EUROPEAN CENTRAL BANK

EUROSYSTEM

Working Paper Series

João B. Duarte, Mariana N. Pires

Financial integration and the transmission of monetary policy in the euro area

ECB – Lamfalussy Fellowship Programme

No 3165

ECB Lamfalussy Fellowship Programme

This paper has been produced under the ECB Lamfalussy Fellowship programme. This programme was launched in 2003 in the context of the ECB-CFS Research Network on “Capital Markets and Financial Integration in Europe”. It aims at stimulating high-quality research on the structure, integration and performance of the European financial system.

The Fellowship programme is named after Baron Alexandre Lamfalussy, the first President of the European Monetary Institute. Mr Lamfalussy is one of the leading central bankers of his time and one of the main supporters of a single capital market within the European Union.

Each year the programme sponsors five young scholars conducting a research project in the priority areas of the Network. The Lamfalussy Fellows and their projects are chosen by a selection committee composed of Eurosystem experts and academic scholars. Further information about the Network can be found at http://www.eufinancial-system.org and about the Fellowship programme under the menu point “fellowships”.

Abstract

We study how financial integration shapes the transmission of monetary policy to consumer prices and output in the euro area. Using local projections, we document that the effect of financial integration is continuous: greater integration systematically strengthens the pass-through of monetary policy. When integration falls to low levels—around the first quartile of its historical distribution—transmission to both prices and output becomes statistically and economically insignificant. The amplification pattern is pervasive across member states and more pronounced in peripheral economies. These results show that financial integration is a key determinant of monetary policy effectiveness within the euro area.

Keywords: Monetary Policy, Financial Integration, Monetary Union, Local Projections

JEL Codes: E44, E52, F36, F45

Non-technical summary

This paper examines how financial integration within the euro area (EA) shapes the effectiveness of monetary policy. When financial markets are well-integrated, monetary policy decisions by the European Central Bank (ECB) are transmitted smoothly and uniformly across member states. In contrast, financial fragmentation—where market responses become more idiosyncratic and disconnected from the common policy stance—can weaken or even completely impair the intended effects of monetary policy.

Using a panel of EA countries, together with a quantity-based proxy for financial integration and state-of-the-art local projection methods, we find that greater financial integration significantly enhances the effectiveness of monetary policy. In financially integrated markets, a monetary shock generates stronger and more persistent responses in consumer prices and in economic activity. In contrast, under conditions of financial fragmentation, the transmission to output and inflation is almost entirely muted.

We also explore whether financial integration affects all EA countries the same way. By comparing core and peripheral member states, we find that while greater financial integration amplifies the effects of monetary policy across both groups, the amplification is noticeably stronger in peripheral economies. In these countries, consumer prices and output respond more forcefully and persistently to monetary policy when financial integration is high. For example, inflation in peripheral countries peaks higher and lasts longer than in the core under similar conditions. These results indicate that financial integration plays a particularly important role in shaping monetary transmission in the periphery where the response to monetary surprises is more sensitive to the degree of integration.

These findings have important implications for policymakers. Financial integration has long been recognized for its broader economic benefits, such as facilitating risk-sharing across countries, improving capital allocation, and supporting economic growth, as shown by a rich body of literature. Our results complement these insights by showing that financial integration also makes monetary policy more effective. Specifically, we show that deeper and more resilient financial integration ensures that monetary policy works uniformly across member states, enhancing the ECB's ability to achieve its primary objective of price stability. These findings add to the case for advancing financial integration in the EA through initiatives, like completing the Banking Union and further developing the Capital Markets Union, by highlighting an additional benefit: a more effective and uniform transmission of monetary policy that can better support macroeconomic stability and growth.

1 Introduction

The transmission of monetary policy begins in the financial markets, and financial integration ensures that these markets in the euro area (EA) respond effectively and uniformly. In contrast, financial fragmentation undermines this process, as credit conditions in each member state become idiosyncratic and fail to align with the broader monetary policy stance. This can impair the transmission of monetary policy to prices and output. Despite its importance in policy discussions, empirical evidence on how the degree of financial integration shapes the transmission of monetary policy in the EA remains limited. In particular, there is little quantitative evidence on how fragmentation weakens transmission to prices and output. Our paper addresses this gap.

Leveraging time variation in financial integration in the EA—proxied by a quantity-based financial integration composite indicator developed by Hoffmann, Kremer and Zaharia (2020)—we examine how financial integration shapes the transmission of monetary policy to inflation and output in a panel of EA member states. We identify monetary policy shocks using daily changes in the two-year German bond rate from Altavilla et al. (2019) instrumented by high-frequency monetary surprises from Jarociński and Karadi (2020) and, after aggregating them to the quarterly frequency of our analysis, estimate their effects using nonlinear local projections. Specifically, financial integration enters our local projections' specification through an interaction term with monetary policy shocks, enabling us to capture how varying levels of integration modulate the strength of the transmission mechanism. Proxying output with real GDP and inflation with quarterly changes in HICP, we use the estimated nonlinear local projections to report the responses of these variables to a one-standard-deviation expansionary shock[1] evaluated at different levels of financial integration.

Our findings reveal that greater financial integration amplifies the response of both consumer prices and output to monetary policy across member states. To quantify the amplification effect of financial integration, we first compute the marginal effects of a one-standard-deviation increase in financial integration[2]—relative to the last sample observation (0.328 in Q4 2019)—by taking the derivative of the impulse responses to a one-standard-deviation decrease in policy rate with respect to financial integration. For HICP, the marginal effect rises sharply, peaking at 0.18 percentage points (p.p.) about two and a half years post-shock and stabilizing at around 0.17 p.p. in later horizons, indicating a sustained positive impact on prices in the short to medium term. For real GDP, the marginal effect peaks at 0.16

[1] Approximately 6 basis points.

[2] This corresponds to an increase of approximately 0.087 units.

p.p. one year after the shock, reflecting a rapid but transitory boost to output growth from higher financial integration, before diminishing and becoming statistically insignificant after three years. These results suggest that financial integration generates a persistent increase in prices, while its impact on output is more immediate but short-lived.

To further explore this amplification effect, we conduct a two-regime analysis, comparing the responses under low versus high levels of financial integration (corresponding to the 25th and 75th percentiles, respectively). Specifically, under high financial integration, transmission to both prices and output is strong, while under low integration, it is completely impaired for prices and reduced by more than half for output. For HICP, the initial response to an unexpected *decrease* in the policy rate under low financial integration is 0.04%, declining thereafter and remaining statistically insignificant. In contrast, under high financial integration, the immediate impact to the same shock more than doubles to 0.13%, peaking nearly two and a half years after the shock, and remaining statistically significant for the majority of the quarters post-shock. The difference in price responses across regimes reaches 0.85 p.p. almost two and a half years post-shock. Real GDP also exhibits a clear amplification effect: the initial response is statistically significant in both regimes, reaching 0.10% in the low integration regime compared to 0.44% under high integration. This gap becomes even more pronounced at the peak of the transmission effect, which occurs about one year after the shock in both regimes. The difference in output responses at the peak across regimes reaches 0.73 p.p. These results provide evidence of a substantial amplification effect driven by financial integration.

A key question is whether financial fragmentation at the EA level impairs monetary policy transmission only in peripheral countries. Given that fragmentation emerged during the sovereign debt crisis, this possibility warrants careful examination. Motivated by this question, we conduct a subsample analysis grouping EA member countries into core and periphery. For HICP, peripheral countries exhibit a more pronounced and sustained reaction to the one-standard-deviation expansionary monetary shock under high financial integration, with inflation peaking at 0.74% around two and a half years after the shock. By contrast, in core countries inflation peaks at 0.33% two years post-shock and then declines more rapidly. The p.p. difference at the peak between periphery and core is 0.41. Real GDP responses follow a similar pattern under high integration: output in peripheral economies reaches 1.07% one year after the shock, while in the core output peaks at 0.75%. The difference in output responses at the peak between groups of countries is 0.32 p.p. These results indicate that the amplification effect of financial integration is evident in both groups but is more pronounced in the periphery, particularly for consumer prices.

Taken together, these findings underscore the critical role of financial integration in enhancing the effectiveness of monetary policy across the EA. By showing that monetary policy transmission is substantially weaker when financial integration is low, our results provide an additional rationale for completing the process of financial integration in the EA. Our research adds to the discussion on the necessity of further integrating financial markets within the eurozone, such as finalizing the Banking Union and progressing the Capital Markets Union, to bolster economic stability and growth.

To ensure the validity of our findings, we conduct a series of robustness checks. First, we control for boom-bust states by augmenting the main specification with an interaction between monetary shocks and a recession indicator, confirming that monetary policy transmission remains stronger in periods of higher financial integration even after accounting for the state of the business cycle. Second, we exclude crisis episodes by estimating impulse responses on a truncated sample ending in Q2 2007, showing that the amplification effect persists even outside the global financial crisis and EA sovereign debt crisis periods. Third, we leverage higher-frequency data to mitigate concerns raised in recent studies that temporal data aggregation can distort the identification of monetary policy transmission. Fourth, we extend the time frame to Q1 2023, incorporating a COVID-19 dummy, and find that the main conclusions hold. Fifth, we restrict the sample to the eleven original EA countries, confirming consistency with the full sample. Finally, we perform additional exercises, including replacing the continuous measure of financial integration with a dummy based on the quantity-based composite indicator (set to one when the indicator is at or above the median and 0 otherwise) and the findings support the key amplification results.

Related Literature. Despite its relevance, the existing literature on the link between financial integration and monetary policy effectiveness remains limited. A notable exception is the recent work by Wu, Xie and Zhang (2024) and Bianchi and Coulibaly (2024). Wu, Xie and Zhang (2024) develop a two-country open-economy New Keynesian model with independent monetary policies and focus on global rather than monetary union integration. They show that monetary policy effectiveness is amplified when financial integration across these countries is high, primarily through a consumption-switching channel (via changes in the terms of trade) and a financial channel (via intermediaries bond holdings). The amplification is stronger for longer bond durations and cannot be replicated under standard models of perfect risk-sharing. In a monetary union, however, the setting is fundamentally different: exchange rates are fixed, and there is a single monetary policy rule. The key question then becomes how much of the impairment from low financial integration comes from non-uniform credit market transmission rather than the channels identified by Wu, Xie and Zhang (2024). This distinction requires further investigation, which we leave for future research. Nonetheless, our empirical findings align with their central theoretical prediction: high financial integration amplifies monetary policy effects. Bianchi and Coulibaly (2024) develop a theoretical framework showing that greater financial integration amplifies cross-border spillovers, making coordinated monetary policy more desirable. While our empirical results document how higher financial integration amplifies the domestic transmission of monetary policy to inflation and output within the EA, Bianchi and Coulibaly (2024) provide a complementary theoretical perspective: financial integration also amplifies cross-border feedback loops, underscoring the case for coordinated monetary policy.

Our paper also relates to the literature that has documented how financial fragmentation during the EA sovereign debt crisis significantly impaired the transmission of monetary policy. For instance, Abbassi et al. (2018) and Horváth, Katuscakova and Podpiera (2018) show that fragmentation weakened the interest-rate pass-through channel, with banks in crisis-hit countries reducing cross-border lending and amplifying regional disparities in credit conditions. Hristov, Hülsewig and Wollmershäuser (2014) further highlight that this fragmentation not only disrupted conventional monetary transmission but also constrained the effectiveness of unconventional policy tools such as the European Central Bank (ECB)'s liquidity facilities. These studies primarily focus on the impact of fragmentation on bank lending and borrowing rates, offering valuable insights into how fractures in the financial system can undermine the effectiveness of policy interventions. Our paper complements and extends this literature by (i) taking a more systematic view of the consequences of fragmentation, using a continuous measure rather than focusing on a specific time window (even though our results are naturally partly influenced by these events), and (ii) by examining not only the transmission of policy rates but also the ultimate impact of monetary policy on prices and output across different levels of financial integration.

Last but not least, our paper also contributes to a growing literature documenting that the effectiveness of monetary policy is state dependent, varying across business cycle phases (Tenreyro and Thwaites, 2016), financial conditions (Curdia and Woodford, 2010), and macroeconomic uncertainty (Castelnuovo and Pellegrino, 2018). Our findings reveal that financial integration enhances the effectiveness of transmission to prices and output. By highlighting this additional state variable, our findings enrich our understanding of the conditions under which monetary policy can effectively stabilize the economy.

Outline. The remainder of the paper is organized as follows. Section 2 presents the data. Section 3 outlines the empirical setting. Section 4 reports the main results and the robustness exercises. Section 5 concludes.

2 Data

This section presents the panel data used which spans from Q1 1999 to Q4 2019, and comprises all current EA member states (except Croatia). The data ends in 2019 to avoid statistical concerns due to COVID-19.[3] The main variables for assessing monetary policy transmission are the HICP and real GDP, both by Eurostat.[4] The HICP, rebased to 2015, is key for evaluating price stability within the EA, guiding policy. Real GDP, equally set to 2015=100, reflects the EA's economic activity. These indicators collectively provide a comprehensive view of the EA economy's response to monetary policy shifts. HICP data is converted to quarterly format to match the real GDP frequency, with both series in natural logarithms. We then detail our financial integration measure and the monetary policy surprises applied.

2.1 Financial Integration

A common hallmark of financially integrated markets—where all participants with similar characteristics face the same rules, enjoy equal access, and receive equal treatment—is the prevalence of cross-border trade and the convergence of prices or returns for assets that differ only by their geographical origin, consistent with the law of one price. Cross-border trade and price convergence arise because agents everywhere pursue the best available opportunities and, operating under uniform rules, generate competitive pressures that eliminate arbitrage possibilities and drive price equalization.

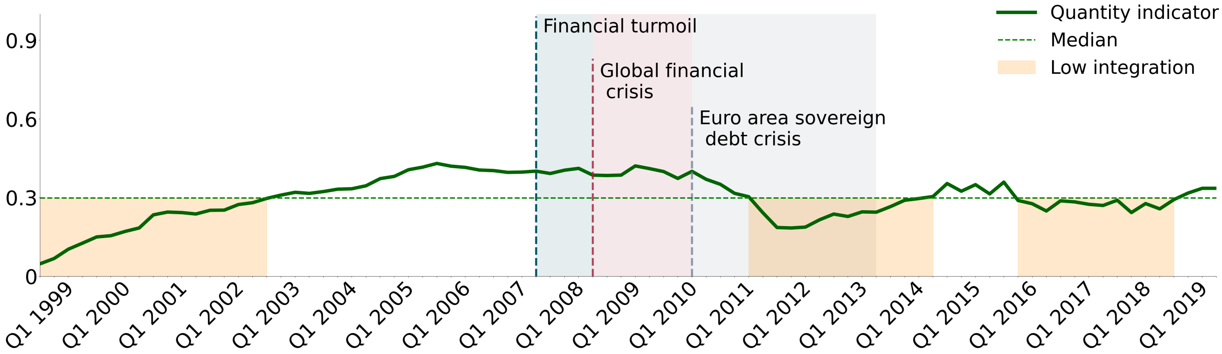
Reflecting these features, the literature[5] distinguishes between quantity-based indicators—which focus on cross-border asset holdings—and price-based indicators—which capture yield or return dispersion—to evaluate the state of financial integration in the EA over time. These two types of composite measures offer complementary perspectives: price indices tend to respond quickly to new information, while quantity indices change more gradually. We use the quantity-based composite indicator developed by Hoffmann, Kremer and Zaharia (2020) as our baseline measure of financial integration, which evaluates cross-border financial integration

[3] See Lenza and Primiceri (2022) for a detailed discussion of the main statistical challenges posed by the COVID-19 crisis.

