Monetary Policy, Mortgage Structure, and Household Sentiment: Evidence from the Euro Area

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Abstract

The European Central Bank sets a single policy rate for the entire euro area, but the structure of mortgage rates differs widely across member states, so that the same change in the policy rate can produce different cash-flow pressures depending on the composition of mortgages within a country. I use panel data for 18 euro area countries from 2007–2025 and instrumental variable local projections identified with high-frequency monetary policy surprises to estimate how household sentiment and macroeconomic outcomes respond depending on how exposed mortgage debt in different countries is to adjustable rates. Consumer confidence, assessments of the financial situation, and intentions to make major purchases all decline significantly more in countries that are highly exposed to adjustable-rate mortgages, which is consistent with cash-flow pressure from rising mortgage payments. The heterogeneity in sentiment is concentrated in the pure monetary component of policy surprises rather than in the information component. Durable consumption provides supporting macro evidence, while GDP and total consumption are directionally consistent but imprecisely estimated.

Keywords: Monetary policy transmission, mortgage rate structure, adjustable-rate mortgages, household sentiment, consumer confidence, liquidity constraints, euro area

JEL Classification: E21, E52, E71, G21, D14

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1 Introduction

The European Central Bank (ECB) implements a single monetary policy across the euro area, but how it is transmitted varies substantially across member countries (Corsetti et al. 2021). Differences in financial structures, household balance sheets, labour market institutions, and housing markets all contribute to cross-country variation in monetary transmission. One of these factors that plays a central role is the structure of mortgage rates (Calza et al. 2013; De Stefani and Mano 2025). The share of adjustable-rate mortgages (ARMs) within all mortgages exceeds 90% in Finland and the Baltic states, while France and Germany remain almost entirely based on fixed-rate mortgages (FRMs). When policy rates rise, ARM borrowers face immediate increases in their debt service costs, whereas FRM borrowers remain insulated until they next refinance. This paper examines how aggregate outcomes vary with the ex-ante structure of the mortgage market, using a panel of 18 euro area countries in 2007–2025.

The structure of mortgage rates is also evolving over time from a monetary policy perspective. The share of adjustable-rate mortgages has declined across the euro area over the past two decades and the prevalence of long-term fixed-rate contracts has consequently increased. While this shift makes households less exposed in the short run to interest rate fluctuations, it may also lengthen and dampen the transmission of policy changes to household spending (Berger et al. 2021), making transmission lags longer and more uncertain. Understanding how the structure of mortgages shapes monetary transmission is therefore relevant not only for cross-country comparisons, but also for keeping policy effective over time.

One of the channels through which monetary policy affects household consumption alongside intertemporal substitution, balance sheet effects, and direct cash-flow pressure (Di Maggio et al. (2017) and Flodén et al. (2020)) is the cash-flow channel, which is particularly important for ARM borrowers because debt service costs adjust almost immediately when policy rates change. Sentiment indicators provide a window into this mechanism. If there is pressure on their disposable income, households facing higher mortgage payments should report worse financial conditions. This paper focuses on this channel by examining how high-ARM countries respond differently to monetary policy shocks.

I use data from the ECB, Eurostat, the European Commission, and the Bank for International Settlements (BIS) and employ an instrumental-variable local projection (IV-LP) framework (Jordà et al. 2015), which is identified using high-frequency (HF) monetary policy surprises (Altavilla et al. 2019). Because policy rate changes respond endogenously to evolving macroeconomic and financial conditions, HF surprises are used to isolate unantic-

ipated policy innovations. The main specification interacts the monetary policy shock with a country-level measure of ARM exposure, that is defined as the product of the ARM stock share and household credit-to-GDP, as this allows the response to vary with the mortgage rate structure. The panel covers up to approximately 1,332 country-quarter observations for the baseline specification and approximately 1,080 for the interaction specification, which requires ARM stock share data available from the second quarter of 2010, with the effective estimation samples varying by outcome and horizon, and the impulse responses traced over eight quarters.

Sentiment indicators are more informative than aggregate macroeconomic outcomes for identifying the cash-flow mechanism. The European Commission's harmonised consumer surveys ask households about their current financial situation, their expected ability to save, and their intention to make major purchases, targeting the specific dimensions that cash-flow pressure should affect. While these remain aggregate country-level measures that mix mortgagors with renters and savers, they are less contaminated by the confounding factors that make it harder to draw inferences from national accounts data, such as wealth effects, trade dynamics, and inventory cycles. If ARM exposure amplifies cash-flow pressure, we should observe systematically worse sentiment in high-ARM countries after monetary tightening.

Alongside the closest related work by De Stefani and Mano (2025), who focus on macroeconomic outcomes and mortgage choice dynamics in a global sample, this paper makes two complementary contributions. The first is that I examine how household sentiment and confidence indicators respond heterogeneously across mortgage rate structures, providing diagnostic evidence on the cash-flow mechanism that aggregate consumption data alone cannot deliver. The second is that I study a single monetary policy applied uniformly across euro area member states, rather than country-specific policy rates, so that identification comes from the interaction of common shocks with cross-sectional variation in the structure of mortgages.

Traditional macroeconomic aggregates provide supporting evidence, though with the measurement challenges that are to be expected. Durable consumption shows statistically significant declines in high-ARM countries, while GDP and total consumption are directionally consistent but imprecisely estimated.

The paper proceeds as follows. Section 2 reviews the related literature, Section 3 describes the data, Section 4 presents the methodology, Section 5 documents results, Section 6 discusses robustness, and Section 7 concludes.

2 Literature Review

This paper connects several strands of the macroeconomic literature. It covers household sentiment and expectations, the cash-flow channel in heterogeneous-agent models, cross-country monetary policy transmission, mortgage choice behaviour, and asymmetric policy responses.

A growing literature examines how household sentiment and expectations respond to monetary policy and shape macroeconomic dynamics. Ludvigson (2004) establishes that consumer confidence contains genuine information about future consumption beyond the standard measures of income. Barsky and Sims (2012) decompose confidence innovations into news about fundamentals and "animal spirits", finding that most of the variation reflects information rather than autonomous sentiment shifts. Carroll (1994) shows that expected income affects current consumption through precautionary motives, while Coibion and Gorodnichenko (2015) document systematic information rigidities in how household expectations are formed. Recent work connects these mechanisms to monetary policy transmission. Ahn et al. (2024) show that homeowners lower their inflation expectations and labour market outlook in response to mortgage rate changes but renters do not, which is consistent with mortgage payments creating incentives to pay attention to monetary policy. Related evidence in Baldassarri et al. (2024), a policy brief based on survey data, shows that households that expect higher interest rates also tend to expect higher inflation in the near term, particularly if they are adjustable-rate mortgage (ARM) borrowers. In the same vein, ARM households are consistently more likely to report a deterioration in their financial situation. This paper extends this literature by examining whether the responses of sentiment to monetary shocks vary systematically with the structure of mortgage rates at the country level.

A large literature examines the mortgage choices of households. Campbell and Cocco (2003) establish the optimal choice framework. Households with stable income should prefer ARMs to avoid the term premiums of FRMs, while those with larger financial wealth are better positioned to handle the payment volatility of ARMs. Subsequent work documents that risk aversion (Coulibaly and Li 2009), borrowing constraints and rate differentials (Badarinza et al. 2016, 2018), macroeconomic conditions (Ehrmann and Ziegelmeyer 2017), inflation expectations (Koijen et al. 2009), and personal inflation experiences (Botsch and Malmendier 2023) all shape the choice of mortgage type.

A growing body of work documents heterogeneous monetary policy transmission across the euro area. Calza et al. (2013) were among the first to show that countries with higher ARM shares exhibit stronger consumption responses. Corsetti et al. (2021) find that while output responses are relatively homogeneous across member states, the responses of con-

sumption, housing, and the labour market diverge substantially, with homeownership rates correlating with the strength of the housing channel. Pica (2021) shows that ARM share and homeownership rates interact to amplify monetary transmission, and neither alone explains country-level heterogeneity. Beyer et al. (2024) document substantial heterogeneity across European countries in interest rate pass-through, with bank characteristics and market structure shaping the transmission to lending rates.

The cash-flow channel is the route through which changes in interest rates impact household disposable income directly through debt service costs (Di Maggio et al. 2017; Flodén et al. 2020). Fagereng et al. (2021) provide micro-level evidence that consumption responses to income shocks are driven primarily by liquidity constraints rather than total wealth. Baptista et al. (2025) quantify this channel in the context of the ECB tightening cycle in 2022–23, finding substantial heterogeneity in the marginal propensity to consume (MPC) across the income distribution, as it ranges from 70% for the bottom quintile to 36% for the top. This amplifies transmission through ARM-heavy markets, as lower-income households are disproportionately exposed to adjustable rates at 32% against 17% for top earners. Andersen et al. (2023) document substantial refinancing frictions in Denmark. Poorer and less-educated households are less likely to refinance regardless of the incentives, limiting their ability to benefit from rate cuts and amplifying asymmetric transmission. They also document a U-shaped relationship between the use of adjustable-rate mortgages and net wealth, suggesting that ARMs are held both by highly constrained households with low income and high debt, and by wealthier households with substantial financial assets. This intra-country heterogeneity cautions against a one-dimensional interpretation of ARM exposure and highlights the importance of expectation-based responses. Kaplan et al. (2014) identify "Wealthy Hand-to-Mouth" households as key drivers of aggregate consumption, while Auclert (2019) shows that ARM households have large negative "Unhedged Interest Rate Exposure". Sciacovelli (2025) and Slacalek et al. (2020) confirm that for euro area mortgagors, the cash-flow channel dominates intertemporal substitution. Survey-based evidence from Ahn et al. (2024) demonstrates that this cash-flow exposure translates into differential attention. Homeowners with mortgages have more accurate perceptions and forecasts of the mortgage rate than outright owners or renters, particularly those who have recently refinanced or plan to refinance. "Heterogeneous Agent New Keynesian" (HANK) models formalise these mechanisms.

The literature on asymmetric responses provides the theoretical foundations for understanding heterogeneous household behaviour. Christelis et al. (2019) document asymmetric consumption responses, where households react more aggressively to negative income shocks because of the binding constraints. At the policy level, Bunn et al. (2018) find that consumption in the UK reacts more strongly to rate rises than cuts, while Tenreyro and Thwaites

(2016) document state-dependent effects. Bandoni et al. (2025) show that the probability of defaulting on an ARM responds asymmetrically, with consecutive increases having three times the impact of an increase following a decrease.

The most closely related work is De Stefani and Mano (2025), who provide a comprehensive cross-country analysis of how the structure of mortgage rates shapes monetary policy transmission. They use a panel of 35 countries over two decades and IV local projections with monetary policy shocks cleaned of information effects to establish a two-way relationship between mortgage structure and monetary policy. Their key contribution is that they document both path-dependency and state-dependency in transmission. Path-dependency operates through mortgage choice. Easing cycles increase the share of FRM in new lending, while tightening cycles decrease it. Over time, this mechanism alters the composition of the outstanding mortgage stock, creating state-dependency. A greater prevalence of FRMs weakens monetary transmission to key macro variables, while prevalence of ARMs strengthens it.

3 Data

The analysis uses a quarterly unbalanced panel dataset covering 18 euro area countries from the first quarter of 2007 to the second quarter of 2025, spanning 74 quarters and yielding 1,332 potential country-quarter observations.[1] The sample covers Austria, Belgium, Germany, Estonia, Spain, Finland, France, Greece, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, the Netherlands, Portugal, Slovenia, and Slovakia. Cyprus is excluded because of missing data on FRM interest rates.

The data have been compiled from multiple sources. The ECB's Statistical Data Warehouse (SDW) provides mortgage interest rates from its Monetary financial institutions interest rate statistics, ARM and FRM volumes and stocks from the Balance Sheet Item statistics, policy rates, and money market rates. Eurostat provides indexes for real GDP, household consumption expenditure and consumer prices. The Eurostat Sector Accounts provide the household saving rates. The Bank for International Settlements (BIS) contributes residential property prices, household debt statistics, and credit-to-GDP ratios. The European Commission's Directorate-General for Economic and Financial Affairs (DG ECFIN) provides the

[1]The sample begins in 2007Q1 to capture the 2007–2009 ECB hiking and cutting cycle, the richest identification source in the data. Although 13 countries have Monetary Financial Institutions Interest Rate (MIR) statistics data from 2003Q1, several others (notably Belgium, Lithuania, Latvia, Malta, and Slovakia) have ARM or FRM rate series that begin only in 2007 or later, making pre-2007 coverage too sparse for balanced estimation. ARM rate coverage is near-complete from 2007 onward (99.5% of country-quarters); FRM rate coverage is 88%. The ARM stock share from ECB residual maturity breakdowns begins in 2010Q2, so interaction analyses using that measure are limited to the post-2010 period.

consumer confidence indicators, expectations of major purchases, savings intentions, and assessments of the financial situation from the Joint Harmonised EU Consumer Survey.

Measuring the structure of mortgage rates in the euro area is not a trivial matter because of the data limitations and ambiguities in the definitions. I follow the approach of De Stefani and Mano (2025) and the conventions of the ECB, and I use two main measures. I define an adjustable-rate mortgage as one whose rate resets within 12 months. This classification applies to both flows, which are based on status at origination, and stocks, which are based on residual maturity. This is an admittedly short fixation horizon that probably underestimates ARM exposure, as mortgages with rate resets in two or more years are classified as FRMs. The ARM stock share is the share of outstanding mortgage debt that has adjustable rates, constructed from the ECB's Balance Sheet Items statistics by residual maturity buckets. This series begins in the second quarter of 2010, as this is when the ECB introduced the residual maturity breakdown, and so interaction analysis using stock measures is limited to the period after 2010 (see Figure A2 in Appendix A for country-level ARM stock shares).

Several interest rate variables were constructed from the ECB statistics on mortgage interest rates. The ARM rate measures the composite interest rate on outstanding adjustable-rate debt with an initial rate fixation of up to one year, while the FRM rate captures the composite rate on fixed-rate debt with an initial rate fixation exceeding one year. The FRM–ARM spread, which is defined as the difference between the FRM and ARM rates, measures the relative pricing of fixed-rate and adjustable products, with negative values indicating that FRMs are cheaper and thus incentivise the choice of fixed rates. The ECB policy rate, which is taken as the main refinancing operations rate, serves as the treatment variable in the baseline specifications. As a robustness check I also use the 3-month, 6-month, and 12-month Euribor rates as alternative treatments, since most ARMs are indexed to Euribor.

The outcome variables span macroeconomic aggregates and measures of household sentiment. Real GDP is measured as quarterly chain-linked volumes in constant prices, while household consumption captures real final consumption expenditure. Durable consumption isolates spending on durable goods such as appliances and furniture. House prices are measured using residential property price indexes.

The Consumer Survey indicators are based on monthly surveys of approximately 40,000 households across the euro area. The respondents answer standardised questions about their financial situation, economic expectations, and spending intentions. The results are reported as balance statistics that are defined as the difference between the percentages of positive and negative responses, ranging from -100 to $+100$, where positive values indicate optimism. The consumer confidence indicator is a composite that averages four sub-indicators for the expected financial situation of the household, the expected general economic situation, ex-

pected unemployment (inverted), and expected savings. I also examine the sub-indicators separately. Expectations for the financial situation capture assessments by households of their own economic circumstances over the next 12 months; intentions for major purchases measure whether households consider that now is a good time for large expenditures on durables; and savings expectations reflect their prediction of their ability to save. These indicators provide forward-looking measures of household sentiment that may respond to monetary policy shocks before behavioural changes materialise in consumption or saving flows.

The euro area HF monetary policy shock series are obtained from Altavilla et al. (2019) as Altavilla-Giannone or AG shocks, and from Jarociński and Karadi (2020) as Jarociński-Karadi or JK shocks. The baseline instrument is the AG rotated Target factor, which is constructed from changes in the overnight index swap (OIS) rates within a narrow window around ECB announcements. This identification strategy isolates surprise policy movements from systematic responses to economic conditions and so provides a valid instrument for causal inference. Shocks are aggregated to quarterly frequency by summing all the announcements within each quarter. As a robustness check, I compare the AG shocks with the JK decomposition, which separates high-frequency surprises into a pure monetary component and a central bank information component (see Section 5.5). Summary statistics for all the variables are provided in Appendix A.

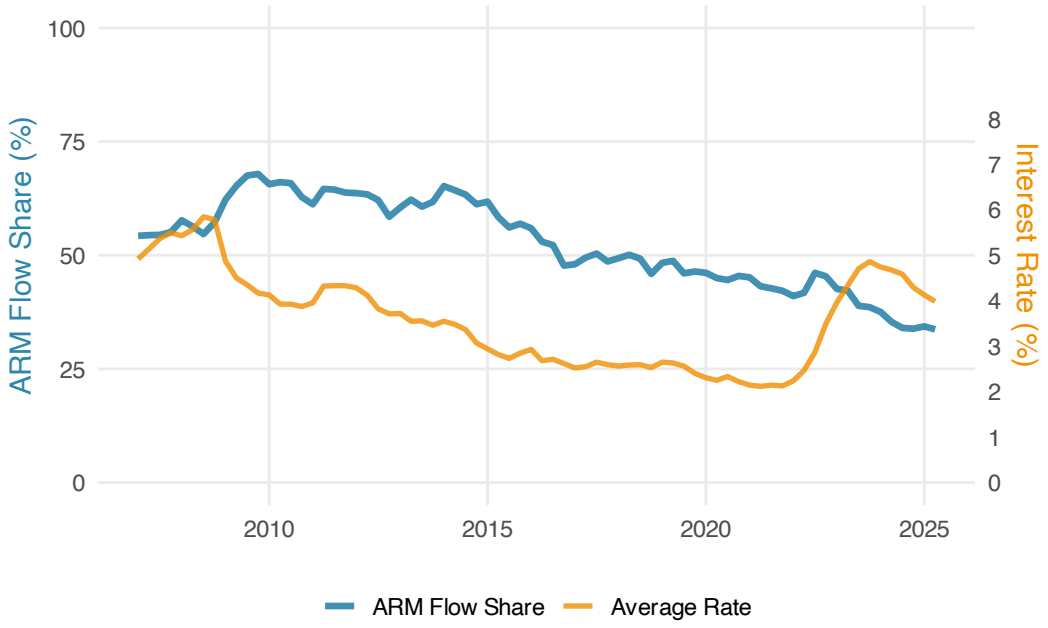
For the interaction analysis, I construct a measure of ARM Debt Exposure:

$$\text{ARM Debt}_{c,t} = \text{ARM share}_{c,t} \times \text{HH Credit-to-GDP}_{c,t}/100 \tag{1}$$

where HH Credit-to-GDP is household credit as a share of gross domestic product. This interaction captures the idea that ARM prevalence matters more for transmission when household leverage is high. A country with an ARM share of 50% but a credit-to-GDP ratio of 50% has lower exposure than a country with an ARM share of 50% and a credit-to-GDP ratio of 100%.

Figure 1 illustrates the aggregate evolution of the ARM flow share and the average mortgage rates across the euro area. The ARM flow share declined steadily over the sample period from approximately 55% in 2007 to around 35% by 2025, reflecting a structural shift towards fixed-rate products. This decline persisted through the financial crisis, the low-rate environment of 2015–2021, and the rapid tightening of 2022–2024. Country-level patterns reveal that there is substantial heterogeneity under this aggregate trend (see Figure A1 in Appendix A). Finland and the Baltic states maintained ARM shares above 90% throughout the sample, reflecting a combination of demand-side and supply-side factors. On the demand side, the Nordic tradition of variable rates, reinforced by the dominance of Nordic banking

groups across the region, has steered the expectations of borrowers towards adjustable-rate products. On the supply side, the absence of deep secondary markets for covered bonds or mortgage-backed securities limits the ability of banks to fund long-term fixed-rate loans without the risk of maturity mismatches. These supply-side constraints are particularly binding in the Baltic states, where the small size of the banking systems reduces the benefits for interest rate risk management from diversification. In contrast, France and Germany remain almost entirely FRM-based, with ARM shares consistently below 15%. Spain, Ireland, and Portugal experienced dramatic shifts, with ARM shares falling from over 80% in 2005 to around 25% by 2024. This cross-country heterogeneity provides the identifying variation for the interaction analysis.

