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MONETARY POLICY TRANSMISSION: THE ROLE OF BANKING SECTOR CHARACTERISTICS IN THE EURO AREA

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ABSTRACT

This study examines the impact of monetary policy shocks on the macroeconomic performance of 20 euro area countries. In doing so, it assesses how variations in the characteristics of the banking system affect the transmission of monetary policy. The main results show that a contractionary monetary policy shock reduces both inflation and retail sales while increasing the unemployment rate. In contrast, an expansionary monetary policy shock has positive but much milder effects on the economy. Banking systems with higher profitability, risk exposure and lower assets-to-GDP cause a stronger effect of monetary policy on the economy. The main results hold when we consider alternative monetary policy shocks.

JEL: E58, E44, F45, G21, G15

Keywords: Monetary Policy, Euro Area, Banking Characteristics, Monetary Policy Transmission

Disclaimer: The article expresses the views of the authors and not those of the Bank of Greece and the National Bank of Greece. We remain solely responsible for any errors and omissions.

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1. Introduction

Monetary policy has played a decisive role in recent years in stabilizing the economy both in Europe and in other countries of the world. Many central banks, including the European Central Bank (ECB), have intervened proactively in order to limit the negative economic impact of the COVID-19 pandemic. They used a variety of policy instruments both traditional, such as changing interest rates, and unconventional, such as increasing their balance sheet by buying bonds and providing targeted loans to the banking sector, with the condition that the latter would channel additional liquidity into the private sector. The energy crisis and Russia's invasion of Ukraine led to rising inflation and, by extension, a growing tightening of monetary policy in Europe and worldwide. The gradual decline in inflation from late 2023 and 2024 has led several central banks to begin the process of phasing out monetary tightening by cutting interest rates and reducing the size of their balance sheets. Therefore, monetary policy has recently played a key role in both stabilizing the economy and maintaining price stability in euro area and in many other countries around the globe.

Motivated by current developments, the purpose of this study is to investigate how announcements from ECB policy meetings regarding monetary policy affect the economic activity and inflation across various banking systems. When a contractionary monetary policy is implemented, access to finance becomes more expensive, reducing aggregate investment and consumption, which in turn slows output growth and lowers inflation. Conversely, an expansionary monetary policy makes financing conditions more favorable, boosting investment, consumption and economic growth and pushing up prices. According to Mishkin (1995), the traditional channels through which monetary policy is transmitted are the asset price channel, the interest rate channel, the exchange rate channel, and the credit channel. Monetary policy can influence asset prices, which in turn affects aggregate consumption and investment (Horatiu, 2013). Through the interest rate channel, a tightening of monetary policy raises borrowing costs and makes saving more appealing, which dampens economic activity and lowers the price level (Angeloni et al., 2003). The exchange rate channel transmits monetary policy effects by influencing exchange rates, which can reduce domestic consumption, exports, and productivity (Taylor, 2001). Additionally, the credit channel impacts macroeconomic performance by altering the volume of bank lending, leading to decreased consumption and investment (Bernanke, 1995). Furthermore, parts of the literature have identified the cost channel as a key factor contributing to the price puzzle, where increased borrowing costs are passed on to final product prices, leading to short-term inflationary pressures even during monetary tightening (Christiano et al., 1997). Moreover, the risk-taking channel suggests that during periods of expansionary monetary policy, banks tend to take on greater risks in an effort to boost profitability (Abbate and Thaler, 2023).

Various studies in the past (see e.g., Sims, 1992; Christiano et.al, 1996) have analyzed the impact of monetary policy on a wide range of economic variables in the US, with particular emphasis on inflation and economic growth. Some of these studies in order to address the inherent endogeneity of monetary policy decisions to economic activity extract exogenous monetary policy shocks by relying on the narrative approach of Romer and Romer (2004). In more detail, Romer and Romer (2024) proceed in two steps, first they derive a series for Federal Reserve intentions for the federal funds rate around FOMC meetings. Next, this series is regressed on the Federal Reserve's internal forecasts in order to create a measure of intended monetary policy actions not driven by information about future economic developments. This type of monetary policy shock is widely used by many recent studies, as it allows researchers to identify the causal relationship between monetary policy and macroeconomic indicators (Coibion,2012).

Focusing on the euro area, traditional approaches involve using nominal interest rate changes to measure these monetary policy shocks. For instance, Peersman and Smets (2001) and Angeloni et al. (2003) examine nominal interest rate increases to gauge the subsequent output and inflation responses. Georgiadis (2014) identifies the monetary policy shocks by applied sign-restrictions in a global VAR model of the euro area countries in which the ECB enters as a separate cross-sectional unit in parallel to individual euro area as well as non-euro area economies. As pointed by Georgiadis (2014) in this GVAR model, euro area economies are affected by the ECB′s monetary policy as well as by external factors, (i.e., exchange rates, oil prices, foreign output growth, inflation, and interest rates). Similarly, Mandler and Scharnagl (2021) employ a BVAR approach to examine these effects specifically for Italy, Germany, France, and Spain. Ribba (2022) extracts the shock by calculating the difference between the average interest rate (EONIA) and the Federal Funds Rate, in order to estimate the policy impact on several indicators such as inflation and unemployment rate. Murgia (2020), following the narrative approach of Romer and Romer (2004) and gathering a novel dataset of ECB's macroeconomic forecasts, estimates the effects of contractionary monetary policy on industrial production and inflation on aggregated euro area data. Pragyan et al. (2023) calculate quarterly interest rate forecast errors for 33 advanced and emerging market economies, subsequently regress these forecast errors on a Taylor rule-type specification. The residuals are then used as the identified monetary policy shock. They find significant heterogeneity in the transmission of monetary policy across countries, with monetary policy being more effective in countries with more developed financial systems, credible monetary policy frameworks and floating exchange rate systems.

Altavilla et al. (2019) adopt an innovative asset price-based shock extraction method inspired by Gürkaynak et al. (2005) that focuses on how monetary policy announcements from the European Central Bank (ECB) influence financial markets. In their analysis, Altavilla et al. identify the Monetary Policy Shocks from changes in yields across various maturities and then apply a rotation technique to interpret these factors as distinct monetary policy shocks, including *target shocks* related to immediate rate changes, *forward guidance shocks* that reflect market expectations about future rates, and *quantitative easing (QE) shocks* that capture the impact of non-standard policy measures on long-term yields. Building on these types of shocks, Akkaya et al. (2024) aim to recalculate these Monetary Policy Shocks utilizing Varimax rotation technique and as a result, it provides a clearer picture of how each policy measure affects asset prices. For US Jarocinski & Karadi (2020) use an asset price-based shock extraction method, examining the impact Federal Reserve (FOMC) announcements. Within this category, Hülsewig and Rottmann (2023) extend the methodology by using stock price co-movements with interest rates to disaggregate the types of shocks for more refined unemployment estimates.

These varied methodologies yield insights into the effects of monetary policy shocks on the Euro area. Peersman and Smets (2001) report a 0.15% GDP decline six months after the monetary policy shock, while Angeloni et al. (2003) also find reductions in GDP, with minimal inflation changes in the short term. Boivin et al. (2009) report a larger impact of a 0.5% GDP reduction one year following short-term interest rate hikes. Georgiadis (2014) finds that GDP responses to monetary policy shocks vary significantly across countries, with estimates ranging from -0.2% to 0.5%. Additionally, the study indicates that a higher concentration of manufacturing or construction activities within an economy correlates with greater output responses to these shocks. On the other hand, Murgia (2020) reports a 0.5% decrease in industrial production following monetary policy changes, accompanied by a limited response in inflation. The study of Mandler and Scharnagl (2021), concludes that GDP decreases by approximately 0.5%, but HICP is unaffected. In contrast, Pragyan et al. (2023) report significant inflation sensitivity but smaller output declines. Ribba (2022) finds a delayed response on inflation, which declines three years after the shock, and a 0.1 percentage points increase in the unemployment rate. Using asset price changes as instrument, Hülsewig and Rottmann (2023) identify a 0.15 percentage point decrease in unemployment one year after an expansionary policy shock.

Overall, these studies highlight varying sensitivities in output, inflation, and unemployment based on the methodological approaches and shock measures used.

In this study, we aim to investigate the effects of monetary policy shocks, obtained from Altavilla et al (2019) on inflation and various indicators of economic activity in the euro area. However, when estimating the effects of monetary policy shocks we rely on a panel of 20 euro area countries, rather than on aggregated euro area data. We do this in order to capture the diverse economic conditions across euro area member states, which could be particularly relevant for the effective transmission of the common monetary policy. Additionally, unlike many previous studies that rely on industrial production as a proxy for output, we focus on retail sales, a measure more closely aligned with consumption. This choice allows us a more comprehensive understanding of consumption related dynamics across euro area countries. Furthermore, we also examine the responses of unemployment rates to monetary policy changes, providing additional insights into labor market adjustments across euro area member states. Moreover, we also explore how the effects of monetary policy shocks vary depending on specific banking characteristics, including profitability, size, funding costs, and risk exposure. The motivation for focusing on these characteristics arises from the likelihood that the transmission of monetary policy may differ significantly between countries with stronger and weaker banking systems (see e.g., Altavilla et al., 2024). For example, banking systems with higher profitability may reflect greater bargaining power, allowing them to pass the effects of financial contraction more aggressively onto consumers and investors. Banks with substantial capital reserves might be less responsive to interest rate changes due to their financial strength, whereas banks facing higher risk exposure could respond more aggressively to policy shifts to manage their risk profiles. Banking systems with higher funding costs are less likely to maintain low interest rates on loans, making them more likely to pass significant interest rate increases onto consumers and investors. Examining these dynamics can offer valuable insights into the overall effectiveness of the monetary policy transmission mechanism across euro area countries.

In addition to including different bank characteristics, we extend the previous literature by separately investigating the effect of expansionary and contractionary monetary policy shocks on the economy. This distinction is important, as the transmission mechanism of expansionary (such as interest rate cuts) and contractionary policies (such as interest rate hikes) differ in both their magnitude and their direction of impact.

Finally, we conduct various robustness checks using an alternative measure of monetary policy shock (as in Murgia, 2020) to ensure the reliability of our findings. Additionally, we analyze the responses of industrial production to monetary policy shocks, allowing us to connect our results with the existing literature and provide a broader perspective on how our approach compares to previous studies. This helps to validate our conclusions and strengthens the overall contribution of the paper.

We find that following a monetary policy shock inflation and retail sales declines in an inverse U-shaped pattern, reaching their lowest points around the middle of the 24-month time horizon considered. Industrial production exhibits a more pronounced negative response than retail sales, with the decline intensifying up to the 13th horizon. After reaching this point, the impact on industrial production stabilizes and remains almost constant until the end of the forecast horizon, suggesting that the shock has a stronger and more sustained effect on industrial production than on retail sales. In contrast the unemployment rate responds in a U-shaped pattern reaching its peak 18 to 20 months after the shock.

However, our baseline specification reveals that there is significant heterogeneity in the transmission of monetary policy across countries. Additionally, contractionary monetary policy shocks have a more substantial impact on the economy compared to expansionary shocks. Lastly, we show that this heterogeneity in the monetary policy transmission is associated with various banking sector characteristics. In more detail, we show that the monetary policy is more pronounced in countries with banking systems that exhibit higher profitability, have fewer banking assets, increased funding costs, and greater risk exposure.

Next, **Section 2** presents the data sources and empirical model used in the analysis. **Section 3**outlines the baseline results, highlighting the main findings. **Section 4** explores how banking characteristics influence the effects of monetary policy shocks on inflation and various measures of economic activity. **Section 5** presents various robustness checks. Finally, **Section 6** concludes with a summary of key insights and implications for future research.

2. Data and empirical model

2.1. Data information

This study uses monthly data for 20 euro area countries[1] from January 2000 to October 2023.The sample spans from January 2000 to October 2023. The main macroeconomic variables are HICP, Retail Sales Index and Unemployment rate which are obtained from

[1] Austria, Belgium, Cyprus, Croatia, Estonia, Finland ,France , Germany, Greece , Ireland, Italy, Latvia ,Lithuania, Luxembourg ,Malta ,Netherlands, Portugal , Slovakia, Slovenia , Spain.

Eurostat[2] and the ECB commodity index obtained by the ECB data portal. In addition, we employ various banking sector data collected from the ECB. In more detail, we use the interest rate profit margin and the return on equity ratio to control for the banking sector monopoly power and profitability respectively. The deposit rates weighted by corporate and household deposits with an agreed maturity for up to two years is a measure of cost of funds for the banking sector. Banking size is measured by the ratio of total banking assets to nominal GDP, and risk exposure is expressed as a ratio of risky assets to total banking assets. The non-performing loan (NPL) index is calculated as the ratio of total non-performing loans to the total equity of each bank in the industry[3]. This banking sector characteristics are split into two groups based on whether they are above or below the sample median. We use a time-varying median for each specific point in time point.[4] Those observations with values above the median are classified into the "high" group, while those below the median are classified into the "low" group. The use of a time-varying median allows the grouping into high and low categories to change over time helps to capture variations in the banking characteristics across countries and over time.

For our monetary policy shock (MPS) variable we use high frequency surprises of 3 month OIS rates. These data are obtained from the Monetary Policy event database EA-MPD developed by Altavilla et al. (2019). We focus on the Monetary event window and we consider as MPS only the changes in the 3 month OIS rates that are negatively correlated with EURO-STOXX 50 index inevery policy event (Jarocinski & Karadi ,2020; FedericHolm-Hadulla et al.,2022). Later, we conduct a robustness check using an alternative monetary policy shock identified by Murgia (2020), which applies the Romer and Romer (2004) narrative-based approach to extract the MPS. To transform the shocks into monthly frequency, we replace with zero value the months with no monetary policy event, and for months that had more than one policy event the MPS is calculated as the total sum of each individual shock into the same month (Romer & Romer, 2004). The descriptive statistics of the variables are displayed in Table 1.

[2] The HICP, retail sales and unemployment data are seasonally adjusted. As a robustness check, later on, we shall replace the retail sales with the industrial production.
[3] The banking sector data are collected on a quarterly basis. We convert them to monthly, by assuming that the value for any given quarter is the same for each month of that quarter.
[4]This process involves calculating the median value of a given banking characteristic across twenty countries at each point in time.

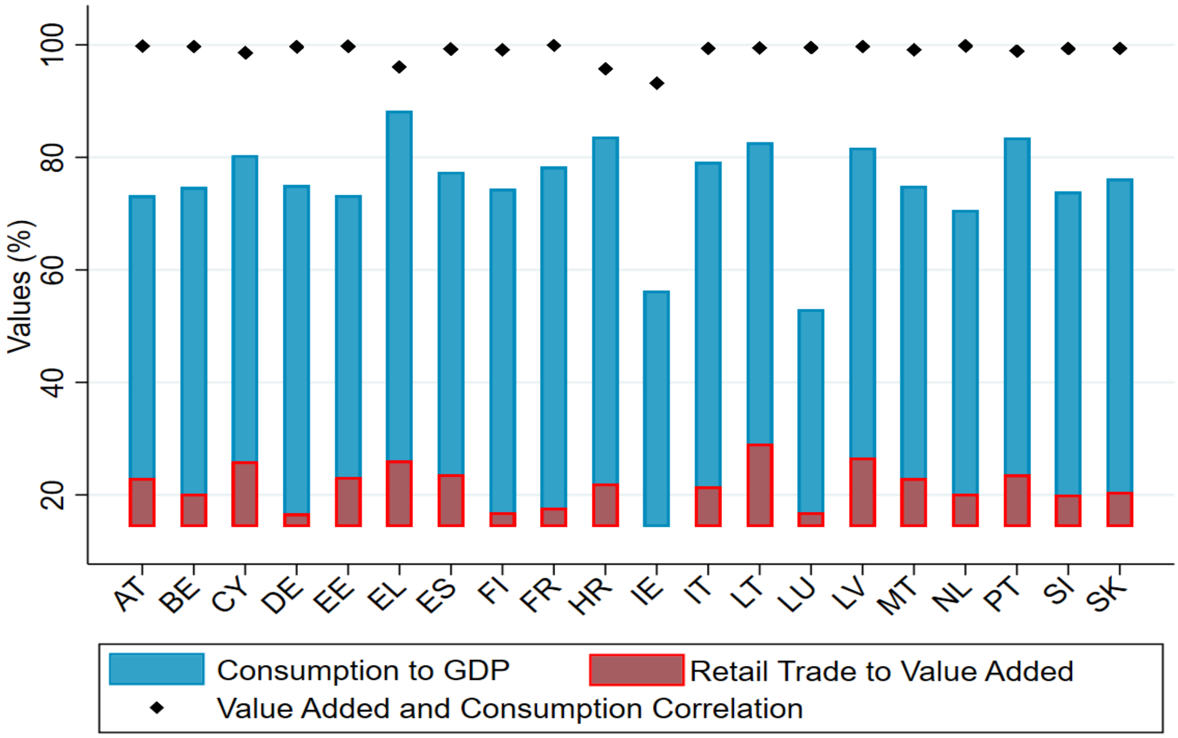
Table 1:
Descriptive Statistics

	mean	Standard Deviation	min	max
Inflation	2.46%	2.51%	-2.53%	18.69%
Retail Sales	1.77%	7.07%	-110.71%	25.89%
Industrial Production	1.48%	8.15%	-58.07%	58.35%
ECB Commodity Index	1.34%	4.95%	-12.39%	14.25%
Unemployment	8.86%	0.04%	1.80%	28.10%
Mon. Policy Shock	0.11	3.24	-28.70	16.15
Mon. Policy Shock by R&R	0.00	13.44	-110.6	46.88
Interest Margin Rate	1.89	0.80	-0.61	4.65
Funding Cost	1.60%	1.37%	-0.31%	7.69%
Aggregate Assets/GDP	157.36%	112.21%	2.45%	571.09%
Risk Exp.	49.21%	14.82%	16.74%	108.01%
ROE	2.71%	12.57%	-165.01%	23.41%
Non Performing Loans	39.82%	52.79%	0.00%	459.20%

2.2. Baseline specification

To estimate the effect of the monetary policy shock on the variables of interest, we employ the local projections technique pioneered by Jorda (2005). The dependent variable is represented by $Y_{c,t}$, MP_t is the monetary policy shock and $X_{c,t-1}$ is a vector that includes all the control variables. $Y_{c,t}$ is either the inflation rate (based on the logarithm of HICP), or the retail sales index or the unemployment rate. While many studies focus on industrial production (IP) as a key indicator of economic activity when examining the euro area as one entity, this analysis considers retail sales (volume) as this is a more appropriate economic activity indicator in a panel of euro area countries. Retail sales is highly correlated with private consumption and, hence, it can serve as a proxy for private consumption, which is the largest component of real GDP and thus more representative indicator of economic activity for various countries within the sample (see Figure 1). Nevertheless, we conduct additional robustness checks using industrial production, instead of retail sales, in order to verify our findings.