[4] Real GDP data from Eurostat are seasonally and calendar adjusted, whereas HICP data are not. We verified that our results remain robust when applying seasonal adjustment to HICP; therefore, we present results based on the unadjusted series.

[5] See, for example, Baele et al. (2004) and more recently Hoffmann, Kremer and Zaharia (2020).

Figure 1: Quantity-based financial integration composite indicator over time



Notes: Quantity-based financial integration composite indicator from Hoffmann, Kremer and Zaharia (2020) is depicted by the dark green line. Median of the indicator is shown as a dotted dark green line. Orange shaded areas indicate periods of low integration (i.e., below sample median). Relevant crisis events are marked based on Hobelsberger, Kok Sørensen and Mongelli (2022).

within the EA based on intra-EA asset holdings. To validate the robustness of our findings, we replace our baseline measure with a price-based indicator from Hoffmann, Kremer and Zaharia (2020) and confirm that our main findings prevail (Appendix D.6.4).

The indicator specifically gauges the proportion of assets owned by other EA countries compared to the total assets across four market segments: money, banking, bond, and equity. For the money and banking segments, the assets include interbank loans; for the bond segment, they cover sovereign bonds held by monetary financial institutions (MFIs) and investment funds (IFs), and corporate bonds held by IFs; for the equity segment, equities held by MFIs and IFs are included. These shares range from zero to one—one signifies complete integration—and are then transformed into a composite indicator using market size-weighted averages of subindices. Further technical details can be found in Hoffmann, Kremer and Zaharia (2020).

The evolution of the resulting quantity-based indicator is depicted in Figure 1, alongside periods of low integration—defined as indicator values below the sample median—and key events identified by Hobelsberger, Kok Sørensen and Mongelli (2022). Notably, while some low-integration periods coincide with downturns in the business cycle, others do not. This is crucial for our identification strategy, as it helps ensure that the estimated responses during low-integration phases are not merely reflecting the effects of crisis-related turbulence.[6]

In terms of trend behavior, financial integration increased steadily in the early years of the monetary union, driven by the introduction of the euro, and reached a peak of 0.423 in Q1 2006.

[6]Two robustness checks, presented in Section 4.4, confirm this result: one excludes all periods after 2007 Q2 (Appendix D.2), and the other augments the main specification with an interaction between monetary shocks and a recession indicator (Appendix D.1), indicating that the findings are not driven by business-cycle dynamics.

The indicator then stabilized, showing limited variation even during the global financial crisis and the preceding period of financial turmoil. This relative stability reflects the symmetric nature of the global shock, which affected EA economies uniformly and therefore did not substantially disrupt intra-area financial linkages. In contrast, the sovereign debt crisis that began in Q2 2010 was region-specific and introduced pronounced asymmetries. Countries perceived as fiscally sound (core member states) experienced capital inflows, while those facing heightened sovereign-risk concerns (peripheral member states) saw capital flight. This divergence is reflected in the decline of the financial integration indicator, which reached a post-crisis trough of 0.181 in Q2 2012. Although the indicator partially recovered thereafter, it did not return to pre-crisis levels, ending the sample period at 0.417. Overall, the indicator captures the trajectory of financial integration in the EA: steady increases during the early years of the monetary union, resilience to a global shock, and sharp declines amid region-specific fiscal vulnerabilities.

Although the quantitative contribution of the cyclical component is less pronounced, the indicator displays frequent short-term fluctuations that closely track the evolution of financial market integration in the EA. These fluctuations are key to identifying how variations in financial integration influence the transmission of monetary policy. We therefore employ this continuous indicator to exploit the full cross-time variation in the data and to assess how the transmission of monetary policy shocks to consumer prices and output depends on the prevailing degree of financial integration. To further validate our results, we conduct a robustness exercise replacing the continuous measure with a dummy version to distinguish between periods of low and high financial integration (Appendix D.6.3).

2.2 Monetary Policy Shocks

We implement an IV framework in which the monetary policy shock series is instrumented with high-frequency surprises. Specifically, we estimate the first-stage regression below at the daily frequency and extract the fitted values, $\widehat{\Delta i_d}$, following Amberg et al. (2022). These fitted shocks are then aggregated to the quarterly frequency to construct the series $\widehat{\Delta i_t}$ used in our baseline local projection specification.

$$\Delta i_d = \alpha + \beta \cdot MP_d + \varepsilon_d \tag{1}$$

In the regression, Δi_d represents the daily change in the two-year German bond rate during the monetary event window from Altavilla et al. (2019), and MP_d denotes the monetary shock series estimated using the high-frequency identification method from Jarociński and Karadi (2020)[7]. This shock series isolates unanticipated components inherent in monetary policy announcements from the ECB and effectively separates these from any informational effects present within the announcements. Hence, this approach addresses concerns in the literature about the central bank "information channel" contaminating monetary policy shocks.[8] Specifically, Jarociński and Karadi (2020) employ surprises in financial market prices within a narrow time window around monetary policy announcements, covering both the press statement and press conference. They apply a sign-restriction approach in a two-variable vector autoregression (VAR) to distinguish pure monetary policy shocks from central bank information shocks. These shocks thus represent policy stance changes that are orthogonal to the ECB's communication regarding the economic outlook. This makes them particularly well-suited to our objective of assessing how financial integration modulates the monetary transmission mechanism.

The results from the estimation of Equation 1 are reported in Appendix A. The F-statistic of 83.87 substantially exceeds the conventional threshold of 10, confirming the strong relevance of the instrument. For the subsequent analysis, the obtained fitted values, $\widehat{\Delta i_d}$, are aggregated to a quarterly frequency by summing within each quarter: $\widehat{\Delta i_t} = \sum_{d \in t} \widehat{\Delta i_d}$. We report responses to a one-standard-deviation expansionary monetary policy shock, corresponding to a 6-basis-point decrease in the policy rate.

3 Empirical Framework

We employ the local projections method as described by Jordà (2005) to estimate the impulse response functions for the HICP and the real GDP with respect to a one-standard-deviation expansionary monetary shock. These shocks are allowed to interact through an interaction term with a lagged continuous measure of financial integration, facilitating the evaluation of the monetary policy effects across different degrees of financial integration. More

[7]Our findings hold when we replace the shocks identified with simple ("Poor Man's") sign restrictions with the median rotation shocks that implement the sign restrictions also from Jarociński and Karadi (2020) (Appendix D.6.5).

[8]See, for example, Nakamura and Steinsson, 2018, Cieslak and Schrimpf, 2019, Miranda-Agrippino and Ricco, 2021, and Bauer and Swanson, 2023.

specifically, we estimate the following panel regression for each quarter $h = 0, 1, \ldots, 16$:

$$y_{i,t+h} - y_{i,t-1} = \alpha_{i,h} + \beta_h \cdot \widehat{\Delta i_t} + \delta_h \cdot \left(\widehat{\Delta i_t} \times FI_{t-1}\right) + \\ + \zeta^h \cdot FI_{t-1} + \sum_{k=1}^{K} \gamma_{k,h} X_{i,t-k} + \varepsilon_{i,t+h} \tag{2}$$

where $y_{i,t}$ denotes the outcome variable (log of HICP or real GDP) for country i at time t, and $\alpha_{i,h}$ are country fixed effects. The term $\widehat{\Delta i_t}$ denotes the series of monetary policy shocks estimated following the procedure explained in Section 2.2. FI_{t-1} is the lagged measure of financial integration (i.e., the quantity-based composite indicator). The term $X_{i,t-k}$ denotes the control variables that include four lags of the outcome variable, one lag of the monetary shock and three dummies to control for the relevant events indicated in Section 2.1: financial turmoil (between Q3 2007 and Q3 2008), global financial crisis (between Q4 2008 and Q2 2010) and EA sovereign debt crisis (between Q3 2010 and Q2 2013). We apply a rolling-window moving average over the response coefficients following Jordà and Taylor (2025) to ensure smoothness. The responses before this adjustment are made available in Appendix C.

The financial integration variable interacts with the monetary policy shocks as a continuous variable to explore how responses to monetary policy shocks vary across different percentiles of integration and to evaluate marginal effects. Motivated by the fragmentation observed during the sovereign debt crisis, we also conduct a subsample analysis to examine heterogeneity in the effects of monetary policy shocks across two groups of countries: core and periphery. The selection of countries into each group is based on the evolution of long-term nominal interest rates for each country between 2010 and 2013. More specifically, we consider core countries those that registered during this time average interest rates equal or below the EA median, while the periphery is composed by countries whose average long-term interest rates were above the EA median.[9] Our categorization of nations into core and periphery, grounded on the progression of long-term nominal interest rates, results in the identical classification originally suggested by Bayoumi and Eichengreen (1992) for countries that overlap.[10]

[9] Annual data for the long-term nominal interest rates was retrieved from AMECO for the years between 2010 and 2013. Core countries include Austria, Belgium, Finland, France, Germany, Luxembourg and Netherlands. The periphery is composed by Cyprus, Greece, Ireland, Italy, Estonia, Latvia, Lithuania, Malta, Portugal, Spain, Slovenia and Slovakia.

[10] Bayoumi and Eichengreen (1992) evaluate the degree of synchronization between supply and demand shocks using data from 1963 to 1989 and the classic Aggregate Demand-Aggregate Supply framework. According to their work, supply-side shocks are highly associated in the core (Germany, France, Belgium, Netherlands, and Denmark) and less so in the periphery (Greece, Ireland, Italy, Portugal, Spain and the UK).

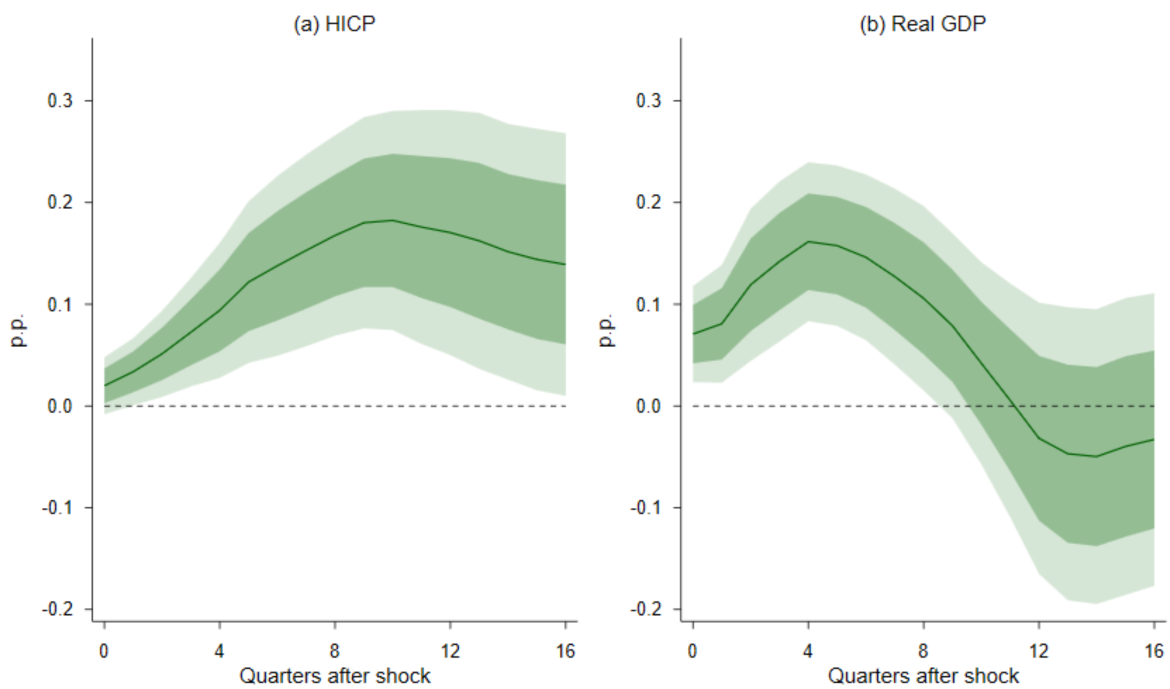
4 Results

This section outlines our empirical findings. We start by quantifying the continuous amplification effects of financial integration on HICP and real GDP in response to an expansionary one-standard-deviation monetary surprise. We then assess how these effects vary across different levels of financial integration (low versus high integration level), followed by a subsample analysis motivated by the fragmentation observed during the sovereign debt crisis (core versus periphery countries). Finally, we present a series of robustness checks.

4.1 Marginal Amplification Effects

To quantify the continuous amplification of monetary policy transmission, we compute the marginal effects of a one-standard-deviation increase in financial integration, relative to its final sample value (0.328 in Q4 2019), by taking the derivative of the impulse responses of HICP and real GDP to a one-standard-deviation expansionary monetary shock with respect to financial integration.

Figure 2: Marginal effects of increased financial integration on HICP and real GDP responses



Notes: Marginal effects (p.p.) of a one-standard-deviation increase in financial integration on the impulse responses of HICP and real GDP to a one-standard-deviation expansionary monetary policy shock, corresponding to a 6-basis-point decrease in the policy rate. Shaded areas represent 68% and 90% confidence intervals, based on Driscoll-Kraay standard errors.

For HICP, the marginal effect rises sharply, peaking at 0.18 p.p. about ten quarters after the shock and stabilising around 0.17 thereafter, confirming a sustained and robust amplification of price responses as financial integration increases. For real GDP, the marginal effect peaks at approximately 0.16 p.p. one year after the shock and fades thereafter, becoming statistically insignificant after about three years. This pattern suggests that greater financial integration provides a persistent boost to prices but only a temporary increase in output. Having documented these marginal amplification effects, we next move to the two-regime comparison between low and high levels of financial integration.

4.2 Monetary Policy Transmission Across Levels of Financial Integration

Figure 3 reports the impulse responses of HICP and real GDP to a one-standard-deviation expansionary monetary policy shock, evaluated at the 25th percentile (approximately 0.242) and 75th percentile (approximately 0.377) of financial integration.[11] The coefficients[12] obtained from estimating Equation 2 are reported in Appendix B.

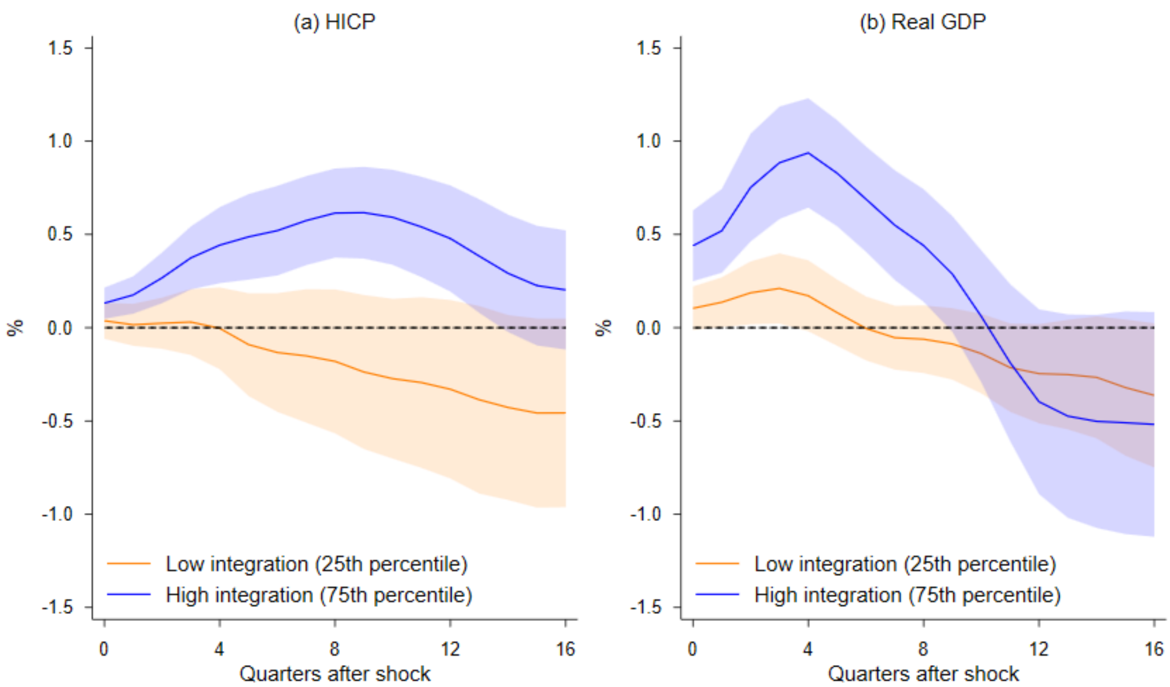
For HICP, the response to an unexpected decrease in the policy rate under low financial integration (25th percentile) is negligible—around 0.04%—and remains statistically and economically insignificant throughout the horizon. In contrast, under high financial integration (75th percentile), the initial response is more than twice as large (0.13%), peaking at 0.62% in quarter 9 and remaining statistically significant thereafter. The difference in price responses between the two regimes reaches 0.85 p.p. at the peak, indicating that monetary policy transmission to prices strengthens markedly with higher financial integration.

