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MONETARY POLICY TRANSMISSION IN THE EURO AREA: CHANNELS AND CROSS-COUNTRY HETEROGENEITY

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AUTHORSHIP STATEMENT

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ABSTRACT

We study heterogeneity of monetary policy transmission in the euro area conditional on five structural characteristics. We use panel local projections with interaction terms in conjunction with a high-frequency identified monetary policy shock, whose effects are shown to be in line with theory. We find evidence of statistically significant and persistent differences in output responses. For unemployment, these are less broad-based, whereas price level responses are weak. Results suggest that the strength of transmission weakens the most with the share of services value added, followed by a notable increase associated with a larger share of liquidity-constrained households. Applying our model estimates to the sample average suggests that monetary policy is in part asymmetric and endogenous.

KEY WORDS: heterogeneity, monetary policy, panel local projections, high-frequency identification

SUSTAINABLE DEVELOPMENT GOALS

POVZETEK

Proučimo heterogenost transmisije monetarne politike v evroobmočju glede na pet strukturnih značilnosti. V ta namen uporabimo panelne lokalne projekcije z interakcijskimi členi in visoko-frekvenčno identificiranim šokom monetarne politike, učinki katerega so v skladu s teorijo. Odkrijemo statistično značilne ter persistentne razlike v odzivih agregatnega proizvoda. Za brezposelnost so te manj široko osnovane, medtem ko so odzivi ravni cen šibki. Rezultati kažejo, da moč transmisije najbolj upada z rastjo deleža storitev v dodani vrednosti, čemur po redu velikosti sledi njena rast v primeru povečanja deleža likvidnostno omejenih gospodinjstev. Z uporabo modelskih ocen na povprečju vzorca pokažemo, da je delovanje monetarne politike v določeni meri asimetrično in endogeno.

KLJUČNE BESEDE: heterogenost, monetarna politika, panelne lokalne projekcije, visoko-frekvenčna identifikacija

CILJI TRAJNOSTNEGA RAZVOJA

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sl. – Slovene

CI – (sl. Kreditna institucija); Credit Institution

EA – (sl. Evroobmočje); Euro Area

ECB – (sl. Evropska centralna banka); European Central Bank

EFP – (sl. Premija zunanjega financiranja); External Finance Premium

FFR – (sl. Ameriška ciljna medbančna obrestna mera); Federal Funds Rate

FED – (sl. Ameriška centralna banka); Federal Reserve

GDP – (sl. Bruto domači proizvod); Gross Domestic Product

HICP – (sl. Harmoniziran indeks cen življenjskih potrebščin); Harmonized Index of Consumer Prices

HH – (sl. Gospodinjstvo); Household

HtM – (sl. Likvidnostno omejeno gospodinjstvo); Hand-to-Mouth

IC – (sl. Interakcijski koeficient); Interaction Coefficient

LP – (sl. Lokalna projekcija); Local Projection

ME – (sl. Mejni učinek); Marginal Effect

MPS – (sl. Šok monetarne politike); Monetary Policy Shock

UCC – (sl. Strošek uporabe kapitala); User Cost of Capital

US – (sl. Združene države Amerike); United States

VA – (sl. Dodana vrednost); Value Added

VAR – (sl. Vektorska avtoregresija); Vector Autoregression

1 INTRODUCTION

In trying to achieve the mandate of price stability in the euro area (hereinafter: EA), the European Central Bank (hereinafter: ECB) acts to influence financial markets, and eventually also the real economy through the behavioral changes of economic agents. Its conduct is primarily geared toward steering macroeconomic aggregates. Since these are based on the dynamics of individual member states, the underlying process can be far from uniform. As such, a single monetary policy can act as a potential source of cyclical divergence and could impose significant adjustment demands on other economic policies (Kieler & Saarenheimo, 1998). This served as motivation for a new strand of literature that emerged in the run-up to the monetary union. Apart from addressing the question about the EA fulfilling the criteria for an optimal currency union, authors also started studying the potential heterogeneity in country-level responses to monetary policy shocks (hereinafter: MPSs) and hypothesized about its sources (Cecchetti, 1999; Dornbusch et al., 1998; Guiso et al., 2000; Mojon et al., 2002; Mihov, 2001).

While the novel literature drifts away methodologically, it analyzes heterogeneity conditional on a similar set of structural characteristics. Inherently, these are deeply rooted in theory and seen as possible factors that could influence the various channels of transmission. What's more, countries still exhibit sizable disparities in this regard. For example, in the fourth quarter of 2024, the gap between the countries with the highest and lowest shares of services value added (hereinafter: VA) was equal to 22 percentage points. For trade openness, this difference was six-fold, whereas it was four times higher for the share of adjustable rate loans to households (hereinafter: HHs). Recently, the importance of heterogeneity was also implied by the ECB with the establishment of the ChaMP Research Network, among other things dedicated to researching how structural changes such as servitization and (de)globalization affect monetary policy transmission (ECB, n.d.). This hints at an additional intertemporal dimension which may be of relevance for policy.

Whereas earlier research primarily relied on vector autoregressions (hereinafter: VARs), local projections (hereinafter: LPs) have become the dominant methodological approach in recent years due to their robustness and flexibility (Altavilla et al., 2024; Gödl-Hanisch, 2022; Holm-Hadulla & Thürwächter, 2020; Mermelas & Tagkalakis, 2024). Namely, they are easily extended to a panel or state-dependent framework. An associated downside is the necessity for an external shock series as within-model identification is not possible in a single equation setup. Luckily, high-frequency literature has made great strides in the past few years, producing shock series, which are now used at large. In general, monetary policy communication conveys monetary policy, information, and risk premium shocks. Moreover, the first can be decomposed based on the different policy actions and maturities they impact. We aggregate and use the MPS series from Jarociński and Karadi (2020), which encompasses conventional monetary policy measures and forward guidance, but is purged of information effects.

The purpose and main contribution of this thesis is to assess the extent to which monetary policy leads to conditionally heterogeneous responses of macroeconomic aggregates in the EA, and to explore the associated policy implications. In support of this endeavor, we also check if the sourced and aggregated MPS behaves in accordance with theory. While this has already been extensively demonstrated in the literature, we do so for the sake of consistency. If the shock is robust, heterogeneity is valuable to explore. We try to address three research questions:

1. Are the effects of monetary policy statistically significant and theoretically consistent?
2. Is the influence of country-specific structural characteristics on the transmission process statistically significant and in line with previous findings in the literature?
3. Based on our results, what are the implications for monetary policy in the EA?

