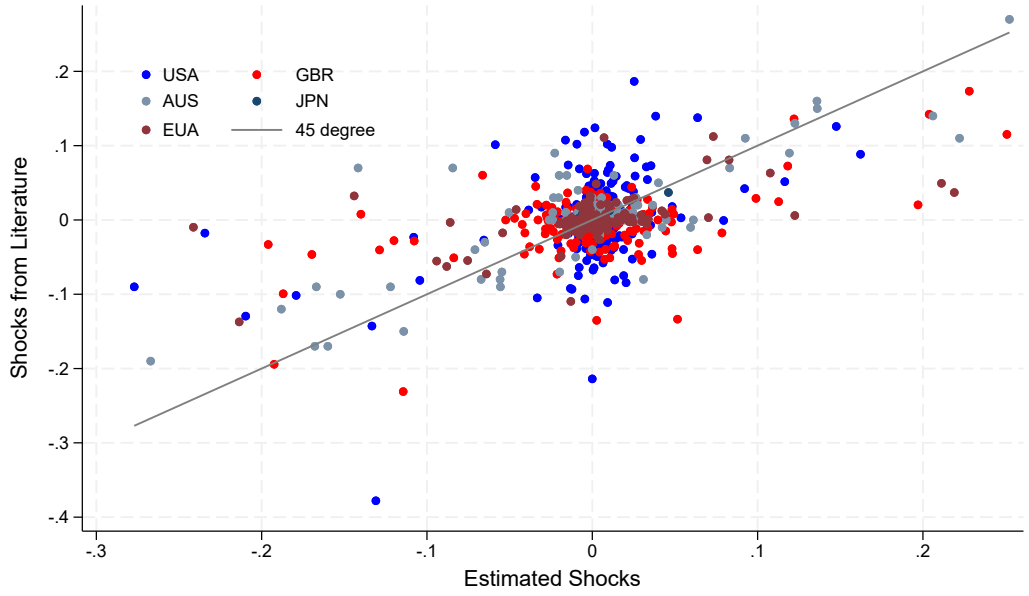
- GDP surprises comprise the difference between the actual release value for GDP and the mean of analyst forecasts available from Bloomberg. Different Bloomberg Indexes are used to maximize coverage. For the Euro Area, Korea, and Norway, advanced stage releases are used, while for the rest, final stage releases are used. To improve coverage further, different GDP series are combined for two countries. For Colombia, the indexes COCIPIBY and COGNPIBY are combined. A backward window of up to 11 months is used to include cases in which GDP releases we done less frequently than quarterly. For the majority of countries/announcements, the two prior GDP announcements occur within 6-7 months before announcements.
- Inflation surprises, similarly, to GDP surprises, comprise the difference between the actual release value for inflation and the mean of analyst forecasts available from Bloomberg. For each monetary policy announcement, 6 lags of inflation surprises are taken within a backward-looking window of 11 months prior to each announcement.
- Stock price changes, obtained from Bloomberg, comprise the change in the domestic stock market price index on the day prior to each monetary policy announcement relative to its value 180 days earlier. The stock price series refer to the performance of the largest Exchange-Traded Funds (ETFs), listed on each country's stock exchange, capturing the evolution of stock prices of the largest domestic companies in terms of capital valuation.

After obtaining the orthogonalized shocks at the announcement-level, these are aggregated to the quarterly frequency. Finally, shocks for major currencies are used for countries that are pegged or have adopted those major currencies as shown in the following Table:

Table A6: *Eurozone and Euro Area Pegs*

Currency	Country (Date of Peg)
Euro Area or year of first ECU/EMU Peg	Austria; Belgium; Denmark; Estonia (2004); Finland; France; Germany; Greece (1999); Ireland; Italy; Latvia (2005); Lithuania (2002); Luxembourg; Malta (2005); Netherlands; Portugal; Slovak Republic (2005); Slovenia (2004); Spain

Figure A5: *Literature and Estimated Shocks*



Notes: This figure compares shocks taken from the literature (y-axis) against those estimated in this paper (x-axis). Each data point represents an economy-month observation for selected economies for which comparable monetary policy shocks were available in the literature. Unbalanced panel covering 1999:1 to 2023:1. The correlation coefficient for the whole sample is 0.56. One data point for GBR $(-0.83, -0.41)$ was excluded to improve visibility. Shocks from literature are: USA Bauer and Swanson, 2022; GBR Cesa-Bianchi et al., 2020; AUS Hambur and Haque, 2024; JPN Kubota and Shintani, 2022; and EUA Altavilla et al., 2019.