For real GDP, a similar but more pronounced pattern emerges. Under low financial integration, the output response is initially small and statistically insignificant, while under high integration it is considerably stronger—starting at 0.44% and peaking at 0.94% in quarter 4. The difference in output responses across regimes reaches 0.73 p.p. at the peak. Taken together, these results reveal a stark contrast between low- and high-integration regimes: monetary policy transmission is essentially muted at low levels of financial integration but becomes powerful and statistically robust when integration is high. In the next subsection, we examine whether this pattern differs across core and peripheral member states.

[11] We find average responses of 0.11% for inflation and 0.31% for output immediately after the shock. These magnitudes are consistent with the literature. For example, Jarociński and Karadi (2020) report smaller responses, unsurprisingly, for several reasons: they employ monthly data, while we aggregate to quarterly frequency; they consider a one-standard-deviation shock of 0.038 over the 1999-2016 sample, whereas we consider a 0.06 shock over 1999-2019; and they use the GDP deflator to represent prices instead of HICP.

[12] These coefficients represent the values before the following adjustments: (i) rescaling of the monetary shock to a one-standard-deviation *expansionary* shock; (ii) scaling by the level of financial integration; and (iii) applying the rolling-window moving average following Jordà and Taylor (2025) to ensure smoothness.

Figure 3: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



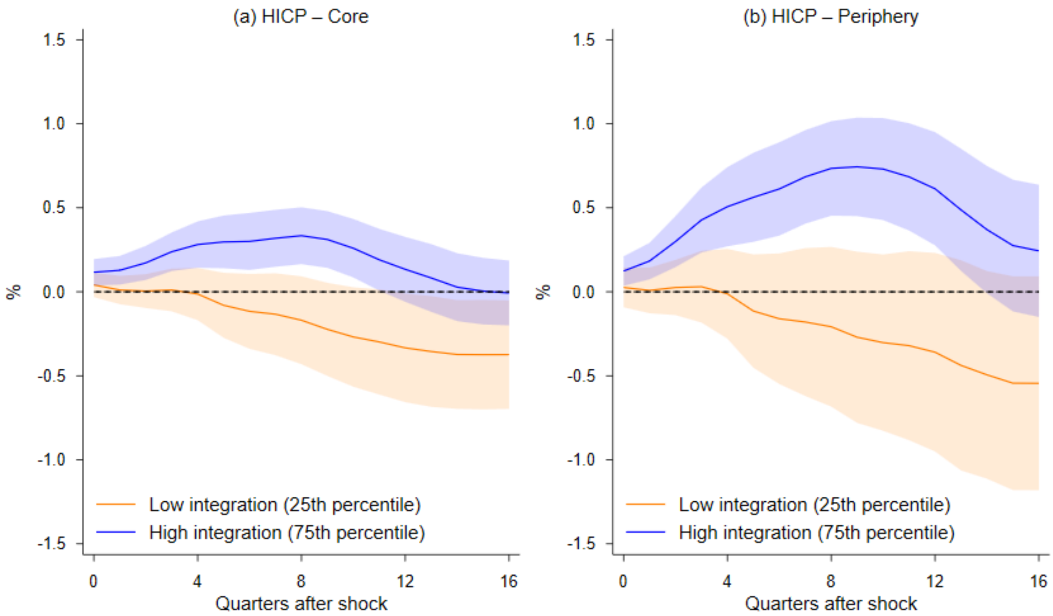
Notes: Impulse responses are shown in percentage terms to a one-standard-deviation expansionary monetary policy shock, corresponding to a 6-basis-point decrease in the policy rate. Results are reported for low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

4.3 Subsample Analysis: Core versus Periphery

The sovereign debt crisis triggered a clear fragmentation within the EA, differentiating core member states—perceived as fiscally sound and attracting capital inflows—from peripheral member states, which experienced significant capital outflows. We exploit this heterogeneity by estimating impulse responses separately for core and periphery groups, shown in Figures 4 and 5.

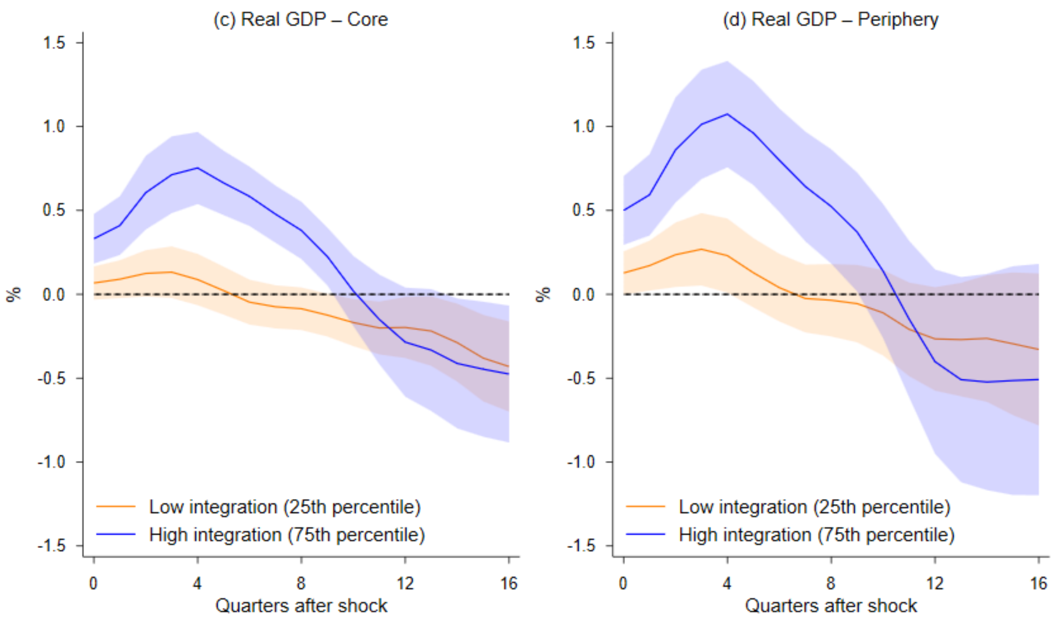
For HICP, peripheral member states exhibit stronger and more persistent responses to the monetary policy shock under high financial integration. The inflation response in the periphery peaks at 0.74% in quarter 9, while the core response peaks at 0.33% in quarter 8 and declines more rapidly. The difference in price responses between low and high integration reaches 1.01 p.p. in quarter 9 for the periphery and 0.50 for the core.

Figure 4: Responses of HICP to a monetary policy shock under different levels of financial integration for core and periphery



Notes: Impulse responses are shown in percentage terms to a one-standard-deviation expansionary monetary policy shock, corresponding to a 6-basis-point decrease in the policy rate. Results are reported for low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

Figure 5: Responses of real GDP to a monetary policy shock under different levels of financial integration for core and periphery



Notes: Impulse responses are shown in percentage terms to a one-standard-deviation expansionary monetary policy shock, corresponding to a 6-basis-point decrease in the policy rate. Results are reported for low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

Real GDP responses reveal a comparable pattern. Peripheral member states show stronger amplification, with output peaking at 1.07% in the high-integration regime one year post-shock, compared with 0.75% for the core. The difference between low- and high-integration regimes at the peak reaches 0.84 and 0.67 p.p. for the periphery and core, respectively. Overall, these findings indicate that peripheral member states experience more persistent gains in both prices and output under high financial integration, whereas effects in the core are more transitory.

4.4 Robustness Checks

Controlling for boom-bust states. A potential concern with our identification strategy is that the state-dependent local projections—designed to capture heterogeneity in monetary policy transmission across levels of financial integration—may instead be reflecting the business cycle. This is particularly relevant given our sample (Q1 1999 – Q4 2019), which spans the global financial crisis and the EA sovereign debt crisis, when both financial integration and policy transmission plausibly co-moved with cyclical dynamics. To address this, we augment Equation 2 with an additional interaction between monetary shocks and a recession indicator. This allows us to purge cyclical heterogeneity from the estimates and isolate the independent role of financial integration. The results, shown in Appendix D.1, confirm that our main conclusion holds: monetary policy transmission is stronger in periods of higher financial integration.

Excluding crisis episodes. To further ensure that our results are not an artifact of the state of the business cycle, we estimate the impulse responses on a truncated sample ending in Q2 2007, thereby excluding both the global financial crisis and the EA sovereign debt crisis. This removes the periods where financial integration and monetary transmission are most likely to be influenced by severe macro-financial stress. As reported in Appendix D.2, the amplification effect persists: monetary policy transmission remains significantly stronger when financial integration is higher, even outside crisis periods.

Higher frequency data. Emerging literature suggests that time aggregation of economic activity and monetary policy shocks can affect the identification of monetary policy transmission (Buda et al., 2025). Thus, caution is needed when matching high-frequency shocks to lower-frequency macro variables like real GDP. We therefore estimate impulse responses using: monthly HICP and Industrial Production (IP) data, the same monetary shocks from Jarociński and Karadi (2020) in monthly frequency, and the price-based financial integration indicator from Hoffmann, Kremer and Zaharia (2020) available at monthly frequency. Results still show that monetary policy transmission is amplified under higher financial integration (Appendix D.3).

Extended time frame. The original sample ends in Q4 2019, raising the question of whether more recent data affect the results. We extend the sample to Q1 2023, capturing recent economic developments. To account for the COVID-19 period, we add a dummy which takes a value of one for the periods Q1 2020 and Q2 2020, and 0 otherwise. Appendix D.4 shows that the main finding—stronger monetary policy transmission under higher financial integration—remains unchanged.

Sample of countries. We include all EA member states except the most recent member, Croatia. One may ask whether the results change if we focus only on the eleven original members that formed the EA in 1999: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain. In fact, the financial integration indicator is based on data for these eleven countries (except for banking and money market data). Appendix D.5 shows the estimated responses for the original members, confirming that the main conclusions remain consistent with the full sample.

Additional exercises. We perform additional robustness checks by modifying the main specification in Equation 2 in several ways to ensure that the results hold. These include: i) varying the number of lags of monetary policy shocks and of the dependent variable (Appendix D.6.1); ii) omitting the time dummies that control for the crisis period (Appendix D.6.2); iii) replacing the continuous measure of financial integration with a dummy based on the quantity-based composite indicator, set to one when the indicator is at or above the median and 0 otherwise (Appendix D.6.3); iv) replacing the quantity-based indicator with the price-based one, both from Hoffmann, Kremer and Zaharia (2020) (Appendix D.6.4); and v) using alternative monetary policy shocks (Appendix D.6.5).

5 Conclusion

This paper shows that the degree of financial integration is a key determinant of how monetary policy affects prices and output within the EA. Using a quantity-based indicator of financial integration and high-frequency identified monetary policy shocks, we document that the transmission of monetary policy is substantially amplified in more financially integrated environments. When financial markets are highly integrated, monetary shocks propagate strongly to both inflation and real activity. In contrast, when financial fragmentation prevails, monetary transmission is significantly impaired—particularly for prices and, to a lesser extent, for output.

These findings underscore that financial integration is not merely a background feature of a monetary union but a core determinant of its aggregate policy transmission. Financial integration enhances both the magnitude and the symmetry of monetary policy effects across member states. Conversely, fragmentation weakens these propagation channels, resulting in a more uneven and attenuated response to common policy shocks.

The analysis opens two main avenues for further research. First, developing a theoretical framework that embeds endogenous financial integration into models of monetary transmission would clarify the mechanisms underlying the amplification effects that we identify. Second, future work could explore how financial integration interacts with structural asymmetries across member states, complementing the insights of Corsetti, Duarte and Mann (2022) on the heterogeneous macroeconomic responses of EA countries to common policy shocks.

References

Abbassi, Puriya, Falk Bräuning, Falko Fecht, and José-Luis Peydró. 2018. "Cross-border liquidity, relationships and monetary policy transmission." *Journal of Financial Intermediation*, 34: 15–36.

Altavilla, Carlo, Luca Brugnolini, Refet S Gürkaynak, Roberto Motto, and Giuseppe Ragusa. 2019. "Measuring euro area monetary policy." *Journal of Monetary Economics*, 108: 162–179.

Amberg, Niklas, Thomas Jansson, Mathias Klein, and Anna Rogantini Picco. 2022. "Five facts about the distributional income effects of monetary policy shocks." *American Economic Review: Insights*, 4(3): 289–304.

Baele, Lieven, Annalisa Ferrando, Peter Hördahl, Elizaveta Krylova, and Cyril Monnet. 2004. "Measuring financial integration in the euro area." ECB occasional paper.

Bauer, Michael D., and Eric T. Swanson. 2023. "A reassessment of monetary policy surprises and high-Frequency identification." *NBER Macroeconomics Annual*, 37(1): 87–155.

Bayoumi, Tamim, and Barry Eichengreen. 1992. "Shocking aspects of European monetary unification."

Bianchi, Javier, and Louphou Coulibaly. 2024. "Financial integration and monetary policy coordination." National Bureau of Economic Research.

Buda, Gergely, Vasco M Carvalho, Giancarlo Corsetti, João B Duarte, Stephen Hansen, Afonso S Moura, Álvaro Ortiz, Tomasa Rodrigo, JV Rodríguez Mora, and G Alves da Silva. 2025. "The short lags of monetary policy."

Castelnuovo, Efrem, and Giovanni Pellegrino. 2018. "Uncertainty-dependent effects of monetary policy shocks: A new-Keynesian interpretation." *Journal of Economic Dynamics and Control*, 93: 277–296.

Cieslak, Anna, and Andreas Schrimpf. 2019. "Non-monetary news in central bank communication." *Journal of International Economics*, 118: 293–315.

Corsetti, Giancarlo, Joao B Duarte, and Samuel Mann. 2022. "One money, many markets." *Journal of the European Economic Association*, 20(1): 513–548.

Curdia, Vasco, and Michael Woodford. 2010. "Credit spreads and monetary policy." *Journal of Money, credit and Banking*, 42: 3–35.

Hobelsberger, Karin, Christoffer Kok Sørensen, and Francesco Paolo Mongelli. 2022. *A tale of three crises: synergies between ECB tasks.* ECB Occasional Paper.

Hoffmann, Peter, Manfred Kremer, and Sonia Zaharia. 2020. "Financial integration in Europe through the lens of composite indicators." *Economics Letters*, 194: 109344.