Figure 1: The Role of Retail Sales as a Proxy for Economic Activity



We estimate the following specification which allows for fixed effects[5]:

$$\boldsymbol{Y_{c,t+h}} = \boldsymbol{a_{c,t}} + \sum_{j=0}^{3}(\widehat{\boldsymbol{\beta_{h,J}}})\boldsymbol{MP_{t-j}} + \sum_{j=1}^{3}(\widehat{\boldsymbol{\varphi_{h,J}}})\boldsymbol{Y_{c,t-j}} + \boldsymbol{X_{c,t-j}} + \boldsymbol{e_{c,t+h}}\ ,\quad \boldsymbol{h = 0,\dots,24} \qquad \textbf{(1)}$$

On the left side of the equation, we set HICP based Inflation rate, Retail Sales or Unemployment Rate. On the right side we have Monetary Policy shocks (3 lags), three lags of the dependent variable and a set of control variables (1 lag). We use the following control variables (X): one lag of the ECB commodity index (Murgia, 2020; Cloyne and Hurtgen,2016), and the remaining variables dependent variables (e.g., when the dependent variable is inflation, we use as control variable the unemployment rate and the retail sales) and a time trend. The index c=1,. . . ,20 , represents each Eurozone country, and the index 't' represents each month since January 2000.

To extend our estimations to include both expansionary and contractionary monetary

[5] In every specification h is set to 24 and the lag length is selected according to the relevant information criteria. In more detail, the BIC and the HnQ criteria suggest using 3 lags.

policy shocks (MPS), we categorize these shocks based on whether they are above or below zero. Specifically, we apply equation (1) in two separate cases: first, when the shock is contractionary (i.e., above zero) and second when it is expansionary (i.e., zero or below). This approach enables us to differentiate between periods of monetary policy tightening and easing, allowing for a more nuanced analysis of the impact of various monetary policy stances.

2.3. The role of specific characteristics of the banking sector

The transmission of monetary policy can be more pronounced under specific banking characteristics, such as banking profitability, cost of funds, risk exposure, non-performing loans, and size. Therefore, we conduct additional robustness checks depending on whether country-year observations are divided in high and low states based on the banking characteristics discussed above. We expect that banking systems with lower-quality characteristics will intensify the transmission of monetary policy (Syngyup Choi et al., 2022). Specifically, banking systems exhibiting higher bargaining power (or lower competition), greater profitability[6], elevated funding costs, increased risk exposure, and low amount of total assets are classified as having "bad characteristics." In contrast, those with lower bargaining power and profitability, lower funding costs, reduced risk exposure, and larger balance sheets are considered to have "good characteristics". These banking characteristics are incorporated into equation (2) by means of the indicator variable $Z_{c,t-1}$. The indicator variable has the value of 1 in case the respective banking characteristics are above their median value and zero when they are below their median value. Note, that the indicator variable Z enters equation (2) at time t-1 to minimize any contemporaneous effect that the monetary policy shock might have on banking sector characteristics. Specification (2) allows us to estimate the effect of the monetary policy shock in different states of nature depending on the specific banking characteristic considered each time.

$$\boldsymbol{Y_{c,t+h} = Z_{c,t-1}\left(a_{c,t} + \sum_{j=0}^{3}(\widehat{\beta_{h,j}})MP_{t-j} + \sum_{j=1}^{3}(\widehat{\varphi_{h,j}})Y_{c,t-j} + X_{c,t-j}\right) + (1 - Z_{c,t-1})\left(a_{c,t} + \sum_{j=1}^{3}(\widehat{\beta_{h,j}})MP_{t-j} + \sum_{j=1}^{3}(\widehat{\varphi_{h,j}})Y_{c,t-j} + X_{c,t-j}\right) + e_{c,t+h}\ , h = 0,\ldots,24} \quad \textbf{(2)}$$

3. Empirical results

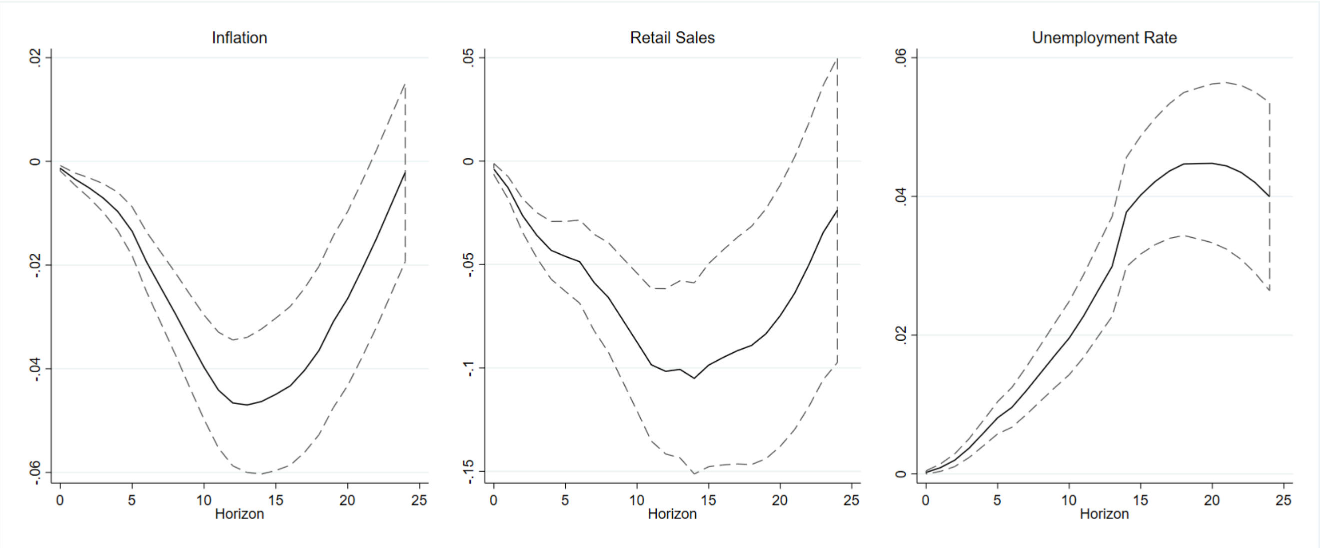
3.1 Baseline specification

[6] However, a high ROE index could also indicate that the banking system makes a more efficient use of its equity

Tightening monetary policy, indicated by an increase in the 3-month Overnight Index Swap (OIS) yield, raises the cost of capital, thereby making access to finance more difficult. This results in a decline in aggregate consumption and investment, leading to lower inflation rates, reduced retail sales, and higher unemployment (see Figure 2).

As observed in Figure 2 the inflation rate drops by 0.04% one year later, and this effect persists until the 19th horizon. Retail sales decrease by 0.1% , while the unemployment rate increases by 0.03 percentage points. Two years after the shock, the impact on unemployment reduces to 0.01 percentage points. In comparison to relevant studies, our results indicate that monetary policy transmission is lower in general. Murgia (2020) finds that one year after a monetary policy shock, the Industrial Production Index decreases by 0.5%, while inflation declines by 0.2%. In contrast, Pragyan et al. (2023), using a disaggregated approach, report a decline in inflation (0.2 %) but a slightly smaller decrease in GDP (0.3 %) one year after the shock. Ribba (2022) finds that the impact for unemployment one year after a shock is 0.1 percentage points.

Figure 2: Responses after a Monetary Policy Shock

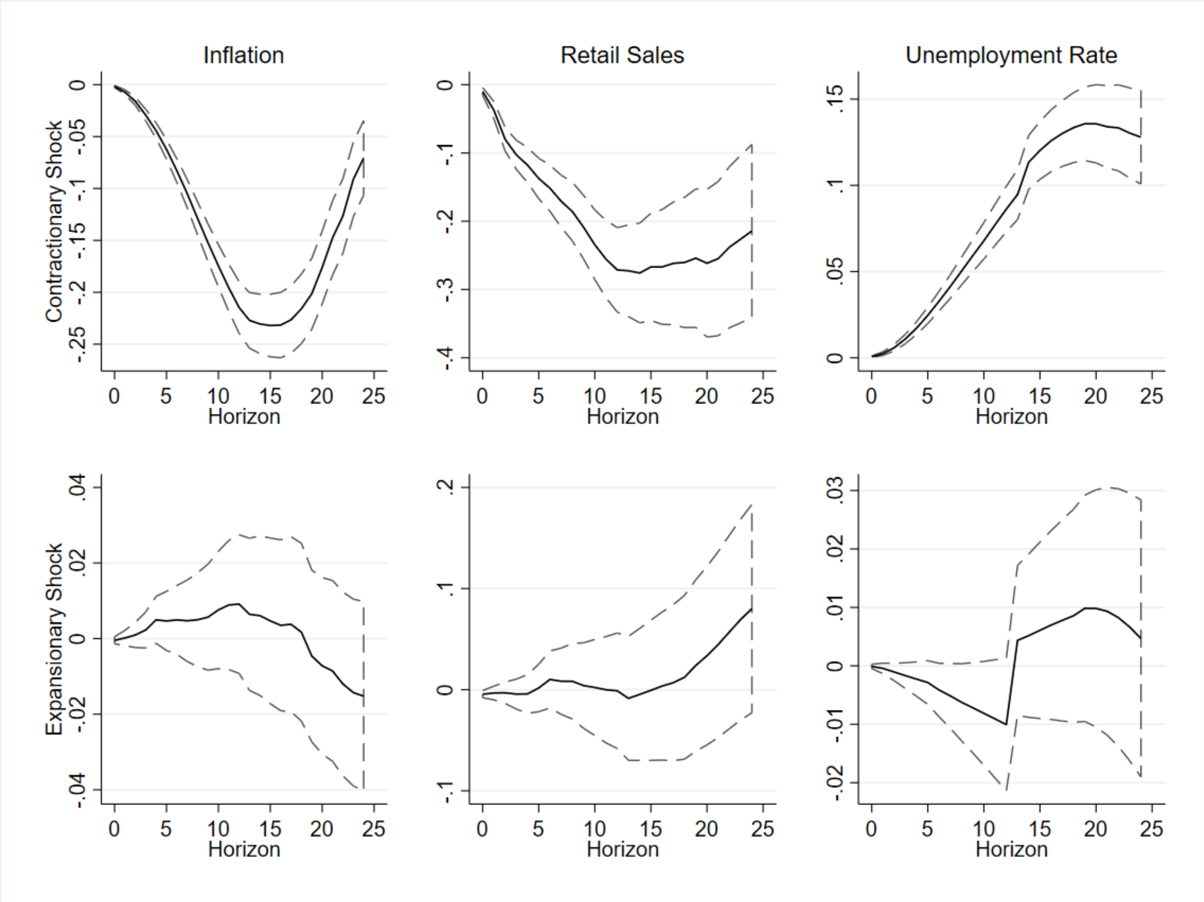


Note : Figure 2 presents inflation, retail sales and unemployment rate responses after a monetary policy shock of 100 bps. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

The responses of the variables of interest are more pronounced after a monetary policy tightening, while they are small and insignificant after an expansionary shock (see Figure 3).

In more detail, as shown in Figure 3, six months after a contractionary policy shock, the inflation rate decreases by 0.08%, and twelve months after that shock the inflation drops by 0.2% - the peak inflation response remains equal to -0.2% until the 19th month and then gradually returns to zero. retail sales decline by 0.24% six months after a positive MPS and by 0.3% one year after the shock. The unemployment rate increases by 0.04 percentage points 6 months after the shock and by 0.1 pp 12 months after the shock.

Figure 3: Responses after a Monetary Policy Shock



Note : Figure 3 presents inflation, retail sales and unemployment rate responses after a contractionary and an expansionary shock of 100 bps. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

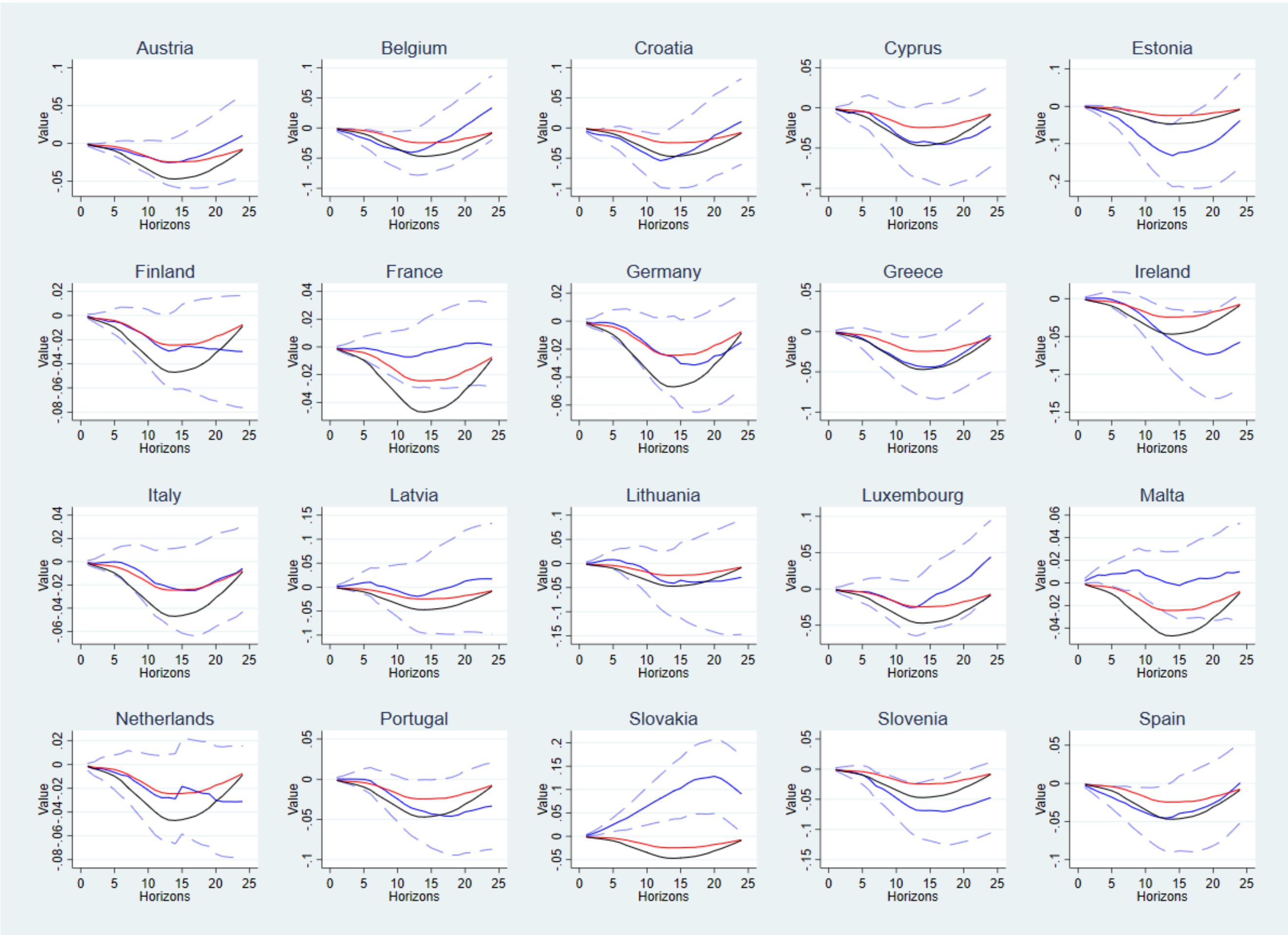
3.2 Cross country heterogeneity

Various studies such as Georgiadis (2014) and Pragyan et al. (2023) have shown that there is a considerable heterogeneity in the transmission of monetary policy shocks. For example, Georgiadis (2014) shows that euro area economies in which a higher share of aggregate output is accounted for by sectors servicing interest rate sensitive demand (industry and construction as opposed to services) exhibit a stronger transmission of monetary policy to real activity. Moreover, according to Georgiadis (2014) euro area economies which feature more real wage and/or fewer unemployment rigidities also appear to display a stronger transmission of monetary policy to real activity. While Pragyan et al. (2023) finds significant heterogeneity in the transmission of monetary policy across 33 advanced and emerging market economies with monetary policy being more effective in countries with more developed financial systems, credible monetary policy frameworks and floating exchange rate systems.