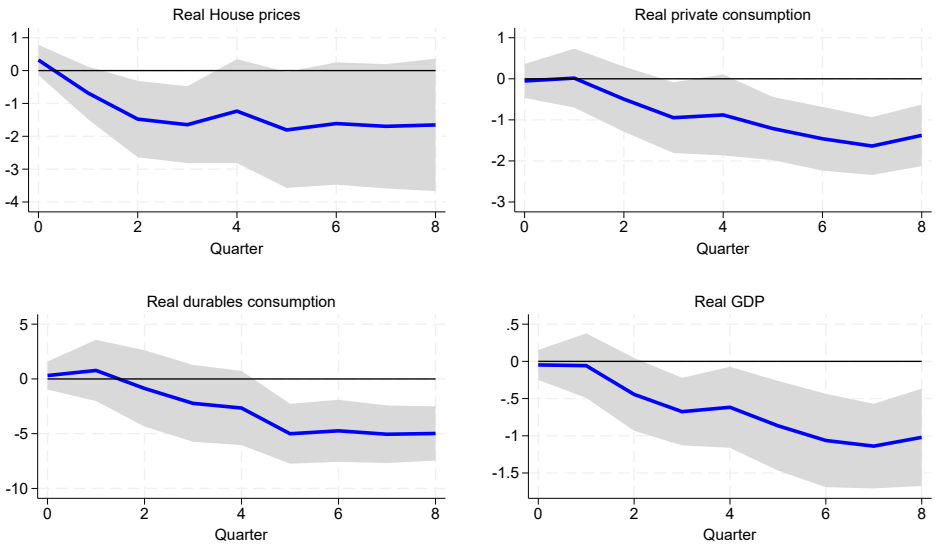
Table A7: *Baseline Specification: First-stage*

VARIABLES	(ARMflow) change in MP rates	(FRM rates) change in MP rates	(ARM rates) change in MP rates	(FRM-ARM spread) change in MP rates	(10y govt yield) change in MP rates	(1y govt yield) change in MP rates
MP shocks	1.088***	1.117***	1.117***	1.080***	1.091***	1.080***
	(0.189)	(0.170)	(0.169)	(0.182)	(0.160)	(0.175)
Observations	1,079	1,346	1,344	1,344	1,121	1,283
F-test	33.16	43.36	43.44	35.34	46.70	37.93
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table reports first-stage estimates of the 2SLS coefficients plotted in figure 3. The dependent variable is always the change in policy rates at time t. Different columns report first-stage coefficient for every IV-LP model, one per dependent variable: Share of ARMs in new originations (col. 1), rates on newly originated FRMs (col.2), rates on newly originated ARMs (col.3), FRM-ARM spread (col. 4), 10y govt yield (col. 5), 1y govt yield (col. 6). Controls include (log) nominal house prices, CPI, real GDP, real private consumption, household debt levels. Country and quarter FE included. Driscoll-Kraay SE with 3 lags in parentheses.