Horváth, Roman, Petra Katuscakova, and Anca Maria Podpiera. 2018. "Interest rate pass-through in the euro area during the sovereign debt crisis." *Journal of Money, Credit and Banking*, 50(5): 957–988.

Hristov, Nikolay, Oliver Hülsewig, and Timo Wollmershäuser. 2014. "Interest rate pass-through during the global financial crisis: The role of bank balance sheet structure." *Journal of Banking & Finance*, 48: 104–120.

Jarociński, Marek, and Peter Karadi. 2020. "Deconstructing monetary policy surprisesthe role of information shocks." *American Economic Journal: Macroeconomics*, 12(2): 1–43.

Jordà, Òscar. 2005. "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review*, 95(1): 161–182.

Jordà, Òscar, and Alan M Taylor. 2025. "Local projections." *Journal of Economic Literature*, 63(1): 59–110.

Lenza, Michele, and Giorgio E Primiceri. 2022. "How to estimate a vector autoregression after March 2020." *Journal of Applied Econometrics*, 37(4): 688–699.

Miranda-Agrippino, Silvia, and Giovanni Ricco. 2021. "The transmission of monetary policy shocks." *American Economic Journal: Macroeconomics*, 13(3): 74–107.

Nakamura, Emi, and Jón Steinsson. 2018. "High-frequency identification of monetary non-neutrality: the information effect." *The Quarterly Journal of Economics*, 133(3): 1283–1330.

Tenreyro, Silvana, and Gregory Thwaites. 2016. "Pushing on a string: US monetary policy is less powerful in recessions." *American Economic Journal: Macroeconomics*, 8(4): 43–74.

Wu, Jing Cynthia, Yinxi Xie, and Ji Zhang. 2024. "The Role of International Financial Integration in Monetary Policy Transmission." *IMF Economic Review*, 1–47.

Appendix

Financial Integration and the Transmission of Monetary Policy in the Euro Area

A First-Stage Regression Results

To estimate the monetary policy shocks used in Equation 2, $\widehat{\Delta i_t}$, we regress the change in the two-year German bond yield from Altavilla et al. (2019) on the high-frequency monetary policy shocks from Jarociński and Karadi (2020), using daily data. This corresponds to the first-stage regression, from which we obtain the fitted values at a daily frequency, $\widehat{\Delta i_d}$. These fitted values serve as the measure of monetary policy shocks in our main analysis after aggregating by summing the values up to a quarterly frequency.

The results from this regression are reported in Table A.1. The instrument is highly significant, indicating that the Jarociński and Karadi (2020) shock series helps explaining a large portion of the variation in the yield. Moreover, the F-statistic is 83.87—well above the conventional threshold of 10—confirming the relevance of the instrument.

Table A.1: Estimation Output from Running First-Stage Regression

Number of obs	= 7,670
F(1, 7668)	= 83.87
Prob > F	= 0.0000
R-squared	= 0.4535
Root MSE	= 0.00648

	Coefficient	Std. Error	t	P>|t|	[95% Conf. Interval]	
Shock	0.90878	0.099234	9.16	0.000	0.7142542	1.103306
_cons	-0.000687	0.000759	-0.90	0.366	-0.002175	0.000801

Notes: This table reports estimates of the first-stage regression $\Delta i_d = \alpha + \beta \cdot MP_d + \varepsilon_d$, where Δi_d represents the daily change in the two-year German bond rate during the monetary event window from Altavilla et al. (2019), and MP_d denotes the monetary shock series from Jarociński and Karadi (2020). Estimates are based on daily data and computed using robust standard errors.

B Local Projections Estimates

Table B.2 and Table B.3 display the coefficients that derive from estimating the impulse responses of HICP and real GDP based on the specification in Equation 2. These coefficients reflect values prior to the following adjustments: i) rescaling of the monetary shock to a one-standard-deviation *expansionary* shock, ii) scaling by the level of financial integration, and iii) applying the rolling-window moving average following Jordà and Taylor (2025) to ensure smoothness. For this reason, here we are assessing impulse responses to a 100 basis points contractionary monetary policy shock. The "Instrumented shock" coefficients indicate the average effect of the monetary shock on the dependent variable, while the "Instrumented shock Œ Integration" term measures how higher financial integration across the EA affects the impact of a 100 basis points monetary shock.

Table B.2: Impulse Responses of HICP Before Adjustments Across Quarters

Quarter	0	1	4	8	12	16
Instrumented shock	-0.01	4.71	14.06	29.27*	31.33	29.94
	(3.416)	(4.271)	(8.910)	(15.300)	(19.610)	(20.756)
Instrumented shock Œ Integration	-5.10	-19.88	-59.93**	-107.56***	-106.08**	-88.96*
	(8.842)	(12.619)	(25.182)	(37.805)	(47.810)	(51.082)
Observations	1,501	1,482	1,425	1,349	1,273	1,197
Within R^2	0.651	0.497	0.316	0.338	0.358	0.360
Lag-aug controls	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: This table reports estimates of $y_{i,t+h} - y_{i,t-1} = \alpha_{i,h} + \beta_h \cdot \widehat{\Delta i_t} + \delta_h \cdot \left(\widehat{\Delta i_t} \times FI_{t-1}\right) + +\zeta^h \cdot FI_{t-1} + \sum_{k=1}^{K} \gamma_{k,h} X_{i,t-k} + \varepsilon_{i,t+h}$, where $y_{i,t}$ is the log of HICP for country i at time t, and $\alpha_{i,h}$ are country fixed effects. The term $\widehat{\Delta i_t}$ denotes the series of monetary policy shocks estimated following the procedure explained in Section 2.2. FI_{t-1} is the lagged measure of financial integration (i.e., the quantity-based composite indicator). The term $X_{i,t-k}$ denotes the control variables that include four lags of the outcome variable, one lag of the monetary shock and three dummies to control for the relevant events indicated in Section 2.1. Standard errors in parenthesis are Driscoll and Kraay.

For HICP, at the shortest horizon (Quarter=0), the interaction effect is negative at -5.10%, though not statistically significant. Over time, the contractionary effect of monetary policy strengthens in more integrated economies. At quarter 1, the coefficient drops to -19.88%, suggesting a more pronounced effect in highly integrated economies. This amplifying effect increases in magnitude and significance over longer horizons. At quarter 4, it reaches -59.93% (significant at the 5% level), and by quarter 8, it grows to -107.56% (highly significant at 1% level), highlighting financial integration's substantial role in enhancing monetary policy impact over the medium term. At the longest horizon (Quarter=16), the interaction effect remains strong at -88.96% (significant at the 10% level), underscoring that deeper financial linkages across countries consistently boost the transmission of contractionary monetary shocks.

Table B.3: Impulse Responses of real GDP Before Adjustments Across Quarters

Quarter	0	1	4	8	12	16
Instrumented shock	4.84	12.92**	22.11***	16.78*	0.83	2.63
	(3.217)	(6.175)	(8.145)	(9.321)	(12.986)	(14.653)
Instrumented shock Œ Integration	-26.65***	-62.19**	-105.46***	-64.46*	17.26	18.81
	(9.911)	(26.187)	(30.546)	(35.356)	(52.623)	(56.250)
Observations	1,497	1,478	1,421	1,345	1,269	1,193
Within R^2	0.183	0.283	0.419	0.338	0.316	0.358
Lag-aug controls	✓	✓	✓	✓	✓	✓
Country FE	✓	✓	✓	✓	✓	✓

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

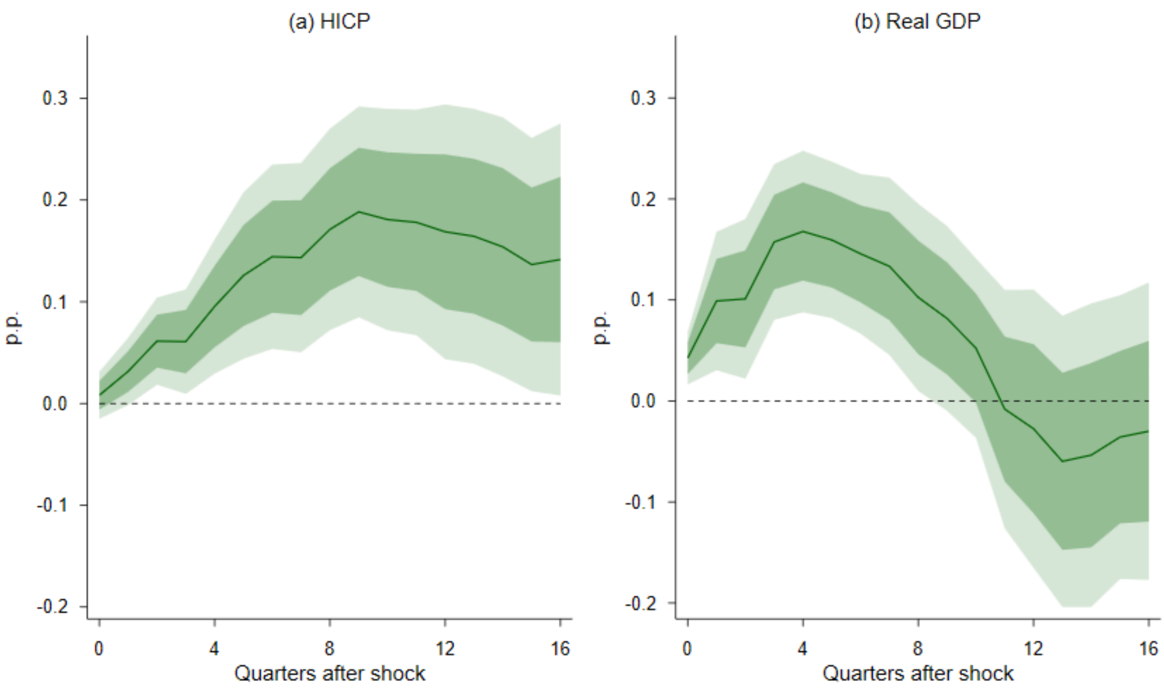
Notes: This table reports estimates of $y_{i,t+h} - y_{i,t-1} = \alpha_{i,h} + \beta_h \cdot \widehat{\Delta i_t} + \delta_h \cdot \left(\widehat{\Delta i_t} \times FI_{t-1}\right) + +\zeta^h \cdot FI_{t-1} + \sum_{k=1}^{K} \gamma_{k,h} X_{i,t-k} + \varepsilon_{i,t+h}$, where $y_{i,t}$ is log real GDP for country i at time t, and $\alpha_{i,h}$ are country fixed effects. The term $\widehat{\Delta i_t}$ denotes the series of monetary policy shocks estimated following the procedure explained in Section 2.2. FI_{t-1} is the lagged measure of financial integration (i.e., the quantity-based composite indicator). The term $X_{i,t-k}$ denotes the control variables that include four lags of the outcome variable, one lag of the monetary shock and three dummies to control for the relevant events indicated in Section 2.1. Standard errors in parenthesis are Driscoll and Kraay.

For real GDP, at quarter 0, the interaction term is negative and significant at the 1% level, estimated at -26.65%. This suggests that, on impact, a 100 basis point tightening in monetary policy curtails real GDP growth more strongly in economies with higher levels of financial integration. The magnitude of this contractionary amplification grows substantially at quarter 1, reaching -62.19% (significant at the 5% level), and peaks at quarter 4 with a coefficient of -105.46% (significant at the 1% level). These figures suggest that in economies with strong degree of financial integration, monetary tightening amplifies the real economic impact in the short to medium term due to enhanced shock transmission. However, this amplification weakens over longer horizons: at quarter 8, the coefficient drops to -64.46% (significant at the 10% level), and by quarters 12 and 16, it becomes positive but non significant.

C Raw Local Projection Responses

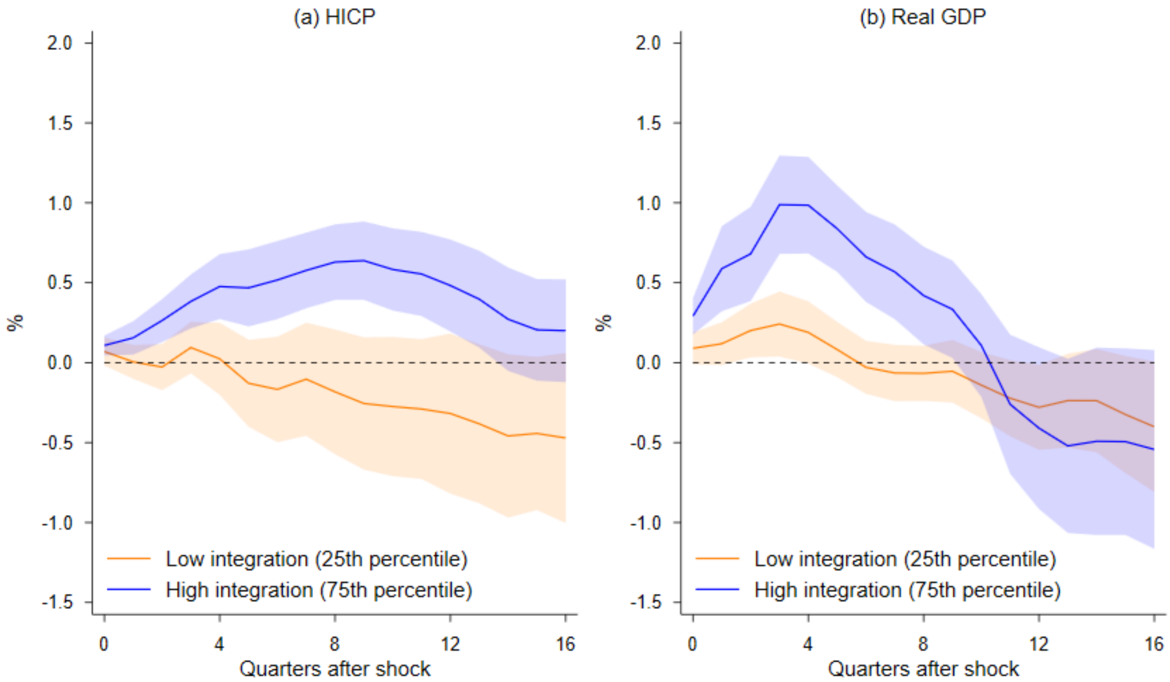
In the main analysis, as detailed in Section 3, we employ a rolling-window moving average to smooth the coefficient estimates derived from local projections, following Jordà and Taylor (2025). This smoothing technique is critical to ensure that the impulse response exhibit a coherent and interpretable trajectory, avoiding a choppy look. The need for such smoothing becomes particularly evident in some robustness exercises, such as the one where we end the sample in Q2 2007. Here, we present the raw local projection responses to offer a transparent view of the responses before applying the rolling-window moving average used in our main findings.