The first half of the thesis tries to provide the theoretical underpinning for our analysis. In the second chapter, we discuss the channels through which interest rate policies are transmitted to the real economy and prices in accordance with our shock measure. We begin with the Keynesian interest rate channel, going from the short to the long end of the yield curve. We continue with other asset prices, where the focus is mainly on the exchange rate channel. The non-neoclassical credit view offers a different perspective on the transmission process, but is equally important for our analysis. The discussion of each channel also tries to provide some empirical facts. Equipped with the baseline understanding of individual channels, we use the subsequent chapter to motivate the problem of heterogeneity in transmission. In the preliminary section, we conduct a literature review based primarily on studies concerned with European countries, and afterwards, tie the discussion back to the second chapter by discussing structural characteristics that could broadly influence the transmission with respect to individual channels. Each section provides an intertemporal and cross-sectional data analysis along with theoretical mechanisms and past empirical results.

The fourth chapter provides the methodological foundation. It revolves around the two main pillars of our approach, which are tightly connected in the literature as well. Firstly, we chronologically discuss the evolution of the high-frequency identification literature with a particular focus on the EA. In a complementary manner, LPs have recently become more popular since they rely on external identification of shocks. Because we also adopt this framework, we dedicate a short section to the theoretical discussion surrounding LPs, providing information with regard to the setup, benefits and inference. We end with a narrative analysis of the aggregated shock from Jarociński and Karadi (2020) and conduct an EA-wide impulse response analysis with cross-sectional LPs to address our first research question. Lastly, our fifth chapter deals with heterogeneity, using panel LPs with interaction terms on a sample of 17 EA member states. We estimate responses of the gross domestic product (hereinafter: GDP), harmonized consumer price index (hereinafter: HICP) and the unemployment rate conditional on the chosen structural characteristics and evaluate the size and significance of interaction coefficients (hereinafter: ICs). To form our policy discussion, we apply our estimates to the latest country-level data and look at how has the EA average (as proxied by our sample) evolved through time.

2 TRANSMISSION CHANNELS OF MONETARY POLICY

Positing sensible hypotheses with regard to monetary policy transmission and heterogeneity thereof is predicated on a good understanding of the underlying theoretical mechanisms. In the literature, these have been systematically discussed in terms of channels, constituting a process through which monetary policy decisions are transmitted into changes of key macroeconomic aggregates such as GDP and inflation (Taylor, 1995). Using this framework, researchers have started to quantify the presence and relative importance of individual channels in transmission, while many central banks have also explicitly included some of them in their large-scale macroeconometric or dynamic stochastic general equilibrium models (Boivin et al., 2010).

Throughout the years, newly identified channels have come about as a result of perceived insufficiency of prevailing narratives, either stemming from the lack of supporting empirical evidence, different schools of thought, or use of novel monetary policy instruments. For example, Mishkin (1995) juxtaposes the standard Keynesian interest rate channel with monetarist Tobin's q theory or Modigliani's wealth effects on consumption, and points out that the credit channel of Bernanke and Gertler (1995) came about due to the inadequacy of the cost of capital in explaining the effects of monetary policy. Furthermore, the widespread use of unconventional monetary policy measures as an antidote to the effective lower bound led to the identification of novel channels such as those related to portfolio (re)balancing or market liquidity premia (Haldane et al., 2016). Given that there is a myriad of channels the literature has identified, we exclude those related to balance sheet policies, following our shock measure sourced from Jarociński and Karadi (2020). Based on Jarociński (2024) and the discussion of Boeckx et al. (2019), we inferred that its information set is solely related to conventional monetary policy and forward guidance, whereas asset purchases are not included (more on this in Section 4.3).

Accordingly, we present the neoclassical and non-neoclassical channels of transmission as classified in Boivin et al. (2010), along with a special consideration for expectations. The delineating factor between the two groups is the assumed state of financial markets, noting that the latter foundationally imply imperfections and form the credit channel of transmission, including both the creditor's (bank lending channel) and borrower's (balance sheet channel) perspective. On the contrary, the first have developed independently of financial frictions and encompass the interest rate and asset price channels. In contemporary macroeconomic models, interest rates play a pivotal role in driving consumption, investment and saving, either through intertemporal decision-making or the user cost of capital (hereinafter: UCC). They are also tightly linked to terms of trade through the exchange rate, a determinant of outward competitiveness, and other more long-lived asset prices such as stocks, bonds and housing (Boivin et al., 2010).

In principle, each channel could be divided into two stages. Firstly, information conveyed by the central bank is quickly reflected in financial conditions, i.e. interest rates and asset prices, while the second stage relates to how repricing indirectly impacts the real economy and inflation through the behavioral changes of economic agents with a lag (Burr & Willems, 2024). It needs to be stressed that the second stage is only possible insofar there are nominal rigidities present in the economy, that is, prices (including wages) slowly adjust to changes in aggregate demand, which is not an unreasonable assumption, for example, see Hoffman et al. (2005) or Dedola et al. (2024) for more recent evidence. If perfect flexibility was the norm, monetary policy actions would result in immediate price adjustment and no implications for real activity, with the economy ending up at the equilibrium or natural level of output yet again. This does not agree with the empirical findings on the effects of identified MPSs (Woodford, 2003).

2.1 Interest Rate Channel

In an effort to fulfill their mandate of price stability, central banks use short-term policy rates to steer their market counterparts in a certain direction. Put simply, a target is announced and open market operations, by varying the supply of reserves, try to ensure that the effective inter-bank lending rate follows it. Until the Great Financial Crisis, the ECB had been adjusting a corridor system limited by the marginal lending (ceiling) and deposit (floor) facility rates, with the main refinancing operations rate acting as the target for the Euro Overnight Index Average, now known as the Euro short-term rate. Afterwards, it flooded the market with ample reserves which moved the market rates towards or even below the corridor floor, making it the primary rate of concern (Schoenholtz & Cecchetti, 2016). Formally, this was also recognized with the changes made to the ECB's operational framework in March 2024 (ECB, 2024).