Building on the abovementioned studies we re-estimate the baseline specification (1) on a country-by-country basis and obtain impulse responses for inflation, unemployment and retail sales. These country-by-country estimations include additional control variables in vector X. In more detail, we also include lags of euro area GDP growth, euro area inflation, and the EUR/USD bilateral exchange rate. This approach helps account for the fact that the common monetary policy is determined with an eye on euro area developments. These country-specific impulse responses (blue color) along with the baseline response (black color) reported in Figure 2 are then presented in Figures 4-6. At the same time in Figures 4-6 we also include the overall response of each variable at the euro area level - which is calculated as the weighted (based on GDP) average of each country's response (red color).

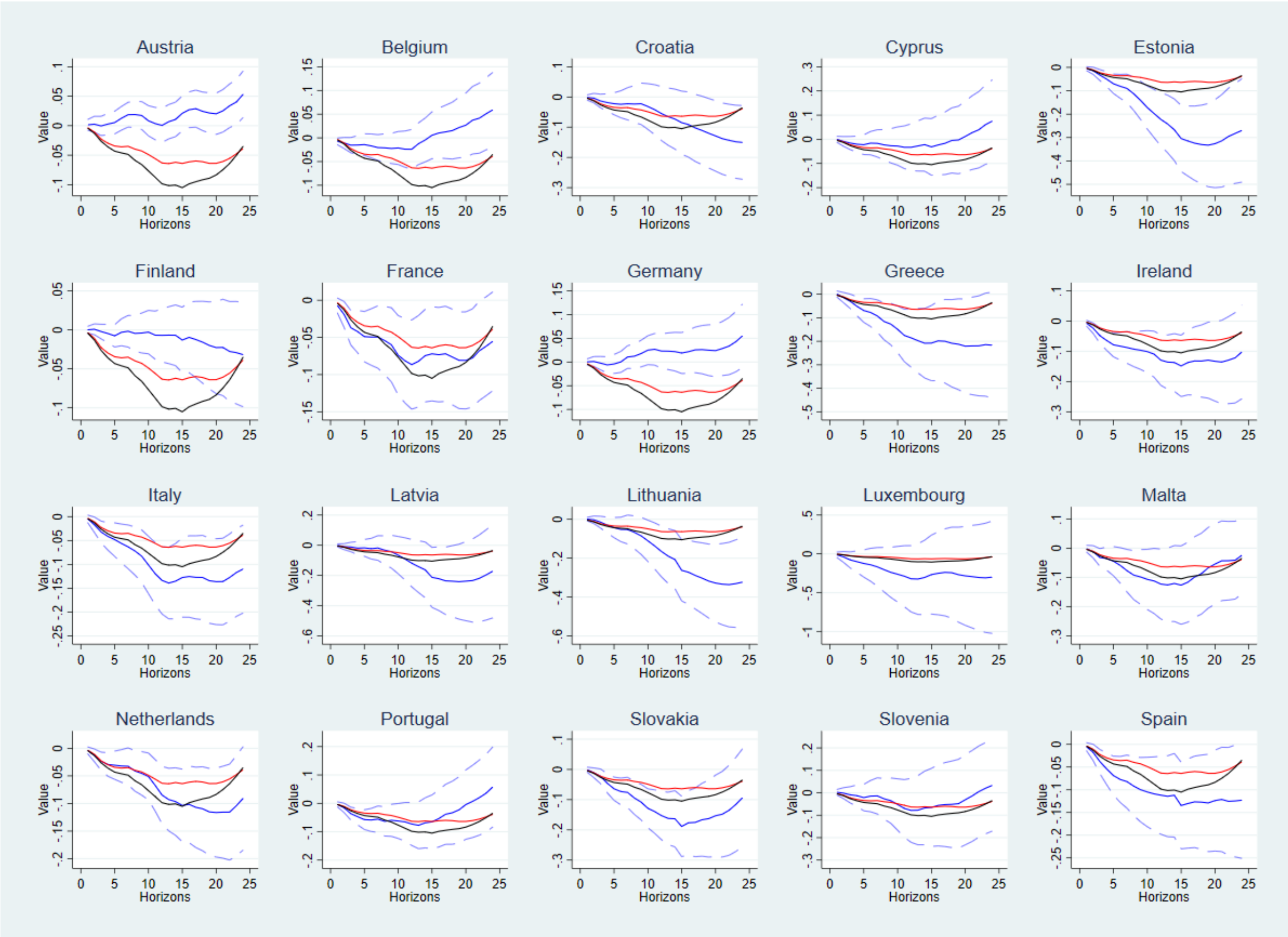
The results indicate substantial heterogeneity across countries in the responses of inflation, unemployment, and retail sales to monetary policy shocks. In the next section we present evidence that these different effects of the common monetary policy can be attributed to the different characteristics of the banking systems among euro area countries.

Figure 4: Inflation Responses after a Monetary Policy Shock | By Country



Note : Figure 4 presents inflation responses for each EA country after a monetary policy shock of 100 bps. The blue IRF refers to the responses of each specific country and the confidence interval is 90% (dashed blue lines). The black IRF refers to the baseline response, while the red IRF stands for the weighted average response All values are represented in (%).

Figure 5: Retail Sales Responses after a Monetary Policy Shock | By Country



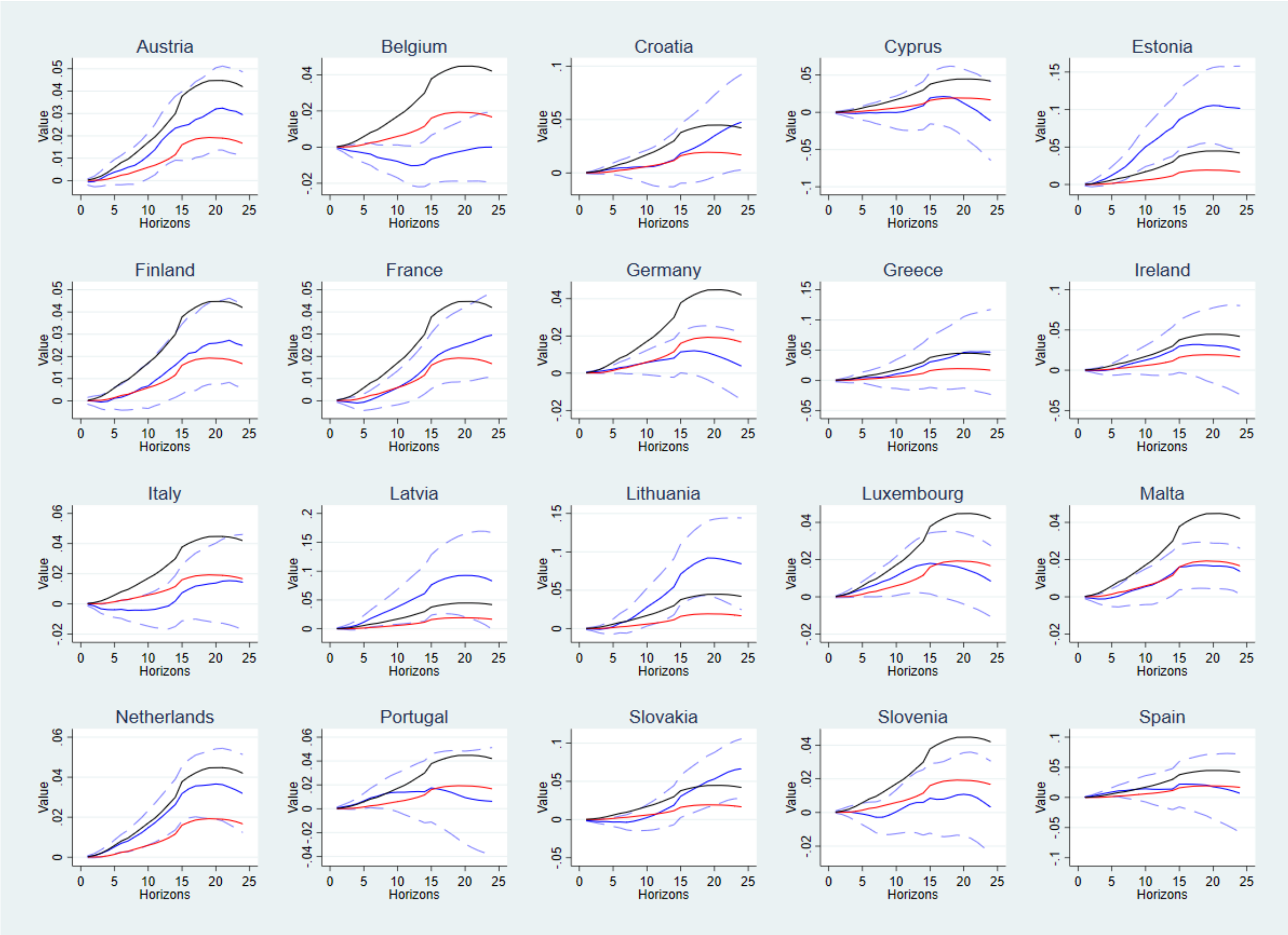
Note : Figure 5 presents Retail Sales responses for each EA country after a monetary policy shock of 100 bps. The blue IRF refers to the response of each specific country and the confidence interval is 90% (dashed blue lines). The black IRF refers to the baseline response, while the red IRF stands for the weighted average response. All values are represented in (%).

4. Robustness check: the role of banking sector characteristics

4.1. Interest rate margins

This sub-section presents the most notable disparities in monetary policy transmission among banking characteristics. We first examine the market power of the banking system as approximated by high interest rate margins. We expect that a more concentrated banking system will be associated with higher market power, which will manifest itself in higher profit margins (Corvoisier et al.,2002). Banking concentration can increase financing obstacles and makes financing more expensive, as banks charge higher interest rates (Beck et al.,2004). impacting heavily the macroeconomic environment. In this context, a monetary policy shock is more easily transmitted to retail interest rates, curbing investment and consumption, thus leading to larger reductions in inflation and output growth.. The significance of banking concentration in monetary policy pass-through is also highlighted by Gödl-Hanisch (2022), who concludes that high concentration makes a contractionary shock to pass quicker

Figure 6: Unemployment Responses after a Monetary Policy Shock | By Country

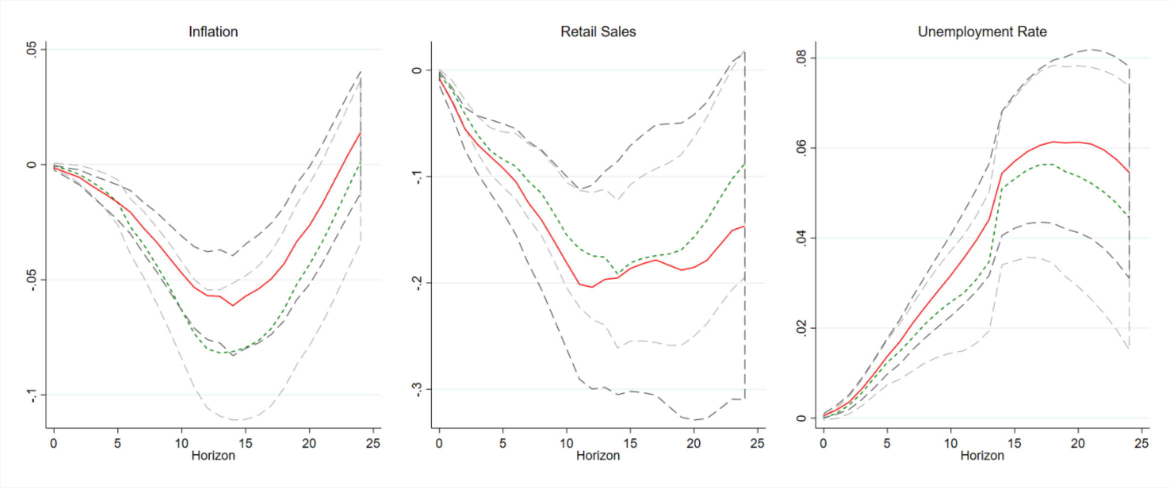


Note : Figure 6 presents Unemployment responses for each EA country after a monetary policy shock of 100 bps. The blue IRF refers to the response of each specific country and the confidence interval is 90% (dashed blue lines). The black IRF refers to the baseline response , while the red IRF stands for the weighted average response. All values are represented in percentage points.

into loan and deposit rates.

Turning to the estimated impulse responses reported in Figure 7, we see that the negative inverse hump-shaped response of inflation is identical in both high (green dotted line) and low (red line) interest margins banking systems and resembles the one in the baseline specification. Retail sales decline in line with the response profile in the baseline specification. However, the magnitude of their negative response is similar across both low and high interest margin banking systems. Similarly, the unemployment rate rises in a hump-shaped pattern following the monetary policy shock, and, as with retail sales, its positive response does not differ significantly between the two groups.

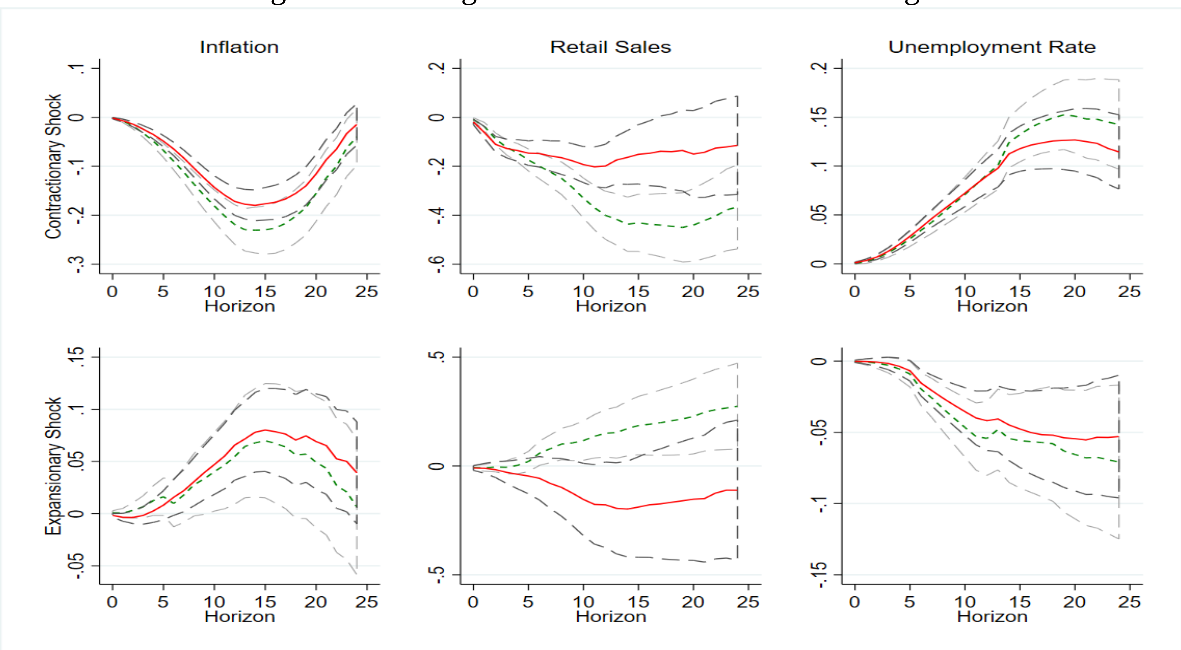
Figure 7: Banking Characteristic: Interest Rate Margin



Note : Figure 7 presents inflation, retail sales and unemployment rate responses after a contractionary monetary policy shock of 100 bps.: The green IRF refers to above median interest rate margins, while the red IRF refers to below median interest rate margins. The sample period spans from 2003 to 2023. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

The differences between banking systems with high and low interest rate margins become more obvious after separating the monetary policy shock into contractionary and expansionary (see Figure 8). In line with the literature, a contractionary monetary policy shock exerts much more powerful effects on inflation, retail sales and unemployment in high profit-margin banking systems (green dotted lines). When an expansionary shock occurs, inflation and retail sales increase in a quite more sizeable manner in high profit margin banking systems (green dotted lines). On the contrary, the decline in unemployment rate is almost identical independently of the interest rate margin.