Figure C.1: Marginal effects of increased financial integration on HICP and real GDP responses



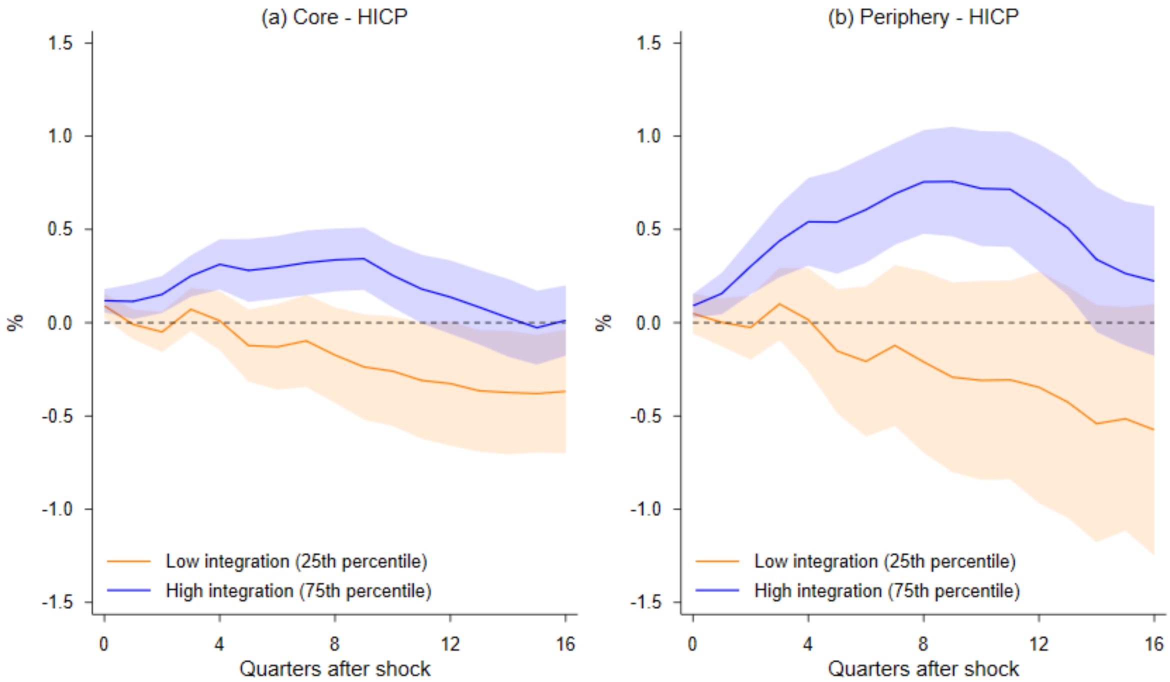
Notes: Marginal effects (p.p.) of a one-standard-deviation increase in financial integration on the impulse responses of HICP and real GDP. Shaded areas represent 68% and 90% confidence intervals, based on Driscoll-Kraay standard errors. These responses are obtained before the step of applying the rolling-window moving average over the coefficients following Jordà and Taylor (2025)

Figure C.2: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



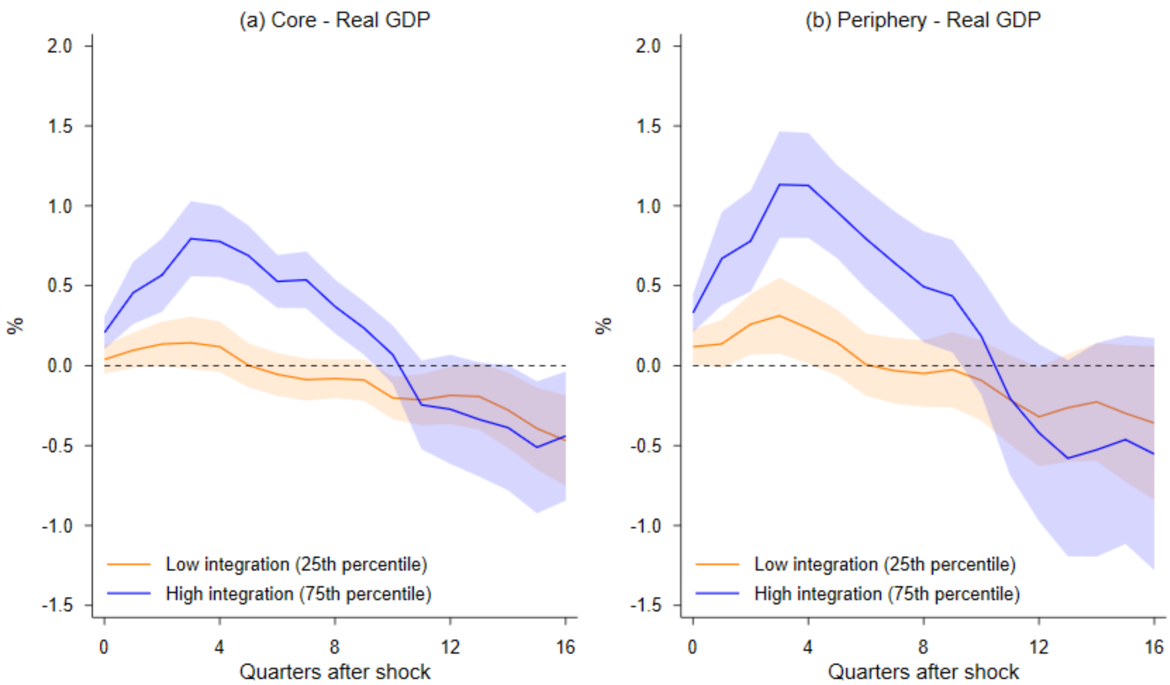
Notes: Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors. These responses are obtained before the step of applying the rolling-window moving average over the coefficients following Jordà and Taylor (2025).

Figure C.3: Responses of HICP to a monetary policy shock under different levels of financial integration for core and periphery



Notes: Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors. These responses are obtained before the step of applying the rolling-window moving average over the coefficients following Jordà and Taylor (2025).

Figure C.4: Responses of real GDP to a monetary policy shock under different levels of financial integration for core and periphery



Notes: Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors. These responses are obtained before the step of applying the rolling-window moving average over the coefficients following Jordà and Taylor (2025).

D Robustness Checks

D.1 Controlling for boom-bust states

A potential concern with our identification strategy is that the observed heterogeneity in monetary policy transmission with different levels of financial integration could partly reflect the business cycle. Our baseline sample (Q1 1999 – Q4 2019) includes episodes of severe macroeconomic stress, such as the global financial crisis and the EA sovereign debt crisis, when both financial integration and the responsiveness to monetary shocks may have co-moved with cyclical fluctuations. Without accounting for this, the estimated amplification effect could overstate the structural role of integration.

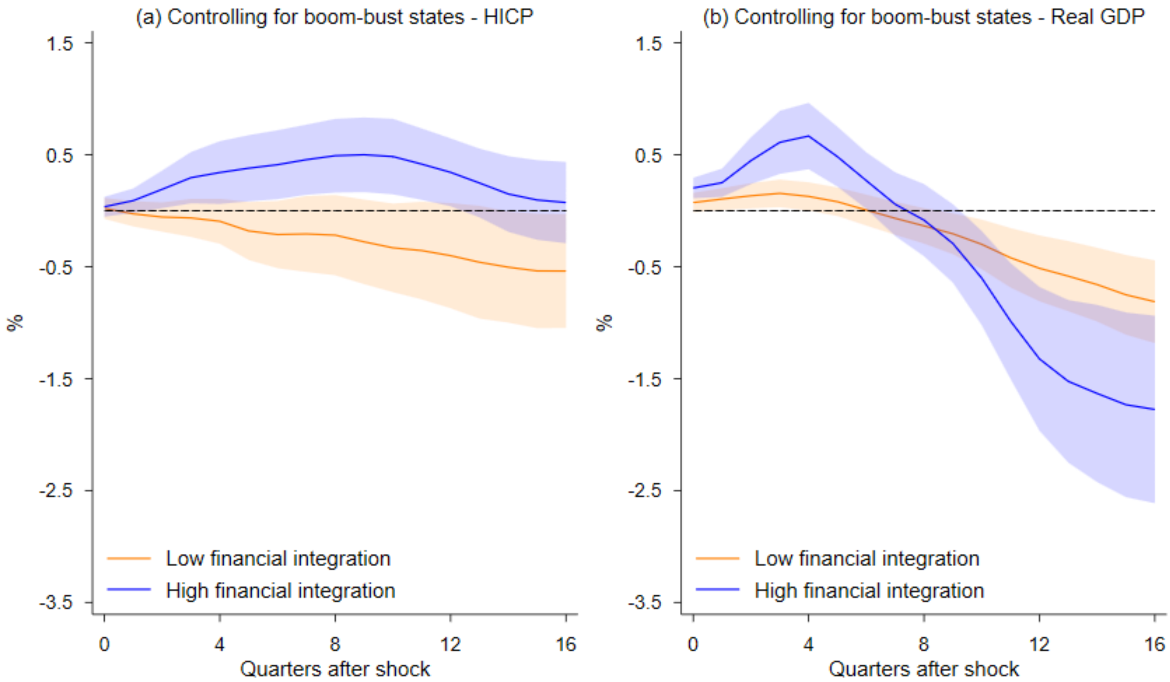
To address this concern, we extend Equation 2 by including an interaction between the monetary policy shock and indicators of recession. Specifically, we consider three alternative measures of economic busts:

- **CEPR recession indicator**: binary measure from the Center for Economic Policy Research that identifies a quarter as recessionary (i.e., dummy equal to one) when the EA economy experiences a notable and widespread decline. This typically involves two or more consecutive quarters of negative growth in key indicators like GDP, employment, and other measures of overall economic activity across the region. We use "peak excluded" version, where the recession begins in the first quarter after the peak (i.e., the last quarter before the decline), focusing solely on quarters with clear economic contraction and excluding the peak quarter, which may still show positive or flat growth.
- **Output gap dummy (one-sided HP filter)**: a dummy equal to one whenever the output gap is negative, with potential real GDP estimated using a one-sided Hodrick–Prescott (HP) filter.
- **Output gap dummy (two-sided HP filter)**: a dummy equal to one whenever the output gap is negative, with potential real GDP estimated using a two-sided HP filter.

For this robustness exercise, we depart from the baseline approach of defining high and low financial integration as the 25th and 75th percentiles. Instead, we create a binary financial integration dummy set to one when the integration level exceeds the sample median. For completeness, Appendix D.6.3 presents the results using this binary indicator in place of the continuous financial integration measure. In this additional exercise, the specification remains otherwise identical to the baseline, thus, includes only one interaction term.

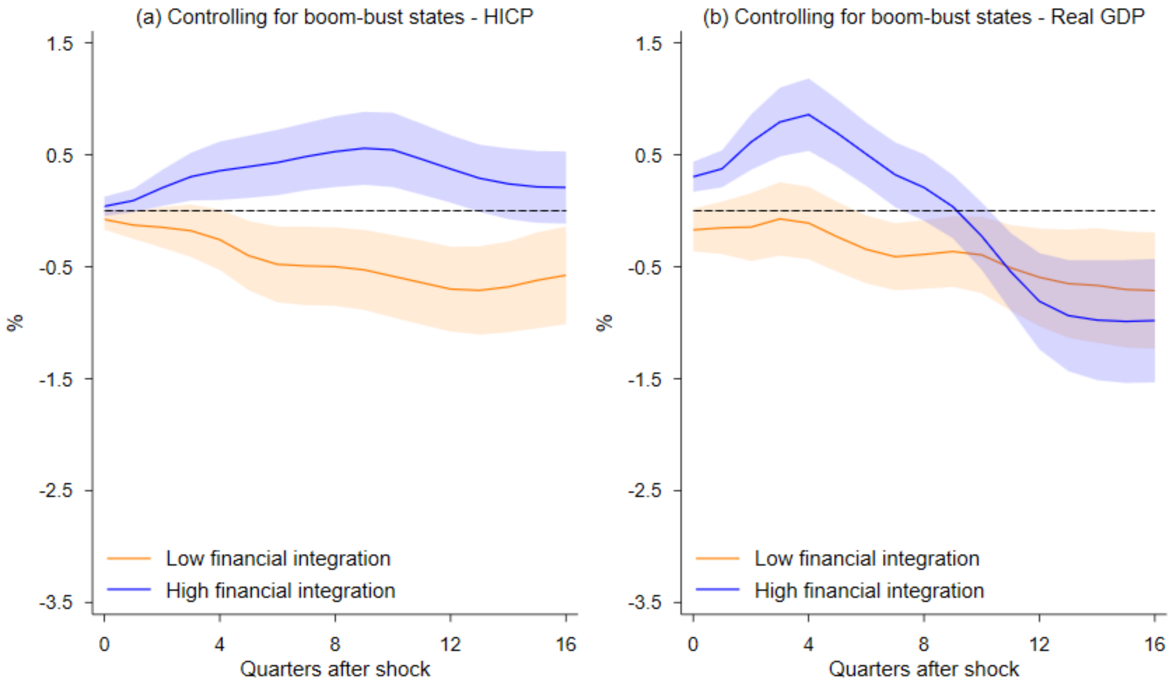
Across all three recession indicators, the amplification effect of financial integration holds. This confirms that our baseline findings are not driven by cyclical fluctuations, and that financial integration itself constitutes a robust channel shaping the transmission of monetary policy.

Figure D.5: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



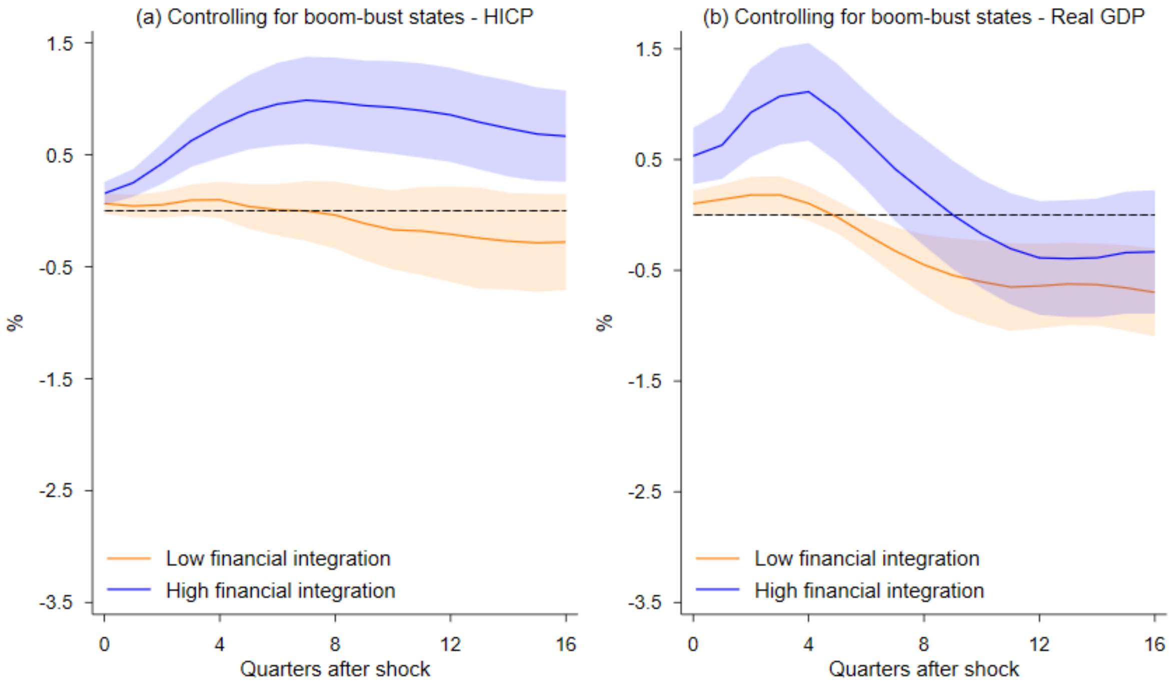
Notes: Additional interaction term using CEPR recession indicator. Impulse responses in levels (percentage terms) to a one- standard-deviation expansionary monetary shock under low (below median, orange line) and high (above median, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

Figure D.6: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



Notes: Additional interaction term using output gap dummy (one-sided HP filter). Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (below median, orange line) and high (above median, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

Figure D.7: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



Notes: Additional interaction term using output gap dummy (two-sided HP filter). Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (below median, orange line) and high (above median, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