Although the discussion usually revolves around the nominal interest rate (i_t), the real interest rate (r_t) is key to effective policy making. In structural models, this relationship is represented by the Fisher equation:

$$(1+i_t) = (1+r_t)(1+\mathbb{E}_t\pi_{t+1}) \tag{1}$$

where the two are mediated by inflation expectations $(\mathbb{E}_t\pi_{t+1})$. Thus, an increase in the nominal interest rate brings about an increase in the real interest rate conditional on the existence of nominal rigidities, meaning inflation expectations increase by a smaller amount. As Taylor (1995) points out, this change in the nominal interest rate is intentional, following a particular central bank reaction function or policy rule, rather than strictly the supply of money. In some sense, the monetary transmission mechanism is endogenous in nature, whereby macroeconomic aggregates are partially a function of the policy rate and vice-versa. A well-known reaction function is the Taylor rule presented in Taylor (1993). Here, the nominal interest rate is a function of the inflation and output gaps or deviations from their target and potential levels, respectively.

2.1.1 Intertemporal Choice

A direct consequence of variation in the real interest rate is connected to the intertemporal substitution effect, impacting the choice between consuming now or later. This is central to the models in the dynamic stochastic general equilibrium tradition through the Euler equation for consumption (C_t), the first order condition of the HH optimization problem. Following Gali (2015), its standard form looks like the following:

$$u'(C_t) = \beta \mathbb{E}_t \left[u'(C_{t+1}) \left(\frac{1+i_t}{1+\mathbb{E}_t \pi_{t+1}} \right) \right] \tag{2}$$

without accounting for taste shocks in the utility function. We can see that the fraction on the right-hand side is simply equal to $1+r_t$ as defined in (1). With a rise in the real interest rate, the marginal utility of consumption in t becomes more expensive relative to the next period, because saving (investment in bonds) will lead to even more consumption in the future. This leads to consumption postponement, which is evident from the log-linearized condition for a risk averse agent with a power utility of the form $u(C_t) = \frac{C_t^{1-\sigma}}{1-\sigma}$:

$$\hat{c}_t = \hat{c}_{t+1} - \frac{1}{\sigma} \left(\hat{i}_t - \mathbb{E}_t \hat{\pi}_{t+1} \right) \tag{3}$$

where we assume that $log(\beta) \approx 0$. Notice, however, that changes in the real interest rate do not fully translate into changes in current consumption. Consumption smoothing is also governed by the relative risk aversion coefficient σ. If utility is highly curved (i.e., σ is high), a larger change in the real interest rate is required for consumers to substantially rearrange consumption over time (Cochrane, 2001). The slope parameter $\frac{1}{\sigma}$, known as the intertemporal elasticity of substitution, has been estimated to be relatively small. For example, extensive literature review by Havranek et al. (2015) shows that the mean estimate is around 0.5 ($\sigma = 2$). Consequently, it has been excluded from large-scale central bank models such as the ECB's Area-Wide Model or the Federal Reserve's (hereinafter: FED) FRB/US model in contrast to the subsequently discussed UCC (Boivin et al., 2010).

2.1.2 Yield Curve

The previous section also applies to long-term interest rates, especially in the context of borrowing as discussed in the next section. Indeed, as Woodford (2005) points out, to the extent that even a large change in the policy rate would only imply a change in the cost of overnight borrowing, it would make little difference to anyone's spending decisions. Instead, it is the expected future path of short-term rates over the coming months and years that should matter. The literature has shown that the relationship between policy changes and the yield curve is not straight-forward. For example, Cook and Hahn (1989) examined the impact of changes in the federal funds rate (hereinafter: FFR) on asset yields across different maturities. Their findings showed that while the changes were the same in sign, their size decreased along the yield curve, supporting the expectations hypothesis of the term structure of interest rates. Romer and Romer (1996) disagreed on theoretical grounds, arguing that long-term rates should decrease due to lower expected inflation in the event of tightening. However, this puzzle could be explained by asymmetric information, in particular, superior information that the central bank possesses in comparison to market participants. In turn, they recalibrate their inflation expectations once this information is revealed through policy actions.

Presently, research distinguishes between monetary policy and central bank information shocks. As elegantly pointed out in Cieslak and Schrimpf (2019), these relate to the non-systematic and systematic parts of the reaction function, respectively. Markets perceive monetary policy announcements as being expansionary or contractionary conditional on the information about the economy. For example, if a policy action is perceived as positively mild, i.e. unexpected smaller increase in the policy rate, relative to the communicated expected positive output growth, a more pronounced monetary policy (central bank information) shock will lead to a decrease (increase) in interest rates. What's more, central bank information shocks exhibit stronger effects at the intermediate section of the yield curve, whereas the impact of standard policy rate shocks is more pronounced at the short end. However, this is just one facet of MPSs. These also encompass path or forward guidance shocks, whereby expectations about future policy more so impact longer maturities similar to information shocks (Gurkaynak et al., 2004).

2.1.3 User Cost of Capital

Owing to a combination of sticky prices and expectations, a rise in real long-term interest rates leads to a drop in investment spending. This need not relate only to firms, but also HHs since they also make decisions about investing in consumer durables or residential housing (Mishkin, 1995). Theoretically speaking, such a tightening in financial conditions affects investment only indirectly through the UCC. Based on Jorgenson (1963) neoclassical theory of investment, Boivin et al. (2010) define it as:

$$u_K = p_K[((1-\tau)i - \pi^e) + \delta - (\pi_K^e - \pi^e)] \tag{4}$$

where p_K is the price of new capital relative to the final good price, τ is the rate of deductibility of interest costs, i is the nominal rate of interest (usually of longer maturity), π_K^e is the expected rate of price appreciation of the capital asset, and δ is the depreciation rate. Alluding to the discussion in Subsection 2.1.1, we add expected inflation π^e to write UCC in real terms. As can be seen, an increase in i implies higher u_K, ceteris paribus. What's more, an increase in $\pi_K^e - \pi^e$ decreases u_K. Moreover, these expectations are a function of the expected policy path, providing an additional channel through which monetary policy may reinforce the effect on investment and spending decisions (Boivin et al., 2010). In modern micro-founded New Keynesian dynamic stochastic general equilibrium models, UCC are usually implemented using the marginal Tobin's q. The link between the two was already established in Hayashi (1982) by introducing increasing and convex investment adjustment costs. The concept of q

also leads us to a more monetarist wealth-oriented interpretation of the investment channel touched upon in the next section.