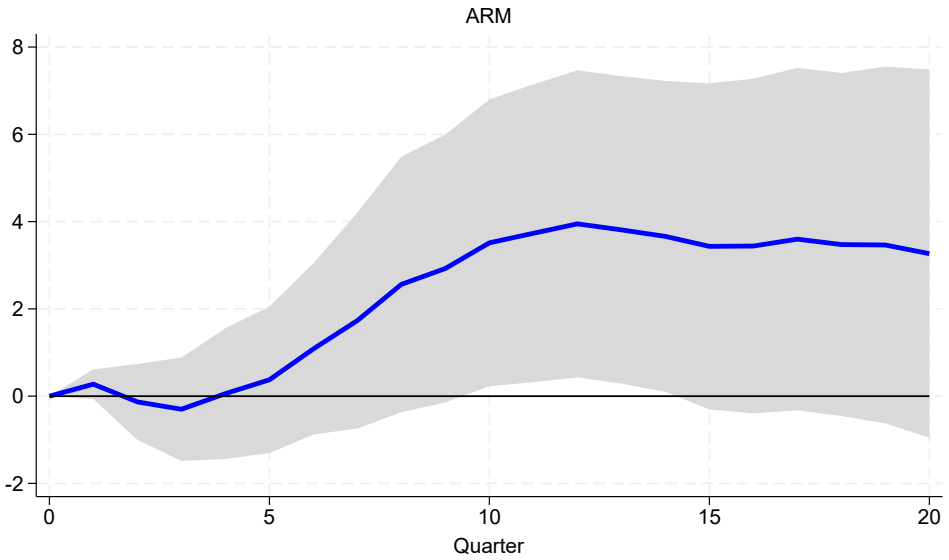
B. Appendix B: Additional Results

Figure B1: *Response to 100bpp change in interest rates: other outcomes*



Notes: This figure shows the results of equation (2), using different dependent variables.Clockwise: real house prices; real private consumption; real GDP; real durables consumption;. Country and quarter FE included. Shaded areas represent 90 percent confidence intervals based on based on Driscoll-Kraay SE with 3 lags. Kleibergen-Paap rk Wald F statistic in first stage is equal or greater than 34.

Figure B2: *Response to 100bpp change in interest rates: ARM stock*



Notes: This figure shows the results of equation (2), using the stock of ARMs as a dependent variable. The projection horizon is extended to 20 quarters. Controls include four lags of the change in ARMstock and in real house prices; real private consumption; real GDP; real durables consumption. Country and quarter FE included. Shaded areas represent 90 percent confidence intervals based on based on Driscoll-Kraay SE with 3 lags. Kleibergen-Paap rk Wald F statistic in first stage is equal or greater than 24.

B.1. Asymmetry and FRMs: the refinancing channel of monetary policy

Fixed-rate mortgages can play an asymmetric role in shaping monetary policy transmission. In a context where a free mortgage prepayment option exists, FRMs are likely to be a larger impairment to transmission during tightening cycles than during loosening ones, as incentives to refinance are substantially different between the two phases (Berger et al., 2021; Eichenbaum et al., 2022). This is because borrowers may choose to refinance their FRMs in a loosening cycle, in order to take advantage of lower interest rates, but are much less likely to do so during a tightening cycle.[28]

Following this intuition, we run an asymmetric specification similar to Tenreyro and Thwaites (2016) to study how ARMs affect transmission of similar-sized loosening and tightening impulses. Specifically, we modify the local projections framework as follows:

[28]Quantitatively, refinancing incentives depend on where current interest rates stand in comparison to *effective* interest rates on existing mortgages, or the extent to which existing FRM borrowers are *in the money* (Berger et al., 2021). Unfortunately, we do not have information on effective mortgage rates for the majority of countries in our sample.

$$
\begin{aligned}
y_{c,t+h} - y_{c,t-1} = a &+ \beta_1^h(|MP_{c,t}| \cdot Tightening_{c,t} \cdot ARM_{c,t-1}) \\
&+ \beta_2^h(|MP_{c,t}| \cdot Loosening_{c,t} \cdot ARM_{c,t-1}) + \beta_3^h(|MP_{c,t}| \cdot Loosening_{c,t}) \\
&+ \beta_4^h(|MP_{c,t}| \cdot Tightening_{c,t}) + \beta_5^h ARM_{c,t-1} \\
&+ \textstyle\sum_{l=0}^{3} \beta_l^h X_{c,t-l} + \sum_{l=1}^{4} \rho_l^h y_{c,t-l} \\
&+ \theta_t^h + \gamma_c^h + \varepsilon_{c,t+h}^h, \quad \text{for } h = 0, \ldots, 8
\end{aligned}
$$

Where $|MP_{c,t}|$ is the absolute value of the monetary policy shock and $Tightening_{c,t}$ and $Loosening_{c,t}$ are dummies capturing the shock's sign: for example, $Tightening_{c,t}$ takes value 1 if the shock is positive, and value 0 otherwise. Therefore, β_1 and β_2 measure the differential effect of tightening and loosening episodes of similar size depending on the ex-ante share of ARMs in stock of debt.

We use this model to test two hypotheses. First, FRMs should impair transmission during a tightening impulse more than during a loosening one. Second, the degree of asymmetry should be more pronounced in countries where a free (or cheap) refinancing option exists. This is not true of all countries in our sample (see Appendix Table A5). In the US, long-term, prepayable FRMs are widely available to homeowners; the same is true in Denmark and Mexico (Zanforlin and Espinosa-Vega, 2008). The setting is similar in Italy and Japan, where FRM borrowers are allowed to refinance free of prepayment penalties (Jappelli and Scognamiglio, 2018; Kishimoto and Kim, 2014) and in Canada, where FRM borrowers have the opportunity to choose an *open mortgage* upon loan origination, which grants them a free-prepayment option.