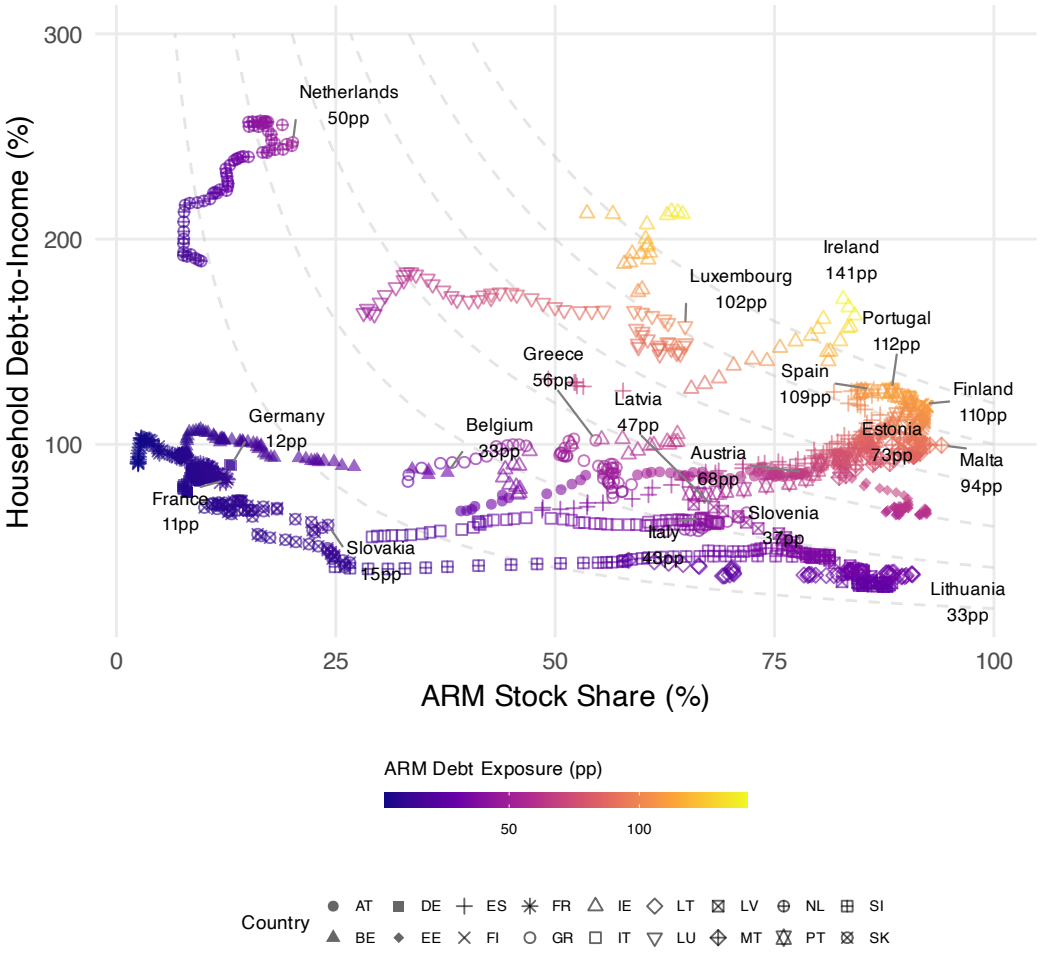


Notes: Unweighted quarterly averages across 18 euro area countries. ARM Flow Share (left axis, solid blue): share of new mortgages with adjustable rates. Average Mortgage Rate (right axis, dashed orange): simple mean of ARM and FRM rates. Sample: 2007Q1–2025Q2.

Figure 1: ARM Flow Share and Average Mortgage Rate Evolution

Figure 2 visualises the ARM Debt Exposure decomposition. Each point represents a country-quarter observation, with the x-axis showing the ARM stock share and the y-axis showing the ratio of household credit to GDP. Points are coloured by the resulting ARM debt exposure, which is the product of these two variables. The dashed contour lines indicate iso-exposure curves, which are combinations of ARM share and leverage that yield the same overall exposure. Countries like the Netherlands and Spain exhibit high levels of ARM debt exposure that are reached through different combinations. The Netherlands reaches its level

by having high levels of leverage and a moderate ARM stock share, while Spain does so by having a large ARM stock share with moderate leverage. This variation in the composition of ARM debt exposure provides identifying variation for the interaction analysis.

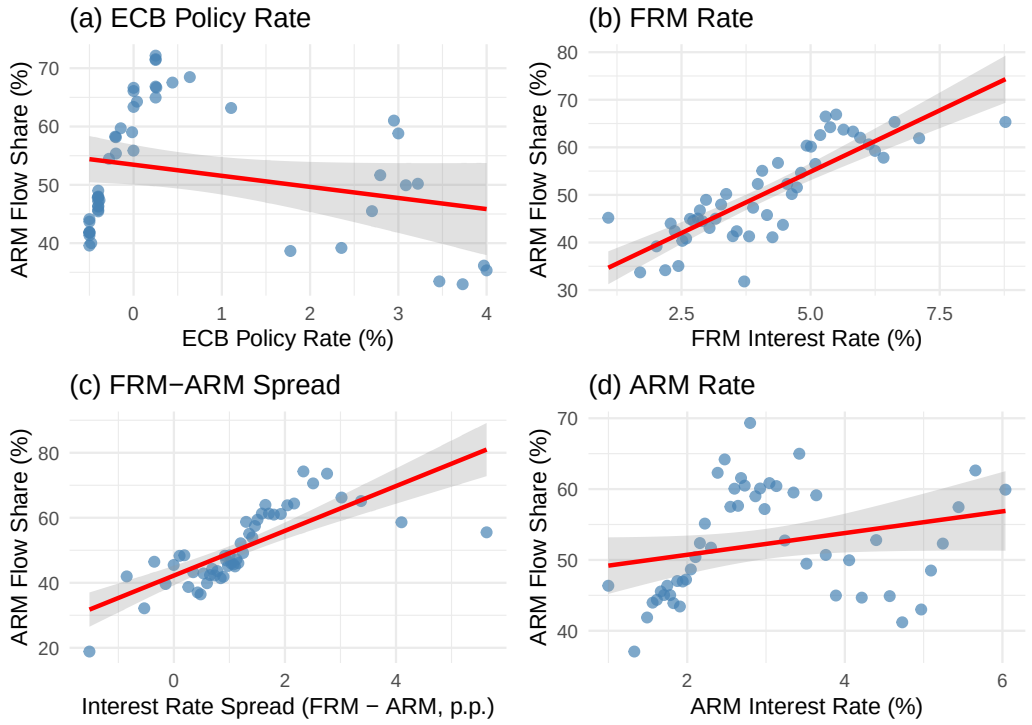


Notes: Scatter plot of ARM stock share (x-axis) against household credit-to-GDP (y-axis) for all country-quarter observations. Colour indicates ARM debt exposure, defined as ARM share × HH Credit-to-GDP / 100. Dashed lines show iso-exposure contours. Labels mark each country's maximum-exposure observation. Sample: 18 euro area countries, 2007Q1–2025Q2.

Figure 2: ARM Debt Exposure: Decomposition into ARM Share and Household Leverage

Figure 3 provides descriptive evidence on the within-country relationship between interest rates and ARM flow share, following the approach of De Stefani and Mano (2025). Each panel shows binned scatter plots where country means are removed to isolate within-country time-series variation. The data are divided into 50 bins based on their x-axis variables, with each point representing the mean of the bin. Panel (a) reveals a slightly negative within-country association between the ECB policy rate and ARM flow share, because when the ECB tightens its rate, ARM lending declines. This descriptive pattern previews the causal mechanism

documented in Section 5. Rises in the policy rate compress the FRM–ARM spread through differential pass-through, making FRMs relatively cheaper. Panels (b) and (c) provide further indications for the relative pricing mechanism. FRM rates and the FRM–ARM spread both exhibit strong positive correlations with the ARM share, because when FRMs become relatively more expensive, households substitute toward ARMs. Panel (d) shows only a weak positive within-country relationship between ARM rate levels and ARM flow share, that is substantially weaker than the correlations between the FRM rate and spread shown in panels (b) and (c). Unconditionally, the composition of mortgages responds primarily to relative pricing across products, or the FRM–ARM spread, rather than to the absolute cost of adjustable-rate borrowing. Panel (a) displays two distinct clusters, which probably reflect the zero lower bound period and a separate cluster at positive rates. The within-country regression line captures the overall conditional correlation but may mask these nonlinear dynamics.



Notes: Binned scatter plots showing within-country variation (country means removed). Each bin contains approximately 50 equal-sized observations. Red lines: within-country OLS fits with 95% confidence bands. Panel (a): ECB policy rate. Panel (b): FRM interest rate. Panel (c): FRM–ARM spread (positive = FRMs more expensive). Panel (d): ARM interest rate. Sample: 18 euro area countries, 2007Q1–2025Q2.

Figure 3: Interest Rates and ARM Flow Share: Within-Country Correlations

4 Methodology

4.1 Instrumented Local Projections

The estimations of the effects of monetary policy use a panel local projections–instrumental variable (LP-IV) approach (Jordà 2005; Stock and Watson 2018). Following Jordà et al. (2015), I interpret the LP-IV estimates within a two-stage least squares framework, where the endogenous change in the policy rate is instrumented with high-frequency monetary policy surprises.

I construct the baseline and interaction specifications following De Stefani and Mano (2025), and two specifications address the core questions. The baseline specification (Equation 2) asks how a common euro area monetary policy shock affects mortgage market outcomes across countries. The interaction specification (Equation 3) asks how monetary policy transmission to aggregate and sentiment outcomes depends on a country's ex-ante degree of mortgage fixation and leverage.

The baseline specification is:

$$y_{c,t+h} - y_{c,t-1} = \alpha_c + \beta_0^h \widehat{\Delta r}_t + \sum_{\ell=0}^{3} \gamma_\ell^h X_{c,t-\ell} + \sum_{\ell=1}^{4} \rho_\ell^h \Delta y_{c,t-\ell} + \varepsilon_{c,t}^h \tag{2}$$

where $y_{c,t+h} - y_{c,t-1}$ is the cumulative change in the outcome variable for country c from $t-1$ to horizon h, α_c are country fixed effects, and $\widehat{\Delta r}_t$ is the instrumented change in the ECB policy rate. The baseline specification is applied to mortgage market outcomes, ARM and FRM interest rates, the FRM–ARM spread, and the ARM flow share in order to document the rate pass-through mechanism underlying the interaction analysis. These variables are measured in levels, so the coefficients represent cumulative percentage point changes. The interaction specification (Equation 3) is applied to macroeconomic aggregates and household sentiment indicators. Macroeconomic outcomes, real GDP, consumption, durable consumption, inflation, and real house prices, are measured as log levels scaled by 100, so $y_{c,t+h} - y_{c,t-1} = [\log(Y_{c,t+h}) - \log(Y_{c,t-1})] \times 100$ and the coefficients represent approximate cumulative percentage changes.[2] Survey indicators for consumer confidence, financial situation, major purchases, and savings expectations are balance statistics in levels, so the coefficients represent cumulative balance point changes. The control vector $X_{c,t-\ell}$ includes contemporaneous changes and three lags of log changes in GDP, the Harmonised Index of Consumer Prices (HICP), nominal house prices, consumption, and household credit-to-GDP. The specification also includes four lags of the dependent variable. Since the change

[2]The household saving rate is an exception. It is already expressed as a ratio and enters in levels without log transformation.

in the policy rate is endogenous, I instrument it with high-frequency monetary policy shocks as described below. The coefficient β_0^h measures the cumulative response at horizon h to an increase of 25 basis points in the policy rate. Unlike De Stefani and Mano (2025), who use a global sample with country-specific policy rates, the ECB policy rate is common across all the euro area countries. The policy rate change $\widehat{\Delta r}_t$ therefore has no cross-sectional variation at any given date, with identification coming from time-series variation in common shocks interacted with cross-sectional variation in the structure of the mortgage market.

To study how transmission depends on the structure of mortgage rates, I augment the baseline with an interaction term:

$$\begin{aligned} y_{c,t+h} - y_{c,t-1} = \alpha_c + \beta_0^h \widehat{\Delta r}_t + \beta_1^h (\widehat{\Delta r}_t \times \text{ARMdebt}_{c,t-1}) + \beta_2^h \text{ARMdebt}_{c,t-1} \\ + \sum_{\ell=0}^{3} \gamma_\ell^h X_{c,t-\ell} + \sum_{\ell=1}^{4} \rho_\ell^h \Delta y_{c,t-\ell} + \varepsilon_{c,t}^h \end{aligned} \tag{3}$$

where $\text{ARMdebt}_{c,t-1}$ is the lagged ARM *stock* share, reflecting the proportion of outstanding mortgages with adjustable rates, multiplied by household credit-to-GDP. This scaling is done because ARM prevalence matters more for transmission when household leverage is high. A country with an ARM share of 50% but low credit-to-GDP has less aggregate exposure to rate changes than one with an ARM share of 50% and high leverage. Crucially this specification captures how monetary policy transmission is state-dependent. The same rate change produces different macroeconomic effects depending on the ex-ante composition of mortgages, and not merely on the level of household leverage. The coefficient β_1^h measures the differential effect of monetary policy for each increase of a percentage point in ARM debt exposure. To assess whether ARM prevalence or leverage drives the interaction, I also estimate a decomposition that enters the two components as separate interactions:

$$\begin{aligned} y_{c,t+h} - y_{c,t-1} = \alpha_c + \beta_0^h \widehat{\Delta r}_t + \beta_{1a}^h (\widehat{\Delta r}_t \times \text{ARM share}_{c,t-1}) + \beta_{1b}^h (\widehat{\Delta r}_t \times \text{Debt/GDP}_{c,t-1}) \\ + \text{controls} + \varepsilon_{c,t}^h \end{aligned} \tag{4}$$

where β_{1a}^h and β_{1b}^h measure the differential effect through the ARM share and the debt level respectively.

A key challenge in the identification is that changes in the policy rate might be endogenous. De Stefani and Mano (2025) construct their own high-frequency instrument following Bauer and Swanson (2023). I instead construct monetary policy surprises from the Euro Area Monetary Policy Event-Study Database (EA-MPD) by Altavilla et al. (2019). They analyse changes in a wide range of yields around ECB policy announcements to extract four types of monetary policy surprises that capture different aspects of policy implementation.

These four are a Target factor for the policy rate stance, a Timing factor for near-term rate expectations, and two factors for forward guidance and quantitative easing. I use the Target factor, which captures surprises to the current policy rate stance. I construct the Target factor from the raw intraday interest rate changes in the publicly available EA-MPD database following the methodology of Altavilla et al. (2019), and aggregate to quarterly frequency by summing all announcement-day surprises within each quarter. This choice reflects the paper's focus on the ARM channel, since adjustable-rate mortgages are repriced in line with short-term rates, so the Target factor most directly measures the shock that is propagated through the ARM channel. High-frequency identification of monetary policy surprises is widely used in the structural VAR literature since Barakchian and Crowe (2013), and more recently in the euro area panel local projection studies that are closely related to the present specification (Almgren et al. 2022; Kuhmann 2025).[3]

The first stage regresses the change in the policy rate on the high-frequency surprise and the same control set as used in the second stage:

$$\Delta r_t = \pi_0 + \pi_1 z_t^{\mathrm{AG}} + \sum_{\ell=0}^{3} \phi_\ell X_{c,t-\ell} + \sum_{\ell=1}^{4} \psi_\ell \Delta y_{c,t-\ell} + \alpha_c + \nu_{c,t} \tag{5}$$

where z_t^{AG} is the quarterly AG Target factor. The predicted values $\widehat{\Delta r_t}$ replace the endogenous policy rate change in Equations (2)–(3). In the interaction specification, the shock is also interacted with the predetermined $\mathrm{ARMdebt}_{c,t-1}$ to provide a second instrument for the endogenous interaction term.

Following De Stefani and Mano (2025), I use Driscoll-Kraay (DK) standard errors (SE) (Driscoll and Kraay 1998) with a lag truncation of three quarters to account for the cross-sectional dependence induced by the common monetary policy shock.

Also following De Stefani and Mano (2025), I include country fixed effects but not time fixed effects. Time fixed effects would absorb the monetary policy shock, as it is common across countries and has no cross-sectional variation at each date.

4.2 Instrument Validity

Instrument validity requires both exogeneity and relevance (Stock and Yogo 2002). The high-frequency identification strategy supports exogeneity. Market movements within narrow time windows around ECB announcements reflect the policy surprise rather than systematic

[3]Studies differ in their choice of shock series and exact shock construction: Almgren et al. (2022) use a Jarociński and Karadi (2020) type of decomposition, while Kuhmann (2025) use the Altavilla et al. (2019) Target factor adopted here. Section 6 provides comparative evidence using both identification schemes.

responses to economic conditions, so the shocks are plausibly uncorrelated with structural error terms.

Relevance is more nuanced. Table 1 reports Kleibergen-Paap F-statistics that fall below the conventional threshold of 10 at several horizons, particularly for the main effect. This pattern is to be expected in LP-IV settings for a persistent endogenous variable. As Almgren et al. (2022) note, the interest rate is highly persistent, so contemporaneous shocks account for only a small fraction of the variance in it, and a monetary policy surprise is itself only a fraction of those contemporaneous shocks. Including autoregressive lags, which are essential for valid LP inference (Jordà 2005; Plagborg-Møller and Wolf 2021), further absorbs the variation that the instrument would otherwise predict (Ramey 2016).

When the F-statistics are low, the IV point estimates may be biased toward OLS. To address this concern, Section 6 presents shock-based OLS estimates that bypass the first stage entirely and remain unbiased under exogeneity regardless of first-stage strength. The core finding that sentiment deteriorates more in high-ARM countries holds across both approaches. For some macro outcomes however, the magnitudes differ between the IV and shock-based OLS, which is consistent with the weak-instrument amplification in the IV estimates at horizons where the first stage is weakest. The Jarociński and Karadi (2020) decomposition provides a further diagnostic by separating the pure monetary component from central bank information effects using shock-based OLS, which does not require a strong first stage (Section 5.5).

The reduced-form figures in Section 5.5 (Figures 9–10) show the significant direct effects of the shock to the outcome variables, which does not violate the exclusion restriction.

5 Results

This section presents the results in four parts. I first examine how monetary policy shocks are transmitted through the mortgage rate channel, and I establish that ARM rates respond immediately while FRM rates remain anchored. Because sentiment indicators provide the most robust evidence for heterogeneous transmission in this sample, I present the results for them second, followed by the traditional macroeconomic aggregates. Finally I investigate asymmetric effects across the policy cycle.

All the impulse responses are scaled to represent a tightening of +25 basis points, which is the typical ECB policy adjustment, and all the impulse responses are shown up to horizon 8, which is equivalent to two years. Table 1 reports the first-stage results. The AG shock enters positively and significantly in the first stage, though Kleibergen-Paap F-statistics for the interaction term remain below the conventional thresholds at most horizons, motivating

the shock-based OLS comparisons in Section 6. Section 4.2 discusses instrument validity in detail. Section 6.1 reports robustness using Euribor tenors as alternative treatment variables.[4]

Table 1: First-Stage Regression Results

	Baseline LP				*Interaction LP*			
	ARM Sh.	ARM r	FRM r	Spread	GDP	Cons.	Dur.	HP
Panel A: First Stage for Δr								
MP Shock	1.814**	1.298*	1.918***	1.971***	1.974***	1.974***	1.974***	1.974***
	(0.688)	(0.665)	(0.671)	(0.652)	(0.766)	(0.766)	(0.766)	(0.766)
Panel B: First Stage for $\Delta r \times$ *ARMdebt*								
MP Shock × ARMdebt	—	—	—	—	2.584***	2.584***	2.584***	2.584***
					(0.634)	(0.634)	(0.634)	(0.634)
N	1,025	1,253	1,075	1,075	1,079	1,079	1,079	1,079
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
K-P F (Δr)	6.95	3.81	8.17	9.13	3.63	3.73	3.99	3.43
K-P F ($\Delta r \times$ ARM)	—	—	—	—	1.96	1.11	0.06	1.49

Notes: First-stage results at h=0. Baseline LP: ARM Sh.=ARM share, ARM/FRM r=mortgage rates. Interaction LP: Dur.=durables, HP=house prices. Interaction LP has two endogenous variables (Δr and $\Delta r \times$ ARMdebt). All specifications include country FE and controls. DK(3) SEs in parentheses. K-P F=Kleibergen-Paap Wald F. * p<0.10, ** p<0.05, *** p<0.01.