Based on firm-level data for Germany, France, Italy and Spain, a paper by Mojon et al. (2002) found that the long-run elasticity of the stock of capital to UCC is approximately unity consistent with theoretical predictions in the case of the Cobb-Douglas production function. On firm-level data for the United States (hereinafter: US), Gilchrist and Zakrajsek (2007) came to the same conclusion, but also thoroughly discussed existing literature as well, highlighting several limitations. These include the reliance on tax changes for identification, the use of non-stationary prices of capital assets as a primary driver of UCC changes and aggregate interest rate data, omitting the cross-country variation in interest rate changes. In the same paper, short-run elasticities of the investment rate to UCC are estimated to range between 50 and 75 basis points.

2.2 Asset Price Channel

From the monetarist perspective, the term structure of interest rates represents only one group of asset prices relevant for the transmission mechanism, making the liquidity trap less of a concern for monetary policy. Other possible examples include equities, residential housing, consumer durables, exchange rates etc. What's more, the composition of asset inventories held by wealth owners changes from cycle to cycle, as do their relative prices. As described in Meltzer (1995), this can also be induced by monetary policy because it changes the stock of money relative to other assets, altering their respective marginal utilities along with that of consumption. Afterwards, reaching equilibrium happens through financial and real readjustment. The former is faster since the associated costs of information and transactions are much lower than for production, consumption or investment in durables. While the asset market returns to equilibrium, output does not. It can then be the case that price of assets rises relative to production goods, leading to an increase in aggregate demand. This development may change the asset composition further, but the chain of events eventually converges to an equilibrium.

In the context of transmission, we are particularly interested in the second part, i.e., the relative price incentives that give rise to real effects. The two popular theories that discuss this with regard to consumption and investment are the Tobin (1969) q theory of investment and Ando and Modigliani (1963) life-cycle hypothesis, falling under the so-called wealth channel. In principle, both describe the same dynamics. Firms decide about investment based on q defined as the market value of capital relative to its replacement costs. If q is high, it pays to invest since the benefit gained outweighs the cost and vice-versa. Put differently, firms can issue equity and get a high price for it relative to the replacement costs of capital. On the other hand, low q can spur acquisitions of old capital from other firms. On the other hand, the life-cycle hypothesis defines consumption as a function of current, expected future labor income and net worth. Therefore, as financial wealth of HHs increases, consumption does as well. Both theories suggest that expansionary monetary policy can increase q and consumer's wealth, and thereby impact real activity (Mishkin, 1995). Owing to the fact that the wealth channel is not important for our analysis as there is no related structural characteristic based on which heterogeneity is studied, we end our overview here.

2.2.1 Exchange Rate Channel

Another particularly important price is the exchange rate. Naturally, this only applies to countries with flexible exchange rate regimes since maintaining a par value makes monetary policy impotent due to capital flows (Obstfeld & Rogoff, 1995). Unlike the wealth channel, which focuses on consumption and investment, the exchange rate channel primarily concerns international trade, particularly its impact on net exports as part of aggregate demand. As Taylor (1995) explains, a positive relationship should exist between the exchange rate and the interest rate differential for any two countries. Specifically, it operates through the interest rate parity condition, which states that the interest rate differential is equal to the expected rate of change in the exchange rate. If this was not true, capital would flow into the country with higher returns, eventually equalizing them. A simple representation of the uncovered interest rate parity condition can be found in Gali (2015):

$$i_t - i_t^* = \mathbb{E}_t(e_{t+1}) - e_t \tag{5}$$

where i_t is the domestic nominal interest rate, i_t^* the foreign nominal interest rate and e_t the nominal exchange rate in t defined as price of foreign in terms of domestic currency. Note that in the short-run, (5) also holds in real terms. Suppose monetary policy increases the domestic nominal interest rate, ceteris paribus, and the left-hand side increases. This entails the right-hand side must also increase to satisfy equality, leading to a decrease in the nominal exchange rate in t (appreciation of domestic currency) to match the corresponding expected depreciation that should prevail under uncovered interest rate parity. Because of appreciation, domestic goods become more expensive, making exports less competitive, whereas imports become cheaper. Hence, net exports decrease and so does output (Boivin et al., 2010).

Interestingly, imports originally invoiced in another currency may also have an important direct effect on inflation, particularly in more open economies. This could be due to either final consumer goods or intermediate goods used in the production process (Burr & Willems, 2024). A paper by Forbes et al. (2018) has found that for the UK the pass-through to consumer and import prices due to a MPS is equal to about 20% and 80% of currency appreciation. Similarly, Comunale and Kunovac (2017) have found that the corresponding values were about 10% and 70% for the EA. Furthermore, Lane (2019) shows that, in line with theory, the nominal trade balance of the EA improves after an unexpected expansionary MPS since the positive response of exports is stronger than the increase in imports and the decline in the terms of trade.

2.3 Credit Channel

Bernanke and Gertler (1995) acknowledge the standard neo-classical framework, but describe the transmission mechanism as a black-box, emphasizing the incompleteness of its understanding in contemporary literature. The gaps in the conventional story supposedly stem from two puzzles. Firstly, the UCC channel is quantitatively hard to identify and the same goes for its Tobin's q formulation, although both should have an impact on the interest sensitive components of aggregate spending. What's more, even when the evidence is affirmative, the accelerator factors such as sales and cash flows remain significant.

Secondly, taking into the consideration that monetary policy exhibits direct control over short-term interest rates, the impact on long-term costs of borrowing relevant for investment in long-lived assets such as housing and production equipment should be weaker. Contrary to this, their monthly VAR analysis based on US data showed that residential investment drops the most in size and speed following a MPS. Both amount to a puzzle of magnitude - a strong policy rate, but weak UCC impacts on spending and investment - and of composition since longer-lived assets are impacted more. To explain these puzzles, a new wave of literature developed the credit channel of monetary policy transmission which should not be seen as trying to replace the mainstream, but rather to uncover amplification mechanisms complementary to the standard ones. A more historical perspective is given by Gertler (1988), arguing that both Keynesian and Monetarist schools of thought failed to properly capture the importance of credit, and rather focused too much on money as the key financial aggregate, even after seminal papers such as Fisher (1933) made the case for interrelatedness of financial structure and output based on evidence from the Great Depression. Specifically, his debt-deflation story suggested that the deterioration in real borrowers' balance sheets and the consequent break-down of financial markets strongly enhanced the downturn and should be of main empirical relevance.