Figure 8: Banking Characteristic: Interest Rate Margin



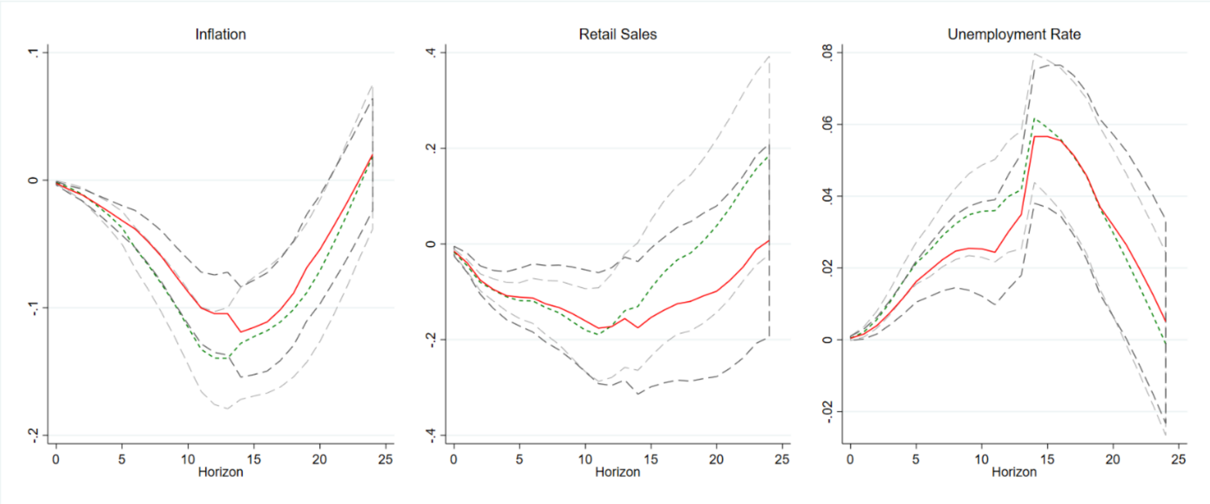
Note : Figure 8 presents inflation, retail sales and unemployment rate responses after a contractionary and an expansionary monetary policy shock of 100 bps.: The green IRF refers to above median interest rate margins, while the red IRF refers to below median interest rate margins. The sample period spans from 2003 to 2023. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

4.2. Banking return on equity

Banking systems with a high ROE often have better pricing power, a better market position due to higher interest margins and often operate more efficiently. This enables them to adjust interest rates more effectively and pass on the effects of tight monetary policy to borrowers and investors. Consequently, the effects of a monetary tightening are expected to be stronger for banking systems with higher ROE.

Indeed, as we observe in Figure 9, inflation declines more strongly in banking systems with a higher ROE ratio (green dashed line), while the rise in unemployment in the first year after the restrictive monetary policy shock is also stronger. However, no significant difference is observed in the response of retail sales one year after the shock, but thereafter it appears that the recovery of retail sales is slower in banking systems with low ROE (red line).

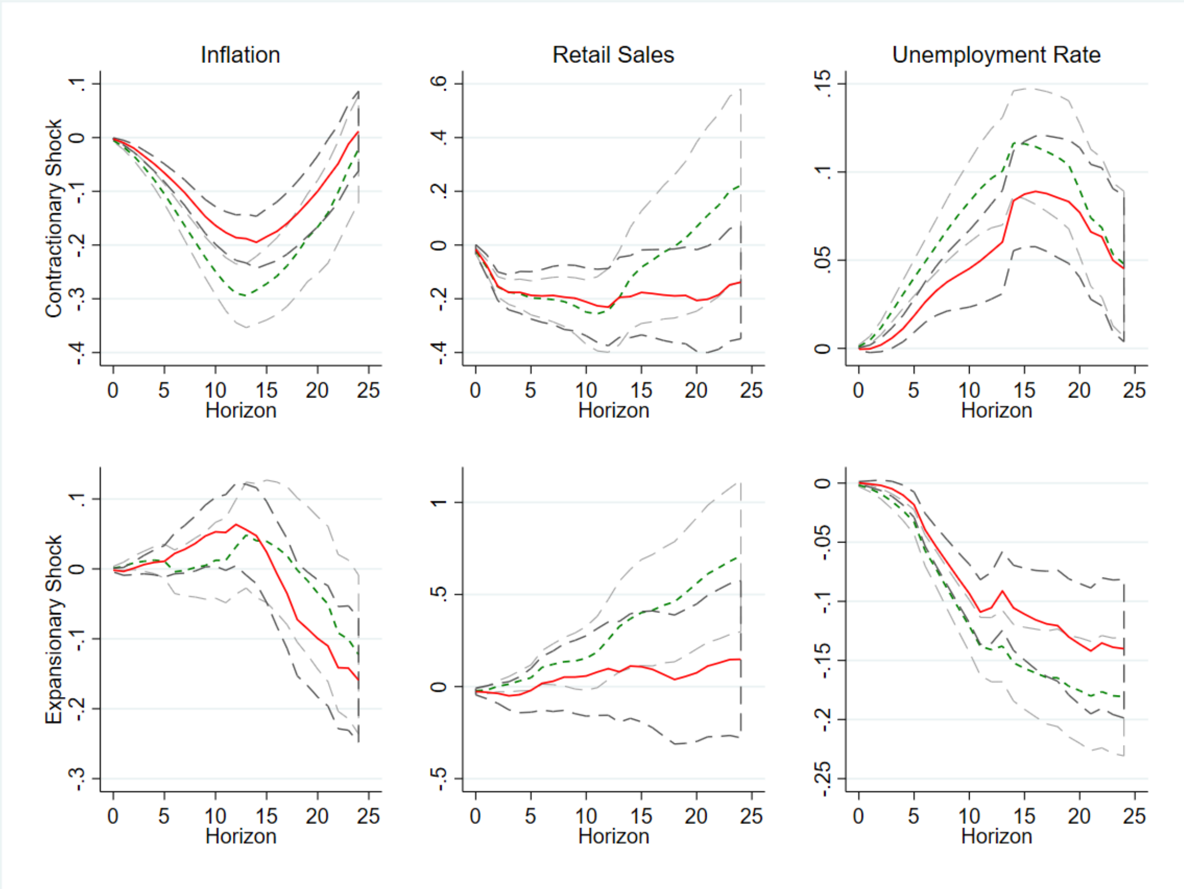
Figure 9: Banking Characteristic: Return on Equity



Note : Figure 9 presents inflation, retail sales and unemployment rate responses after a contractionary monetary policy shock of 100 bps.: The green IRF refers to above median Return on Equity, while the red IRF refers to below median Return on Equity. The sample period spans from 2008 to 2023. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

The differences between high and low ROE banking systems become more apparent after disaggregating the monetary policy shock into contractionary and expansionary (see Figure 10). Indeed, inflation declines and unemployment rises more sharply after a restrictive monetary policy shock in banking systems with high ROE (green line). In contrast, retail sales are not affected by the level of ROE the first year after the monetary policy shock. It is also noted that, as in the baseline model, in the second year retail sales recover faster in banking systems with high ROE (green line). After an expansionary shock occurs, inflation increases and unemployment decrease in a quite more sizeable manner in high ROE banking systems (green dotted lines). On the contrary, the increase in retail sale generated by the expansionary monetary policy shock is almost identical independently of the level of ROE.

Figure 10: Banking Characteristic: Return on Equity



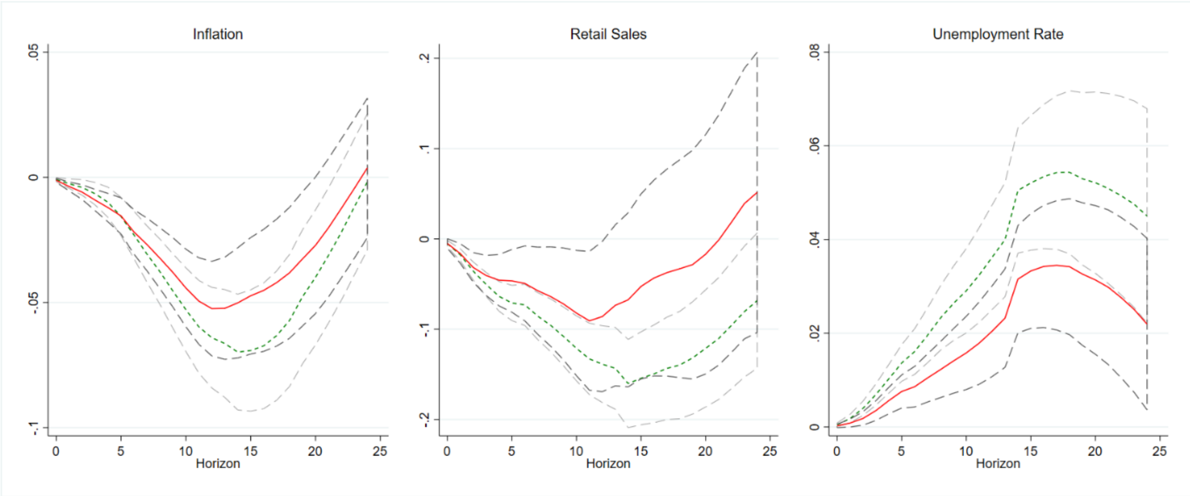
Note : Figure 10 presents inflation, retail sales and unemployment rate responses after a contractionary and an expansionary monetary policy shock of 100 bps.: The green IRF refers to above median Return on Equity, while the red IRF refers to below median Return on Equity. The sample period spans from 2008 to 2023. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

4.3. Cost of funding

Splitting the sample into high and low funding cost banking industries will reveal that banks with higher funding costs are more likely to transmit a monetary policy shock to the economy faster. Conversely, banks that have lower funding costs, which can absorb higher costs more comfortably, are more likely not to pass on the full range of monetary policy rate increases to their borrowers (C. Altavilla et al., 2024). Thus, banks with higher funding costs play a critical role in transmitting the effects of monetary policy changes to the wider economy.

When a monetary policy shock occurs, the impact on inflation does not vary between banking systems with high and low costs of funding (Figure 11). However, as anticipated, the decline in retail sales and the rise in unemployment is significantly greater in the case of banking systems with high funding costs (green dashed line).

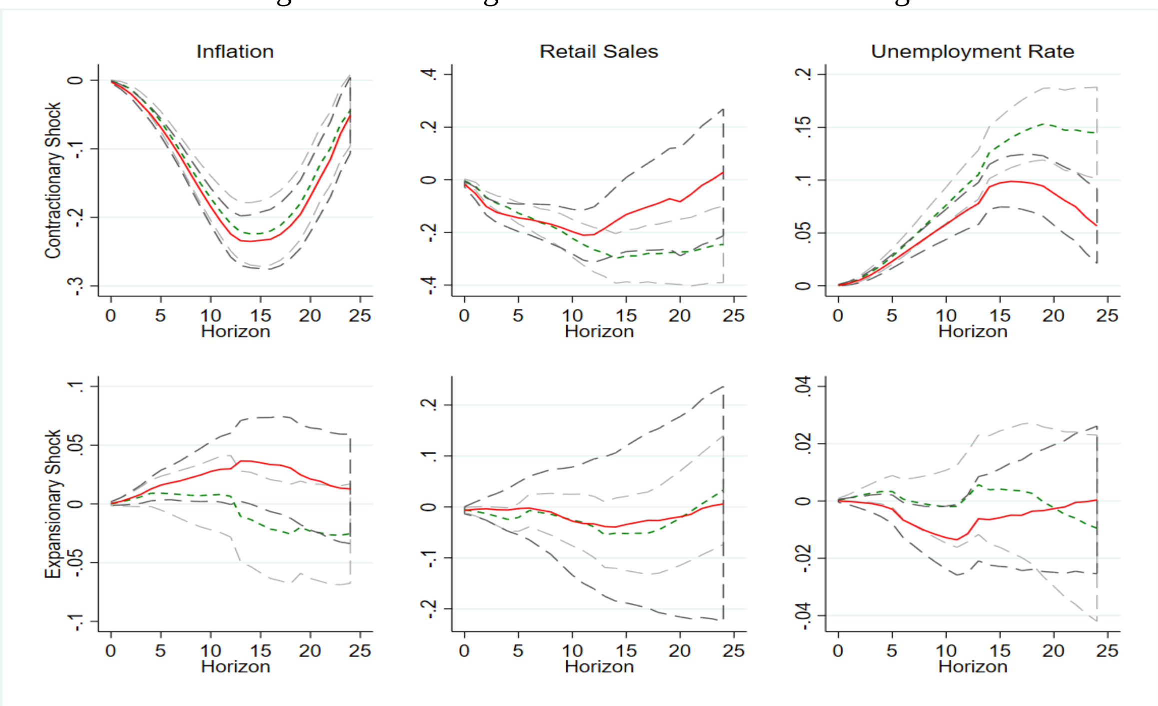
Figure 11: Banking Characteristic: Cost of Funding



Note : Figure 11 presents inflation, retail sales and unemployment rate responses after a contractionary monetary policy shock of 100 bps.: The green IRF refers to above median Cost of Funding, while the red IRF refers to below median Cost of Funding. The sample period spans from 2008 to 2023. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

Focusing only on restrictive monetary policy shocks we observe that, as in the baseline model, retail sales decline more and unemployment increases more sharply in the medium term in the case of banking systems with high funding costs (green line). Conversely, despite the above findings, inflation declines more strongly in banking systems with low funding costs (red line). Following an expansionary monetary policy shock, the responses of the variables move (excluding inflation) around zero, so there are no significant differences between the banking systems.

Figure 12: Banking Characteristic: Cost of Funding



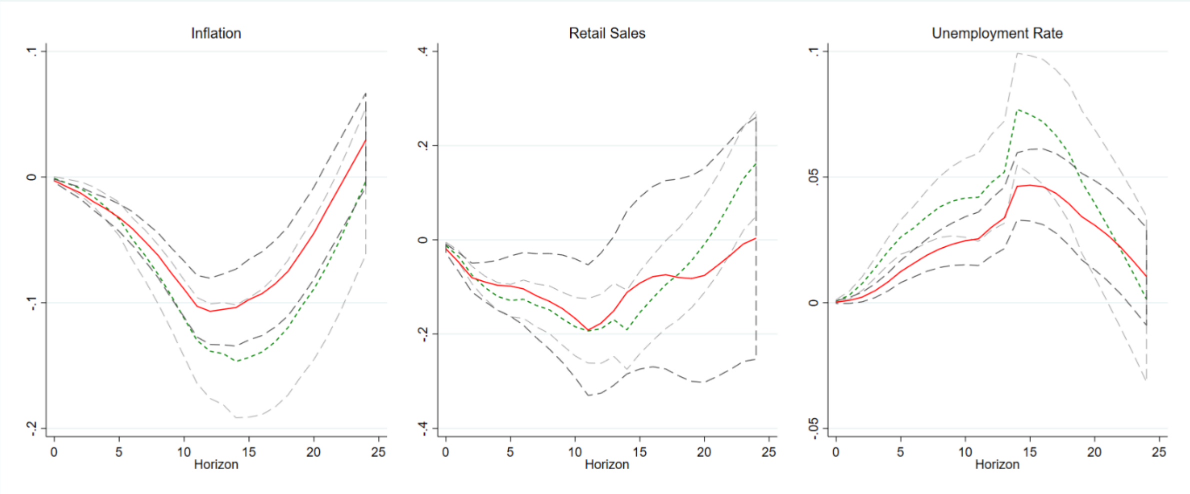
Note : Figure 12 presents inflation, retail sales and unemployment rate responses after a contractionary and an expansionary monetary policy shock of 100 bps.: The green IRF refers to above median Cost of Funding, while the red IRF refers to below median Cost of Funding. The sample period spans from 2008 to 2023. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

4.4. Asset risk exposure

The exposure of banks to asset risk plays a significant role in the transmission of monetary policy. Higher risk exposure appears to amplify the impact of monetary policy transmission. When a contractionary monetary policy is implemented, banks that have higher risk on their assets begin to face higher potential losses and volatility. This may lead them to tighten their lending standards and raise loan rates to mitigate risk. (Yener Altunbas et al., 2009). As a result, the higher interest rates charged by these banks lead to a more substantial reduction in aggregate consumption and investment, significantly affecting inflation, output and employment. Numerous studies (e.g. Jimenez et al. 2014) show that banking systems with higher risk exposure are more sensitive to changes in monetary policy. Specifically, after reductions in policy rates, these banks are more likely to increase their lending activities. This approach leads to a greater surge in aggregate consumption and investment, thereby positively impacting inflation, output, and employment.