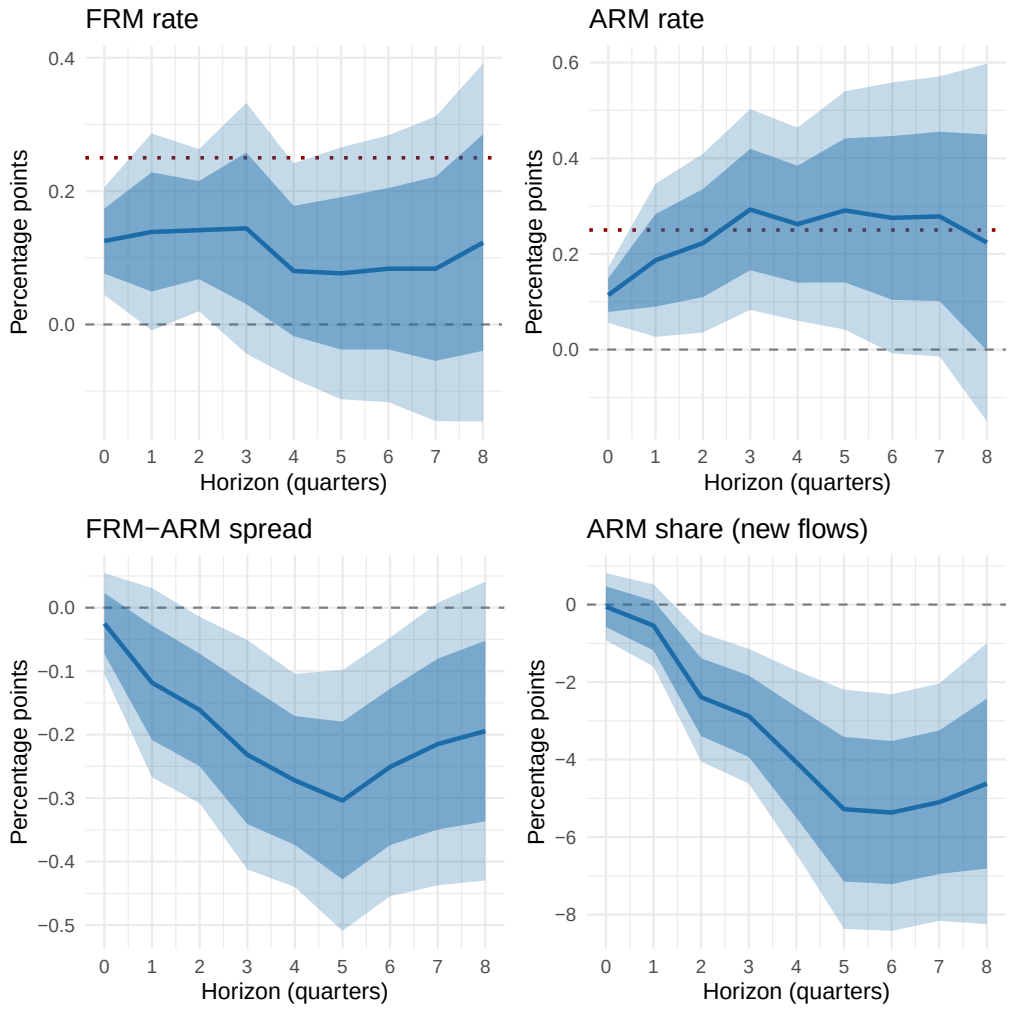
5.1 Mortgage Rate Pass-Through

I now turn to the impulse response functions. Figure 4 presents the impulse responses of mortgage interest rates and the ARM flow share to a policy tightening of 25 basis points.

Panel (a) of Figure 4 shows the response of FRM interest rates. FRM rates rise by approximately 12 basis points on impact,which is statistically significant at the 90% level, and remain elevated through quarter 2 before fading. By quarter 4, the cumulative response has declined to nearly zero and is no longer statistically significant. This muted persistence arises because FRM rates are priced from long-term government bond yields, which are less sensitive to transitory policy rate changes.

In contrast, Panel (b) shows the response of ARM interest rates. The impact response is attenuated because the shock occurs at some point during the quarter, so only a fraction of new contracts are priced at the post-shock Euribor level. Pass-through builds steadily over the following quarters and slightly exceeds one-for-one by quarter 3, peaking at roughly 29 basis points.The point estimate at horizon 3 implies a pass-through of approximately

[4]When Euribor 3M replaces the policy rate, the Kleibergen-Paap F-statistic for the interaction term rises from approximately 1–2 to approximately 9.6 (Tables A2–A3), reflecting the more direct link between high-frequency surprises and money market rates.



Notes: Coefficient β_0^h from equation (2). Panels: (a) FRM rate, (b) ARM rate, (c) FRM–ARM spread, (d) ARM share of new flows. IV-LP with AG shock as instrument. Responses to a 25bp policy rate increase. Shaded: 68% (dark) and 90% (light) CI. Country FE. DK(3) SE. 18 EA countries, 2007Q1–2025Q2.

Figure 4: Baseline Mortgage Rate Pass-Through

117%, or slightly above unity. This mild overshoot probably reflects Euribor temporarily running ahead of the policy rate because of term premiums or expectations of further hikes, or banks widening their lending mark-ups during episodes of tightening. Both channels would push the new-business ARM rate above the benchmark of 25 basis points, and the excess is within the range that these factors could plausibly explain. [5] The strong and persistent transmission is consistent with the mechanical Euribor indexation that is typical of adjustable-rate contracts. ECB rate decisions are transmitted to money market rates within days, and new ARM contracts are priced at the updated Euribor plus a bank lending spread. For existing ARM borrowers, the timing of the pass-through depends on the frequency of the contractual reset, which is typically every three or six months for euro area ARMs, so the full stock of ARM debt is repriced within one to two quarters of a policy change. The response remains elevated and statistically significant through quarter 5 before losing precision at longer horizons. Shock-based OLS estimates confirm this temporal pattern with tighter confidence bands (see Appendix B.2), ruling purely weak instruments out as an explanation for the eventual reversion.

The different responses of the FRM and ARM rates imply that the FRM–ARM spread is compressed. Panel (c) shows that the spread (the FRM rate minus the ARM rate) falls steadily following a policy tightening and reaches approximately 27–30 basis points of compression by quarters 4–5,then remains statistically significant at the 90% level through quarter 6, before partially reverting by quarter 8. The persistent compression reflects the asymmetric rate dynamics. The ARM rates remain elevated through quarter 5, while the FRM rates fade after quarter 2, so the spread continues to widen well beyond the initial rate shock. The magnitude of the spread compression is consistent with the literature on bank pass-through. Beyer et al. (2024) document substantial heterogeneity in the pass-through of interest rates across European countries, with ARM rates adjusting more rapidly than FRM rates following policy changes.

The compression has important implications for the choice of mortgage. Badarinza et al. (2016) emphasise that relative pricing across mortgage products plays a key role in the choices households make about mortgages. When the spread becomes more negative, FRMs become relatively cheaper than ARMs, creating an incentive for households to choose fixed-

[5]The baseline specification starts the sample in 2007Q1, consistent with the availability of mortgage rate data across countries. For comparison, I also examined specifications that align the mortgage pass-through sample with the macroeconomic and sentiment outcome analysis by starting in 2010Q2. Restricting the sample in this way leaves the responses of the FRM rate, the FRM–ARM spread, and the ARM share quantitatively similar. The estimated pass-through of ARM rates is somewhat smaller, but remains close to one-for-one at horizons two to four where it is statistically significant. The slightly higher pass-through estimated in the 2007Q1 baseline sample may partly reflect the inclusion of the pre-2010 tightening cycle from 2006 to 2008, in addition to the 2022–2024 episode.

rate products.

Given the substantial compression of the FRM–ARM spread documented above, households should respond by shifting toward FRMs when they take out new mortgages. Panel (d) of Figure 4 presents the impulse response to a policy tightening of 25 basis points of the ARM flow share, which is the share of new mortgage lending at adjustable rates. The results confirm this hypothesis, and the magnitude of the response is economically significant.

For comparison, the aggregate euro area ARM flow share declined by roughly 15 percentage points from approximately 50% to 35% during the 2022–2024 tightening cycle, a period that coincided with the ECB tightening cycle, though the decline might also reflect the continuation of longer-term structural trends toward fixed-rate products. The estimated causal effect of a single shock of 25 basis points is thus plausibly scaled relative to observed movements. Moreover, because mortgage contracts are long-lived, this shift has persistent effects on the composition of the housing finance stock, and it gradually reduces aggregate ARM exposure over time.

The results for my euro area sample yield findings for interest rate pass-through that are qualitatively and quantitatively similar to those of De Stefani and Mano (2025). However, the ARM share responses differ. In De Stefani and Mano (2025), the ARM share increases after tightening, which they attribute to budget-constrained borrowers shifting toward more affordable ARMs. In contrast, my estimates show ARM shares declining after tightening, which is consistent with households substituting toward cheaper FRMs when the spread compresses. This difference may arise because of sample composition, the use of different identification strategies, or differences in market structures.

The immediate ARM rate pass-through documented above is consistent with cash-flow pressure that may generate heterogeneous household responses across different structures for mortgage rates.

5.2 Household Sentiment and Expectations

The previous subsection established that ARM rates pass through immediately to mortgage payments, the FRM–ARM spread compresses, and new lending shifts toward fixed-rate contracts. This subsection turns to household sentiment indicators, including consumer confidence, major purchase intentions, savings expectations, the perceived financial situation, and inflation expectations, in order to examine whether the differences in the pass-through of the rate have heterogeneous effects on household perceptions. Survey-based sentiment measures are informative about the cash-flow mechanism because they target dimensions such as the financial situation, intention to make purchases, and expectations for savings

that should respond if there is pressure on disposable income.

The strongest and most robust heterogeneity emerges in household sentiment and expectations. While these indicators cannot establish that changes in sentiment cause changes in consumption, they provide diagnostic evidence for the cash-flow mechanism. If the differential ARM effect operated primarily through expectations or uncertainty channels that are unrelated to direct pressure on payments, the information component of policy surprises would be expected to generate similar heterogeneity. The JK decomposition in Section 5.5 provides a direct test of this prediction. That sentiment deteriorates more substantially in countries with high ARM and high debt levels, where the payment shocks are the largest, supports the interpretation that the mechanism operates through direct disposable income effects. In this sense, heterogeneity in sentiment reinforces rather than substitutes the evidence from consumption. Experimental evidence from Roth and Wohlfart (2020) demonstrates that macroeconomic expectations directly affect personal expectations and planned behaviour, and they establish a link from beliefs to economic decisions.

The cash-flow channel generates specific predictions for each sentiment sub-indicator. Assessments of the financial situation should show the strongest response, as they most closely target perceived financial wellbeing. Intentions to make major purchases should also respond strongly, since discretionary spending is the category that is easiest to postpone. Expectations for savings are theoretically ambiguous, as income falls for constrained households but so does consumption, leaving the net effect on expected saving uncertain. Consumer confidence, as a composite, should reflect a weighted average of these sub-components. I assess the results against these priors below.

Figures 5 and 6 show the heterogeneity for sentiment and expectations, which are split into personal finance indicators and economy-wide indicators respectively.

Figure 5 presents the indicators that are most directly tied to the financial circumstances of households. The first row shows the perceived financial situation, where countries with high levels of ARM and debt show worse assessments, though the effects are small and imprecisely estimated. The weak response of the financial situation is somewhat surprising given that it most directly measures perceived disposable income. The imprecision may arise because this sub-indicator captures heterogeneous household circumstances beyond mortgage payments alone. The second row shows the intention to make major purchases, where high-ARM countries show increased pessimism about big-ticket purchases, which is consistent with discretionary spending being postponed when cash flows become tighter.

Figure 6 presents broader measures of sentiment. Consumer confidence exhibits a negative and statistically significant response, with larger declines in countries with high levels of ARM and debt, as the interaction effect reaches approximately -0.05 to -0.06 balance

points per unit of ARM debt exposure at horizons 3–4.

The magnitudes across indicators are in a comparable range of 0.03–0.06 balance points per unit of ARM debt exposure. For a difference of one standard deviation in exposure ARM debt, which is approximately 21 units, these coefficients imply an additional deterioration in sentiment of the order of 0.6–1.3 balance points following a tightening shock of 25 basis points. Comparing these results to the ex-ante predictions shows that consumer confidence and major purchases respond as expected.

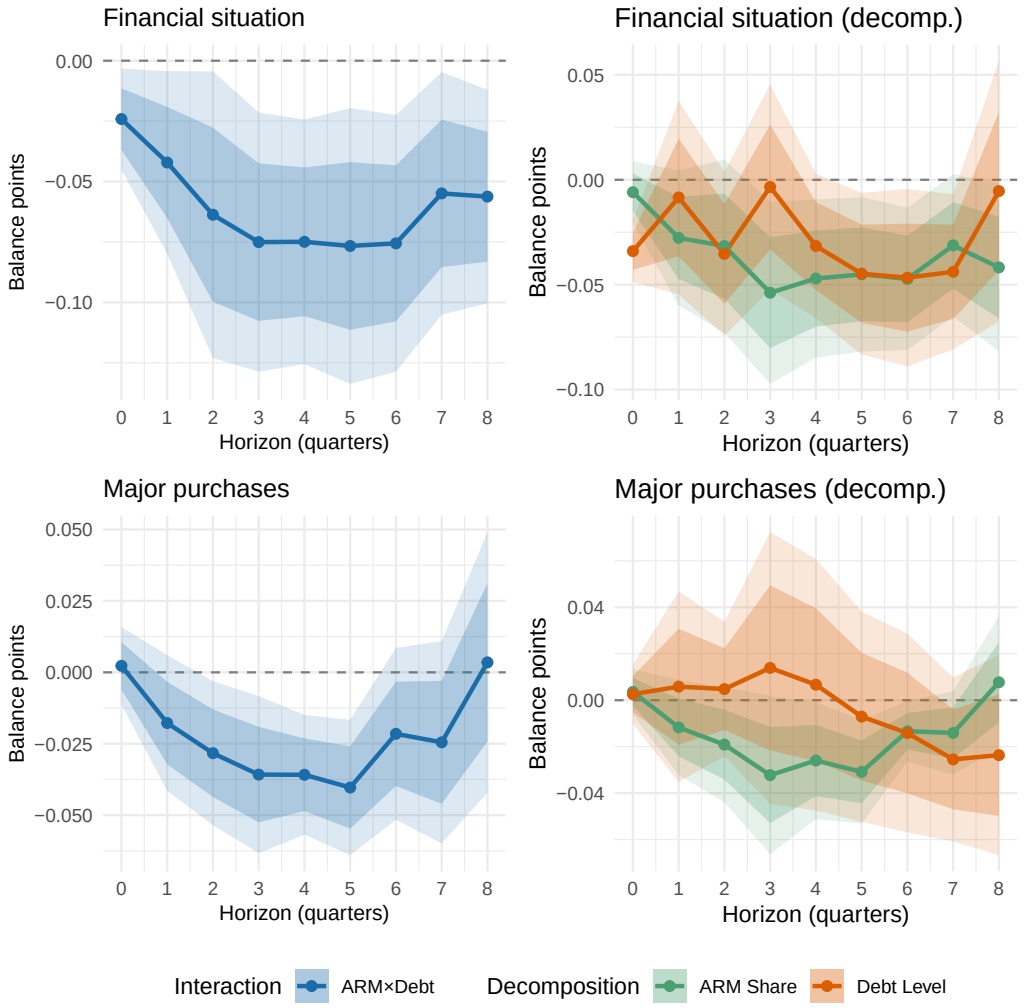
The decomposition into the components of ARM share and debt level is often imprecise, with wide confidence bands that largely overlap. Point estimates for sentiment indicators suggest that both channels contribute at short horizons, but the ARM share component tends to show larger magnitudes for consumer confidence and major purchase intentions, which is consistent with exposure to rate resets driving perceived financial pressure most directly. At longer horizons it is only savings expectations that show both components moving in the same direction with statistical significance. The wide confidence bands caution against strong conclusions about which component dominates for sentiment, but the pattern suggests that the combined ARM×Debt measure captures meaningful joint variation. [6]

The sentiment results are consistent with the cash-flow channel interpretation. Aggregate sentiment deteriorates in countries with high ARM and debt levels, with respondents reporting worse financial conditions and more pessimism about major purchases, so providing diagnostic evidence that the transmission mechanism operates through perceived financial pressure. Macro outcomes like GDP reflect many competing channels simultaneously, whereas sentiment indicators target subjective assessments that are more closely aligned with cash-flow pressure and are less confounded by wealth effects, trade dynamics, or supply-side factors.

Sentiment effects emerge at shorter horizons than consumption effects, which is consistent with the cash-flow narrative in which payment shocks first affect perceived financial wellbeing, and behavioural adjustments follow. However, both responses may reflect correlated reactions to the same underlying shock to disposable income rather than a strict causal sequence.

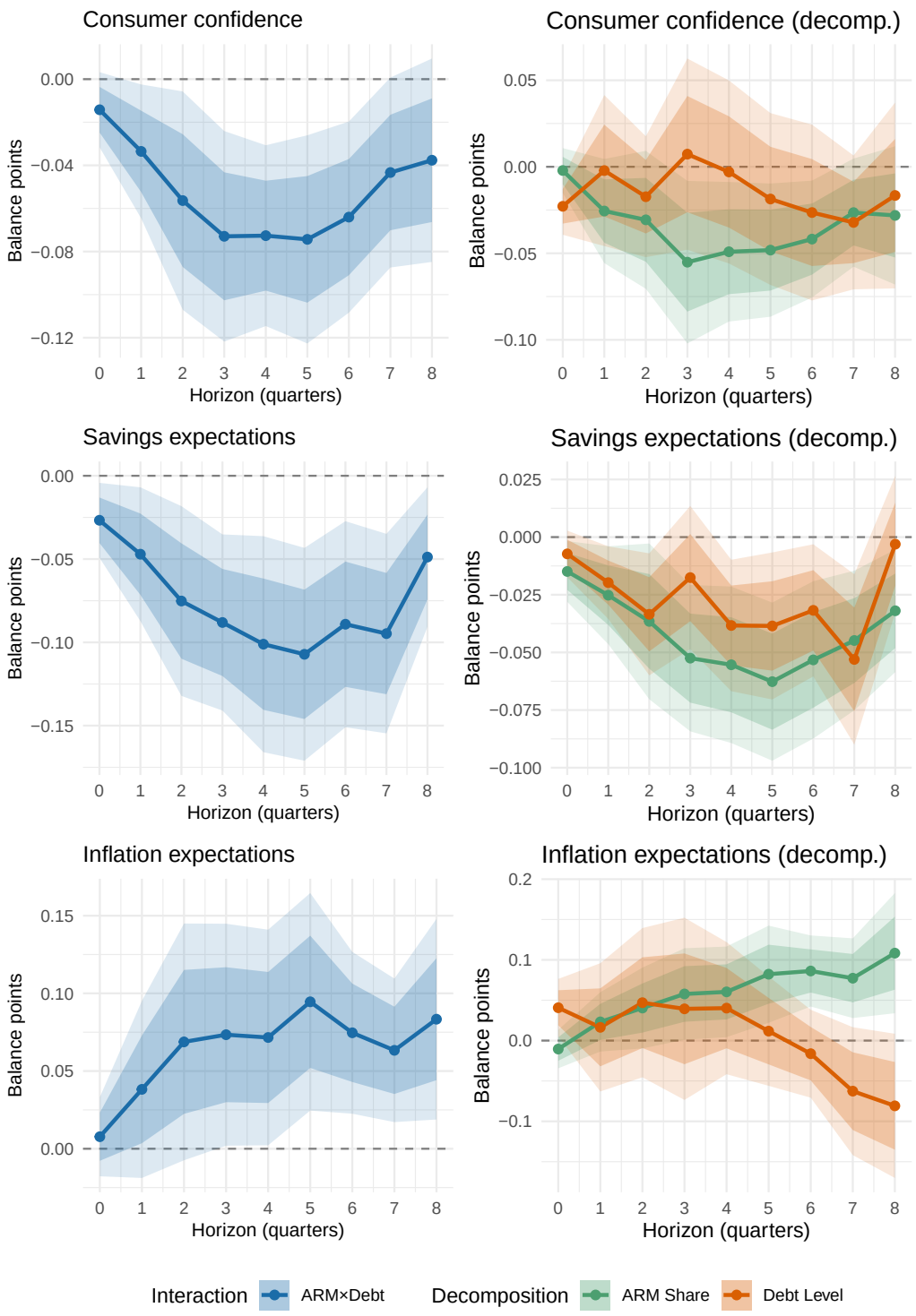
Interpreting Sentiment Evidence. A natural question is whether deteriorating sentiment causes consumption to decline or whether both effects are parallel symptoms of the same underlying cash-flow shock. The local projection framework cannot definitively answer this question, as doing so would require a structural VAR with ordering assumptions,

[6] I report a robustness specification in Appendix B that includes ARM share and debt-to-GDP as separate level controls alongside the interaction; the interaction coefficient is quantitatively similar, indicating that the combined measure is not simply proxying for omitted main effects.