Except for these six cases, all other countries in our sample do not provide FRM borrowers with a free prepayment option: for these countries, asymmetry in the extent to which ARMs help transmission between tightening and loosening phases should be less pronounced.[29]

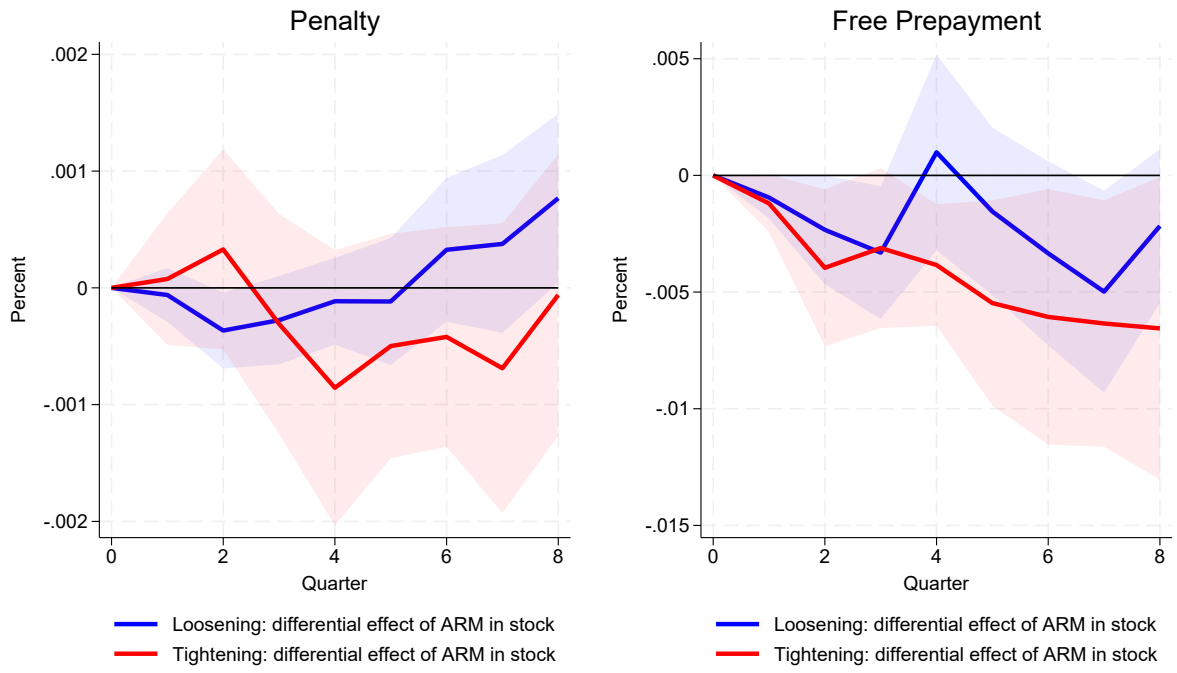
We run this specification separately for countries where FRM prepayment is free and for countries where this is costly. Where FRM prepayment is free, (*Free prepayment* in Figure B3), the transmission of a tightening impulse is significantly *weaker* the higher the share of FRMs in stock (Figure B3). We do not observe the same differential effect during loosening episodes, implying that transmission of these impulses is unaffected by the

[29]Early payment is possible in all other countries in our sample, but not for free. Penalties vary substantially across jurisdictions and can be a percentage of the loan balance, or a requirement to compensate the lender for the yield loss.

relative composition of the outstanding mortgage stock. This is consistent with the view that, at least in loosening phases, FRM borrowers may decide to refinance their loans to take advantage of *lower* rates. If this is the case, FRMs (ARMs) do not impair (help) transmission as much, relative to a world with only ARMs (FRMs).

Where refinancing is costly (*Penalty* in Figure B3), instead, the degree of asymmetry is much less pronounced. Over time, ARMs (FRMs) help (impair) transmission in a similar way in both tightening and loosening phases (albeit coefficients are smaller and not statistically different from zero).

Figure B3: *FRMs and asymmetry*



Notes: This figure plots the differential response of real private consumption to tightening shocks (red) and loosening ones(blue), depending on the ex-ante share of ARM as a percentage of the stock of loans outstanding. Country and quarter FE included. Shaded areas represent 90 percent confidence intervals based on Driscoll-Kraay SE with 3 lags.