The results reported in Figure 13 suggest that the transmission of monetary policy seems to be more significant in banking systems with higher risk exposure. The decline in inflation and retail sales as well as the rise in the unemployment rate is more pronounced in the case of banking systems that face higher risk in their assets.

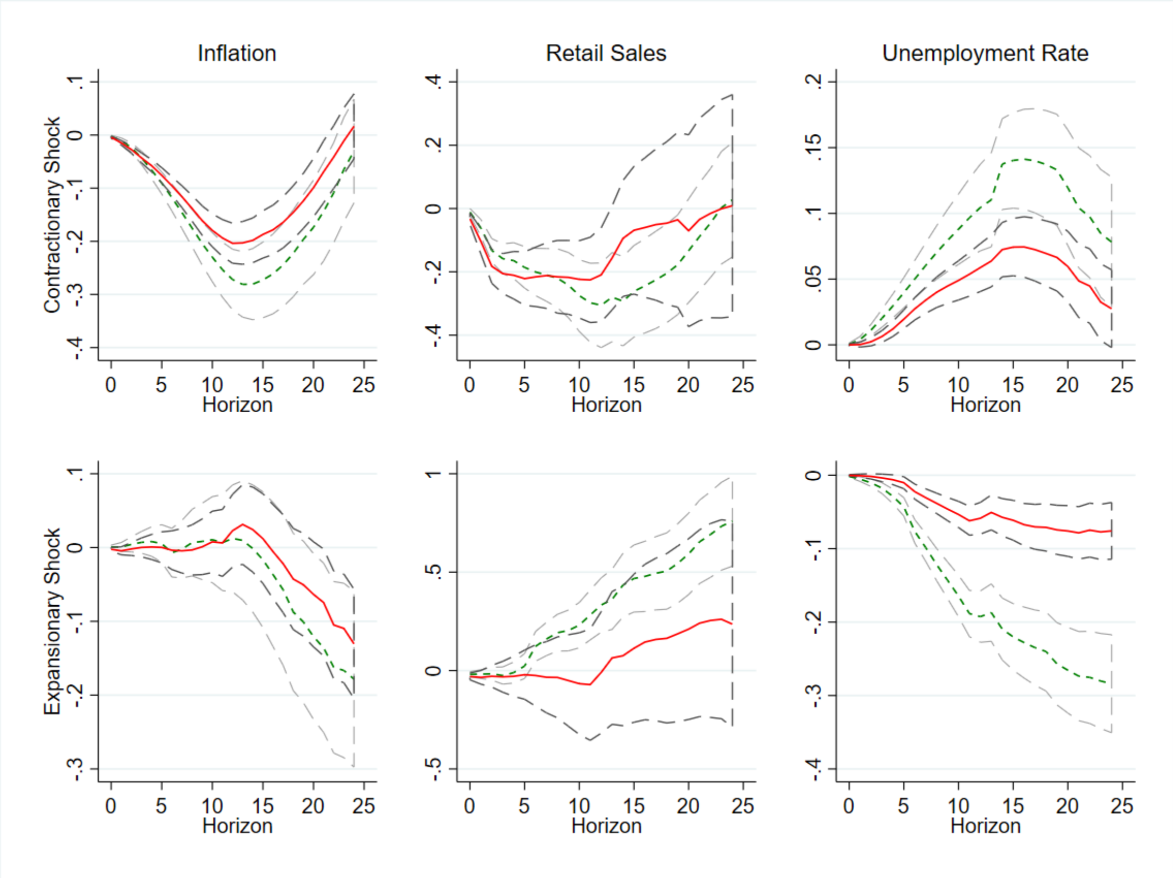
Figure 13: Banking Characteristic: Risk Exposure



Note : Figure 13 presents inflation, retail sales and unemployment rate responses after a contractionary monetary policy shock of 100 bps.: The green IRF refers to above median Risk Exposure, while the red IRF refers to below median Risk Exposure. The sample period spans from 2008 to 2023. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

Our main conclusions remain the same if we separate the monetary policy shock into restrictive and expansionary. Specifically, as we see in Figure 14, after a restrictive monetary policy shock (as in Figure 13), inflation and retail sales fall more and unemployment rises more strongly in cases of banking systems facing high risk in their assets. In the case of an expansionary monetary policy shock, inflation and retail sales rise more in the medium term, while unemployment falls much more sharply in banking systems whose assets are more exposed to risk (Figure 14).

Figure 14: Banking Characteristic: Risk Exposure

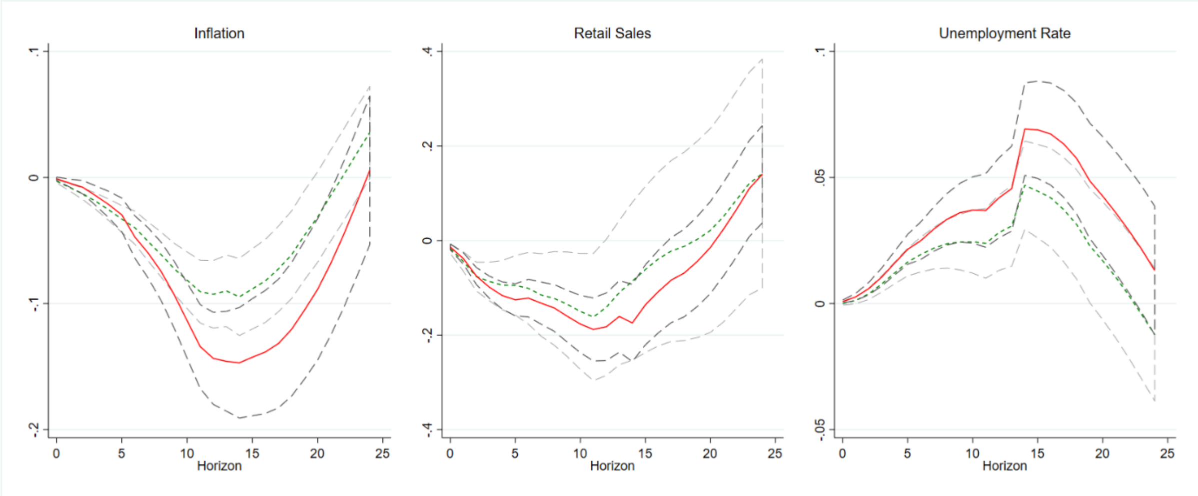


Note : Figure 14 presents inflation, retail sales and unemployment rate responses after a contractionary and an expansionary monetary policy shock of 100 bps.: The green IRF refers to above median Risk Exposure, while the red IRF refers to below median Risk Exposure. The sample period spans from 2008 to 2023. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

4.5. Banking total aggregate assets

In banking systems with a low total aggregate banking assets-to-GDP ratio, the transmission of a contractionary monetary policy shock is more pronounced. Banks, having a smaller asset base relative to economic activity, are less able to absorb a shock to monetary policy, resulting in a more significant reduction in lending and a greater negative impact on the wider economy (Altunbas et al., 2009). In contrast, in banking systems with high total assets relative to GDP, banks are better equipped to handle the shock, leading to less severe economic effects. As Figure 15 shows, inflation and retail sales fall more sharply and unemployment rises more in the case of a restrictive monetary policy shock in banking systems with a low ratio of total assets to GDP (red line).

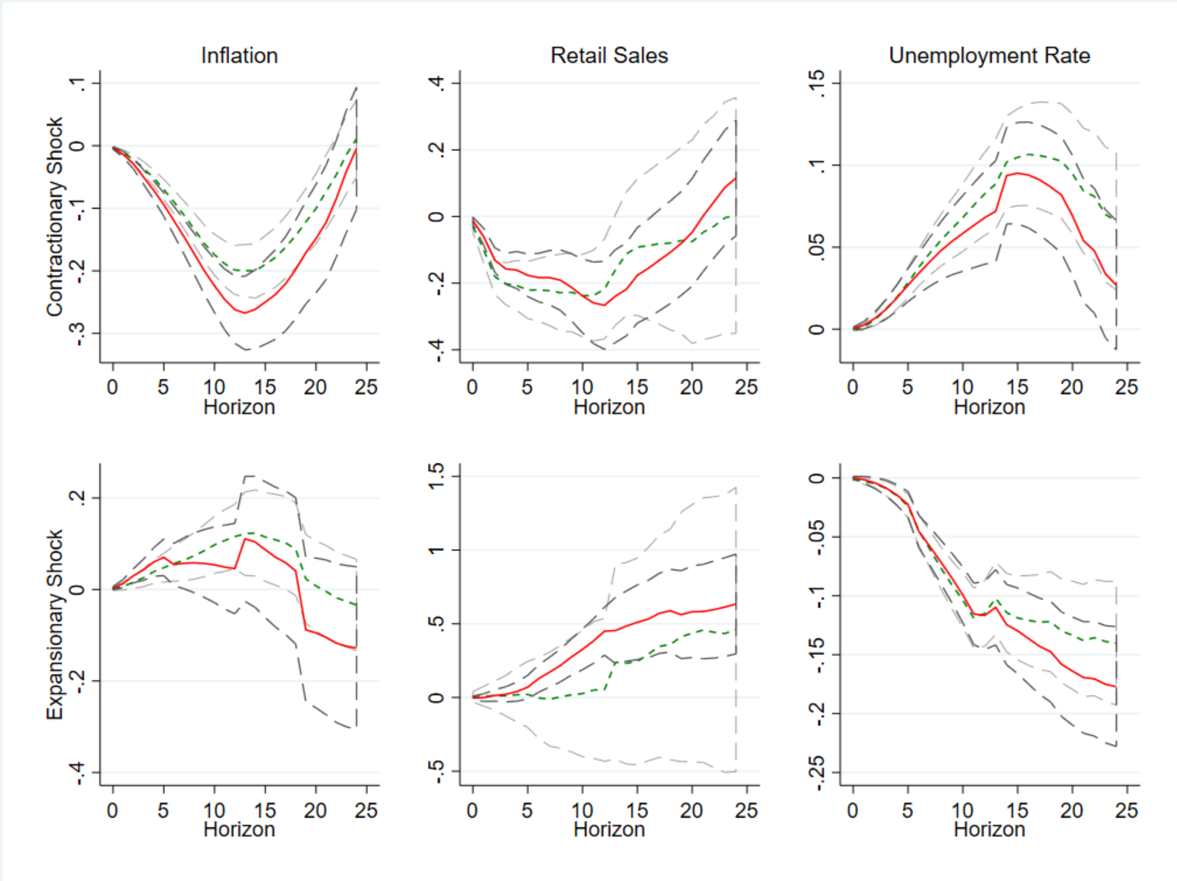
Figure 15: Banking Characteristic: Banking Total Aggregate Assets



Note : Figure 15 presents inflation, retail sales and unemployment rate responses after a contractionary monetary policy shock of 100 bps.: The green IRF refers to above median Total Aggregate Assets to GDP, while the red IRF refers to below median Total Aggregate Assets to GDP. The sample period spans from 2007 to 2023. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

In banking systems, where total assets relative to GDP are lower, banks may have a greater incentive to aggressively increase lending following an easing of monetary policy. This is because they are more constrained by their asset base and more sensitive to lower interest rates (Bernanke & Gertler, 1995; Jimenez et al., 2012). As a result, the response to expansionary monetary policy is strengthened, as banks with smaller asset bases seek to boost profitability by expanding credit, leading to higher economic activity. As we observe in Figure 16, the rise in inflation following an expansionary monetary policy shock does not differ significantly between banking systems with low or high asset-to-GDP ratios. However, in the cases of banking systems with a low asset-to-GDP ratio we see a larger rise in retail sales and a faster decline in unemployment (red line) after an expansionary monetary policy shock. In the case of a restrictive monetary policy shock, the decline in inflation and retail sales as well as the rise in unemployment are milder in banking systems with a high ratio of assets to GDP (Figure 16 -green dashed line).

Figure 16: Banking Characteristic: Banking Total Aggregate Assets



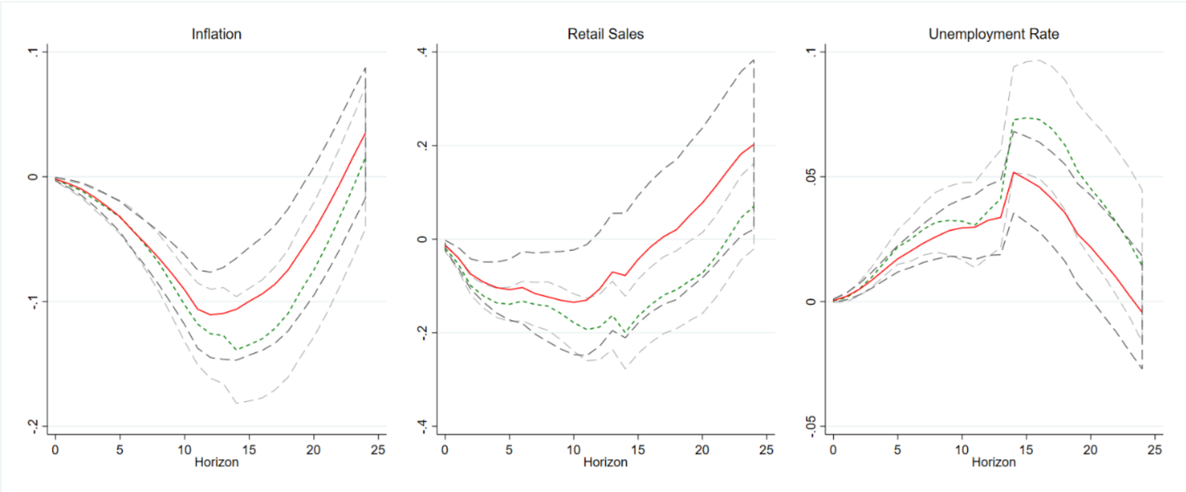
Note : Figure 16 presents inflation, retail sales and unemployment rate responses after a contractionary and an expansionary monetary policy shock of 100 bps.: The green IRF refers to above median Total Aggregate Assets to GDP, while the red IRF refers to below median Total Aggregate Assets to GDP. The sample period spans from 2007 to 2023. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

4.6. Non-Performing Loans

Banking systems that have more troubled assets such as high non-performing loans will face higher credit risk. Because of this, they will likely limit credit expansion and charge higher interest rates. If in such an environment an increase in the monetary policy rate takes place, banks are expected to increase interest rates faster than banks that do face such a credit risk. However, if lending rates are already high, they may not rise to the same extent as the policy rate (see Byrne and Kelly, 2019). In the event of a reduction in the monetary policy rate, there is likely to be a delay in the decline in bank rates if there is increased credit risk. As we observe in Figure 17, inflation, and retail sales decline more in the medium term and unemployment increases more strongly in banking systems that have high non-performing loans and, by extension, high credit risk. In banking systems with high non-performing loans (NPLs), monetary policy tightening tends to provoke more pronounced responses compared to systems with low NPLs (see Figure 17). This is because banks burdened with high NPLs are in a weakened financial state, which amplifies the effects of policy changes. When monetary policy tightens, these banks, already struggling with strained capital buffers, experience a more significant contraction in lending. On the other hand, under expansionary monetary policy, banks with high NPLs may respond more actively due to their marginal lending capacity. In such cases, these banks are more likely to increase their lending significantly in response to lower interest rates, trying to improve their financial standing by expanding credit. Conversely, banks with low NPLs, which are already more aggressivein their lending and have stronger financial positions, exhibit relatively muted responses to expansionary policies (See Figure 18).

The inflation and unemployment rate responses appear similar across both banking groups. However, retail sales exhibit a slightly stronger response twelve months after the shock. Specifically, the impact is nearly statistically insignificant for banking systems with low levels of Non-Performing Loans (NPLs). In contrast, for banking systems with high NPLs, retail sales decrease by 0.2%.