Notes: Coefficient β_1^h from equation (3). Rows: (1) financial situation, (2) major purchase intentions. Left panels: ARM×Debt interaction effects; right panels: decomposition into ARM share (blue) and debt level (orange) contributions. IV-LP with AG shock as instrument. Responses to a 25bp policy rate increase. Shaded: 68% (dark) and 90% (light) CI. Country FE. DK(3) SE. 18 EA countries, 2007Q1–2025Q2.

Figure 5: Interaction Effects: Personal Finance Sentiment



Notes: Coefficient β_1^h from equation (3). Rows: (1) consumer confidence, (2) savings expectations, (3) inflation expectations. Left panels: ARM×Debt interaction effects; right panels: decomposition into ARM share (blue) and debt level (orange) contributions. IV-LP with AG shock as instrument. Responses to a 25bp policy rate increase. Shaded: 68% (dark) and 90% (light) CI. Country FE. DK(3) SE. 18 EA countries, 2007Q1–2025Q2.

Figure 6: Interaction Effects: Economy-Wide Sentiment

randomised information treatments, or data as a higher frequency than quarterly aggregates.

What the data can establish is that (i) sentiment heterogeneity is larger and more precisely estimated than consumption heterogeneity, and (ii) both heterogeneities respond in directions that are consistent with the cash-flow mechanism. The first fact suggests that sentiment indicators, being survey-based and targeted specifically at financial perceptions, may make them more informative about which mechanism is operating than the indicator for aggregate consumption, which reflects many competing channels simultaneously. The second fact is difficult to reconcile with alternative mechanisms that would predict similar responses regardless of the structure of mortgages, though the JK decomposition in Section 5.5 provides a more nuanced test.

I therefore interpret sentiment as diagnostic evidence for the cash-flow mechanism rather than as a causal channel. The claim is not that improving sentiment would restore consumption, but that the pattern of sentiment heterogeneity reveals where the mechanism is operating most intensely.

Isolating the cash-flow channel from alternative mechanisms such as heightened attention to rate news among ARM borrowers (Ahn et al. 2024) or uncertainty about future payments would require household-level data that link actual changes in payments to sentiment responses. The aggregate country-level evidence presented here is consistent with cash-flow transmission but cannot rule out other alternatives.

The sentiment findings have important implications for understanding the heterogeneity of monetary policy transmission. Consumer confidence, as a composite measure of overall sentiment, exhibits statistically significant heterogeneity that is comparable to that of its sub-components. The magnitudes are consistent across sentiment indicators, as an increase of one standard deviation or approximately 21 units in exposure to ARM debtcombined with a 25-basis-point tightening shock reduces consumer confidence by approximately 1.0 balance points at the one-year horizonwith an interaction coefficient of approximately -0.05 per unit of ARM debt exposure.

Several channels could explain the relationship between ARM and sentiment. The first is that higher mortgage payments directly reduce disposable income, creating financial pressure that households perceive immediately through the cash-flow channel. Second, ARM borrowers face greater uncertainty about future payments, meaning they have precautionary concerns even before rate changes materialise. Third, media coverage of rate changes may amplify the sentiment effects in high-ARM countries, where monetary policy decisions are more personally salient. The aggregate evidence presented here cannot definitively distinguish between these mechanisms, though the pattern is most naturally interpreted through the cash-flow lens.

Inflation expectations present a more nuanced pattern. The point estimates are positive across horizons 2–8, suggesting that high-ARM countries expect somewhat higher inflation after interest rates rise, but the effects are initially not statistically significant at conventional levels. At the 68% confidence level however, the positive effect can be detected at several horizons. This finding could relate to information rigidity in the formation of expectations (Coibion and Gorodnichenko 2015). Households are slow to revise their inflation expectations downward after a contractionary shock, so they experience higher debt service costs without the offsetting belief that inflation will fall. This pattern is also consistent with recent micro-level evidence from the ECB's Consumer Expectations Survey (Baldassarri et al. 2024). That analysis finds that the positive relationship between expectations for interest rates and inflation is strongest for ARM holders, who perceive rate increases as direct rises in the cost of living rather than as disinflationary policy. This interpretation echoes Bolhuis et al. (2024), who argue that "the cost of money is part of the cost of living". Households treat interest expenses as a component of their perceived inflation, which would explain the anomalous responses of sentiment to rate increases. Households may perceive higher debt service costs as part of their cost of living rather than as a signal of disinflationary policy. My aggregate-level results provide suggestive support for this mechanism, as high-ARM countries show directionally higher inflation expectations after tightening, even though the aggregate relationship is weaker than in the micro-level finding.

5.3 Heterogeneous Macroeconomic Effects

Having established the sentiment effects, I now examine traditional macroeconomic aggregates. Figures 7 and 8 summarise the interaction results for real activity, and housing, and saving. Each row shows the impulse response function for the ARM×Debt interaction on the left and its decomposition into the ARM share and debt level channels on the right.

Durable consumption shows the strongest and most precisely estimated amplification among the macro outcomes, with the interaction coefficient β_1^h reaching approximately -0.02 to -0.04 percentage point per unit of ARM debt at horizons 4–6and remaining statistically significant at the 68% level through horizon 7. For a country at the 75th percentile of ARM debt exposure relative to one at the 25th percentile, a difference of approximately 25 units, this implies an additional cumulative decline in durable consumption of roughly 0.5–1.0 percentage point over one to one-and-a-half years following a tightening shock of 25 basis points. This finding is consistent with the cash-flow interpretation. Big-ticket purchases can be postponed, and households facing payment pressure delay purchases of furniture, appliances and vehicles rather than cutting back on necessities (Di Maggio et al. 2017). The result

for durables provides a cleaner test of the ARM channel because although the aggregate responses of GDP and consumption, while directionally consistent with larger contractions in countries with high levels of ARM and debt, are not statistically significant even at the 68% confidence level. This imprecision reflects the well-known difficulty of identifying aggregate output effects in cross-country studies of monetary policy. House prices fall more in highly leveraged economies, though this heterogeneity appears to be driven primarily by debt levels rather than ARM shares. House prices might respond to the collateral channel (Iacoviello 2005), in which higher leverage tightens borrowing constraints when asset prices decline, and that would amplify the downturn through feedback between collateral values and credit availability. This mechanism depends on total debt exposure rather than rate fixation, which explains why debt levels dominate ARM shares for housing markets specifically. Combined with the sentiment decomposition in Section 5.2, these results suggest that the ARM share and the debt level may operate through a partially distinct channel. The ARM share drives heterogeneity in sentiment and perceived financial pressure through the cash-flow channel, while debt levels drive heterogeneity in asset prices through the collateral channel. The combined ARM×Debt measure captures the joint exposure that is most relevant for cash-flow transmission, while the decomposition reveals that the two components contribute differently across outcomes. Household saving rates show small and statistically insignificant interaction effects, with point estimates that are slightly positive at longer horizons ($h \geq 3$), suggesting inconclusively that there may be modest increases in the saving rate in high-ARM countries. The small magnitude and imprecision of this suggestion preclude any strong conclusions being drawn about which mechanism dominates. Several interpretations are consistent with a positive response from the saving rate. Households facing greater uncertainty about their income because of the variable mortgage payments may increase their precautionary buffers (Christelis et al. 2019). Higher real interest rates increase the return to saving, which may dominate the income effect for households that have a positive net interest rate exposure. Higher mortgage payments also mechanically reduce the gap between income and debt service, which in the conventions of the national accounts can appear as reduced consumption rather than increased saving. The imprecision of these estimates is itself informative, as it suggests that the saving rate is less clean as a diagnostic tool for the cash-flow channel than the sentiment indicators or durable consumption are.

These results align qualitatively with those of De Stefani and Mano (2025), who also do not find statistically strong GDP effects at the 90% confidence level despite having similar IRF shapes. Their house price responses are also relatively flat and show stronger debt effects in the decomposition. The consistency across studies that use different samples and identification strategies supports the robustness of the underlying transmission mechanism,

even if the aggregate effects remain imprecisely estimated. The macro results thus provide supporting evidence for the cash-flow mechanism documented in the sentiment indicators, though with the expected measurement challenges of aggregate national accounts data.

5.4 Asymmetric Effects Across the Policy Cycle

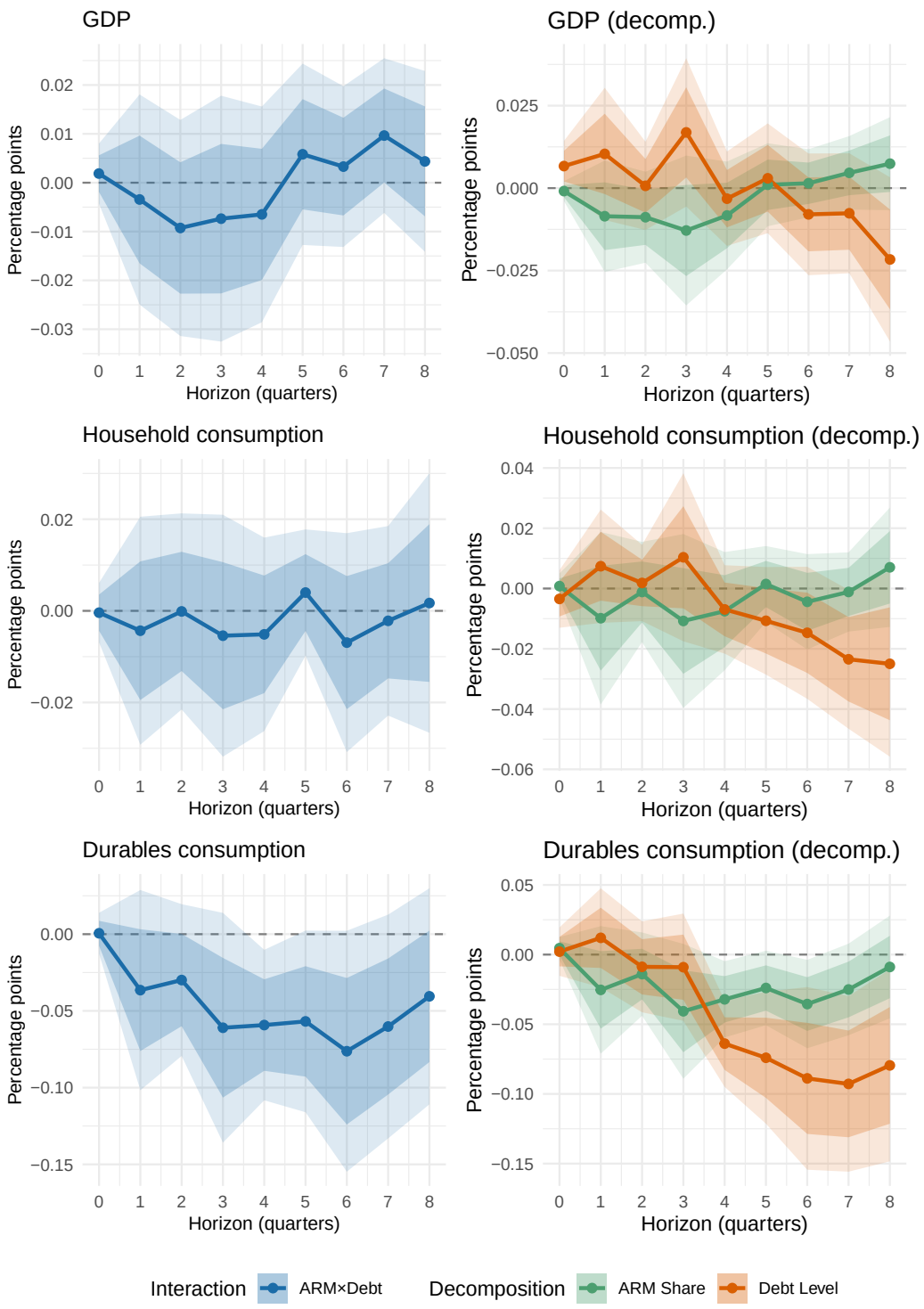
I also examine whether ARM amplification differs across episodes of tightening and loosening. Appendix B.3 presents phase-specific interaction effects estimated following Tenreyro and Thwaites (2016) and De Stefani and Mano (2025). Tightening effects tend to be larger for durable consumption and for sentiment indicators, while house prices respond more during loosening. However, formal tests cannot reject symmetric transmission at conventional significance levels across all outcomes and horizons.

5.5 Monetary Shocks and Information Shocks

The AG high-frequency surprises capture the full policy announcement, bundling the interest rate change with any information the central bank communicates about the macroeconomic outlook. If the information component is non-trivial, the baseline interaction effects could partly reflect differences in sensitivity to expectations for growth rather than pure cash-flow pressure. The Jarociński and Karadi (2020) decomposition addresses this concern by separating high-frequency surprises into a pure monetary component seen as policy tightening accompanied by falls in share prices, and a central bank information component seen as policy tightening accompanied by rises in share prices, signalling positive news about growth. This exercise does not introduce a new identification strategy but it serves as a shock-content diagnostic that clarifies the economic interpretation of the baseline results.

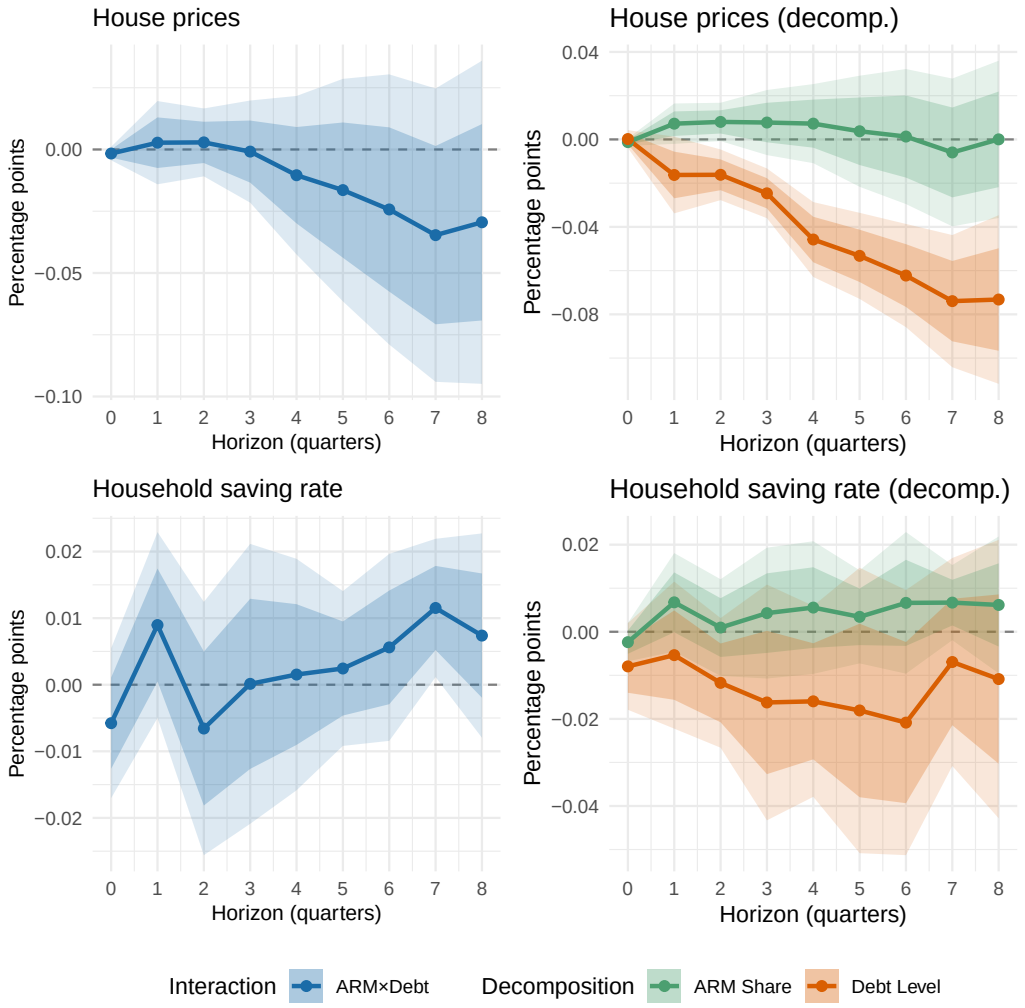
The decomposition yields testable predictions. The monetary component is transmitted through the cash-flow channel, where it raises ARM payments, squeezes disposable income, and should generate heterogeneous effects that are concentrated in high-ARM countries. The information component signals the prospects for growth and should not generate cash-flow pressure or direct payment pressure, since growth news does not mechanically alter mortgage servicing costs. If interaction effects track the monetary component and are absent for the information component, the cash-flow interpretation of the baseline results is strengthened.

I use the median-rotation decomposition of Jarociński and Karadi (2020), which apportions each announcement continuously between the monetary and information components, rather than the "poor man's" sign restriction that assigns each event entirely to one type. Because the two components are estimated on the same scale and sum to the total surprise, they are directly comparable. Differences in magnitude or significance across the mone-



Notes: Coefficient β_1^h from equation (3). Rows: (1) GDP, (2) total consumption, (3) durable consumption. Left panels: ARM×Debt interaction effects; right panels: decomposition into ARM share (blue) and debt level (orange) contributions. IV-LP with AG shock as instrument. Responses to a 25bp policy rate increase. Shaded: 68% (dark) and 90% (light) CI. Country FE. DK(3) SE. 18 EA countries, 2007Q1–2025Q2.

Figure 7: Interaction Effects: Real Activity



Notes: Coefficient β_1^h from equation (3). Rows: (1) house prices, (2) household saving rate. Left panels: ARM×Debt interaction effects; right panels: decomposition into ARM share (blue) and debt level (orange) contributions. IV-LP with AG shock as instrument. Responses to a 25bp policy rate increase. Shaded: 68% (dark) and 90% (light) CI. Country FE. DK(3) SE. 18 EA countries, 2007Q1–2025Q2.