While the idea that financial factors influence macroeconomic behavior gradually gained traction, it remained peripheral to mainstream academic and policy discussions until the 1980s. This has been mainly due to methodological constraints and heavy reliance on reduced form VAR models. Up to that point, macroeconomic models built on the Modigliani and Miller (1958) theorem, allowing one to disregard financial structure. Note that introducing imperfections naturally entails heterogeneous agents, making modelling less tractable. Furthermore, time series analysis had often shown that lagged values of money were important for forecasting variation of output. However, a renewed interest in the role of financial factors emerged following the reassessment of the Great Depression by studies such as Mishkin (1978) and Bernanke (1983), alongside the advancements in information economics.

According to Bernanke and Gertler (1995), monetary policy transmission is amplified by changes in the external finance premium (hereinafter: EFP), which is defined as the difference between the cost of external (by issuing equity or debt) and internal (by way of retained earnings) financing. This wedge reflects the deadweight costs associated with the principal-agent problem such as the expected costs of monitoring, evaluation and collection, the lemons premium due to difficulties in distinguishing between high and low-quality borrowers, and the restrictions imposed to mitigate moral hazard. As such, its size is positively correlated with the stance of monetary policy through the balance sheet (broad credit) and bank lending (narrow credit) channels, resulting in the financial accelerator phenomenon. As for empirical evidence, it is in general hard to construct a test to distinguish between the importance of individual sub-channels, albeit the existence of a credit channel is undisputed.

2.3.1 Balance Sheet Channel

In part, the EFP inversely depends on the borrower's financial standing. A larger amount of liquid assets or marketable collateral allows for a larger share of self-financing or liabilities collateralization, decreasing the probability of an adverse event and works in favor of less stringent conditions considered by the lender. This constitutes a clear pathway through which monetary policy can impact the EFP, and by extension economic activity. In response to higher interest rates, financial positions can be weakened directly either through rising debt service costs (lower cash-flows) or declining asset prices (lower collateral value). Indirectly, there are also spill-over effects, whereby downstream agents cut spending as a result of tighter monetary policy, resulting in lower revenues but stable interest and factor costs. This discrepancy leads to an additional decrease in creditworthiness. When talking about the balance sheet channel, Boivin et al. (2010) also points out that the peculiarity of the cash-flow channel lies in its effect on spending and investment through nominal as opposed to real interest rates in the case of neo-classical channels. As described in the next chapter, the balance sheet channel is also present for HHs.

An important early empirical contribution was made by Gertler and Gilchrist (1991) who showed that small and large firms behave quite differently, particularly in recessions and periods of tight monetary policy. Whereas the former decumulate their inventories following unanticipated declines in cash flows, the latter increase their short-term borrowing, maintaining their level of production and employment. This divergence is attributed to the easier access to short-term credit markets. Factors such as that smaller firms are normally younger, have higher idiosyncratic risk and are not well collateralized contribute to this. What's more, they are also more bank-lending dependent as they are not able to issue equity or commercial paper. The end result is that, in aggregate, the brunt of the decline in economic activity is borne by the liquidity-constrained smaller firms. For the EA, a similar conclusion of larger sensitivity to monetary policy by younger firms was also recently reached by Durante et al. (2020).

2.3.2 Bank Lending Channel

The borrowers' EFP and economic activity may also be affected by a shift in the supply of intermediated credit. Because banks specialize in overcoming informational problems, allowing them to extend credit to a broader pool of borrowers, a cutoff in supply (initiated by the monetary authority) necessarily leads to a decline in activity and spending for those that cannot make use of alternative forms of financing (e.g. smaller firms) (Bernanke & Gertler, 1995). Thus, the EFP rises either by way of establishing new creditor-debtor relationships, or higher costs of bank funding.

In some sense, the bank lending channel can be seen as working through the banks' balance sheets with the two key items being reserves and capital. Restrictive monetary policy pulls reserves out of the system, decreasing the amount of reservable liabilities that a bank can take advantage of (e.g. demand deposits), and in turn reducing lending should it not be able to substitute them with non-reservable liabilities or liquidate assets other than loans. Moreover, non-reservable liabilities are perceived as more risky, hence the market is imperfect and the lemon's premium is present (Van den Heuvel, 2002). Holders of uninsured bank liabilities are concerned about the credit quality, which affects the cost and availability of said liabilities. This dynamic effectively creates the EFP for banks, which in turn influences the EFP of bank-dependent borrowers (Bernanke, 2007). The presence of the bank lending channel is usually assessed by examining differences across banks. The usual conclusion is that banks with higher funding costs, weaker regulatory balance sheet positions and less liquid assets charge higher loan rates and react more strongly to monetary policy (Altavilla et al., 2024). Analogously to the balance sheet channel, smaller banks are assumed to be more constrained in attaining alternative forms of financing as found by Kashyap and Stein (1995) and Kashyap and Stein (2000). This leads to a stronger reaction in loan supply to a change in monetary policy.

Van den Heuvel (2002) also discusses capital as an important determinant of lending. Firstly, when bank equity is at or below the regulatory minimum, lending cannot be expanded without additional capital due to the risk-based capital requirement. When the constraint is binding, no positive shock to reserves will impact lending. Secondly, liability structure matters for banks. If two banks have the same quality of assets, but one has more debt, new debt issuance will be more costly because it has less equity to cover potential losses. Dynamically, monetary policy can impact equity since the business model of banks is inherently predisposed to interest rate risk due to maturity transformation. Higher short-term interest rates lower banks' profits, overtime resulting in less capital and lending. This bank capital channel complements the previous static discussion.

3 SOURCES OF HETEROGENEITY IN TRANSMISSION

A large body of research has already tackled the issue of significant heterogeneity in the responses of European countries to MPSs. The first influential studies on this topic emerged during the 1990s, in the wake of European monetary integration, which raised numerous questions about the future conduct of a common monetary policy and its potentially divergent effects on member states. This differed from the previous papers, which focused more so on the likely incidence of asymmetric shocks and corresponding adjustment mechanisms (Kieler & Saarenheimo, 1998). The analysis at hand faced multiple challenges that were described in review papers such as Dornbusch et al. (1998) and Kieler and Saarenheimo (1998). In essence, modelling the behavior of a monetary union by taking into account countries with sovereign monetary authorities proved to be a methodologically difficult task. With this in mind, we look at some of the results.