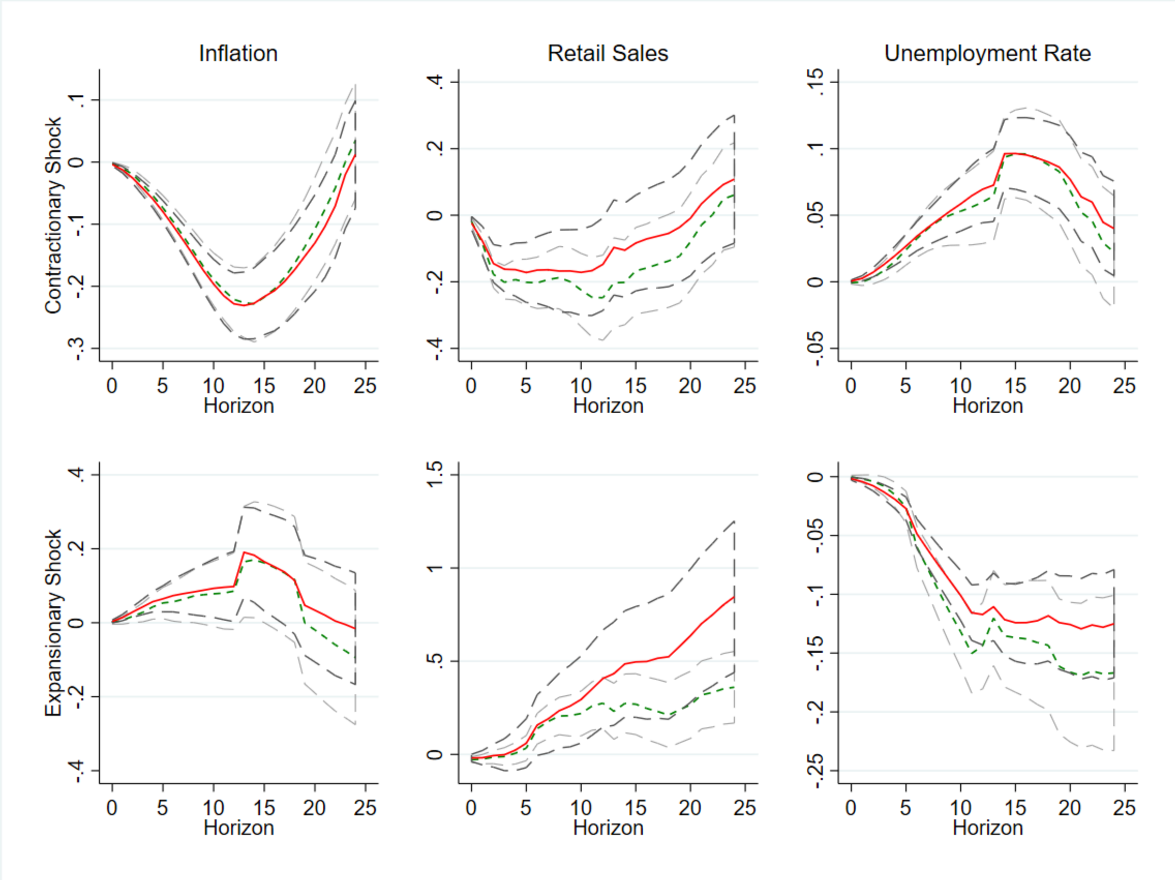
Figure 17: Banking Characteristic: Non-Performing Loans



Note : Figure 17 presents inflation, retail sales and unemployment rate responses after a contractionary monetary policy shock of 100 bps.: The green IRF refers to above median Non-Performing Loans to Equity, while the red IRF refers to below median Non-Performing Loans to Equity. The sample period spans from 2008 to 2023. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

After a tightening shock, retail sales decrease by 0.2% one year later in banks with high non-performing loan (NPL) ratios, whereas inbanks with low NPL ratios, the responses are almost negligible (see Figure 15). Green impulse response functions represent banking systems with Non-Performing Loans above median, and red impulse response functions represent banking systems with Non-Performing Loans below median.

Figure 18: Banking Characteristic: Non-Performing Loans



Note : Figure 18 presents inflation, retail sales and unemployment rate responses after a contractionary and an expansionary monetary policy shock of 100 bps.: The green IRF refers to above median Non-Performing Loans to Equity, while the red IRF refers to below median Non-Performing Loans to Equity. The sample period spans from 2008 to 2023. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

5. Further analysis and robustness

5.1. R&R monetary policy shocks

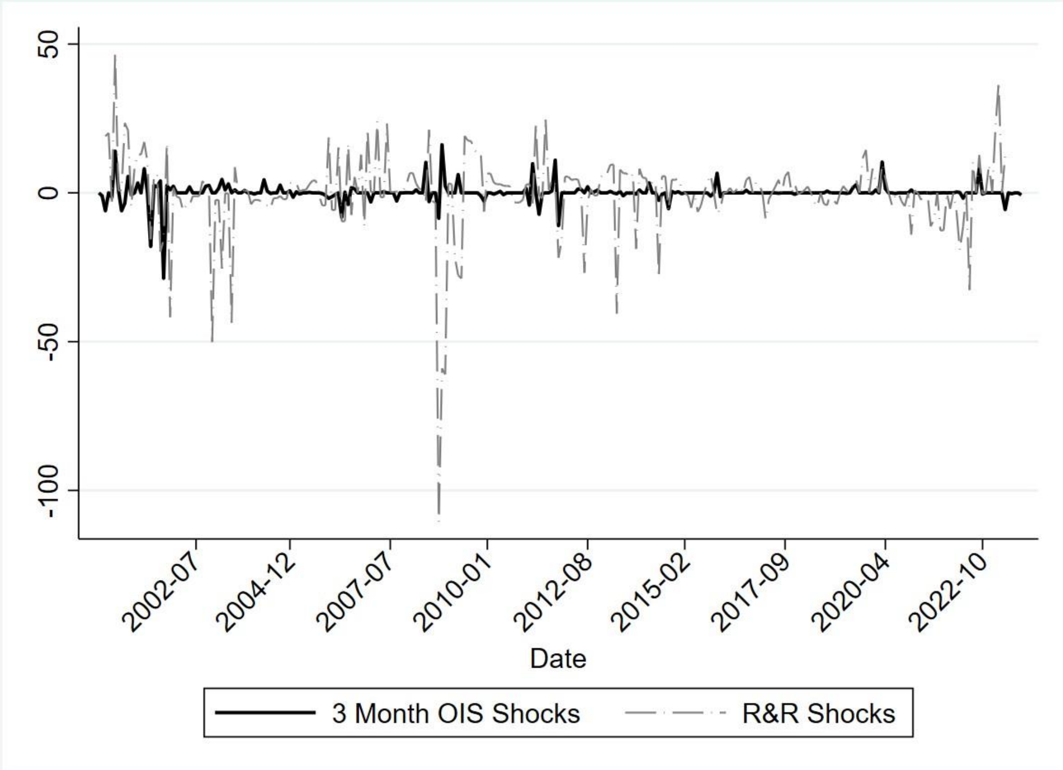
As a robustness check we consider an alternative type of monetary policy shock proposed by Romer and Romer (2004). Romer and Romer (1989) developed a methodology to extract exogenous monetary policy shocks by isolating the component of central bank interest rate decisions that are unexplained by economic conditions. In their original study, they aimed to differentiate the predictable, systematic component of monetary policy decisions (which responds to macroeconomic variables like inflation and GDP) from the unexpected component, i.e., the shock. The unexpected component represents policy surprises, which can be viewed as pure shocks to the economy that are not based on the expected course of macroeconomic conditions.

Following Murgia (2020), we estimate monetary policy shocks using ECB meeting-by-meeting data, such as policy rates, GDP and inflation predictions, unemployment rate, and the central bank's total assets. Hence, in the first stage we estimate equation (3) which used to predict interest rate changes:

$$\Delta r_m = f(\Omega) + \varepsilon_m \tag{3}$$

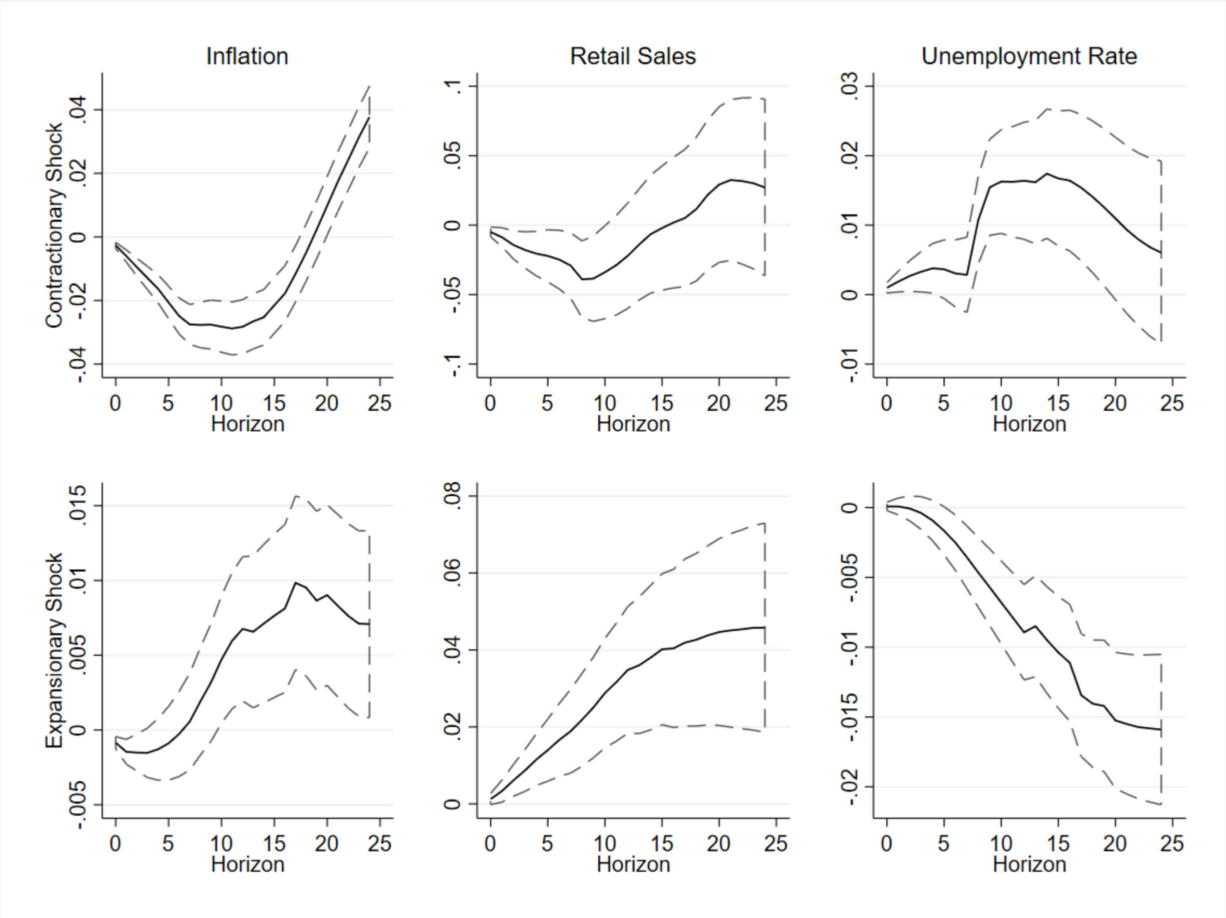
The systematic component f (Ω) contains the factors that mostly affect the decisions of policy makers. These are the eurozone's one and two-year ahead GDP and inflation projections, as well as their revisions, which are displayed as the initial discrepancies between the projections. The revisions represent the first differences between the one- and two-year projections, highlighting how updates in forecasts reflect changes in expected economic conditions over time. The equation also includes the unemployment rate level at meeting 'm', the ECB total assets and the interest rate level fourteen days before the meeting. The residuals from this regression (ε_m) are the monetary policy shock series, which will be used to re-estimate equations (1) and (2). The optimal lag length, determined based on the relevant information criteria, is found to be one. To convert the frequency from meeting-by-meeting to monthly data, we use the R&R approach, which replaces zero values in months without a meeting and takes the sum of the shocks in months with several meetings. We observe that shocks by R&R tend to be larger and more negative compared to 3 Month OIS Yield Swap Shocks (see Figure 19).

Figure 19: Monetary Policy Shocks in Basis Points since 2000



The baseline results (see Figure 20) indicate that, following a contractionary monetary policy shock, the inflation responses range around -0.025% from the 6th to the 12th horizon. The Retail Sales response is equal to -0.05%, while unemployment rate increases by 0.01 percentage points. Following an expansionary shock, inflation increases by 0.025% after one year and retail sales by 0.03%. The unemployment rate decreases by almost 0.015 percentage points one year after a monetary policy shock. In contrast, Murgia (2020) reports more pronounced effects, documenting a 0.5% decline in industrial production and a 0.2% decrease in inflation following contractionary shocks. Similarly, our baseline estimations suggest that results from this alternative approach yield more subdued impacts, particularly regarding retail sales and unemployment.

Figure 20: Responses after a Monetary Policy Shock R&R



Note : Figure 20 presents inflation, retail sales and unemployment rate responses after a contractionary and an expansionary shock of 100 bps. The confidence interval is 90%. All values are represented in (%), except for Unemployment Rate.

As a further robustness check, as before we separate the banking systems into those with good and bad characteristics and repeat the same analysis examining the effect of expansionary and contractionary shocks. Overall, the responses derived from the R&R shocks are less pronounced relative to the baseline specification. This suggests that monetary policy shocks identified using the Romer and Romer method have a more muted effect on the economy than those identified using the monetary policy shocks identified by Altavilla et al (2019). Moreover, the use of the R&R shock reveals a greater degree of heterogeneity in monetary policy transmission across different banking characteristics. In more detail, our evidence shows that banking systems characterized by limited competition, limited access to affordable financing, lower risk aversion and lower asset volume tend to transmit monetary policy more effectively in the sense that they magnify the effect of a monetary policy shock on the indicators of economic activity under consideration[7]. Conversely, when we examine the 3-month OIS

[7] The results are reported in the supplementary material appendix (Appendix D).

swap yield shock, the banking characteristics that exhibit the greatest heterogeneity in monetary policy transmission are banking concentration, risk exposure, and the level of funding costs. This indicates that the transmission of policy shocks varies more significantly based on factors such as bank size, risk exposure, or liquidity when using R&R shocks, highlighting the sensitivity of certain types of banks to unexpected policy changes. [8]

5.2. Industrial production

Another robustness check involves examining the impact of both types of Monetary Policy Shocks on Industrial Production. Given that most studies use this variable as a measure of output, it is essential to observe how its response compares to that of the retail sales index, which tracks closely private consumption. As anticipated, and in line with previous studies, e.g., Murgia (2020) industrial production declines after a contractionary monetary policy shock and increases in case of expansionary monetary policy shocks. In more detail, one year after a tightening shock to the 3-Month OIS Rate, industrial production decreases by 0.57 % . When a contractionary R&R shock occurs, the decrease after one year is 0.03% (see Figure 21). In general, the responses of industrial production are more closely aligned with those of retail sales following R&R shocks. However, when using the 3-Month OIS Rate, the differences between these indices are more sizeable.

We also observe that the transmission of monetary policy shock is more pronounced in the presence of weaker banking systems, particularly in the case of R&R shocks. Banking systems characterized by higher concentration, elevated risk exposure, high funding costs, low amount of total assets to GDP, and a significant amount of non-performing loans are considered to be “weaker” (see Figures 22-27). Furthermore, the differences in the impact of monetary policy shock on the output variable between "strong" and "weak" banking systems become significantly more pronounced when using retail sales as a measure of output, rather than industrial production. This indicates that the response of industrial production is relatively unaffected by the structure of banking markets, whereas retail sales are much more sensitive to these variations. In comparison to the retail sales responses, industrial production exhibits more significant reactions to monetary policy shocks. However, the variation in responses across different banking characteristics is notably smaller for industrial production than for the retail sales index. This suggests that while industrial production is more sensitive overall to monetary policy changes, the impact of banking characteristics such as profitability, risk, and size plays a more

[8] The impulse responses are reported in the supplementary material appendix (see Figures 1-6)

substantial role in shaping the response of retail sales compared to industrial production.

6. Conclusion

This study investigates the impact of monetary policy shocks on macroeconomic performance in 20 Eurozone countries. At the same time, it examines the role played by the characteristics of the banking system in the transmission of monetary policy. Using the monetary policy shocks constructed by Altavilla et al (2019 and examining both contractionary and expansionary shocks, we find that contractionary policy shocks lead to a significant decline in retail sales volume and inflation, alongside a rise in unemployment. In contrast, expansionary shocks elicit a more muted response across these variables. Our analysis also highlights the importance of the banking sector in the transmission of monetary policy. Economies with banking systems characterized by higher profitability, greater bargaining power, elevated funding costs, increased risk exposure, and lower amount of total assets to GDP exhibit more pronounced responses to monetary policy shocks. This supports the notion that the structure and health of the banking sector play a critical role in amplifying or dampening the effects of monetary interventions.