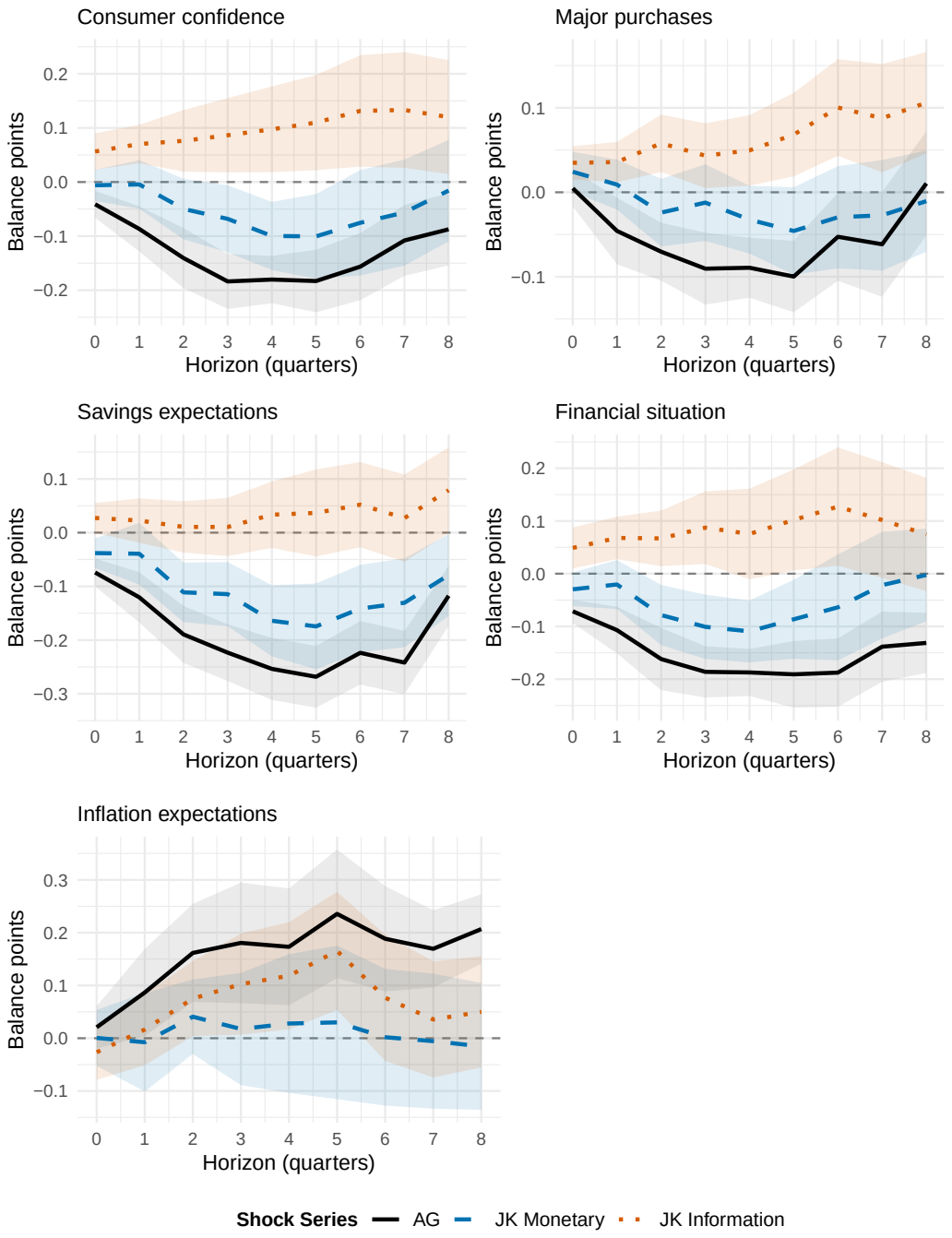
Figure 8: Interaction Effects: Housing and Saving

tary and information IRFs reflect genuine differences in transmission rather than artifacts of classification. Rather than using JK shocks as alternative instruments, where first-stage F-statistics fall below conventional thresholds at longer horizons, I compare all three shock series, AG, JK monetary, and JK information, using shock-based OLS, regressing outcomes directly on the identified shocks. The AG estimates in these figures therefore differ from the IV baseline and are re-estimated via OLS to ensure a like-for-like comparison.

Figures 9 and 10 present this comparison across the full set of sentiment and macro outcomes (all bands show 68% confidence intervals for visual clarity).

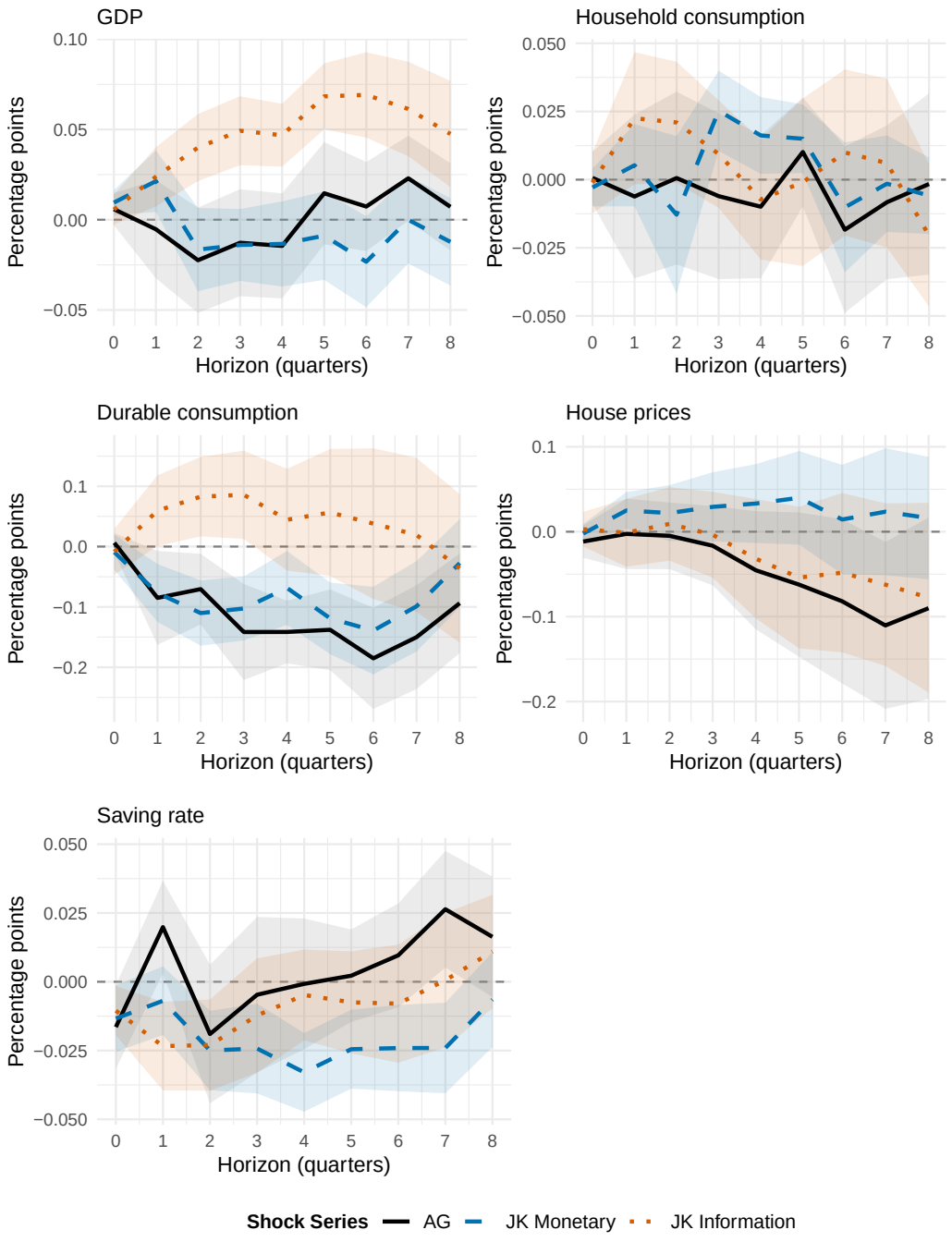
For sentiment outcomes (Figure 9), a recurring ordering emerges. AG generates the largest negative interaction, JK monetary is also negative but smaller, and the information component is near zero or positive. Savings expectations display this pattern most clearly, with AG and JK monetary both declining persistently while the information component remains near zero. ARM households revise saving plans downward as more income is absorbed by debt service, and this budget-constraint pressure is absent from the information channel. Consumer confidence shows the widest absolute gap between the monetary and information components, with the monetary component negative and the information component positive, and AG more negative than the monetary component alone. Major purchases and financial situation follow a qualitatively similar ordering, with the monetary component generating larger negative interactions than the information component. The fact that AG is consistently more negative than the JK monetary component across sentiment indicators likely reflects the greater variance of the unbundled surprise, though the directional alignment between AG and the monetary component is the key finding. Inflation expectations stand apart. AG produces the largest positive interaction, exceeding both JK components, neither of which alone generates an effect of comparable magnitude. The wide confidence bands caution against strong inference, but the pattern is consistent with the salience of observed payment adjustments shaping inflation perceptions through a channel that the monetary–information decomposition does not fully capture.

For macro outcomes (Figure 10), the three shock series display a consistent ordering for most variables, with the relative magnitudes indicating which component drives the bundled AG interaction effect. Durable consumption exhibits the widest separation. AG and JK monetary are both negative and follow similar paths, though AG is somewhat larger in magnitude, while the information component is positive throughout. The sustained gap between the monetary and information paths supports the cash-flow interpretation for durable consumption. ARM payment adjustments from the pure rate change reduce discretionary spending in high-ARM countries, while positive growth news boosts it. For GDP, AG is modestly negative and falls between the two JK components, consistent with the bundled



Notes: Interaction coefficients (β_1^h: shock × ARM×Debt) from shock-based OLS LP for sentiment outcomes: consumer confidence, major purchases, savings expectations, financial situation, and inflation expectations. Three shock series: AG total surprise (black, solid), JK pure monetary component (blue, dashed), and JK central bank information component (red, dotted). JK decomposition uses median rotation. Shock-based OLS. All bands: 68% CI. Responses scaled to a 25bp shock. Country FE. DK(3) SE.

Figure 9: Shock-Based OLS Interaction Effects: AG vs JK Decomposition: Sentiment Outcomes



Notes: Interaction coefficients (β_1^h: shock × ARM×Debt) from shock-based OLS LP for macro outcomes: GDP, household consumption, durable consumption, house prices, and saving rate. Three shock series: AG total surprise (black, solid), JK pure monetary component (blue, dashed), and JK central bank information component (red, dotted). JK decomposition uses median rotation. Shock-based OLS. All bands: 68% CI. Responses scaled to a 25bp shock. Country FE. DK(3) SE.

Figure 10: Shock-Based OLS Interaction Effects: AG vs JK Decomposition: Macro Outcomes

surprise averaging over a contractionary monetary effect and an expansionary information effect. Household consumption is less sharply separated, with all three series closer to zero and overlapping confidence bands, suggesting the decomposition is less informative for aggregate consumption than for durable consumption. The saving rate responds distinctly to the monetary component, which produces a persistently negative interaction while the information component remains near zero, consistent with cash-flow pressure reducing disposable income available for saving through a channel that growth news does not activate. House prices diverge from the expenditure pattern. The AG path aligns more closely with the JK information component, with both turning negative at longer horizons, while the monetary component remains near zero. This suggests that forward-looking expectations channels captured by the information component matter more for housing valuations than contemporaneous cash-flow effects.

The results match the ex-ante predictions. For expenditure and sentiment variables, interaction effects track the JK monetary component. AG and monetary-only paths are very close to each other, confirming that the heterogeneous response reflects cash-flow pressure from rate changes rather than differential sensitivity to growth expectations. The information component shows opposite-signed or attenuated effects for most expenditure and sentiment outcomes, consistent with growth news operating through different channels than cash-flow pressure. For consumer confidence, the information component is positive at several horizons, suggesting that positive growth news improves sentiment in high-ARM countries, while the monetary component drives the differential deterioration. This separation is inconsistent with heightened attention to policy announcements alone driving the heterogeneity (Ahn et al. 2024), since attentive households would react to both components. The cash-flow content of the shock, not merely its salience, appears necessary to generate the differential response. House prices and inflation expectations are exceptions where expectations-based channels appear to play a distinct role, consistent with the forward-looking nature of asset valuations and the salience of observed payment adjustments for inflation perceptions. The consistency between AG and JK monetary paths, which differ in shock content but share the same high-frequency identification window, supports the baseline findings, with the attenuated JK magnitudes reflecting the smaller variance of the purged shock. The decomposition sharpens the interpretation of the baseline results but does not structurally identify the channel. Appendix B.1 provides additional details, including baseline mortgage rate pass-through for the JK components.

6 Robustness Checks

The baseline estimates face several potential concerns beyond the shock-content question addressed above. The IV strategy requires sufficient first-stage power; if instruments are weak at some horizons, IV estimates may be unreliable (see Section 4.2 for discussion). The treatment variable (ECB policy rate) may not directly reflect the rates facing ARM borrowers, who typically pay spreads over Euribor. The ARM debt exposure measure (ARM share $\times$ credit-to-GDP) involves normalization choices that could affect inference.

I address these concerns through the following robustness exercises. Section 6.1 examines transmission using Euribor rates at various tenors as alternative treatment variables. Section 6.2 re-estimates the model using household debt-to-income as an alternative normalization.[7] Appendix B.7 excludes the Netherlands, Luxembourg, and Ireland from the sample to verify that results are not driven by these outlier countries; the dynamics are qualitatively similar, though point estimates are larger in the restricted sample. Across all specifications, the core finding, that ARM debt exposure amplifies monetary transmission to household outcomes, remains robust.

6.1 Alternative Treatment Variable

As a robustness check, I replace the ECB policy rate with Euribor rates at various tenors (3-month, 6-month, and 12-month) as alternative treatment variables. These are more directly linked to ARM pricing since most euro area ARMs are contractually indexed to Euribor, with 12-month Euribor serving as the primary benchmark in high-ARM countries such as Spain and Finland. Figure A9 shows that the baseline mortgage rate pass-through is qualitatively identical across all four treatment variables: ARM rates rise on impact, FRM rates respond more gradually, the spread narrows, and ARM new flow shares decline persistently. Euribor-based estimates are slightly larger in magnitude than their policy rate counterparts, with point estimates increasing monotonically across tenors (3-month $<$ 6-month $<$ 12-month).

Figure A10 confirms that the interaction effects, the core ARM$\times$Debt heterogeneity, are equally robust across treatment variables. The amplified transmission through sentiment and durable consumption in high-ARM countries documented in the baseline holds for all four specifications. The consistency across treatment variables confirms that results are not an artifact of using the policy rate, which is set at discrete intervals, rather than the continuously adjusting market rate that directly determines ARM payments.

[7] As a complement, Appendix B.2 compares shock-based OLS estimates, which bypass the first stage entirely, with endogenous OLS to diagnose simultaneity bias.

6.2 Alternative Normalization: Income-Scaled Measure

The baseline uses a GDP-scaled measure (ARM stock share × household credit-to-GDP). As an alternative, I construct an income-scaled measure using household debt-to-disposable-income, which is conceptually closer to the household budget constraint but less commonly used in the literature. Table A4 shows that results are qualitatively identical. The interaction coefficient β_1^h is negative and statistically significant for consumer confidence, savings expectations, and financial situation at $h = 4$, with the sign and significance pattern matching the baseline. Macro outcomes (GDP, consumption, durable consumption) show negative point estimates that are directionally consistent but not statistically significant at conventional levels. Coefficients for the income-scaled measure are roughly 40–50% smaller in absolute value, reflecting the larger scale of the debt-to-income ratio (mean ≈ 95) relative to credit-to-GDP (mean ≈ 55), which mechanically rescales the interaction variable and thus the coefficient.

6.3 Sentiment as a Transmission Channel

To distinguish whether the ARM×Debt heterogeneity operates through household sentiment expectations or represents a direct cash-flow effect, I implement a control-based mediation analysis. Following the same structure as other macroeconomic controls, I add the contemporaneous and 3 lags of the sentiment indicator in levels to the baseline specification. If sentiment expectations explain the heterogeneous response, controlling for sentiment should attenuate the interaction coefficient. This exercise tests whether controlling for the level of sentiment attenuates the interaction coefficient. It does not constitute a structural analysis and cannot establish causal pathways. Rather, it asks whether observable sentiment variation around the time of the shock accounts for part of the heterogeneous response, complementing the interpretive discussion in Section 5.4.

Figure A8 in Appendix B.4 present results for GDP with consumer confidence, and durable consumption with both consumer confidence and major purchase intentions. For GDP, controlling for consumer confidence attenuates the interaction coefficient by approximately 18% at the peak horizon, indicating modest sentiment mediation. For durable consumption, controlling for consumer confidence explains approximately 11% of the heterogeneous response on average, while major purchase intentions (a measure directly aligned with discretionary spending decisions) explains approximately 17%. Even with the more targeted mediator, over 80% of the heterogeneous durable consumption response remains unexplained by sentiment. This modest mediation share is consistent with sentiment reflecting rather than driving the cash-flow mechanism. Survey-based indicators capture only a

portion of the financial pressure that constrains actual spending decisions. The finding supports the interpretation that ARM×Debt heterogeneity operates primarily through direct cash-flow pressure on disposable income rather than through expectations channels.

7 Conclusion

This paper documents that the structure of mortgage rates shapes not only macroeconomic outcomes but also household sentiment and confidence in response to monetary policy. Using instrumental variable local projections on a panel of 18 euro area countries over 2007–2025, I trace how monetary policy shocks transmit through the mortgage rate channel. ARM rates respond immediately to policy changes, rising approximately 11 basis points on impact and building to around 29 basis points by the third quarter, with substantial though incomplete pass-through, while FRM rates remain anchored to long-term yields. This differential is associated with cash-flow pressure concentrated in high-ARM countries.

The most robust heterogeneous effects appear in sentiment indicators. Consumer confidence, financial situation assessments, and major purchase intentions all deteriorate more in countries with higher ARM exposure during monetary tightening. These responses are statistically significant and economically meaningful, with interaction coefficients of comparable magnitude across indicators at the one-year horizon. Because sentiment deteriorates most where payment shocks are largest, the pattern supports transmission through direct disposable income pressure rather than through general expectations or uncertainty channels that would affect all countries similarly. Traditional macro aggregates are directionally consistent but estimated with less precision; durable consumption shows the strongest response, consistent with households postponing discretionary spending under cash-flow pressure. The Jarociński and Karadi (2020) shock decomposition provides further support: interaction effects track the pure monetary component rather than the central bank information component, particularly for savings expectations and consumer confidence, indicating that the cash-flow content of the shock drives the heterogeneous response.

These findings may have implications for monetary policy in a heterogeneous monetary union. First, if sentiment deterioration captures welfare costs beyond measured consumption, then standard transmission metrics based on GDP or consumption may understate the full impact of monetary policy in ARM-heavy countries. Second, the heterogeneous sentiment effects have political economy implications. ARM-heavy countries may experience greater public dissatisfaction with monetary tightening, complicating ECB communication and policy coordination across member states. Third, the ongoing shift toward fixed-rate products across several euro area countries may weaken the interest rate channel over time,

requiring larger or more persistent rate changes to achieve the same degree of transmission and complicating the calibration of monetary policy in a union where the structures of mortgages continue to evolve heterogeneously.

Several limitations warrant mention. Aggregate macroeconomic responses are estimated with limited precision, likely reflecting the short sample period and the small number of independent policy cycles. The panel approach masks within-country heterogeneity that could be uncovered using micro-level data, such as household finance and consumption panels, including the ECB's Household Finance and Consumption Survey (HFCS). General equilibrium effects operating through labour markets and credit supply are abstracted from, and a fully specified HANK model with heterogeneous mortgage structures would be required to assess welfare implications.