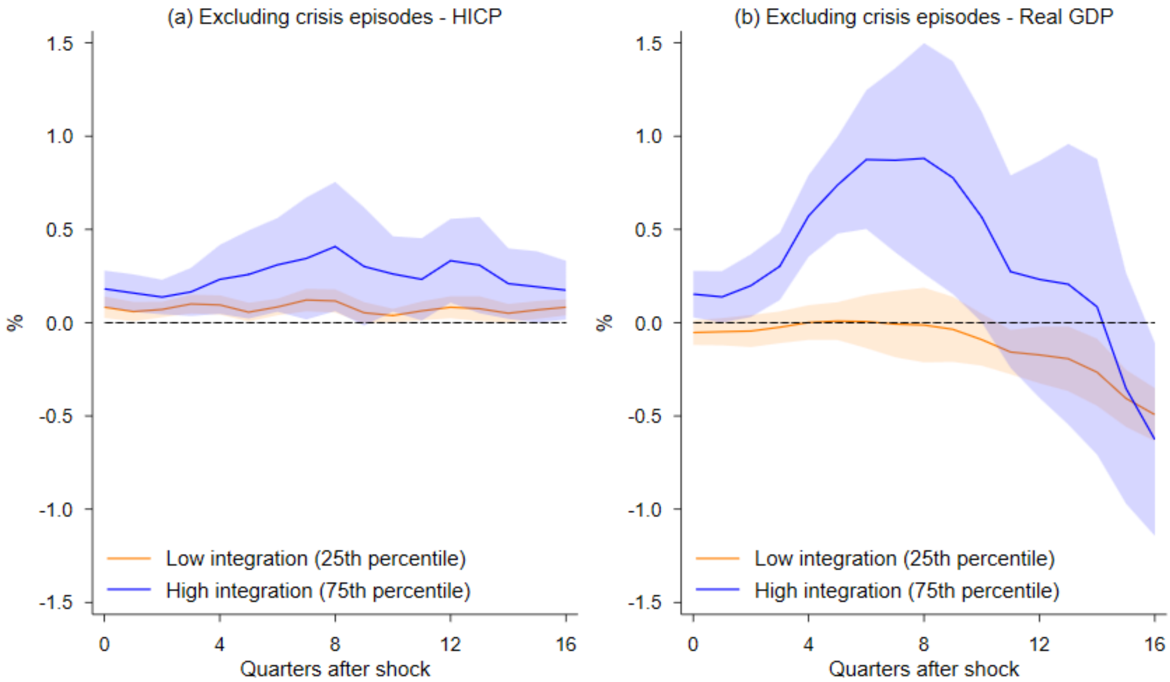
D.2 Excluding crisis episodes

Our sample spans Q1 1999 to Q4 2019, covering major events like the global financial crisis and the EA sovereign debt crisis, which align with significant business cycle slumps. These episodes raise the concern that our baseline results on the role of financial integration in monetary policy transmission may be influenced by cyclical dynamics rather than financial integration alone. As shown in Figure 2.1, periods of low financial integration do not consistently coincide with these crises, suggesting that external shocks are not the sole drivers of outcomes during low-integration periods.

To address the potential confounding effect of business cycle fluctuations, we start by augmenting the baseline model with an interaction term between monetary shocks and a recession indicator – Appendix D.1. To further reinforce these findings, we also conduct a second exercise by estimating impulse responses using a restricted sample ending in Q2 2007, excluding the global financial crisis and the EA sovereign debt crisis. This removes periods of severe macro-financial stress where financial integration and policy transmission are most likely to co-move with the business cycle.

As reported in Figure D.8, the results using this shorter sample are aligned with our baseline findings: higher financial integration is associated with stronger monetary policy transmission to both prices and output, even outside crisis periods.

Figure D.8: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



Notes: Sample ends in Q2 2007 instead of Q4 2019. Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

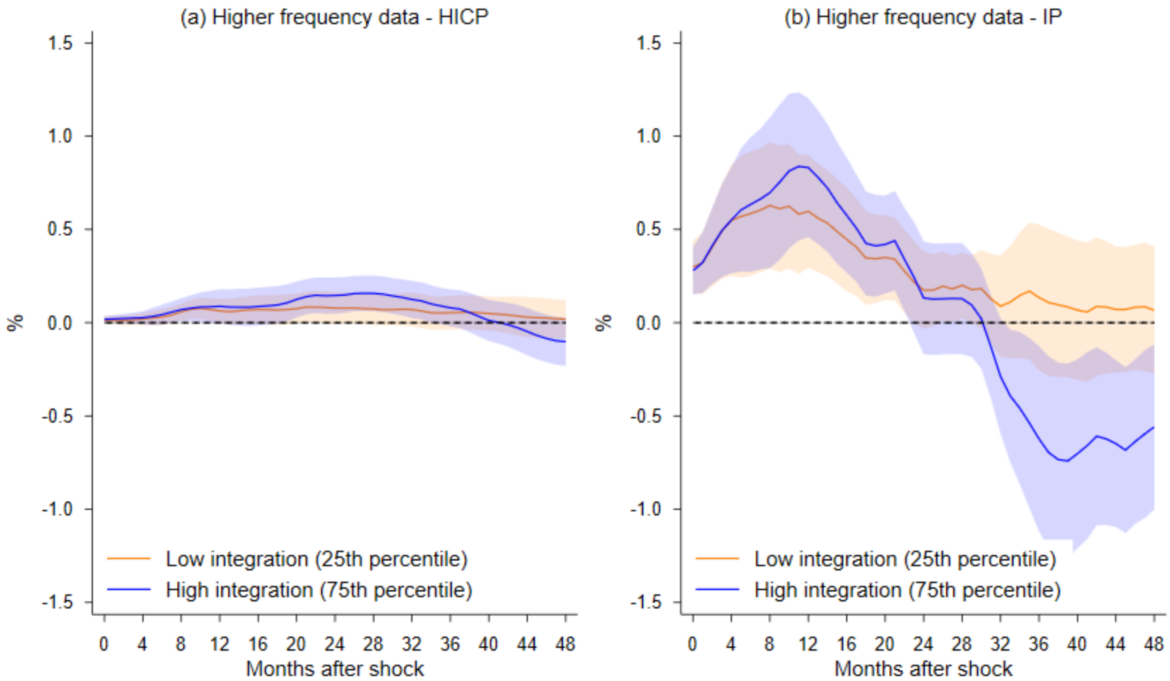
D.3 Higher frequency data

Recent literature shows that the time aggregation of economic activity and monetary policy shocks can influence the identification of monetary policy transmission (Buda et al., 2025). In particular, when high-frequency shocks are aggregated to match the lower frequency of standard macroeconomic variables, such as quarterly real GDP, the empirical response can be shifted to longer lags.

To address this concern, we estimate the impulse responses using higher-frequency data. Specifically, we use monthly observations for HICP and Industrial Production (IP) from Eurostat. IP similarly to HICP is set to 2015=100. Also, IP is seasonally and calendar adjusted, while for HICP we seasonally adjust the data using JDemetra+. The monetary policy shocks are still from Jarociński and Karadi (2020) but in monthly frequency to match these variables. For financial integration, we rely on the price-based indicator from Hoffmann, Kremer and Zaharia (2020), which is available at monthly frequency. In terms of the specification used to estimate the impulse responses, we adjust to increase the number of lags of the dependent variable from 4 to 12.

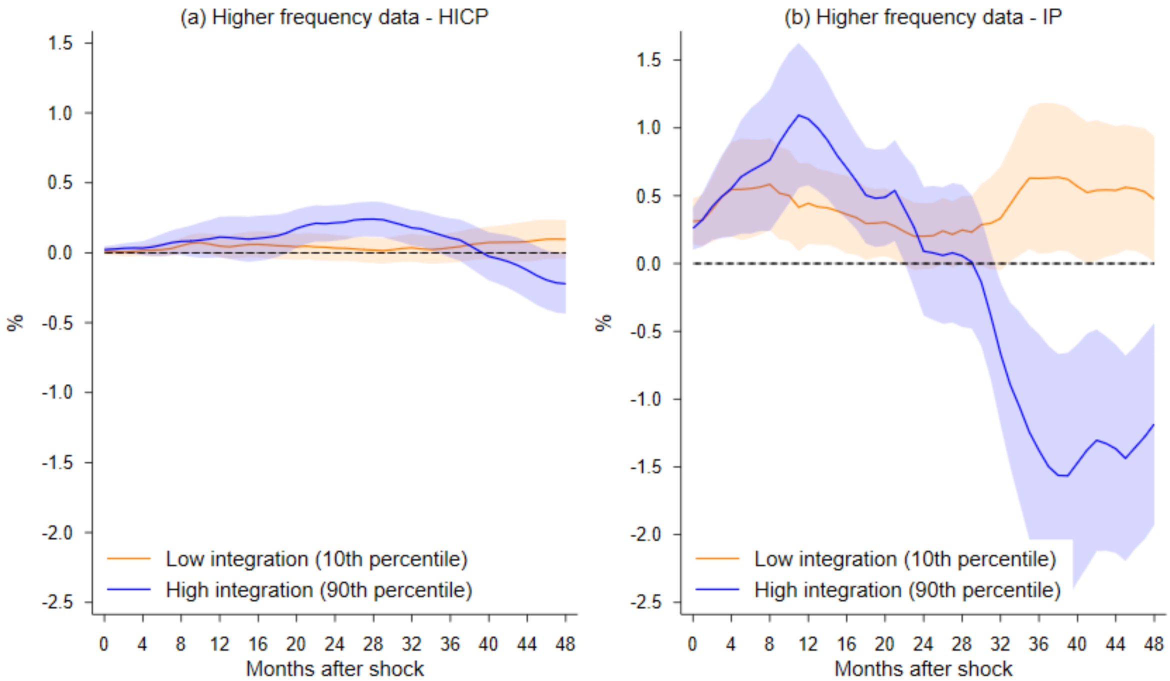
Using this higher-frequency setup allows us to capture more precisely the timing and magnitude of the responses of key macroeconomic variables to monetary policy shocks. Importantly, the results remain consistent with our baseline findings: the transmission of monetary policy is stronger during periods of higher financial integration. This confirms that our main conclusions are not an artifact of time aggregation, and that the amplification effect associated with financial integration is robust to using higher-frequency data.

Figure D.9: Responses of HICP and IP to a monetary policy shock under low and high levels of financial integration



Notes: Monthly data is employed for all variables in Specification 2. Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

Figure D.10: Responses of HICP and IP to a monetary policy shock under low and high levels of financial integration



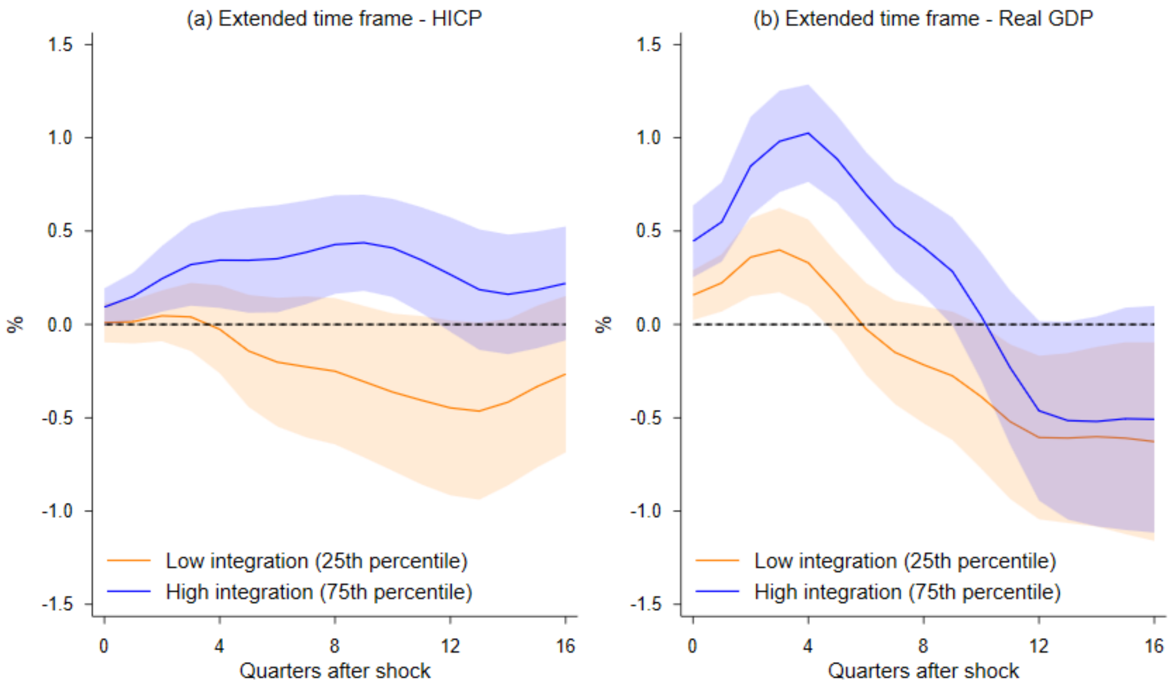
Notes: Monthly data is employed for all variables in Specification 2, and 10th and 90th percentiles of price-based financial integration are considered. Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

D.4 Extended time frame

We examine how extending the sample period beyond Q4 2019 to include more recent data up to Q1 2023 affect our results. This longer time frame captures relevant economic events, including the disruptions from the COVID-19 pandemic. To address the pandemic's unique impact, we adjust the baseline specification from Equation 2 by adding a COVID-19 dummy variable as an additional control. This variable is 1 for Q1 2020 and Q2 2020, the peak of global economic disruptions, and 0 otherwise. By including this dummy, we account for unusual economic patterns during these quarters, ensuring our results remain reliable.

The impulse response functions, shown in Figure D.11, confirm that the main findings from Section 4 hold. Under high financial integration, monetary shocks continue to have stronger effects on consumer prices and production compared to low financial integration.

Figure D.11: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



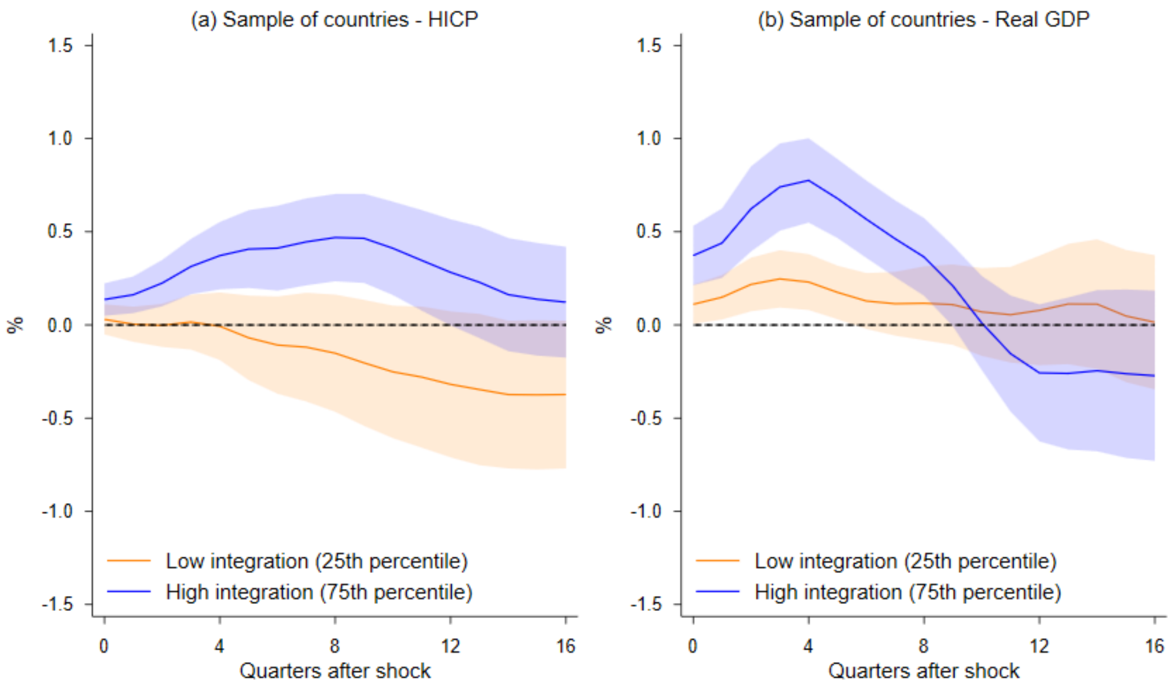
Notes: Sample ends in Q1 2023 instead of Q4 2019. Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

D.5 Sample of countries

To check if our findings hold with a different sample, we analyze only the eleven original EA countries that adopted the euro in 1999: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Portugal, and Spain. Our baseline analysis includes all EA countries except Croatia, which joined in 2023. The financial integration indicator, described in Section 2.1, is based mainly on data from these eleven countries. By focusing on them, we test whether including later EA members, which may have different levels of financial integration or economic traits, affects our results. We use the same specification as in Equation 2.