When applying Romer and Romer (R&R) shocks as in Murgia (2020), we observe overall lower macroeconomic responses compared to our baseline specification. However, the differences between "healthy or strong" and "ailing or weak" banking systems become even more pronounced. This indicates that the structural characteristics of banks, such as profitability and size, are key factors that influence the effectiveness of monetary policy, especially when policy shocks are measured using the R&R approach. These findings are consistent with the existing literature, particularly studies like Murgia (2020) and Pragyan et al. (2023), which emphasize the role of banking system attributes in the transmission of monetary policy. Our results also complement recent research, such as Altavilla et al. (2024) and Choi et al. (2022), which highlight the heterogeneous effects of monetary policy across different banking environments.

These differences in the transmission of monetary policy are mitigated by the common supervision of significant banks under the Single Supervisory Mechanism (SSM). However, they remain a source of risk and divergence in the monetary policy transmission mechanism as long as the Banking Union remains incomplete, particularly due to the absence of a common deposit insurance scheme and other crucial components. Future research could extend this analysis by exploring the asymmetry between expansionary and contractionary monetary policy shocks and their interaction with macroprudential policies. In addition, the analysis can be extended to explore the impact of changes in the global financial and regulatory environment on the banking system and shadow banks as well as interactions with other countries' monetary policy. These factors can affect the transmission of monetary policy through the banking sector and generally the effectiveness of the common monetary policy in the euro area.

References

[1] Abbate, A., & Thaler, D. (2023). Optimal monetary policy with the risk-taking channel. *European Economic Review*, *152*, 104333.

[2] Akkaya, Y., Bitter, L., Brand, C., & Fonseca, L. (2024). A Statistical Approach to Identifying ECB Monetary Policy.

[3] Altavilla, C., Brugnolini, L., Gürkaynak, R. S., Motto, R., & Ragusa, G. (2019). Measuring euro area monetary policy. *Journal of Monetary Economics*, 108, 162-179.

[4] Altavilla, C., Burlon, L., Giannetti, M., & Holton, S. (2022). Is there a zero lower bound? The effects of negative policy rates on banks and firms. *Journal of Financial Economics*, 144(3), 885-907.

[5] Altavilla, C., Gürkaynak, R. S., & Quaedvlieg, R. (2024). Macro and micro of external finance premium and monetary policy transmission.

[6] Altunbas, Y., Gambacorta, L., & Marques-Ibanez, D. (2009). Securitisation and the bank lending channel. *European Economic Review*, 53(8), 996-1009.

[7] Angeloni, I., Kashyap, A. K., Mojon, B., & Terlizzese, D. (2003). Monetary transmission in the Euro Area: does the interest rate channel explain it all?.

[8] Beck, T., Demirgüç-Kunt, A., & Maksimovic, V. (2004). Bank competition and access to finance: International evidence. *Journal of Money, Credit and Banking*, 36(3), 627-648.

[9] Bernanke, B. S., & Gertler, M. (1995). Inside the black box: The credit channel of monetary policy transmission. *Journal of Economic Perspectives*, 9(4), 27-48.

[10] Blotevogel, R., Hudecz, G., & Vangelista, E. (2024). Asset purchases and sovereign bond spreads in the euro area during the pandemic. *Journal of International Money and Finance*, 140, 102978.

[11] Boivin, J., Giannoni, M. P., & Mihov, I. (2009). Sticky prices and monetary policy: Evidence from disaggregated US data. *American economic review*, *99*(1), 350-384.

[12] Choi, S., Willems, T., & Yoo, S. Y. (2024). Revisiting the monetary transmission mechanism through an industry-level differential approach. Journal of Monetary Economics, 103556.

[13] Christiano, L. J., Eichenbaum, M., & Evans, C. L. (1997). Sticky price and limited participation models of money: A comparison. *European Economic Review*, 41(6), 1201-1249.

[14] Christiano, L. J., Eichenbaum, M., & Evans, C. L. (1999). Monetary policy shocks: What have we learned and to what end? *Handbook of Macroeconomics*, 1, 65-148.

[15] Cloyne, J., & Hürtgen, P. (2016). The macroeconomic effects of monetary policy: A new measure for the United Kingdom. *American Economic Journal: Macroeconomics*, 8(4), 75-102.

[16] Coibion, O. (2012). Are the effects of monetary policy shocks big or small? *American*

Economic Journal: Macroeconomics, 4(2), 1-32.

[17] Corvoisier, S., & Gropp, R. (2002). Bank concentration and retail interest rates. *Journal of Banking & Finance*, 26(11), 2155-2189.

[18] Dan, H. (2013). The asset price channel and its role in monetary policy transmission. *The Annals of the University of Oradea*, (1), 445-454.

[19] Deb, P., Estefania Flores, J., Firat, M., & Furceri, D. (2023). Monetary policy transmission heterogeneity: Cross-country evidence. *Journal of International Money and Finance*, 138, 103788.

[20] Gambacorta, L., & Shin, H. S. (2018). Why bank capital matters for monetary policy. *Journal of Financial Intermediation*, 35, 17-29.

[21] Georgiadis, G. (2015). Examining asymmetries in the transmission of monetary policy in the euro area: Evidence from a mixed cross-section global VAR model. European Economic Review, 75, 195-215.

[22] Gödl-Hanisch, I. (2022). Bank concentration and monetary policy pass-through. *FDIC Center for Financial Research Paper*, (2022-06).

[23] Gürkaynak, R. S., Sack, B., & Swanson, E. (2005). The sensitivity of long-term interest rates to economic news: Evidence and implications for macroeconomic models. *American economic review*, *95*(1), 425-436.

[24] Holm-Hadulla, F., Mazelis, F., & Rast, S. (2023). Bank and non-bank balance sheet responses to monetary policy shocks. *Economics Letters*, 222, 110918.

[25] Hülsewig, O., & Rottmann, H. (2023). Unemployment in the euro area and unconventional monetary policy surprises. *Economics Letters*, *226*, 111097.

[26] Jarociński, M., & Karadi, P. (2020). Deconstructing monetary policy surprises—the role of information shocks. *American Economic Journal: Macroeconomics*, 12(2), 1-43.

[27] Jiménez, G., Ongena, S., Peydró, J. L., & Saurina, J. (2012). Credit supply and mone- tary policy: Identifying the bank balance-sheet channel with loan applications. *American Economic Review*, 102(5), 2301-2326.

[28] Jiménez, G., Ongena, S., Peydró, J. L., & Saurina, J. (2014). Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking? *Econometrica*, 82(2), 463-505.

[29] Jordà, Ò., & Taylor, A. M. (2024). Local projections. *Annual Review of Economics*, 16, [page range or article number if available].

[30] Mandler, M., Scharnagl, M., & Volz, U. (2022). Heterogeneity in euro area monetary policy transmission: Results from a large multicountry BVAR model. *Journal of Money, Credit and Banking*, 54(2-3), 627-649.

[31] Mishkin, F. S. (1995). Symposium on the monetary transmission mechanism. *Journal of Economic Perspectives*, 9(4), 3-10.

[32] Murgia, L. M. (2020). The effect of monetary policy shocks on macroeconomic variables: Evidence from the Eurozone. *Economics Letters*, 186, 108803.

[33] Peersman, G., & Smets, F. (2001). The monetary transmission mechanism in the euro area: more evidence from var analysis (mtn conference paper). *Available at SSRN 356269*.

[34] Portilla, J., Rodríguez, G., & Castillo B, P. (2022). Evolution of monetary policy in Peru: An empirical application using a mixture innovation TVP-VAR-SV model. *CESifo Economic Studies*, 68(1), 98-126.

[35] Pragyan D., Estefania-Flores J., Melih First M., Furceri D., Kothari S., (2023) Monetary Policy Transmission Heterogeneity: Cross-Country Evidence IMF Working Paper No23/204.

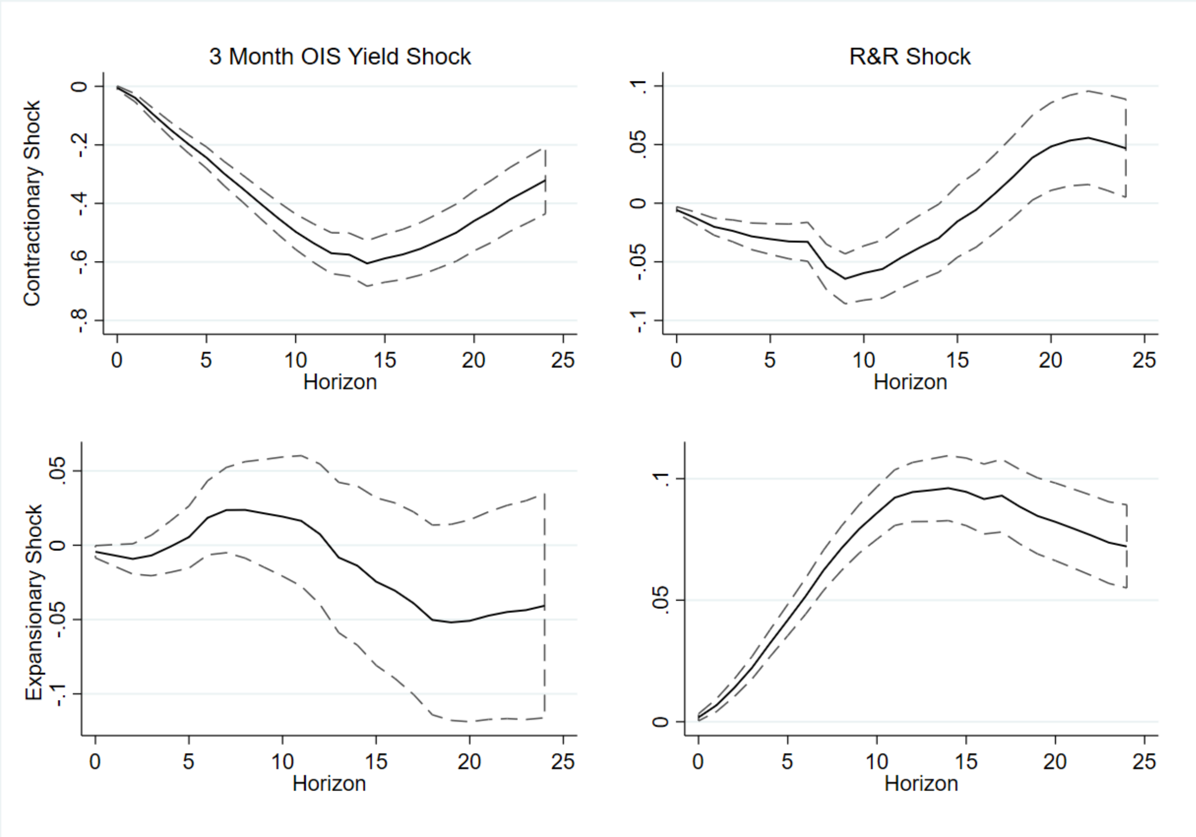
[36] Ribba, A. (2022). Monetary policy shocks in open economies and the inflation-unemployment trade-off: The case of the Euro Area. *Journal of Risk and Financial Management*, 15(4), 146.

[37] Romer, C. D., & Romer, D. H. (2004). A new measure of monetary shocks: Derivation and implications. *American Economic Review*, 94(4), 1055-1084.

[38] Sims, C. A. (1992). Interpreting the macroeconomic time series facts: The effects of monetary policy. *European Economic Review*, 36(5), 975-1000.

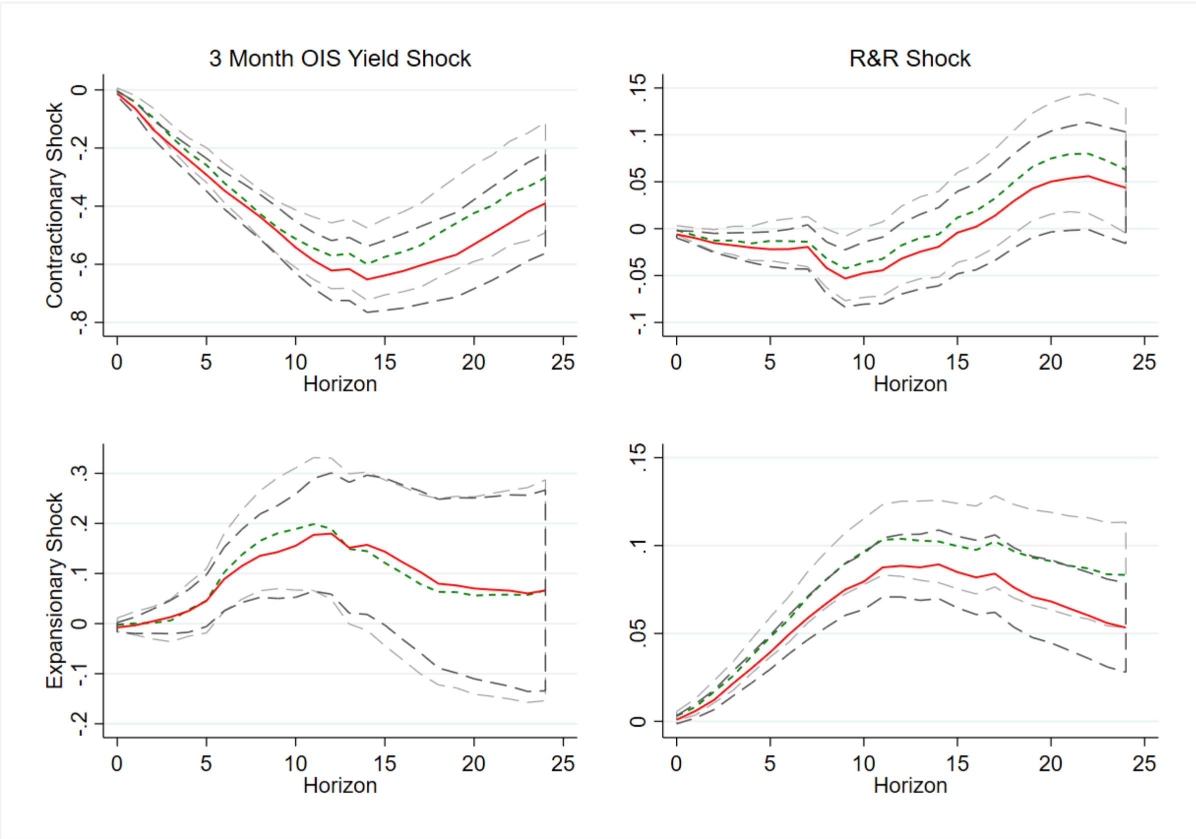
[39] Taylor, J. B. (2001). The role of the exchange rate in monetary-policy rules. *American economic review*, *91*(2), 263-26

Figure 21: Industrial Production | Baseline



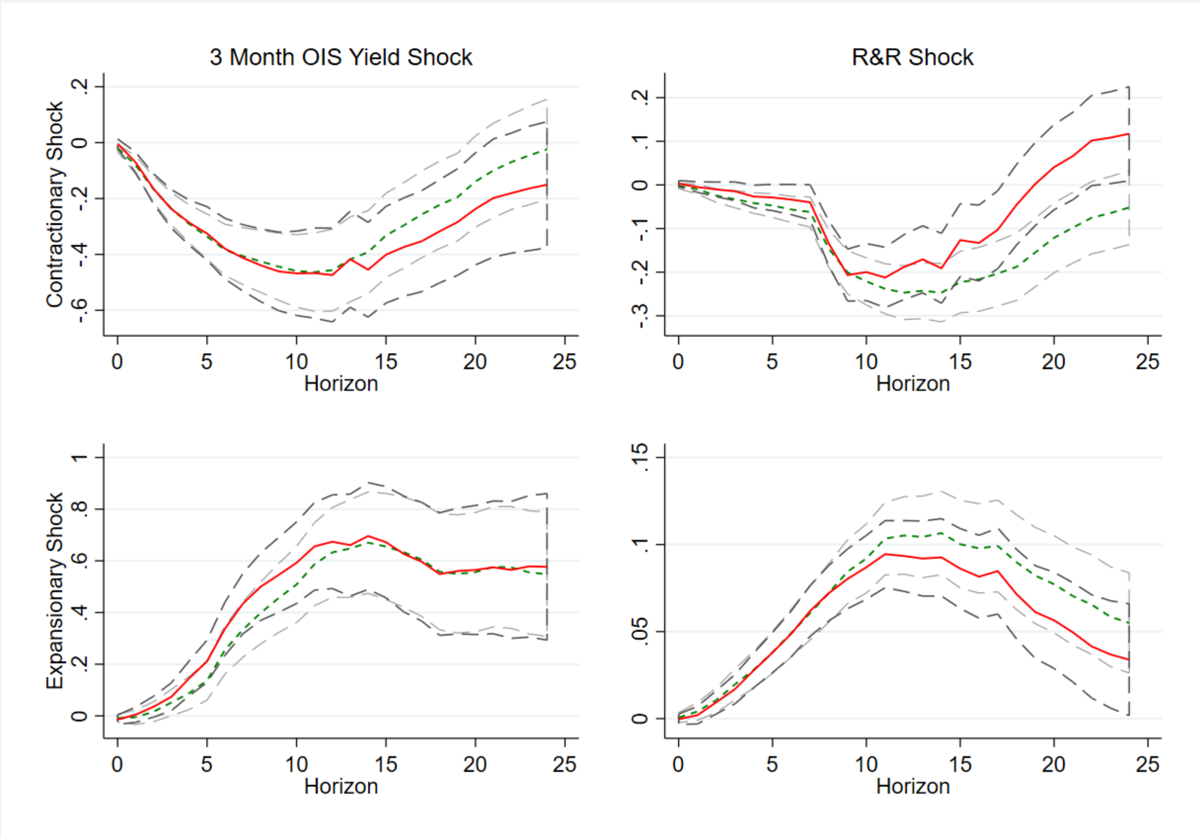
Note : Figure 21 presents inflation, retail sales and unemployment rate responses after a contractionary and an expansionary shock of 100 bps. The confidence interval is 90%. All values are represented in (%).