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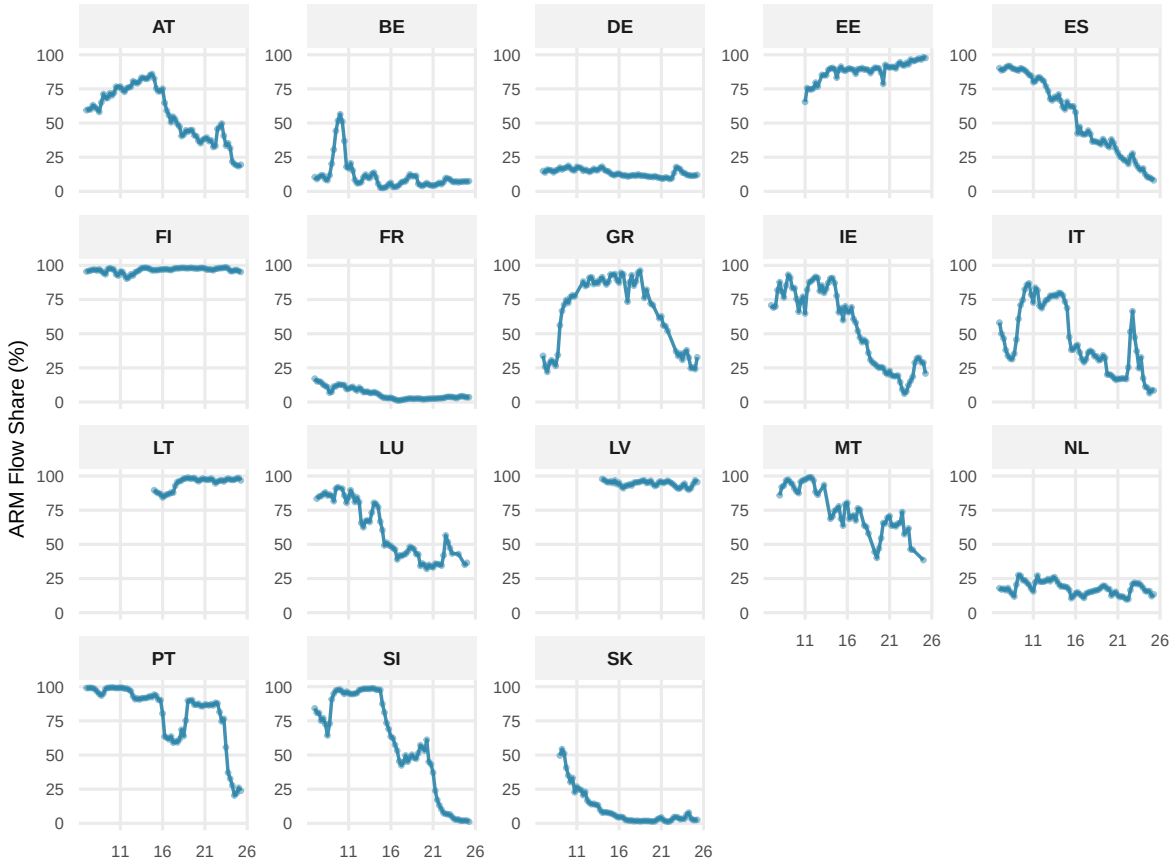
A Data and Summary Statistics

Table A1: Summary Statistics

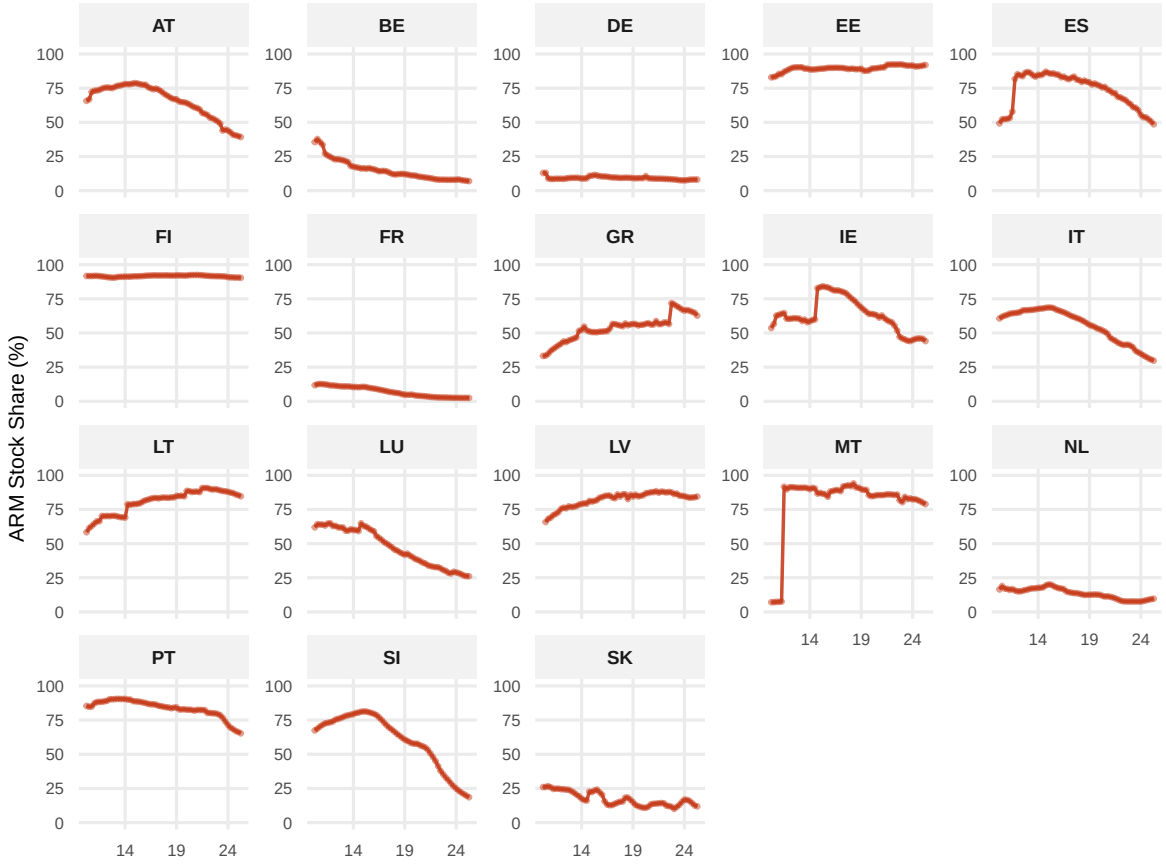
Variable	N	Mean	SD	Min	P25	P75	Max
Panel A: Treatment Variables							
ARM Flow Share (%)	1212	52.16	35.27	1.11	15.65	88.86	99.39
ARM Stock Share (%)	1097	54.93	30.87	2.47	19.41	83.91	94.02
ARM Debt Exposure	1097	27.57	18.94	1.49	11.40	39.03	81.46
Panel B: Macroeconomic Outcomes							
Real GDP Growth (%)	1332	1.62	4.72	-24.15	-0.02	3.52	24.80
Consumption Growth (%)	1332	1.35	4.86	-27.51	0.02	3.19	24.34
Durables Growth (%)	1332	2.54	10.76	-58.06	-1.59	7.94	52.26
Nominal House Price Growth (%)	1324	3.08	8.22	-54.91	0.00	7.14	40.30
Real House Price Growth (%)	1324	0.68	8.03	-59.54	-2.18	5.02	32.93
Panel C: Saving							
HH Saving Rate (%)	1243	11.37	5.41	-6.82	8.29	14.66	32.90
Panel D: Sentiment Indicators							
Consumer Confidence	1332	-13.48	13.80	-78.53	-19.51	-4.47	14.60
Financial Situation	1332	-5.31	14.22	-76.93	-10.45	4.13	22.50
Major Purchases	1332	-20.04	13.65	-79.07	-27.36	-11.80	15.80
Savings Expectations	1332	-6.54	29.80	-84.93	-25.62	13.43	55.93
Inflation Expectations	1332	23.74	17.33	-41.33	11.69	35.86	67.40
Panel E: Interest Rates							
ARM Rate (%)	1326	3.04	1.33	0.63	1.97	3.86	6.95
FRM Rate (%)	1174	4.03	2.25	0.00	2.39	5.15	16.22
FRM-ARM Spread (pp)	1174	1.04	1.97	-2.94	-0.11	1.65	13.48
ECB Policy Rate (%)	1332	0.68	1.46	-0.50	-0.40	1.30	4.00
Panel F: Monetary Policy Shocks							
MP Shock (AG)	1332	0.001	0.039	-0.095	-0.012	0.004	0.217
MP Shock (JK Monetary)	1332	0.012	0.054	-0.081	-0.019	0.035	0.213
MP Shock (JK Information)	1332	-0.005	0.046	-0.141	-0.028	0.018	0.144
Panel G: Control Variables							
Inflation (%)	1332	2.45	2.99	-4.05	0.70	3.17	21.59
HH Debt-to-Income (%)	1296	96.03	48.95	30.72	66.09	104.43	257.58
HH Credit-to-GDP (%)	1332	54.16	22.97	16.03	39.63	62.38	126.29

Notes: Summary statistics computed over the LP estimation sample (2007Q1–2025Q2). ARM Debt Exposure = ARM Stock Share × HH Credit-to-GDP / 100. HH Saving Rate expressed as % of adjusted gross disposable income. Sentiment indicators are balance statistics (−100 to +100). MP shocks: AG (Altavilla-Giannone); JK Monetary and JK Information are the median rotation decomposition of Jarociński-Karadi (2020). 18 Euro Area countries.



Notes: Share of new mortgage lending with adjustable interest rates (rate reset within 12 months) for each euro area country. Y-axis scaled 0–100%. Sample: 2007Q1–2025Q2.

Figure A1: ARM Flow Share by Country



Notes: Share of outstanding mortgages with adjustable interest rates (residual maturity or rate reset within 12 months) for each euro area country. Y-axis scaled 0–100%. Sample: 2007Q1–2025Q2.

Figure A2: ARM Stock Share by Country

B Additional Robustness Results

This appendix presents additional robustness figures and tables. See Section 6 for interpretation.

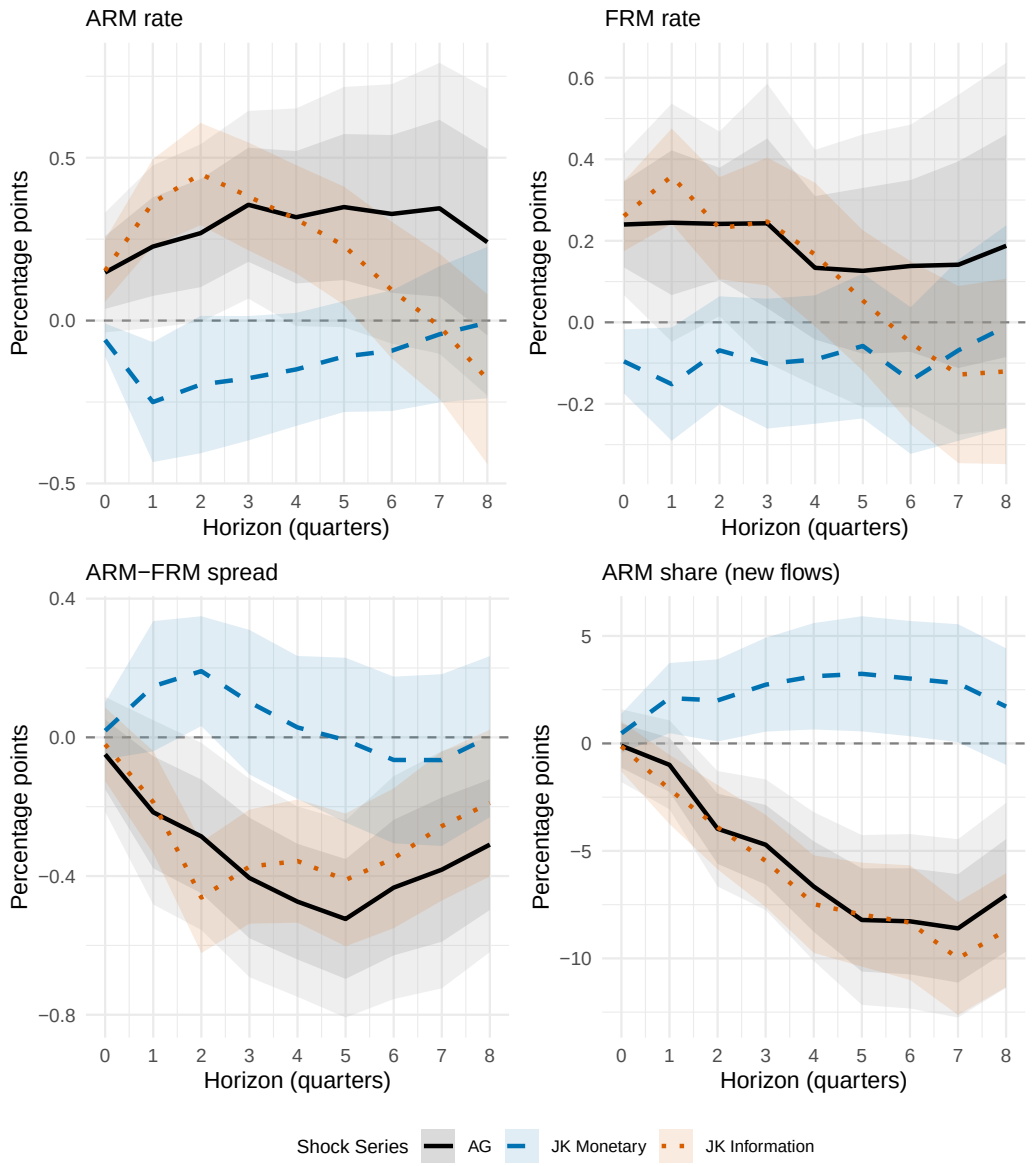
B.1 Alternative Shock Series: JK Decomposition

This section provides details on the comparison between the AG and Jarociński and Karadi (2020) shock series discussed in Section 5.5. The JK decomposition separates high-frequency policy surprises into a pure monetary component (rate increases accompanied by stock price declines) and a central bank information component (rate increases accompanied by stock price increases, signalling positive growth expectations). Results are presented as shock-based OLS to avoid weak-instrument concerns that affect JK-based IV estimates at longer horizons.

Baseline Mortgage Rate Pass-Through. Figure A3 compares the AG and JK shock-based OLS baseline IRFs for mortgage market outcomes. The AG shock produces the expected positive pass-through to mortgage rates, with FRM rates responding more strongly on impact. The JK information component mirrors this pattern, consistent with rate increases driven by positive growth news being transmitted through standard yield-curve channels. The JK pure monetary component, by contrast, shows muted or reversed baseline pass-through for mortgage rates, suggesting that the median rotation decomposition attributes much of the direct rate transmission to the information component. This asymmetry does not affect the interaction analysis, where the monetary component produces the expected heterogeneous effects (Figures 9–10), but it does indicate that the JK decomposition is better suited for testing mechanism heterogeneity than for studying average mortgage rate pass-through.

B.2 Endogenous OLS vs Shock-Based OLS

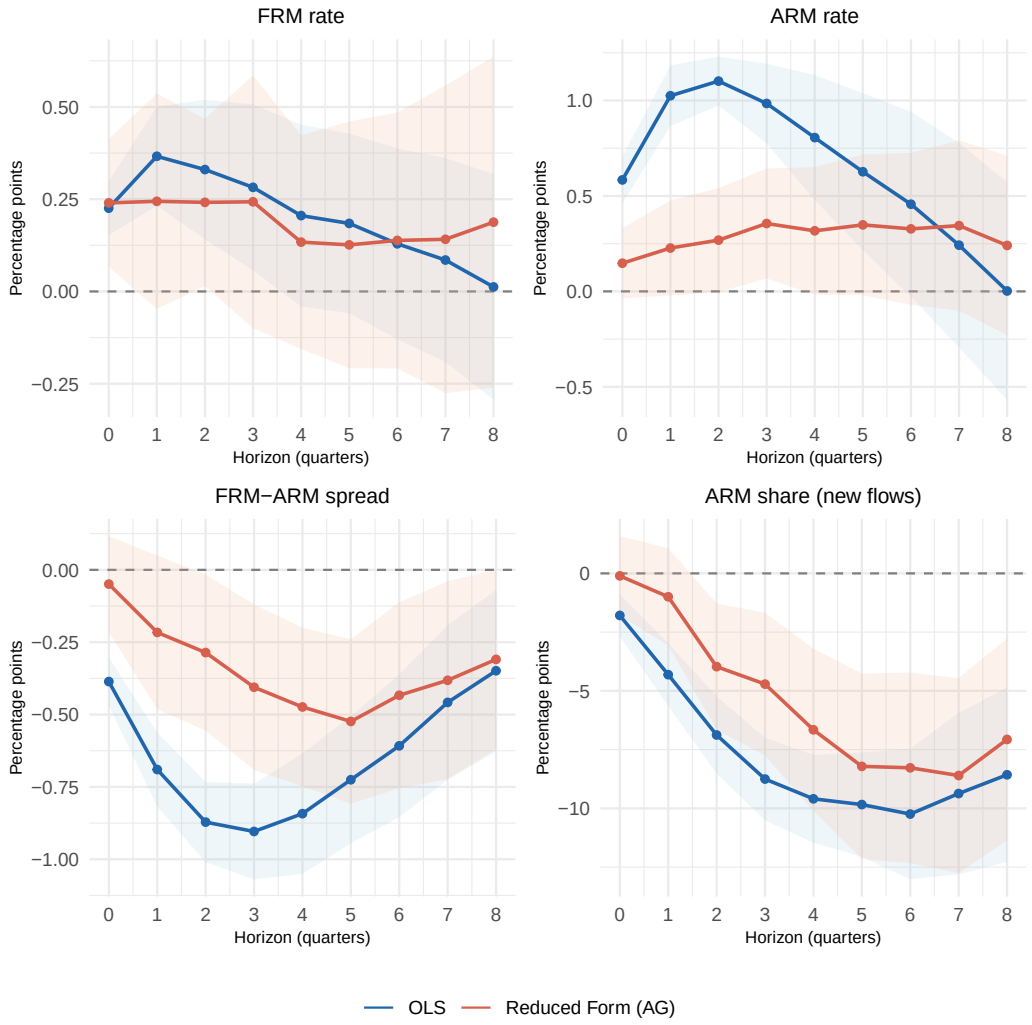
As a complement to the IV estimates in the main text, Figures A4 and A5 compare two OLS specifications: endogenous OLS, which treats the policy rate as exogenous, and shock-based OLS, which directly regresses outcomes on the AG high-frequency shock z_t. Since the shock is exogenous by construction, the shock-based OLS estimates remain unbiased regardless of first-stage strength. The endogenous OLS main effects are biased toward finding tightening expansionary, consistent with standard simultaneity bias. Importantly, the interaction effects



Notes: Coefficient β_0^h from shock-based OLS LP using three shock series: AG total surprise (black, solid), JK pure monetary component (blue, dashed), and JK central bank information component (red, dotted). Panels: (a) ARM rate, (b) FRM rate, (c) ARM–FRM spread, (d) ARM share of new flows. Shock-based OLS. AG bands: 68% and 90% CI; JK bands: 68% CI. Responses scaled to a 25bp shock. Country FE. DK(3) SE. 18 EA countries, 2007Q1–2025Q2.

Figure A3: Baseline Mortgage Rate Pass-Through: AG vs JK Decomposition

(ARM×Debt heterogeneity) are similar across the two specifications, suggesting that cross-sectional variation is less susceptible to time-series endogeneity.