Simulations of national central banks' large macroeconometric models included in the seminal work BIS (1995) showed that output in the Italy decreases twice as much as in the Netherlands on impact due to an interest rate increase. While inflation decreases comparably in the Netherlands, Belgium and Italy, the impact response in France is a third of that. In the same study, simulations using the FED's large multi-country macroeconometric model showed much more uniform cross-country estimates in both variables. Smaller models (although criticized for their limited information sets) were also used to gauge the possible differences in transmission. Dornbusch et al. (1998) jointly estimated prediction equations for output and found that the two-year response of output for Italy to a permanent change in all short-term interest rates is much bigger than those for Germany, France or Spain. The variation was also shown to be statistically significant. In contrast, Britton and Whitley (1997) found no significant differences in responses of output and inflation between France, Germany or the UK, using a small structural Dornbusch overshooting model.

The last, and by far the largest group of papers has examined heterogeneity in transmission using structural VARs. Starting with the three variate price, output and short-term interest rate model of Gerlach and Smets (1995), Germany was found to respond more strongly than France and Italy, but the differences were limited and might have been the product of missing exchange rates. These were included in Barran et al. (1996) who also found differences in transmission between nine European countries, with output decreasing by 0.2 to 0.7% on impact. Heterogeneity was also confirmed by Ehrmann (2000), Mojon et al. (2002), Mihov (2001) and Ramaswamy and Sløk (1998). In general, these studies pointed at Germany as being the most sensitive to MPSs. Austria and the Netherlands also responded strongly, likely due to their close alignment with German monetary policy within the European Exchange Rate Mechanism (Clements et al., 2001). In general, VAR results also depended on the method of identification (Kieler & Saarenheimo, 1998).

Apart from testing for heterogeneity, papers like Britton and Whitley (1997), Cecchetti (1999), Dornbusch et al. (1998), Guiso et al. (2000), Mihov (2001) and Mojon et al. (2002) also hypothesized its possible sources, emphasizing specific country-level structural characteristics related to transmission channels, whose relevance continues to be studied. Based on our review of cited and novel literature (discussed more in-depth in the following subsections), we have chosen five such characteristics with which we roughly cover all the aspects of transmission as put forth in the previous chapter. In relation to the interest rate channel, we look at sectoral composition as proxied by the share of services VA. Furthermore, openness to trade and its empirical proxy remain the primary way of gauging the exchange rate channel. Considering balance sheets and cash-flows, we look at the share of liquidity-constrained HHs according to survey data. Likewise, the share of adjustable rate HH loans is also an indicator closely connected to the cash-flow channel. Lastly, we gather data on the shares of assets of the 5 largest credit institutions (hereinafter: CIs) as a relevant characteristic for bank lending and capable of altering the transmission mechanism.

It is important to note that alternatives have also been floated in the cited literature. For example, apart from banking sector concentration, studies also focused on its health proxied by the return on assets, equity or the interest rate margin. Other important aspects might also be the share of bank loans in liabilities of non-financial corporations, the average size of banks, the time and cost of collateral repossession, the importance of capital markets and the share of firms with only a single bank. Concerning the balance sheet channel, share of short-term liabilities, net debt position of HHs and firms, firm size and HH financial assets relative to their disposable income are the conventionally used measures. In the past few years, literature has also recognized the importance of the housing channel, whereby papers look at the importance of measures such as loan-to-value ratio, homeownership rates and the share of HHs with mortgages (di Casola, 2023; Grandi, 2019; Pica, 2021). Lastly, Georgiadis (2014) and Georgiadis (2015) also pointed out the role of labor market flexibility, an important aspect of optimal currency areas, but also a possible source of heterogeneity in transmission.

Our review of structural characteristics includes the discussion of the relevant theoretical and empirical literature that informs our hypotheses about their potential for mitigation or exacerbation of transmission. Furthermore, we describe our data sources, transformations and analyze the general trends and possible dispersions to facilitate our policy implications discussion. To this end, we employ a figure with two graphs in each instance. On the right-hand side, we show the sample period averages along with the end point values and their corresponding unweighted standard deviations. With this, we can clearly see where individual countries stand and how did their value change over time. This complements the left graph showing cross-sectional box plots throughout the observed sample period.

The box is the interquartile range which covers the values from the 25$^{\text{th}}$ to 75$^{\text{th}}$ percentile, with medians displayed as horizontal lines. Upper and lower values of whiskers are determined by the last values inside the range of 1.5 times the interquartile range from the boxes' ends. Outliers lie outside of the whiskers and are represented by black dots. Additionally, we plot both the unweighted and GDP-weighted EA averages. In the aggregate, the latter are more relevant since they give more weight to larger countries. However, as far as our analysis is concerned, we implicitly treat every country equally. The weights are based on each country's share in the total nominal GDP sum of all countries in the sample. We conduct the analysis on a sample of 17 member states in line with our estimation in Chapter 5. Code for figures was created with the help of Generative Artificial Intelligence.

3.1 Sectoral Composition

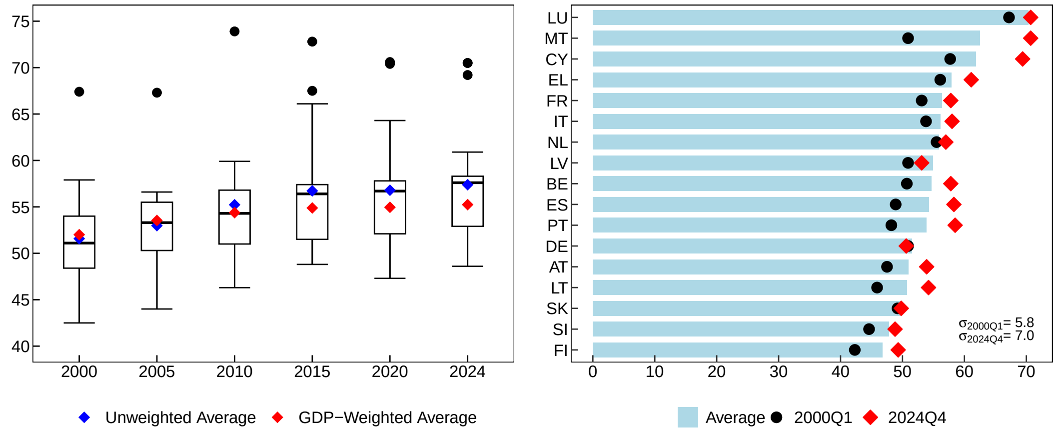
According to the UCC channel, the demand for investment and durable consumer goods should be interest sensitive. Therefore, sectoral composition might impact the effectiveness of monetary policy. Specifically, manufacturing and construction should be more cyclical than other sectors. With regard to this, Carlino and Defina (1998) might be the most influential paper. The authors talk about the regional differences in the US and find that the cumulative response of state real personal income is (in absolute terms) positively correlated with the manufacturing sector size as a share of gross state product. What's more, being a part of a region such as the Great Lakes, whose manufacturing share is much larger relative to the aggregate, also positively influences the cumulative response. The opposite holds for a region like the Southwest, where manufacturing does not account for a high share of gross state product. Similar regional studies were later also performed by Arnold and Vrugt (2002), Ridhwan et al. (2014), Vespignani (2015) and Guo and Masron (2017).