The impulse response functions for this smaller sample, shown in Figure D.12, confirm that the main findings from Section 4 hold. Higher financial integration translates into monetary policy shocks having stronger effects on prices and production. These results are consistent with the broader EA sample, suggesting that including later EA members does not significantly change the link between financial integration and monetary transmission.

Figure D.12: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



Notes: Sample of countries include original eleven member states of EA instead of nineteen. Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

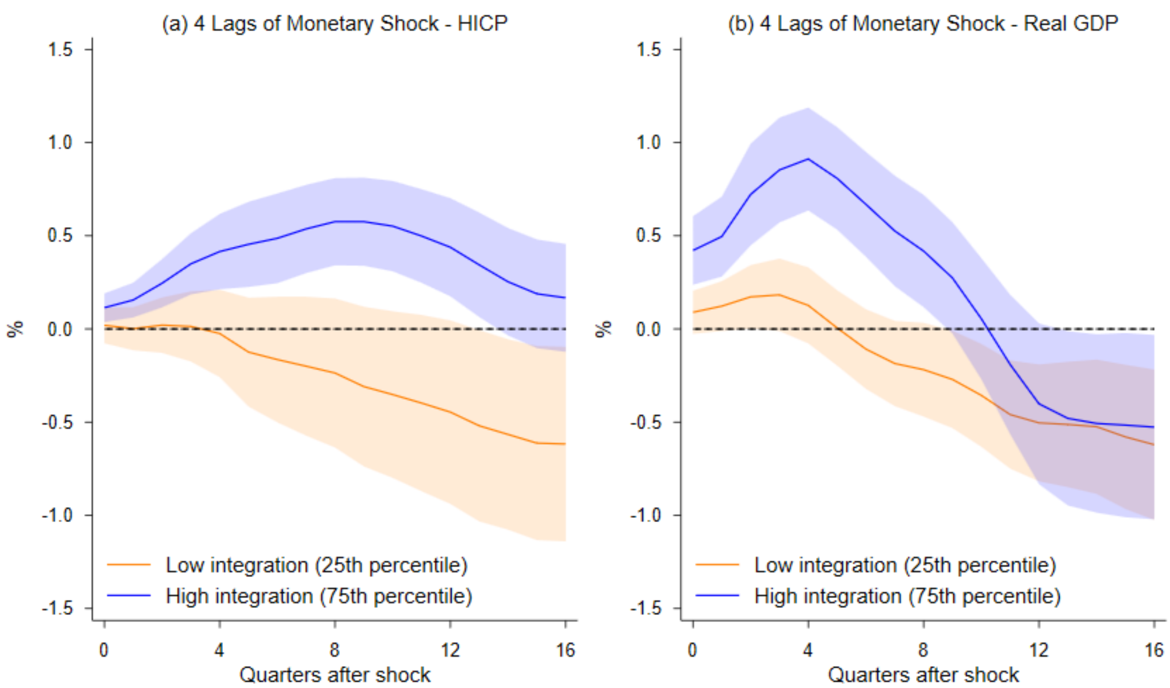
D.6 Additional exercises

D.6.1 Number of lags of monetary policy shocks and dependent variable

We modify the baseline specification to test the robustness of our findings to changes in the lag structure of the monetary policy shock and dependent variables. In the baseline specification, we include one lag of the monetary shock. For the dependent variable, we incorporate four lags to account for seasonality effects over a one-year period, consistent with the quarterly data structure. To test the sensitivity of our results to the lag structure, we estimate two alternative specifications. First, we increase the number of lags for the monetary shock from one to four, with results shown in Figure D.13. Second, we extend the lags of the dependent variable from four to eight to capture potential longer-term effects, with results presented in Figure D.14.

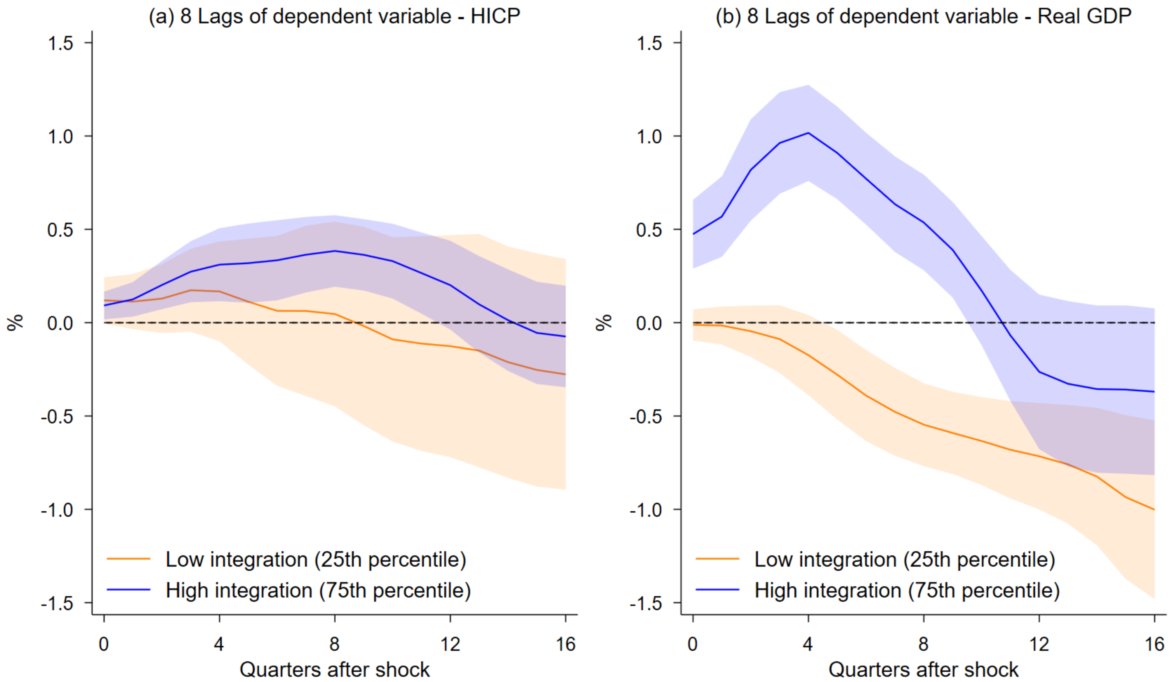
The impulse response functions from these alternative specifications confirm the main findings from Section 4. Under high financial integration regimes, the responses to the monetary policy shock remain amplified, consistent with the baseline results.

Figure D.13: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



Notes: Specification in Equation 2 has four instead of one lag of monetary shock. Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

Figure D.14: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



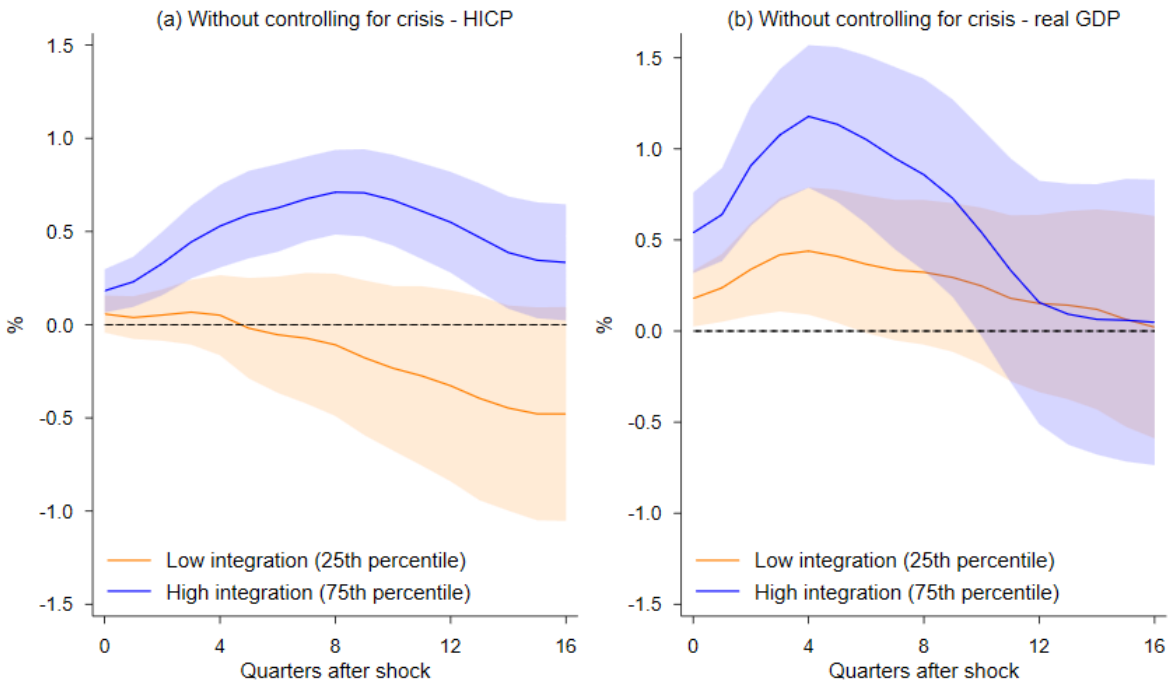
Notes: Specification in Equation 2 has eight instead of four lags of dependent variable. Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

D.6.2 Without controlling for crisis

To further assess the robustness of our main results, we estimate the specification presented in Equation 2 after removing the set of time dummies that were originally included to control for major events occurring during the sample period. These dummies are intended to account for large, economy-wide shocks—such as the global financial crisis and the sovereign debt crisis—that could have influenced all countries simultaneously and potentially confounded the estimation of transmission effects.

By excluding these dummies, we test whether our findings are sensitive to the presence of these controls and whether the results are being driven by a few large common shocks rather than by structural differences in financial integration. As shown in Figure D.15, the impulse responses obtained without these controls are remarkably similar to those in the baseline specification. Monetary policy continues to have a significantly stronger effect on both prices and output under higher levels of financial integration, reinforcing the interpretation that our results are not merely an artifact of slumps in the business cycle.

Figure D.15: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



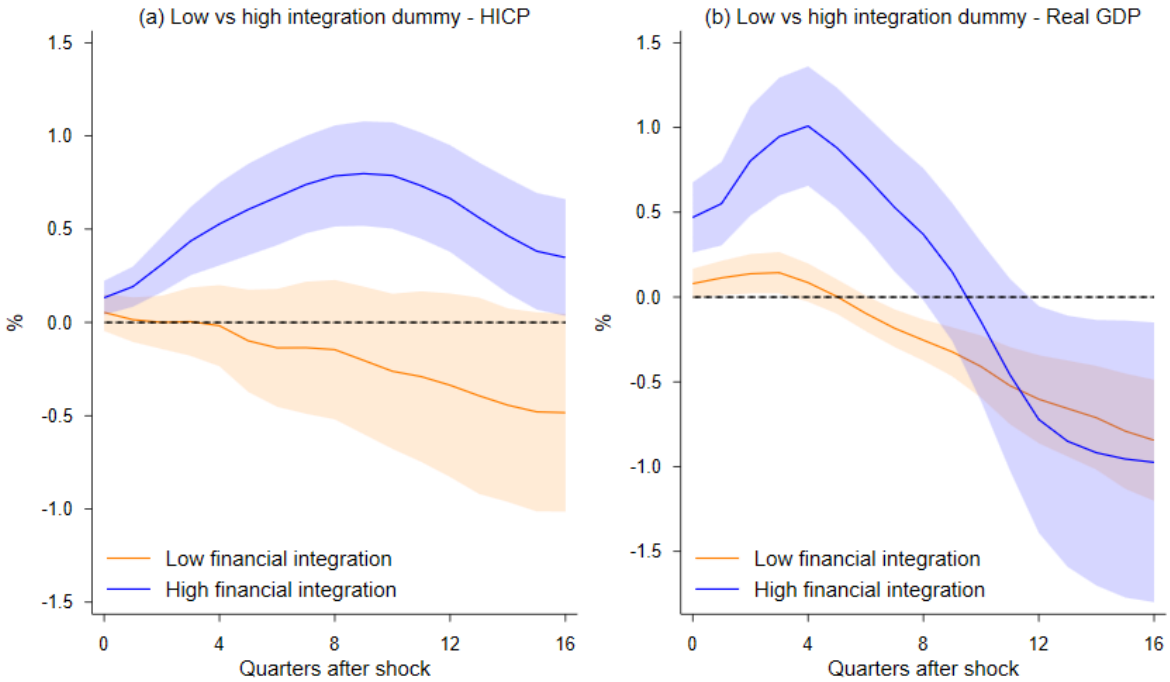
Notes: The dummies controlling for the crisis period are removed from the specification. Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

D.6.3 Financial integration regimes using a dummy

To further investigate how different levels of financial integration affect responses to a monetary policy shock, we adopt an alternative approach using a dummy variable to distinguish between low and high financial integration regimes. We use the quantity-based composite indicator of financial integration, described in Section 2.1, to create a binary variable that takes the value of 1 when the composite indicator is at or above its median value (0.2988) and 0 otherwise.

The analysis follows the same specification as outlined in Equation 2, but replaces the lagged continuous financial integration measure with the dummy variable. This change allows us to capture the distinct effects of high versus low financial integration on responses to monetary policy shocks. As shown in Figure D.16, the results align with those in Section 4. During periods of high financial integration, responses to a monetary shock are significantly stronger than in low-integration periods. The dummy variable approach clearly and intuitively separates these regimes, reinforcing our conclusion that higher financial integration amplifies the effects of an expansionary monetary policy shock.