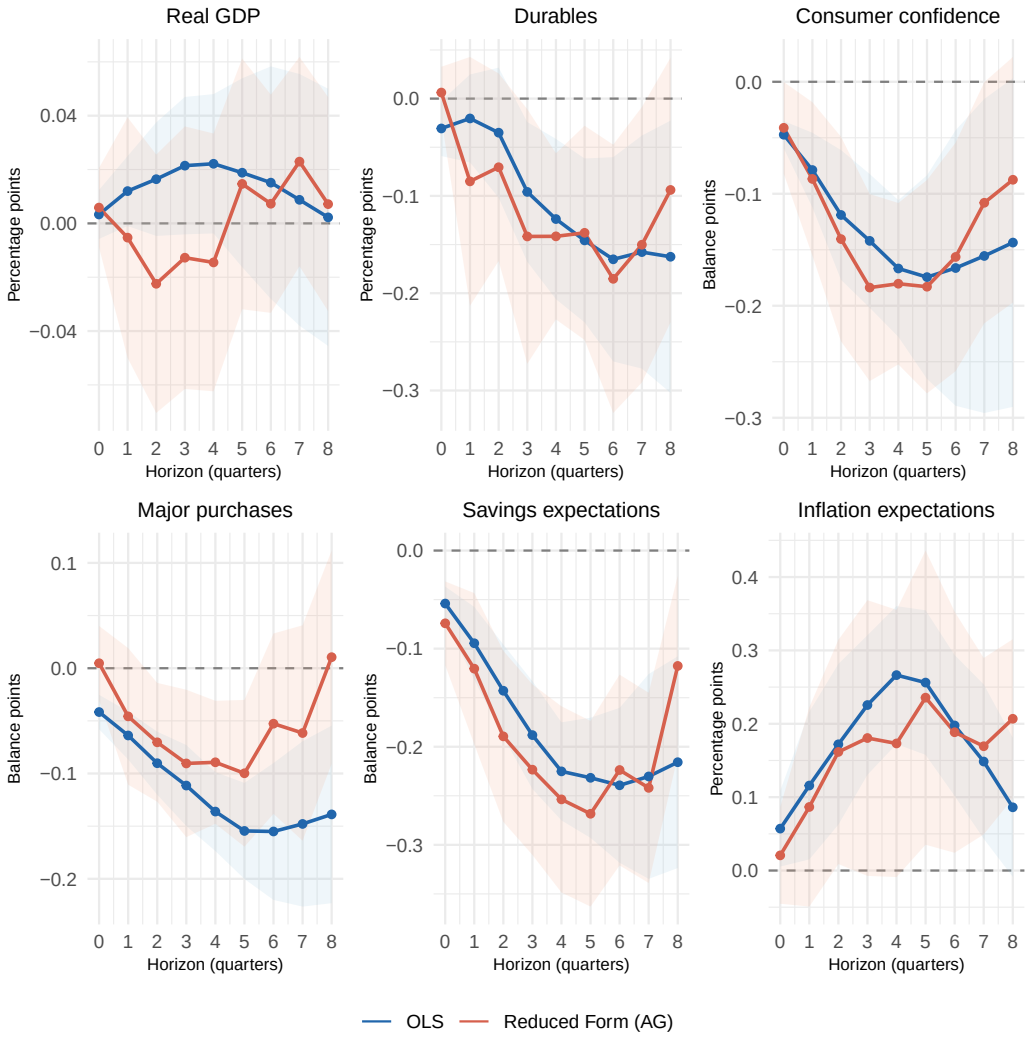


Notes: Baseline mortgage rate transmission (β_0^h). Endogenous OLS (blue): policy rate treated as exogenous. Shock-based OLS (red): AG shock enters directly. Shaded: 90% CI. Country FE. DK(3) SE. 18 EA countries, 2007Q1–2025Q2.

Figure A4: Endogenous OLS vs Shock-Based OLS: Baseline Mortgage Transmission

B.3 Asymmetric Effects

The structure of mortgage rates may generate asymmetric monetary policy transmission across the policy cycle. Where borrowers hold a free prepayment option, fixed-rate mortgages impair transmission more during tightening than during loosening (Berger et al. 2021; Eichenbaum et al. 2022): FRM holders can refinance when rates fall but have no incentive



Notes: Interaction effects (β_1^h). Endogenous OLS (blue): policy rate treated as exogenous. Shock-based OLS (red): AG shock enters directly. Shaded: 90% CI. Country FE. DK(3) SE. 18 EA countries, 2007Q1–2025Q2.

Figure A5: Endogenous OLS vs Shock-Based OLS: Interaction Effects

to do so when rates rise, so the differential ARM effect should be larger during tightening episodes. Theoretical predictions for sentiment and housing asymmetry are ambiguous, however, because competing mechanisms point in different directions: binding liquidity constraints during tightening (Christelis et al. 2019) versus information effects during loosening (Jarociński and Karadi 2020) produce opposing predictions depending on the outcome.

To examine whether transmission differs between tightening and loosening episodes, I estimate a phase-specific specification following Tenreyro and Thwaites (2016) and De Stefani and Mano (2025):

$$\begin{aligned} y_{c,t+h} - y_{c,t-1} = \alpha_c^h &+ \beta_1^h(|s_t| \times \mathbf{1}_{\text{tight}} \times \text{ARMdebt}_{c,t-1}) + \beta_2^h(|s_t| \times \mathbf{1}_{\text{loose}} \times \text{ARMdebt}_{c,t-1}) \\ &+ \beta_3^h(|s_t| \times \mathbf{1}_{\text{tight}}) + \beta_4^h(|s_t| \times \mathbf{1}_{\text{loose}}) + \beta_5^h \text{ARMdebt}_{c,t-1} \\ &+ \sum_{\ell=0}^{3} \gamma_\ell^h X_{c,t-\ell} + \sum_{\ell=1}^{4} \rho_\ell^h \Delta y_{c,t-\ell} + \varepsilon_{c,t}^h \end{aligned} \tag{6}$$

where s_t is the AG shock, $\mathbf{1}_{\text{tight}} = \mathbf{1}[s_t > 0]$ and $\mathbf{1}_{\text{loose}} = \mathbf{1}[s_t < 0]$ are phase indicators, and $|s_t|$ is the absolute shock magnitude. The coefficients β_1^h and β_2^h measure ARMdebt amplification during tightening and loosening; asymmetry implies $\beta_1^h \neq \beta_2^h$. The specification is estimated using shock-based OLS because the heavy parameterization (five coefficients per horizon) makes IV estimation impractical.[8]

Figures A6 and A7 present asymmetric impulse responses, separating tightening and loosening episodes. Tightening effects tend to be larger and more precisely estimated for most outcomes, particularly durable consumption and financial sentiment indicators, though major purchases and house prices show the reverse pattern.[9]

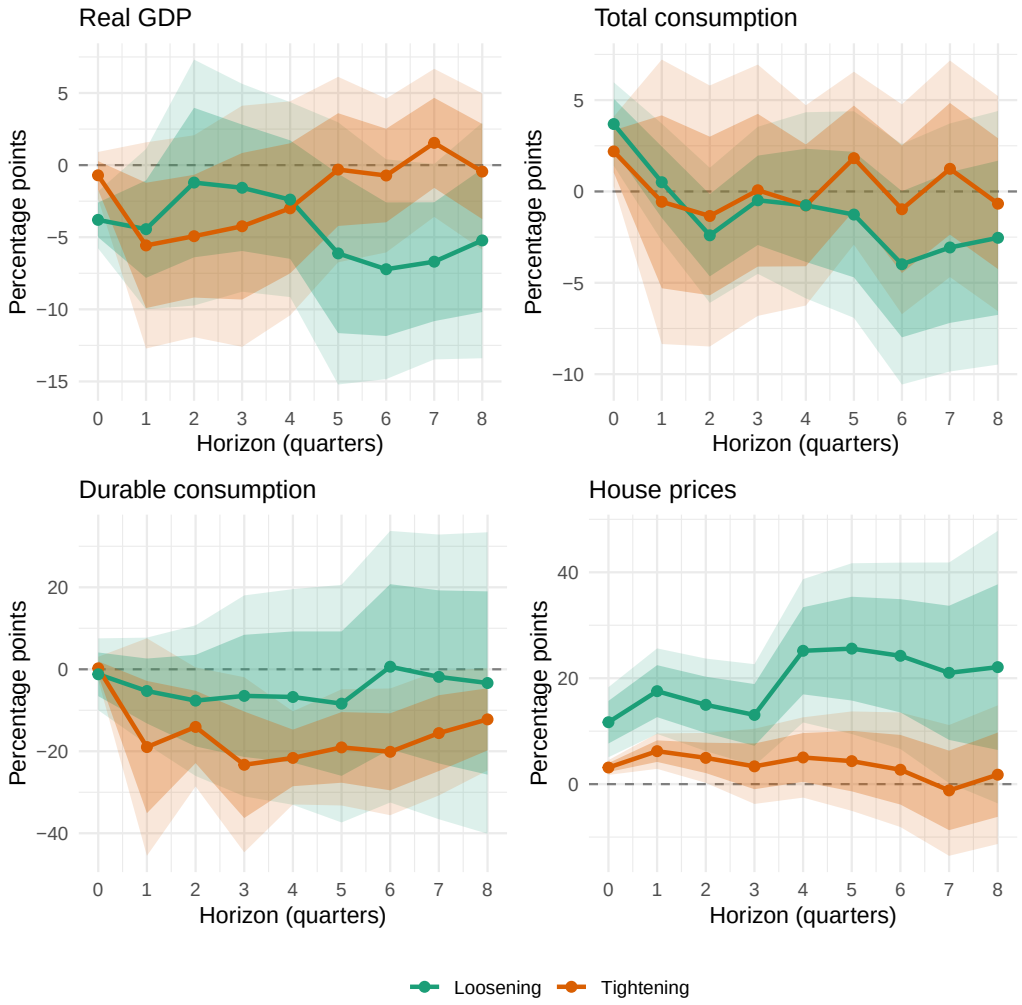
As a robustness check, I estimate the asymmetric specification using actual ECB policy rate changes rather than high-frequency identified shocks.

B.4 Sentiment Mediation Analysis

Figure A8 decomposes the ARM×Debt heterogeneity into total and direct (sentiment-controlled) components. The control-based approach adds $l(\text{sentiment}, 0{:}3)$ to the interaction

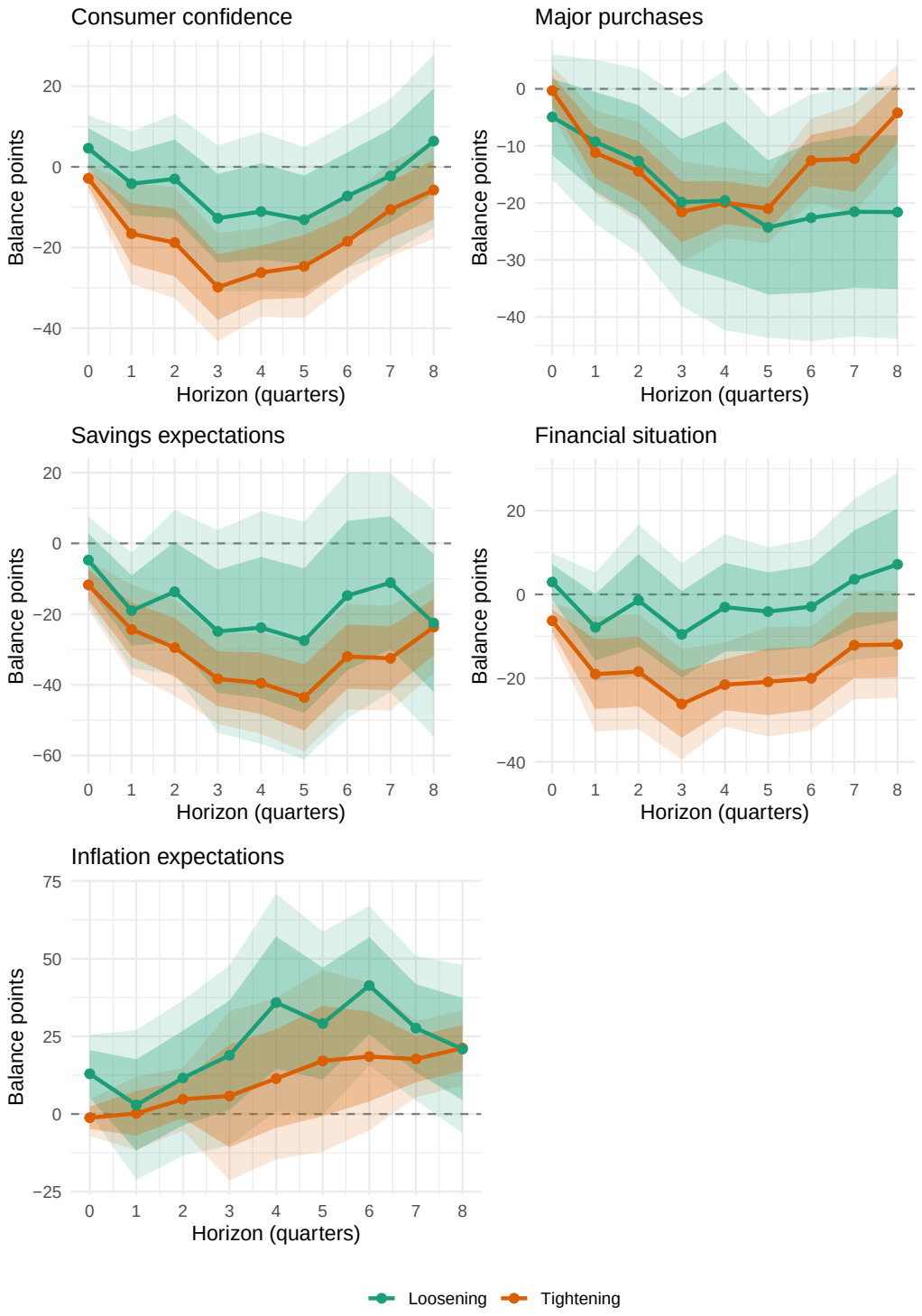
[8] I also estimated this specification using ARM share without debt scaling following De Stefani and Mano (2025). Results are qualitatively similar but magnitudes are smaller, consistent with the debt component amplifying the cash-flow channel.

[9] The sample begins in 2007Q1 to capture the 2007–2009 ECB hiking and cutting cycle. The tightening-to-loosening ratio reflects the zero lower bound (ZLB) years when markets often expected more aggressive easing than delivered. This imbalance reduces statistical power for estimating loosening effects, and wider confidence bands for loosening responses partly reflect sample composition rather than economic uncertainty.



Notes: Coefficients β_1^h (tightening, left) and β_2^h (loosening, right) from equation (6). Rows: (1) GDP, (2) total consumption, (3) durable consumption, (4) house prices. Shock-based OLS LP with AG shock. Responses to a 25bp absolute shock. Shaded: 68% (dark) and 90% (light) CI. Country FE. DK(3) SE. 18 EA countries, 2007Q1–2025Q2.

Figure A6: Asymmetric Macroeconomic Responses: Tightening vs Loosening



Notes: Coefficients β_1^h (tightening, left) and β_2^h (loosening, right) from equation (6). Rows: (1) consumer confidence, (2) major purchase intentions, (3) savings expectations, (4) financial situation. Shock-based OLS LP with AG shock. Responses to a 25bp absolute shock. Shaded: 68% (dark) and 90% (light) CI. Country FE. DK(3) SE. 18 EA countries, 2007Q1–2025Q2.

Figure A7: Asymmetric Sentiment Responses: Tightening vs Loosening

specification. If sentiment expectations explain the heterogeneous response, the direct effect (controlling for sentiment) should be attenuated relative to the total effect.

For GDP, the total and direct effects are nearly identical, with consumer confidence explaining less than 10% of the heterogeneity at most horizons. For durable consumption, consumer confidence explains approximately 11% on average, while major purchase intentions explains approximately 17%. The modest difference between mediators suggests that even a survey measure directly targeting discretionary purchase decisions captures only a small portion of the transmission mechanism. The dominant channel remains the direct cash-flow effect of higher mortgage payments on household budgets.

B.5 Alternative Treatment Variable

Figures A9–A10 and Tables A2–A3 present the Euribor-based results discussed in Section 6.1.

Table A2: First-Stage Regression Results (Euribor 3M as Treatment)

	Baseline LP				*Interaction LP*			
	ARM Sh.	ARM r	FRM r	Spread	GDP	Cons.	Dur.	HP
Panel A: First Stage for ΔEuribor 3M								
MP Shock	1.984**	1.345	1.907**	1.968***	1.677**	1.677**	1.677**	1.677**
	(0.859)	(0.828)	(0.751)	(0.747)	(0.759)	(0.759)	(0.759)	(0.759)
Panel B: First Stage for ΔEuribor 3M× ARMdebt								
MP Shock × ARMdebt	—	—	—	—	2.670***	2.670***	2.670***	2.670***
					(0.650)	(0.650)	(0.650)	(0.650)
N	1,093	1,253	1,075	1,075	1,079	1,079	1,079	1,079
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
K-P F (ΔEuribor 3M)	5.33	2.64	6.45	6.95	3.35	3.41	3.66	3.67
K-P F (ΔEuribor 3M× ARM)	—	—	—	—	9.60	9.55	9.66	9.69

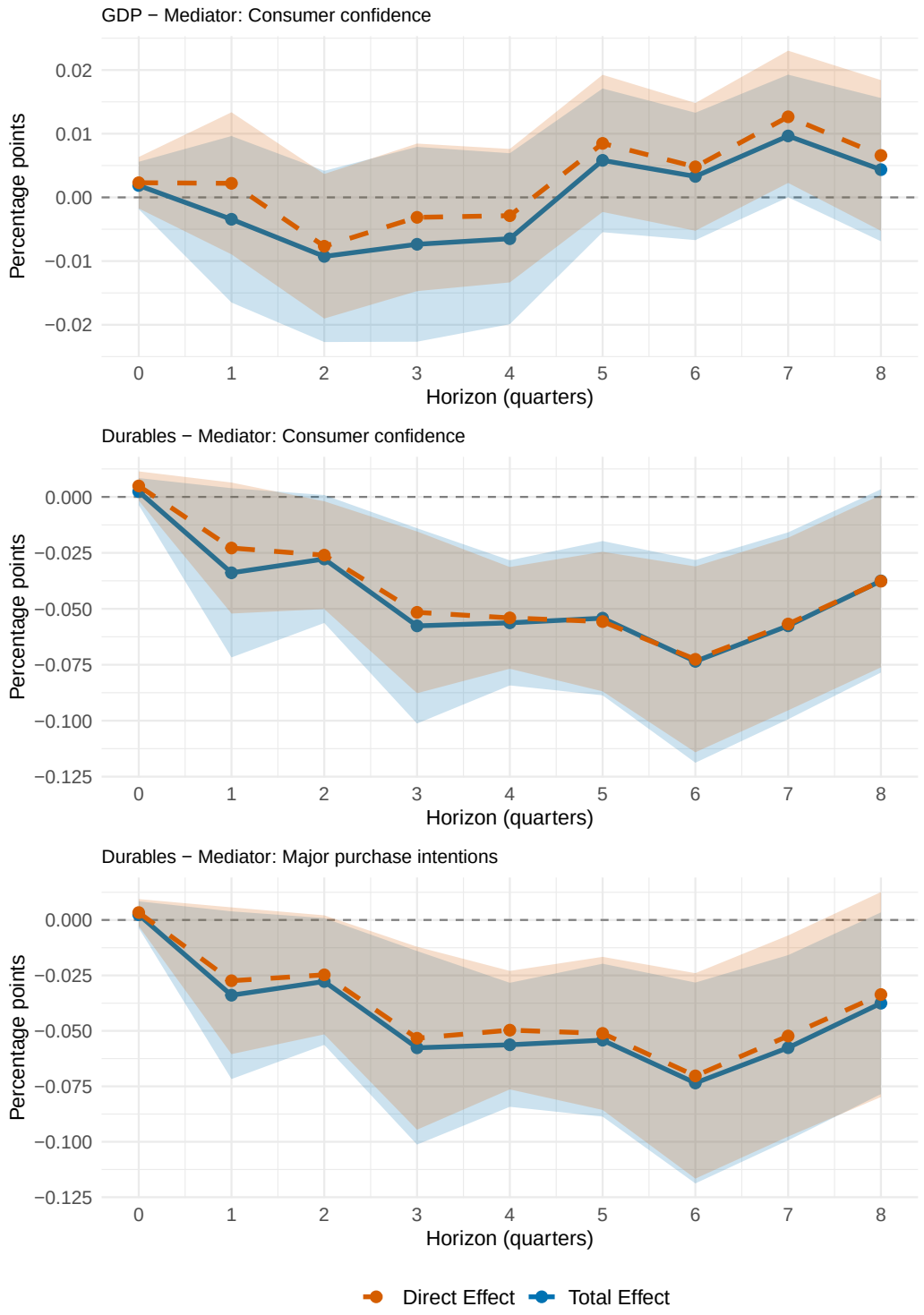
Notes: First-stage results at h=0 with Euribor 3M as endogenous treatment. Baseline LP: ARM Sh.=ARM share, ARM/FRM r=mortgage rates. Interaction LP: Dur.=durables, HP=house prices. Interaction LP has two endogenous variables (ΔEuribor 3M and ΔEuribor 3M × ARMdebt). All specifications include country FE and controls. DK(3) SEs in parentheses. K-P F=Kleibergen-Paap Wald F. * p<0.10, ** p<0.05, *** p<0.01.