Two cross-industry analyses by Peersman and Smets (2002) and Dedola and Lippi (2005) (mainly based on EA data) have shown that the differences in the overall policy effects can be mainly explained by the durability of sectors' products. For example, output of the motor vehicles sector tends to respond more strongly than the aggregate, whereas it responds less for the food sector. On the other hand, capital or investment intensity does not seem to play a role in explaining the strength of monetary policy as one would theoretically expect. Georgiadis (2015) extrapolates this analysis to the aggregate responses of output and shows that the trough real GDP responses are positively (negatively) correlated with the manufacturing (services) share. Moreover, he did not find a statistically significant correlation with the construction share. More recently, equal conclusion was also reached by Datsenko and Fleck (2024). Along with Battistini and Gareis (2023) and Hauptmeier and Holm-Hadulla (2023), these three analyses also confirm the asymmetry between manufacturing and services sector responses based on aggregate EA data.

To conduct our analysis, we rely on gross VA of the market services sector of individual EA member states, which is equal the sum of the VA of G to N and R to U sectors according to NACE-2 classification. Of course, the values are expressed as a percentage of total VA given that we are interested in differences of economic structure rather than size. The data was sourced from Eurostat (2025d) at quarterly frequency, ranging from 2000Q1 to 2024Q4, and is seasonally and calendar adjusted. In Figure 1, we can see that the weighted average has increased throughout the last 25 years by about 3 percentage points to 55%. This aligns with the narrative of Galesi and Rachedi (2019), who state that advanced economies undergo a structural transformation in which economic composition shifts from manufacturing to services, with both sectors also becoming more intensive in service inputs. Unweighted average is expectedly more influenced by outliers, starting out 0.5 percentage points below its weighted counterpart but ending up 2 percentage points higher.

Initially, Luxembourg stood out as the sole outlier, but was later joined by Cyprus and Malta. In these countries, the financial and insurance activities sector accounts for approximately 26%, 11% and 9% of total VA, respectively, compared to just 4% for the EA aggregate. By the end of the sample period, the standard deviation increased to 7 percentage points, indicating a higher dispersion overall. Nonetheless, non-extreme values appear more concentrated than in 2000, with a slightly lower interquartile range. Across the years considered, all countries recorded an increase in the services share with the exception of Germany, which experienced a slight decline of 0.7 percentage points. The largest increase occurred in Malta, whose share rose by 19.4 percentage points.

Figure 1: Services Value Added (% of Total Value Added) - Distributions Over Time (Left) and Country-Level Averages and Endpoints (Right)



Note: Sample includes 17 EA countries excluding Ireland, Estonia and Croatia and ranges from 2000Q1 to 2024Q4. In the left graph, the first and last box plot represent the distribution of initial and final quarters, respectively, whereas the remaining ones correspond to the first quarter. Upper and lower values of whiskers are determined by the last values inside the range of 1.5 times the interquartile range from the boxes' ends. Outliers lie outside of the whiskers and are represented by black dots. Standard deviations in the right graph are unweighted.

Source: Own work based on Eurostat (2025d).

3.2 Openness to Trade

Openness impacts heterogeneity of monetary policy transmission insofar as value of the domestic currency changes vis-à-vis other currencies. This is why in the case of the EA, only extra EA trade is of interest (Favero & Giavazzi, 1999). This point was also made in Peersman and Smets (2002), who found that more open sectors are less affected during recessions. However, the effect is small for which the authors blamed their sub-optimal construction of the proxy for openness, specifically, their failure to control for within EA trade due to data limitations. Ex ante, they do not make an assumption about the expected sign of the effect of this indicator on the strength of monetary policy. While industries that are more open are less exposed to domestic slumps, their competitiveness is also dependent on exchange rate fluctuations.

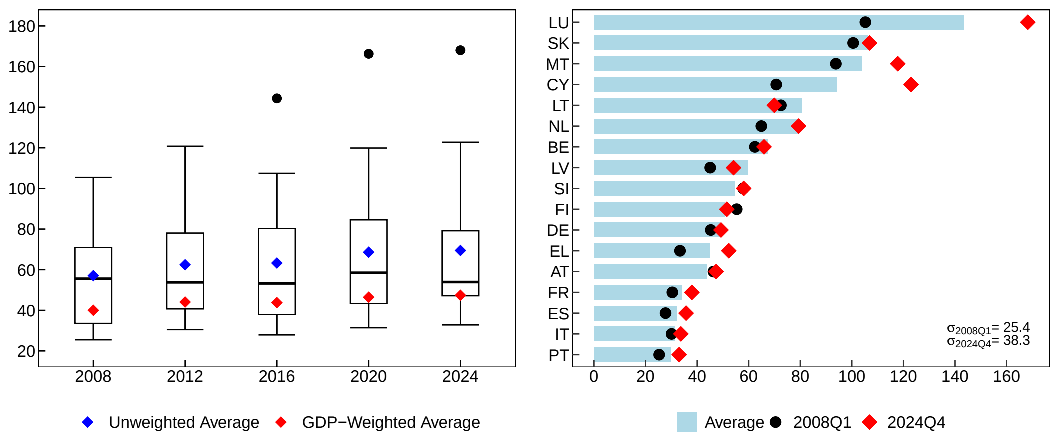
Karras (1999) went further and showed that the degree of openness negatively (positively) impacts the effects of monetary policy on output (inflation). The more open an economy is, the more monetary policy actions will be reflected in prices rather than output. For example, expansionary monetary policy decreases the real exchange rate which makes imports pricier. This results in higher input costs and wage demands, producing inflationary pressures and lower output. The author stated that this relationship is reflected in the steepening of aggregate supply. He also confirmed the theoretical prediction empirically on a panel of 38 countries for both output and prices. Although not statistically significantly, Bowdler and Nunziata (2006) also came to the same conclusion.