Figure D.16: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



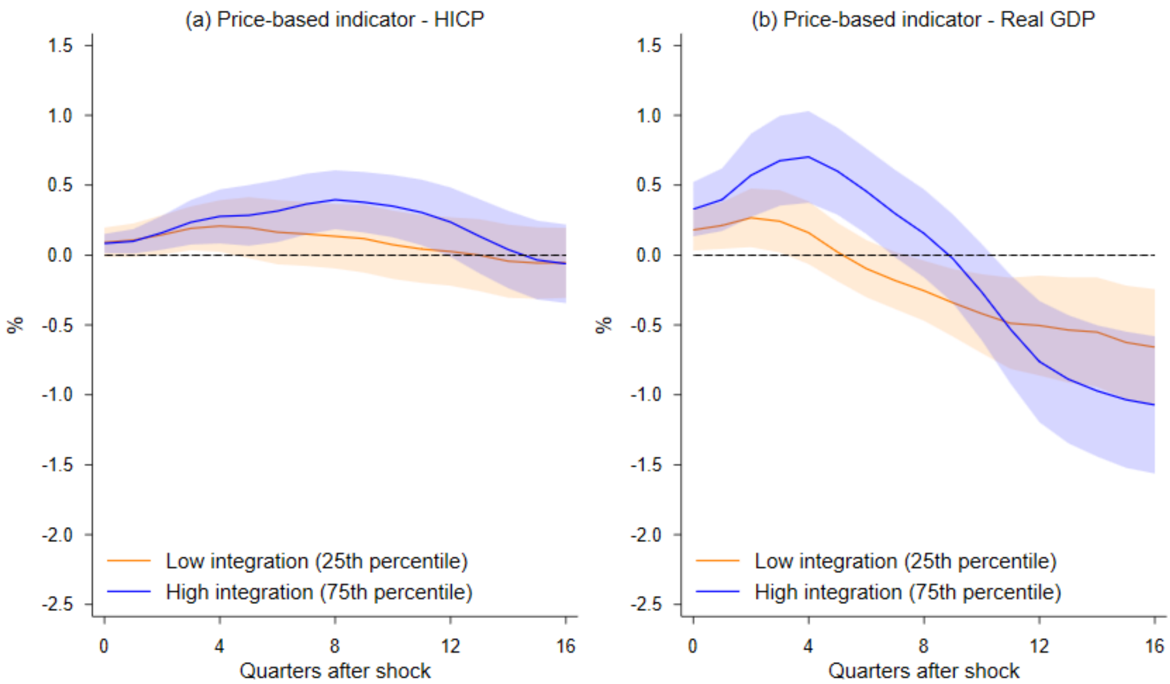
Notes: The two regimes of financial integration (low versus high) are defined based on a dummy created using data on the quantity-based composite indicator. Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (below median, orange line) and high (above median, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

D.6.4 Price- versus quantity-based composite indicator

We replace the quantity-based composite indicator from Section 2.1 with a price-based one, also from Hoffmann, Kremer and Zaharia (2020), to test if our results are dependent on the measure of financial integration. The baseline uses a quantity-based indicator that relies on cross-border asset holdings, while the price-based indicator measures integration through similar asset prices across EA countries. We apply the same specification from Equation 2, using the price-based indicator instead.

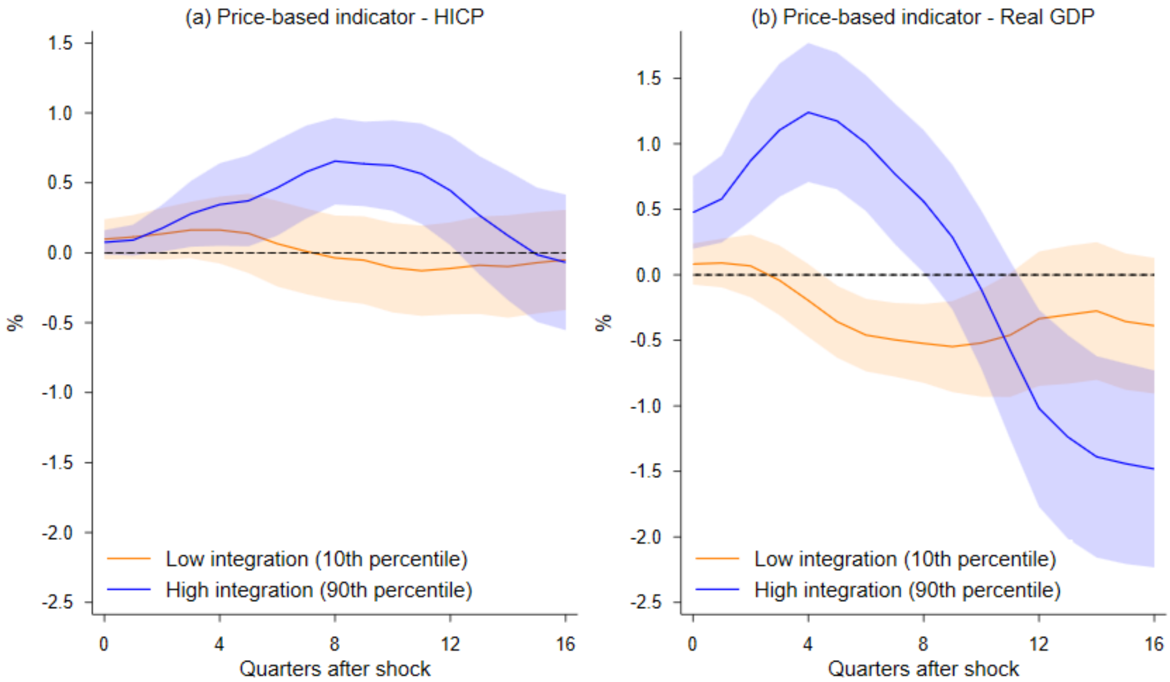
As shown in Figure D.17, the results confirm the main findings from Section 4. For a high level of financial integration, monetary shocks have stronger effects on consumer prices and production compared to low integration. To further verify this, we look into the responses considering the 10th and 90th percentiles of the price-based indicator instead of the baselines 25th and 75th percentiles. The results, presented in Figure D.18, support the main findings, showing that higher financial integration consistently amplifies the impact of monetary shocks.

Figure D.17: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



Notes: Price-based composite indicator from Hoffmann, Kremer and Zaharia (2020) is used instead of the quantity-based indicator. Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

Figure D.18: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration

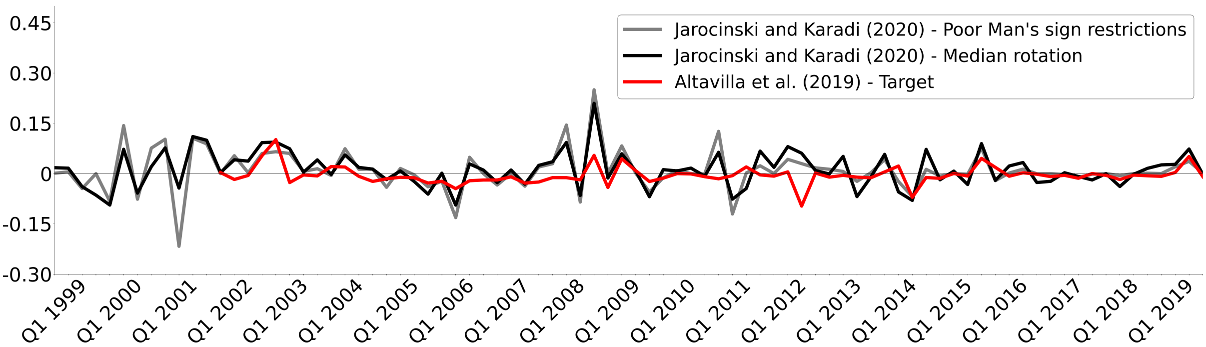


Notes: Price-based composite indicator from Hoffmann, Kremer and Zaharia (2020) is used instead of the quantity-based indicator, and the 10th and 90th percentile are considered (instead of 25th and 75th). Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (10th percentile, orange line) and high (90th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

D.6.5 Alternative monetary policy shocks

Jarociński and Karadi (2020) estimate monetary policy and central bank information shocks using two methods: a simple ("Poor Man's") sign restrictions approach and a median rotation approach. The first method identifies monetary policy shocks with basic sign restrictions (e.g., higher interest rates with falling stock prices) and can also detect information shocks (where interest rates and stock prices move together), but it uses a simple high-frequency framework that may not fully separate the two. The median rotation approach better distinguishes monetary policy shocks (opposite movements of interest rates and stocks) from information shocks (same-direction movements) by choosing the median response from a set of valid rotations. Using shocks from this second method, we calculate impulse responses for prices and output, and the results, shown in Figure D.20, confirm stronger effects under higher financial integration.

Figure D.19: High-frequency monetary shocks from the literature

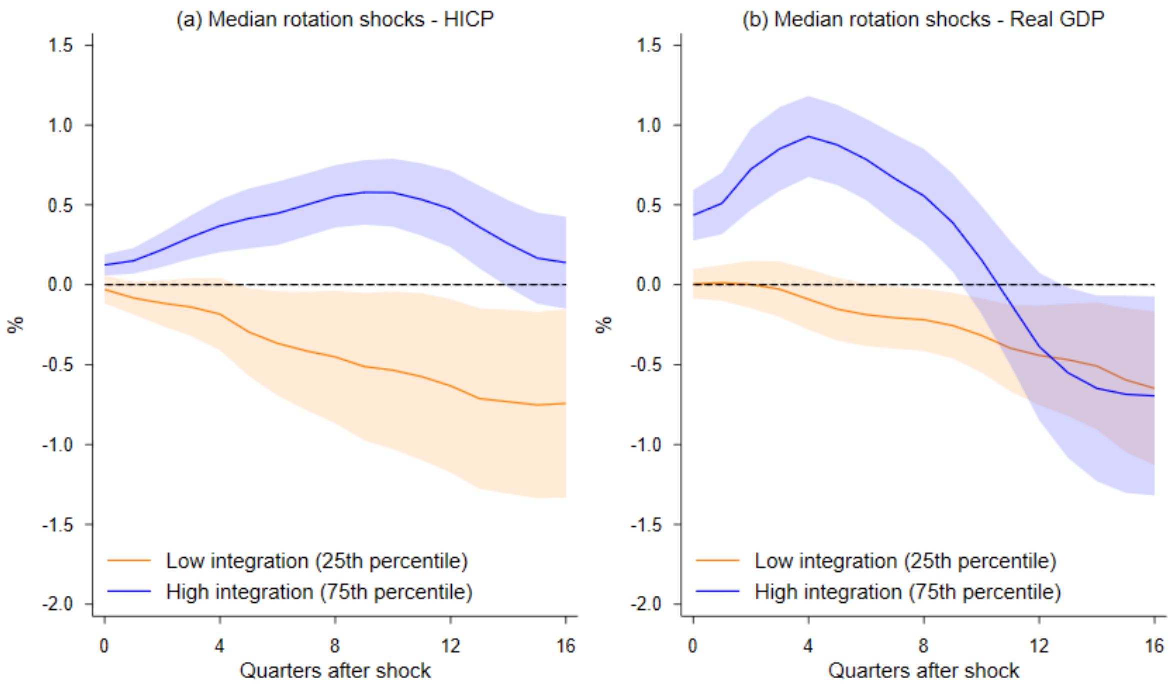


Notes: Monetary policy shocks from Jarociński and Karadi (2020) and target shocks from Altavilla et al. (2019).

Another approach to identifying monetary policy shocks comes from Altavilla et al. (2019). They break down ECB policy surprises into target, timing, forward guidance, and quantitative easing factors using high-frequency changes in OIS yields. Target shocks, which reflect surprises in short-term policy rates, are identified from intraday yield curve shifts around ECB announcements, especially press releases.

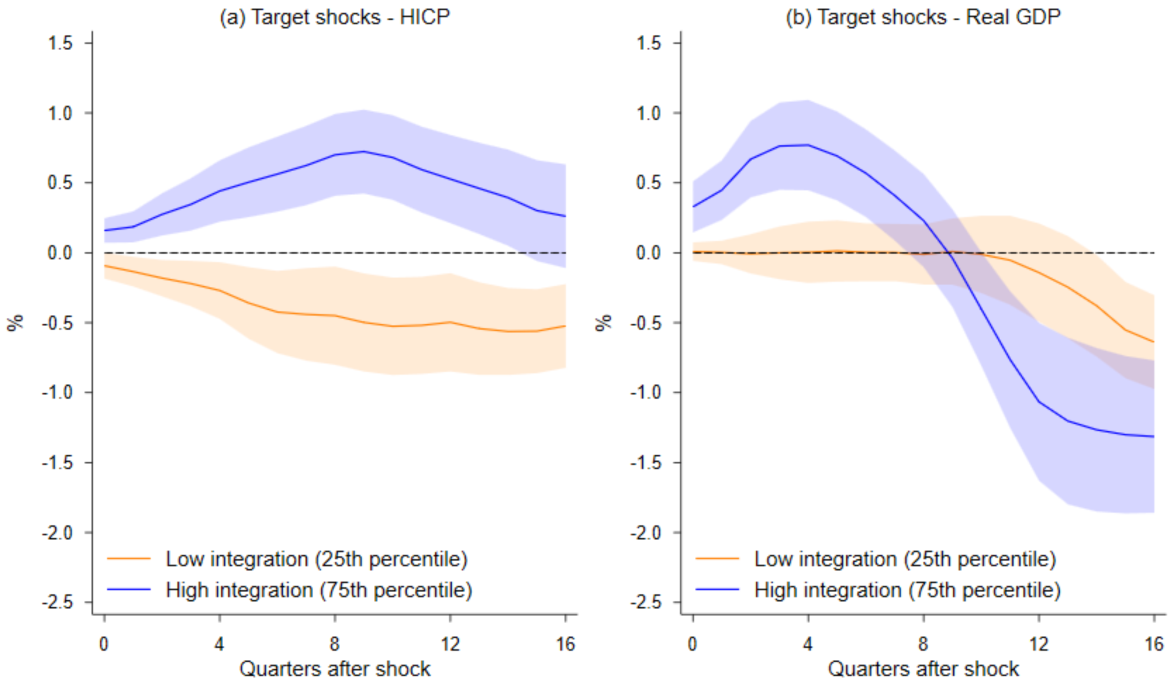
Figure D.19 compares the two shock measures from Jarociński and Karadi (2020) with the target shocks from Altavilla et al. (2019). The Jarociński and Karadi (2020) shocks are generally similar to each other, while target shocks show smaller changes but often align in direction. This difference makes sense since Jarociński and Karadi (2020) focus on separating monetary policy from information effects without splitting conventional and unconventional policies, while Altavilla et al. (2019) keep information effects but distinguish between conventional and unconventional measures. Using the target shocks, we estimate impulse responses, shown in Figure D.21. These results confirm that higher financial integration amplifies the effects, consistent across all shock measures.

Figure D.20: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



Notes: The alternative shocks from Jarociński and Karadi (2020) are used. Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

Figure D.21: Responses of HICP and real GDP to a monetary policy shock under low and high levels of financial integration



Notes: Target shocks from Altavilla et al. (2019) are used instead of shocks from Jarociński and Karadi (2020). Impulse responses in levels (percentage terms) to a one-standard-deviation expansionary monetary shock under low (25th percentile, orange line) and high (75th percentile, blue line) levels of financial integration. Shaded areas denote 68% confidence intervals computed using Driscoll-Kraay standard errors.

Acknowledgements

We thank all the participants of the Internal Exchange Seminar at Banco de Portugal, Nova SBE internal seminar series and of the 16th Annual Meeting of Portuguese Economic Journal for their useful comments and suggestions. Duarte gratefully acknowledges funding from Fundação para a Ciência e a Tecnologia (UID/00124/2025, UID/PRR/124/2025, Nova School of Business and Economics), LISBOA2030 (DataLab2030 - LISBOA2030-FEDER-01314200), and from the ECB's Lamfalussy Research Fellowship. Pires gratefully acknowledges funding from FCT - Fundação para a Ciência e Tecnologia, I.P. (2022.13051.BD).

João B. Duarte

Nova School of Business and Economics, Universidade NOVA de Lisboa, Carcavelos, Portugal; email: joao.duarte@novasbe.pt

Mariana N. Pires

Nova School of Business and Economics, Universidade NOVA de Lisboa, Carcavelos, Portugal; email: mariana.pires@novasbe.pt

Postal address 60640 Frankfurt am Main, Germany
Telephone +49 69 1344 0
Website www.ecb.europa.eu

PDF ISBN 978-92-899-7529-2 ISSN 1725-2806 doi:10.2866/5444151 QB-01-25-276-EN-N