B.6 Alternative Normalization

Table A4 presents the income-scaled robustness results discussed in Section 6.2.

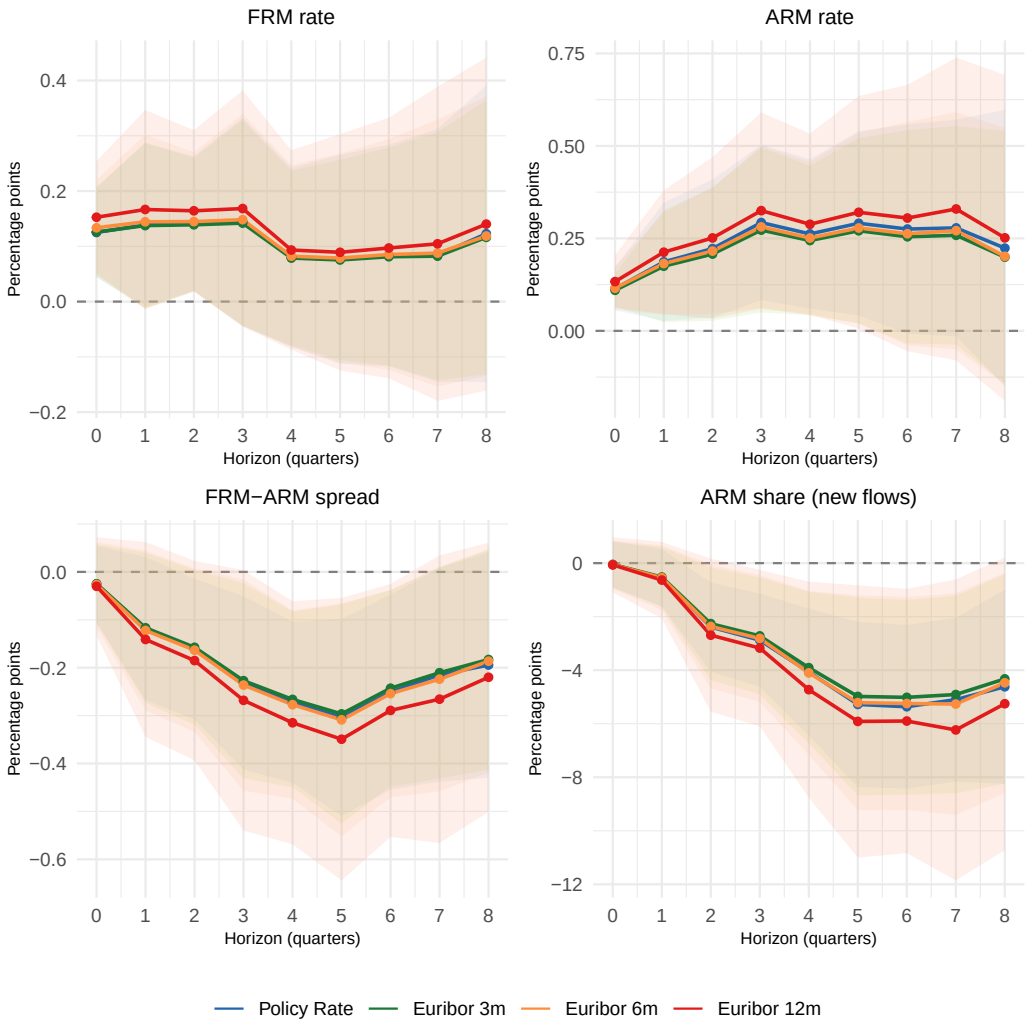
B.7 Sample Restriction: Excluding Outliers

As a further robustness check, I exclude the Netherlands, Luxembourg, and Ireland from the sample. Figures A11 and A12 show that all interaction effects retain the same sign as



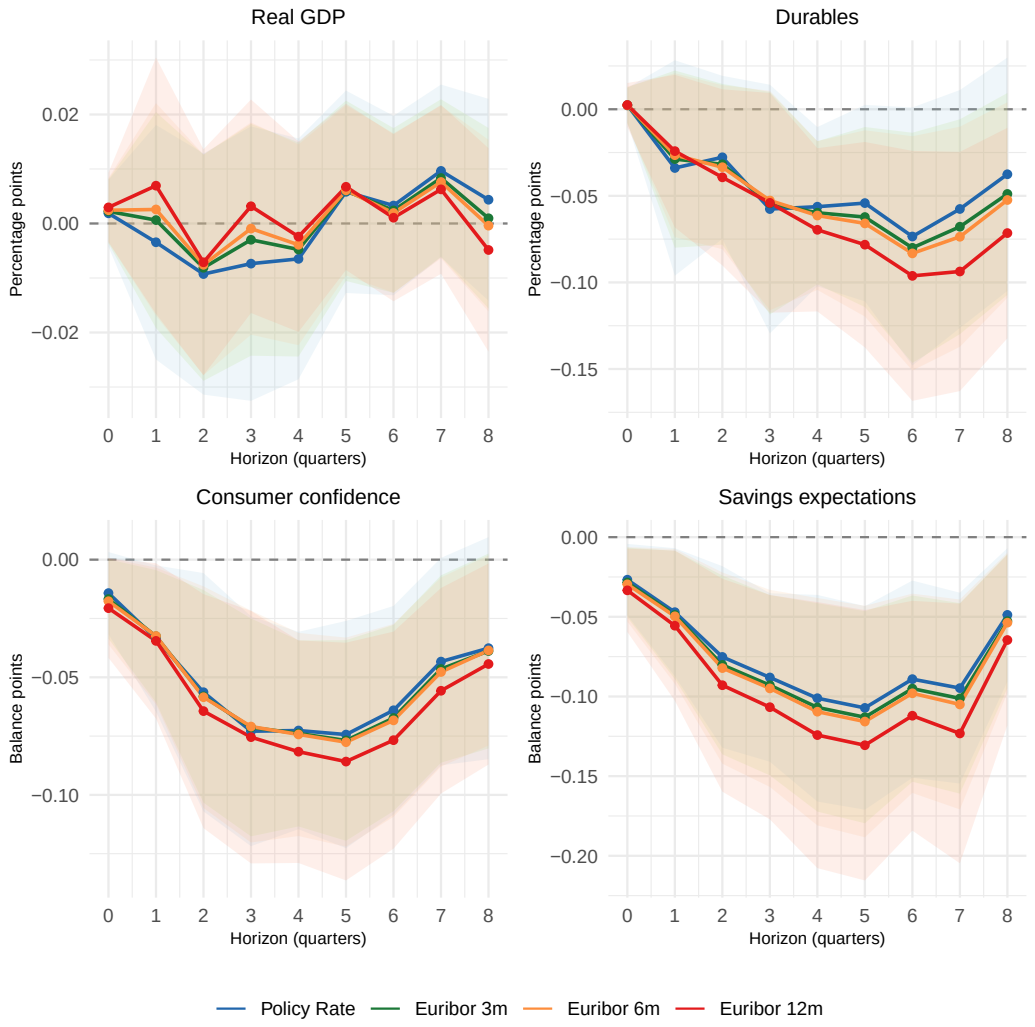
Notes: ARM×Debt interaction effect (β_1^h): total (blue) and direct (orange, controlling for sentiment). Rows: (1) GDP controlling for consumer confidence, (2) durable consumption controlling for consumer confidence, (3) durable consumption controlling for major purchase intentions. IV-LP with AG shock as instrument. Shaded: 68% CI. Country FE. DK(3) SE. 18 EA countries, 2007Q1–2025Q2.

Figure A8: Sentiment Mediation: GDP and Durable Consumption



Notes: Baseline mortgage rate transmission (β_0^h). Treatment variables: ECB policy rate (blue), 3-month Euribor (green), 6-month Euribor (orange), 12-month Euribor (red). IV-LP with AG shock as instrument. Responses to a 25bp shock. Shaded: 90% CI. Country FE. DK(3) SE. 18 EA countries, 2007Q1–2025Q2.

Figure A9: Euribor vs Policy Rate: Baseline Mortgage Transmission



Notes: Interaction effects (β_1^h). Treatment variables: ECB policy rate (blue), 3-month Euribor (green), 6-month Euribor (orange), 12-month Euribor (red). IV-LP with AG shock as instrument. Responses to a 25bp shock. Shaded: 90% CI. Country FE. DK(3) SE. 18 EA countries, 2007Q1–2025Q2.

Figure A10: Euribor vs Policy Rate: Interaction Effects

Table A3: First-Stage Regression Results (Euribor 6M as Treatment)

	Baseline LP				*Interaction LP*			
	ARM Sh.	ARM r	FRM r	Spread	GDP	Cons.	Dur.	HP
Panel A: First Stage for ΔEuribor 6M								
MP Shock	1.873**	1.280	1.797**	1.863***	1.523**	1.523**	1.523**	1.523**
	(0.814)	(0.789)	(0.706)	(0.718)	(0.713)	(0.713)	(0.713)	(0.713)
Panel B: First Stage for ΔEuribor 6M× ARMdebt								
MP Shock × ARMdebt	—	—	—	—	2.696***	2.696***	2.696***	2.696***
					(0.744)	(0.744)	(0.744)	(0.744)
N	1,093	1,253	1,075	1,075	1,079	1,079	1,079	1,079
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
K-P F (ΔEuribor 6M)	5.30	2.64	6.48	6.73	3.44	3.45	3.93	3.77
K-P F (ΔEuribor 6M× ARM)	—	—	—	—	7.50	7.49	7.76	7.60

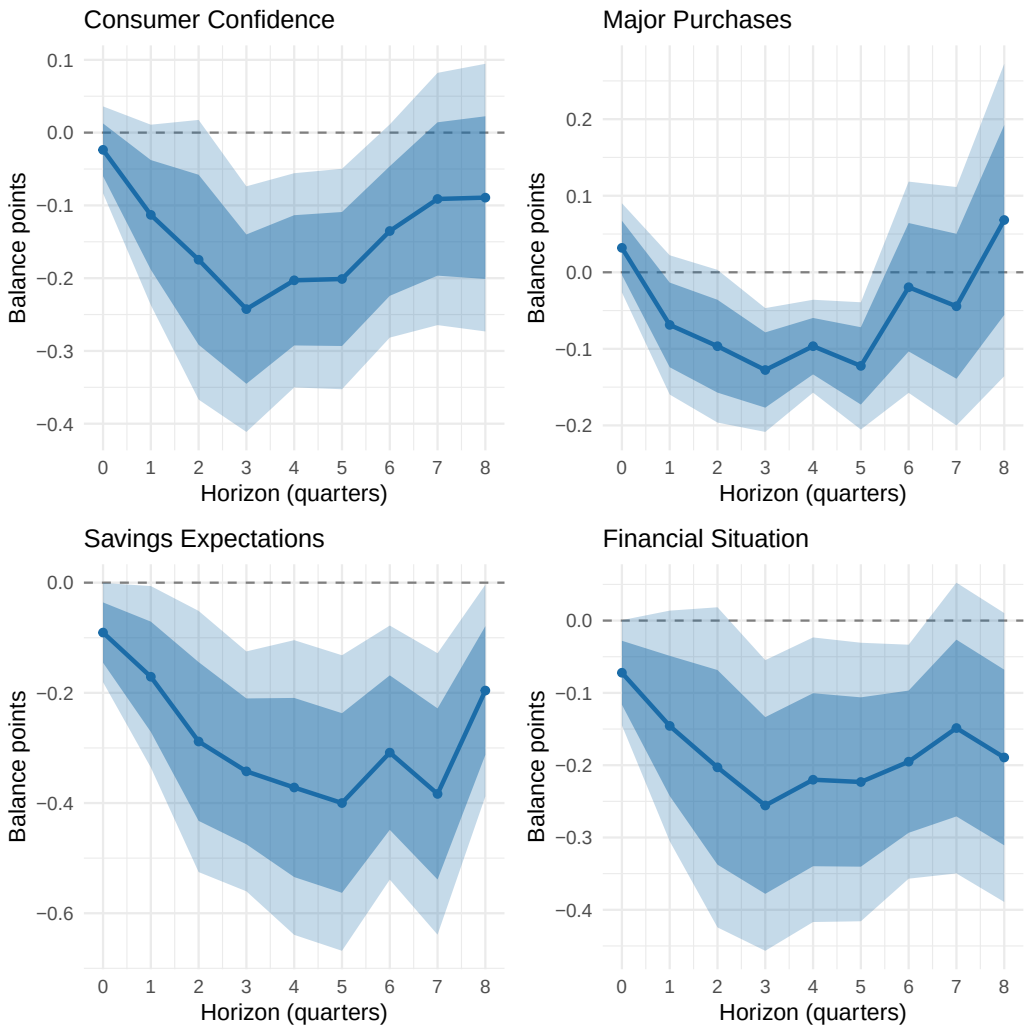
Notes: First-stage results at h=0 with Euribor 6M as endogenous treatment. Baseline LP: ARM Sh.=ARM share, ARM/FRM r=mortgage rates. Interaction LP: Dur.=durables, HP=house prices. Interaction LP has two endogenous variables (ΔEuribor 6M and ΔEuribor 6M × ARMdebt). All specifications include country FE and controls. DK(3) SEs in parentheses. K-P F=Kleibergen-Paap Wald F. * p<0.10, ** p<0.05, *** p<0.01.

the baseline, but point estimates are roughly 2.5–4 times larger, while standard errors also increase (15 vs. 18 countries), leaving significance levels comparable. The amplification is consistent with these countries adding noise to the ARM×Debt interaction: the Netherlands combines very high debt (112% of GDP) with a very low ARM share (14%), making it effectively an FRM country to which the composite variable assigns moderate exposure; Ireland's multinational-inflated GDP understates the effective debt burden. Individual country exclusions confirm that no single outlier drives the pattern. The baseline with 18 countries thus provides a conservative estimate of the interaction effect.

Table A4: Robustness: Alternative Debt Normalization (Income-Scaled)

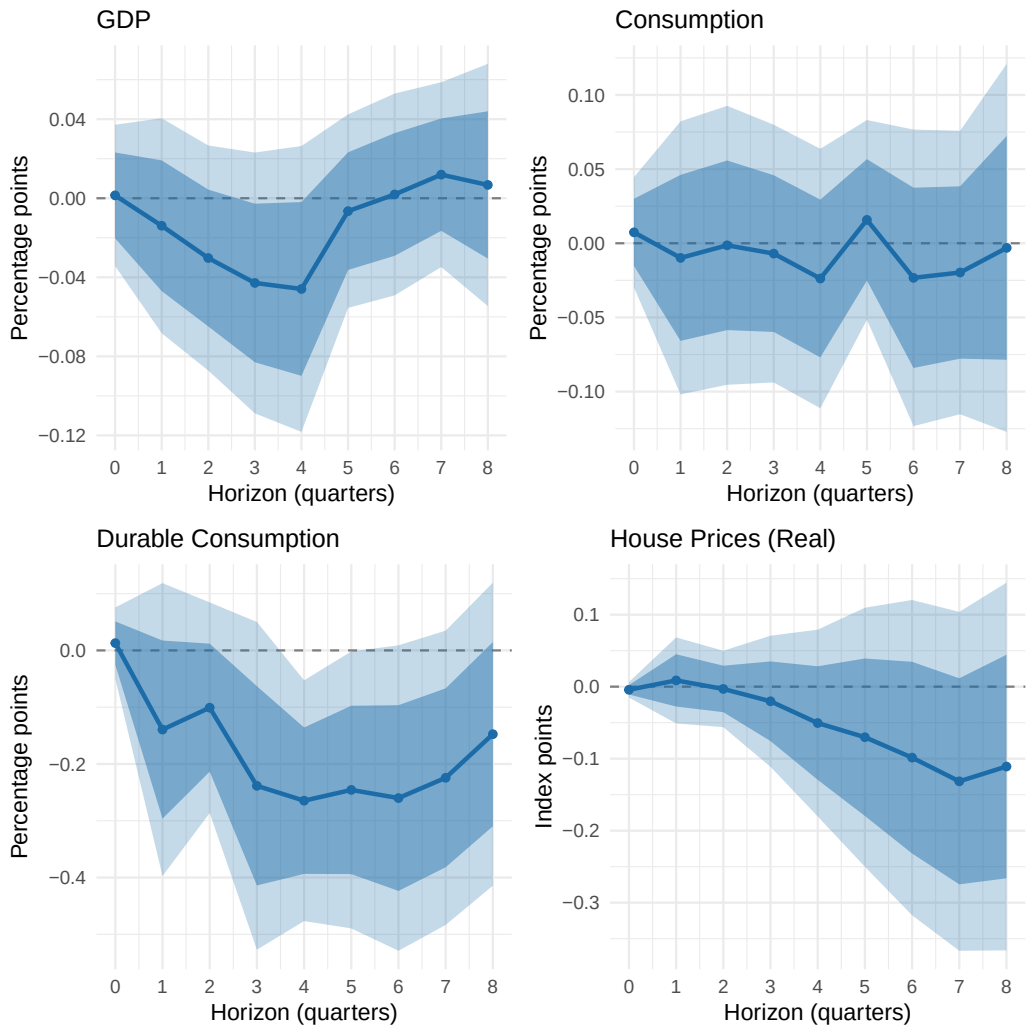
	GDP-Scaled (Baseline)			Income-Scaled		
Outcome	h=0	h=4	h=8	h=0	h=4	h=8
Panel A: Macro Outcomes						
Real GDP	-0.000	-0.078	0.009	0.000	-0.057	-0.019
	(0.000)	(0.119)	(0.098)	(0.000)	(0.043)	(0.041)
Consumption	0.000	-0.040	-0.003	-0.000	-0.039	0.014
	(0.000)	(0.101)	(0.125)	(0.000)	(0.082)	(0.086)
Durables	0.025	-0.566***	-0.376	0.045	-0.342**	-0.266
	(0.064)	(0.208)	(0.331)	(0.031)	(0.151)	(0.214)
House Prices	-0.017	-0.104	-0.277	-0.011	-0.093	-0.211
	(0.020)	(0.179)	(0.311)	(0.011)	(0.090)	(0.179)
Panel B: Sentiment Outcomes						
Consumer Confidence	-0.094	-0.434**	0.082	-0.060	-0.241***	0.065
	(0.079)	(0.189)	(0.222)	(0.050)	(0.090)	(0.123)
Major Purchases	0.083	-0.173*	0.295*	0.060	-0.111**	0.187*
	(0.081)	(0.104)	(0.179)	(0.041)	(0.057)	(0.101)
Savings Expectations	-0.271***	-0.899***	-0.240	-0.155***	-0.450***	-0.101
	(0.089)	(0.202)	(0.232)	(0.056)	(0.115)	(0.145)
Financial Situation	-0.190***	-0.431***	0.001	-0.099**	-0.216***	0.042
	(0.070)	(0.151)	(0.203)	(0.043)	(0.075)	(0.122)

Notes: Interaction coefficients (β_1^h) from IV-AG local projections. GDP-scaled: ARM share $\times$ HH credit/GDP. Income-scaled: ARM share $\times$ HH debt/disposable income. Both measures lagged one quarter. Log-level outcomes (GDP, consumption, durables, house prices) scaled $\times 100$ for interpretation in percentage points. Sentiment outcomes in index points. All specifications include country fixed effects and Driscoll-Kraay standard errors with 3 lags. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.



Notes: ARM×Debt interaction coefficient (β_1^h) estimated on the restricted sample excluding the Netherlands, Luxembourg, and Ireland (15 countries). IV-LP with AG shock as instrument. Shaded: 68% (dark) and 90% (light) CI. Responses scaled to a 25bp shock. Country FE. DK(3) SE. 2007Q1–2025Q2.

Figure A11: Sample Restriction: Sentiment Interaction Effects Excluding NL, LU, IE



Notes: ARM×Debt interaction coefficient (β_1^h) estimated on the restricted sample excluding the Netherlands, Luxembourg, and Ireland (15 countries). IV-LP with AG shock as instrument. Shaded: 68% (dark) and 90% (light) CI. Responses scaled to a 25bp shock. Country FE. DK(3) SE. 2007Q1–2025Q2.

Figure A12: Sample Restriction: Macro Interaction Effects Excluding NL, LU, IE