Figure 22: Industrial Production | Banking Characteristic: Interest Rate Margin



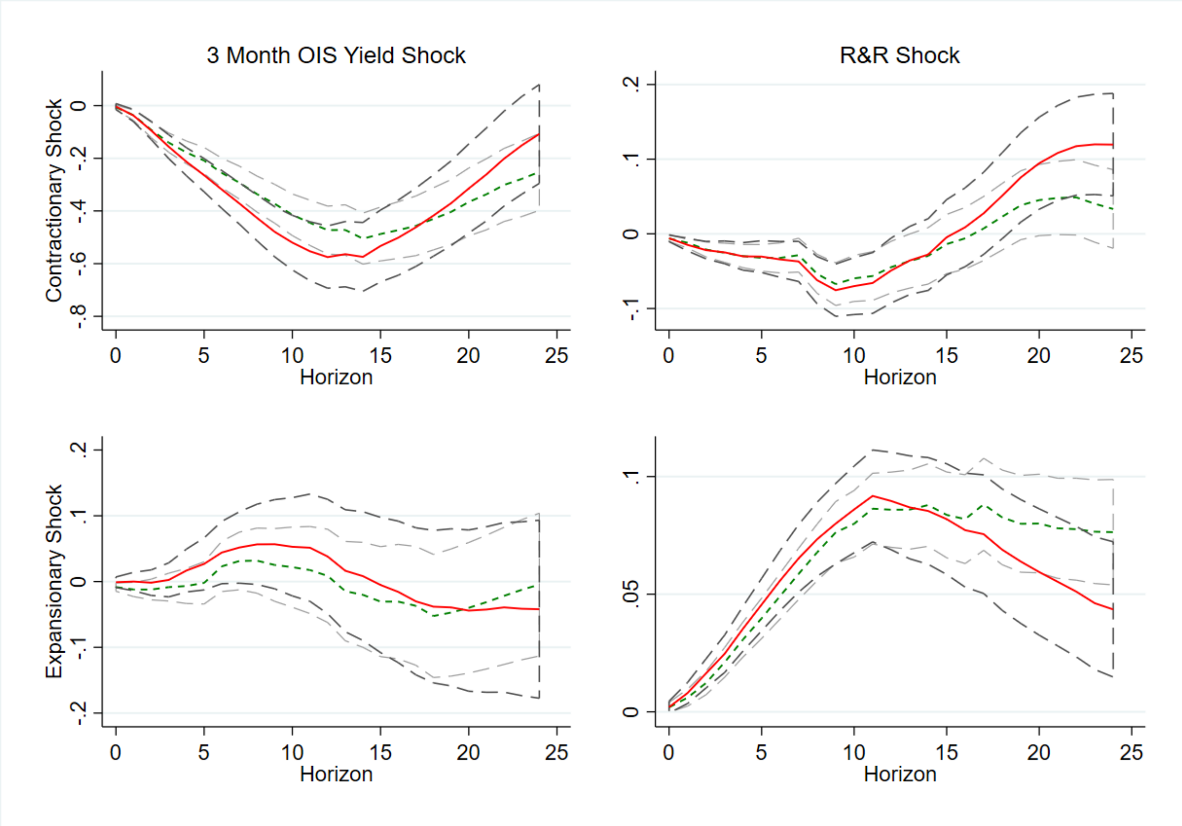
Note : Figure 22 presents the Industrial Production responses after a contractionary and an Expansionary monetary policy shock of 100 bps.: The green IRF represents the sample with interest rate margins above the median, while the red IRF represents the sample with interest rate margins below the median. The sample period spans from 2003 to 2023. The Confidence Interval is 90%. All values are represented in (%).

Figure 23: Industrial Production | Banking Characteristic: Return on Equity



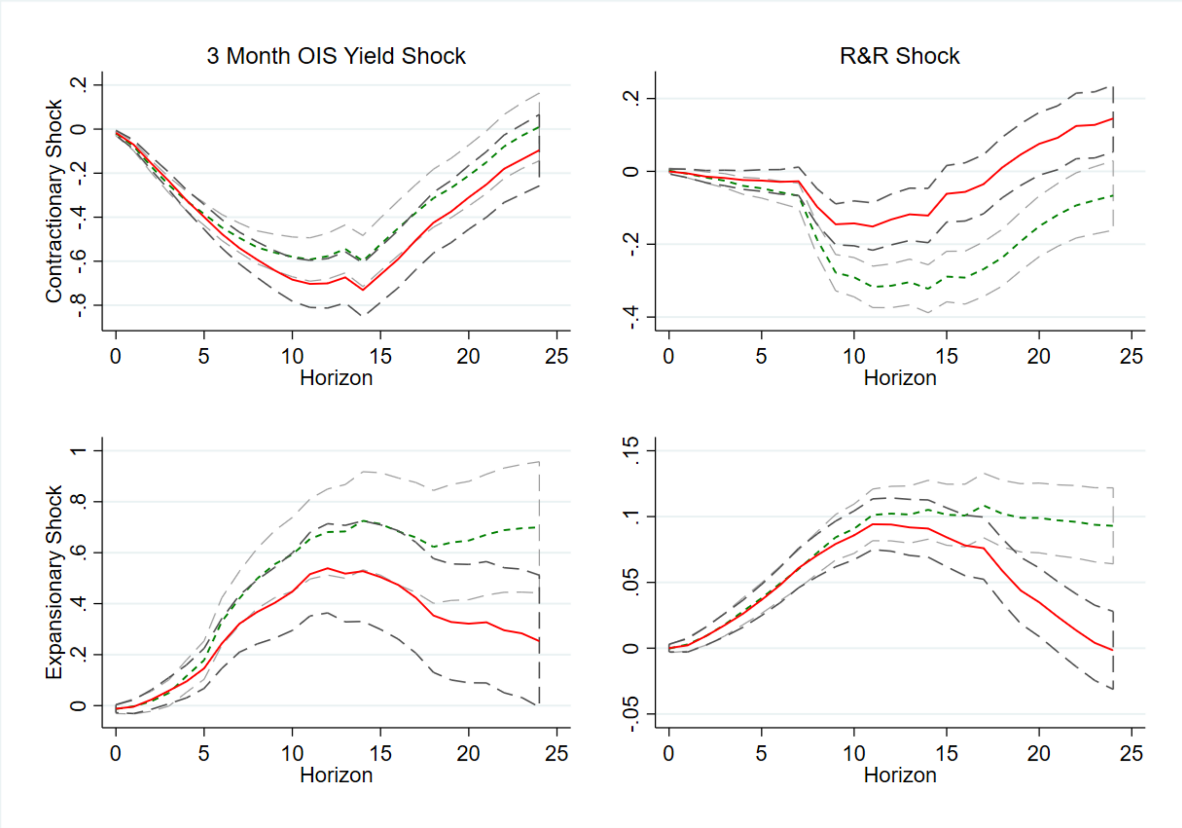
Note : Figure 23 presents the Industrial Production responses after a contractionary and an Expansionary monetary policy shock of 100 bps.: The green IRF represents the sample with Return on Equity above the median, while the red IRF represents the sample with Return on Equity below the median. The sample period spans from 2008 to 2023. The Confidence Interval is 90%. All values are represented in (%).

Figure 24: Industrial Production | Banking Characteristic: Cost of Funding



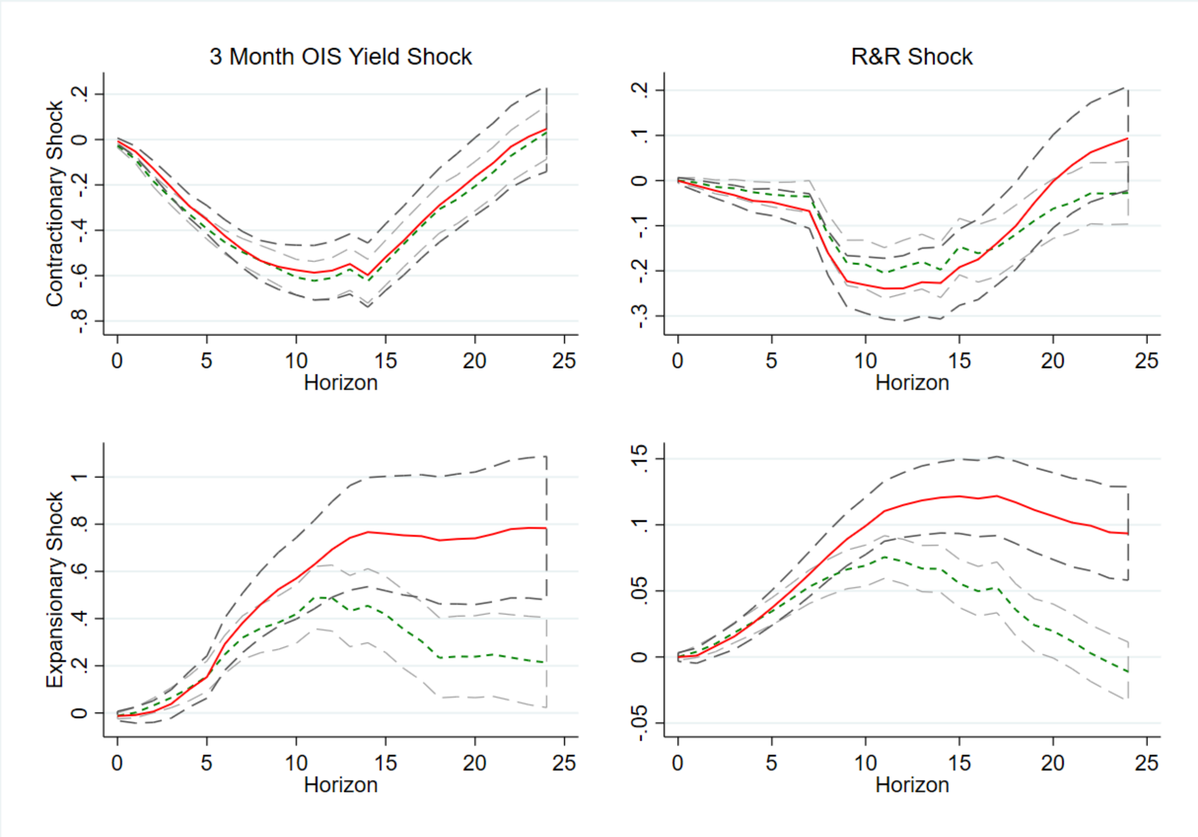
Note : Figure 24 presents the Industrial Production responses after a contractionary and an Expansionary monetary policy shock of 100 bps.: The green IRF represents the sample with Cost of Funding above the median, while the red IRF represents the sample with Cost of Funding below the median. The sample period spans from 2000 to 2023. The Confidence Interval is 90%. All values are represented in (%).

Figure 25: Industrial Production| Banking Characteristic: Risk Exposure



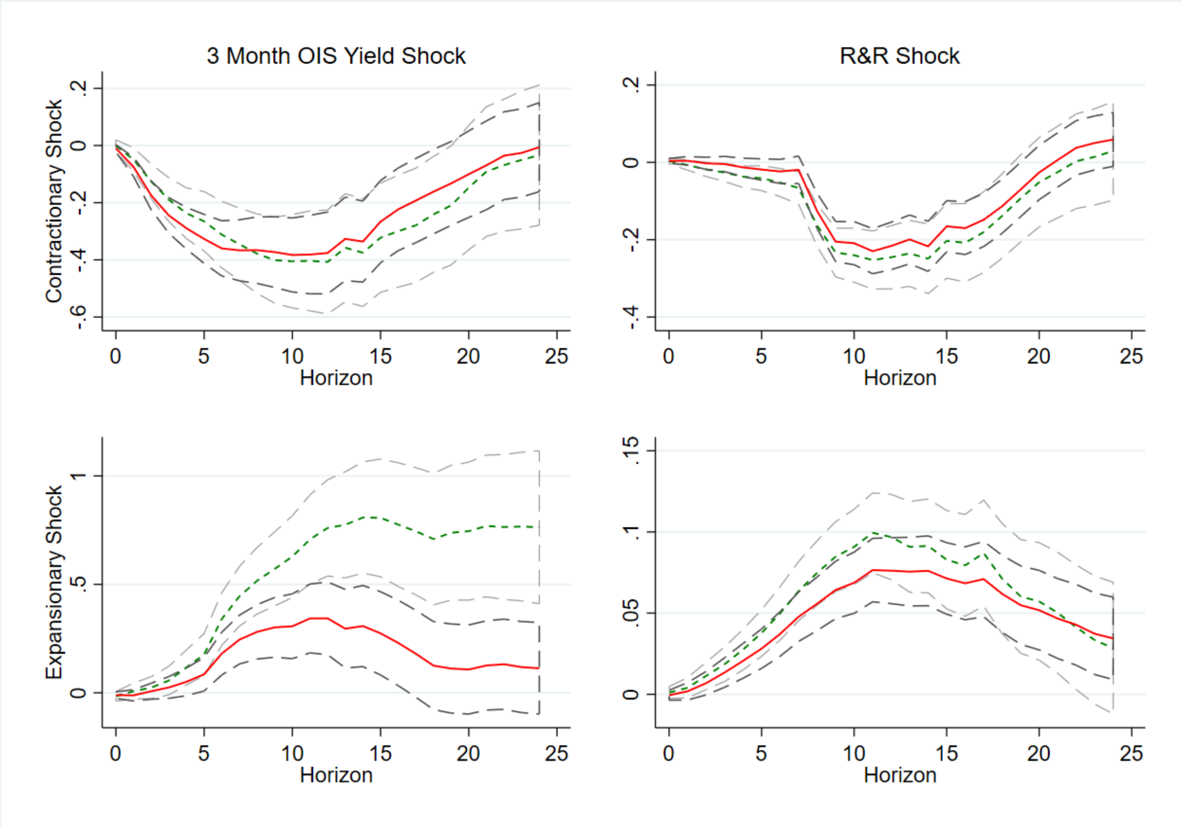
Note : Figure 25 presents the Industrial Production responses after a contractionary and an Expansionary monetary policy shock of 100 bps.: The green IRF represents the sample with Risk Exposure above the median, while the red IRF represents the sample with Risk Exposure below the median. The sample period spans from 2008 to 2023. The Confidence Interval is 90%. All values are represented in (%).

Figure 26: Industrial Production | Banking Characteristic: Banking Total Aggregate Assets



Note : Figure 26 presents the Industrial Production responses after a contractionary and an Expansionary monetary policy shock of 100 bps.: The green IRF represents the sample with Total Banking Assets to GDP above the median, while the red IRF represents the sample with Total Banking Assets to GDP below the median. The sample period spans from 2007 to 2023. The Confidence Interval is 90%. All values are represented in (%).

Figure 27: Industrial Production | Banking Characteristic: Non-Performing Loans



Note : Figure 27 presents the Industrial Production responses after a contractionary and an Expansionary monetary policy shock of 100 bps.: The green IRF represents the sample with Non-Performing Loans above the median, while the red IRF represents the sample with Total Non-Performing Loans below the median. The sample period spans from 2008 to 2023. The Confidence Interval is 90%. All values are represented in (%).

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