Following Peersman and Smets (2002), we construct the trade openness index (TOI) as the sum of total nominal exports (X) and imports (M) relative to nominal GDP (GDP):

$$TOI = \frac{(X+M)}{GDP} * 100 \tag{6}$$

To focus exclusively on extra EA trade, we include only trade (exports and imports) with European Union member states outside the monetary union, third countries, and international organizations. The data was sourced from Eurostat (2025b) and Eurostat (2025c) at quarterly frequency, ranging from 2008Q1 to 2024Q4, and is seasonally and calendar adjusted.

Figure 2: Trade Openness Index (%) - Distribution Over Time (Left) and Country-Level Averages and Endpoints (Right)



Note: Sample includes 17 EA countries excluding Ireland, Estonia and Croatia and ranges from 2008Q1 to 2024Q4. In the left graph, the first and last box plot represent the distribution of initial and final quarters, respectively, whereas the remaining ones correspond to the first quarter. Upper and lower values of whiskers are determined by the last values inside the range of 1.5 times the interquartile range from the boxes' ends. Outliers lie outside of the whiskers and are represented by black dots. Standard deviations in the right graph are unweighted.

Source: Own work based on Eurostat (2025b) and Eurostat (2025c).

Throughout the sample period, the weighted average of trade openness remained significantly lower than the unweighted average not only due to the influence of outliers, but also the below-median openness of large countries such as France, Italy, and Spain (see Figure 2). This pattern aligns with the well-documented inverse relationship between country size and openness (Alesina & Wacziarg, 1998). Over time, the weighted average increased from 40% to 47.5%, while the unweighted average rose from 57% to 69.5%. Both reflect broad-based gains across countries, with the largest improvements observed in Cyprus and Luxembourg, each registering an increase of 50 and 60 percentage points, respectively. As the most open countries also experienced the largest gains, the distribution of trade openness became more dispersed and asymmetric compared to 2008. Standard deviation increased from 25.4 to 38.3 percentage points, the range of non-extreme values widened, and the median decreased by about 1.5 percentage points. From 2016 onward, Luxembourg was the only country consistently identified as an outlier. The four most open economies are also among the ones with the most substantial multinational enterprise activity (Andersson et al., 2023).

3.3 Banking Sector Concentration

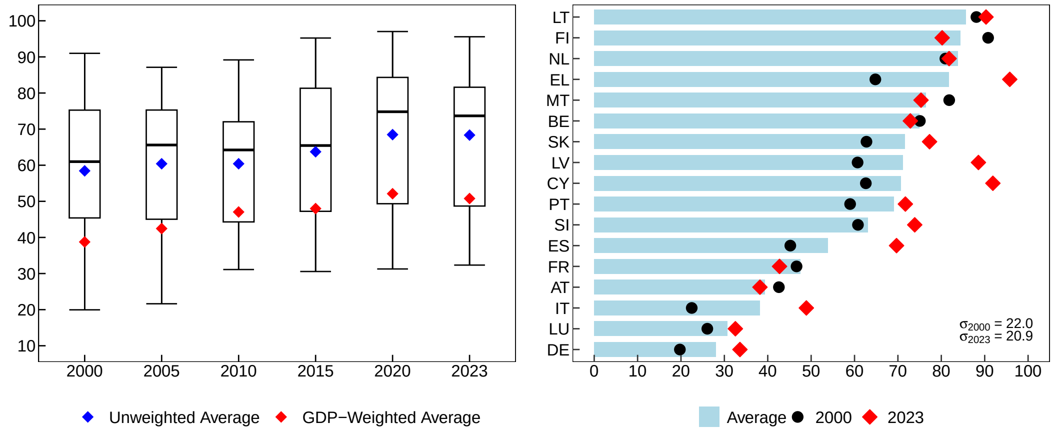
The literature on the banking sector concentration in relation to heterogeneity in transmission to financial markets is broad, but without a consensus about its effects. Therefore, the impact on macroeconomic aggregates is likewise unclear. Beck et al. (2004) describe the existence of two opposing hypotheses. The information-based hypothesis is in line with our discussion about the bank lending channel. Taking into account informational asymmetries and agency costs, market power should lead to less frictions in credit markets. In more concentrated sectors, banks are more willing to engage in relationship lending since they can share in future surpluses, leading to lower interest rates overall (Petersen & Rajan, 1995). What's more, larger banks also have more information about the market, making them more efficient at screening (Marquez, 2002). On the other hand, there is the so-called structure-performance or market power hypothesis. The higher the market power, the lower the competition pressures and the higher costs of lending.

Based on a panel of firm from 20 European countries, Fungacova et al. (2017) find that competition increases the cost of credit, especially for smaller companies. On the other hand, Petersen and Rajan (1995), Beck et al. (2004) and Cetorelli and Strahan (2006) conclude that market power increases the obstacles to obtaining finance. Likewise, an analysis by van Leuvensteijn et al. (2013) based on eight EA countries finds that mark-ups and corresponding bank loan rates tend to be lower in the presence of stronger competition. With regard to the degree of policy pass-through to loan rates, which may be even more relevant in our case, the authors find that it is negatively correlated with concentration.

On the contrary, Gödl-Hanisch (2022) find that the policy rate pass-through is stronger in the case of higher concentration. This finding is also conveyed through their simple Monti-Klein type exposition, which models the banking sector as monopolistically competitive. To our knowledge, it is also one of the few papers that connects the discussion of concentration with its impact on macroeconomic aggregates, finding that based on US branch-level data, the impact of monetary policy on output has become larger, whereas inflation has become less sensitive. A recent paper by Mermelas and Tagkalakis (2024) has shown that higher concentration proxied by the interest rate margin leads to a stronger response of EA inflation, retail sales and unemployment to a contractionary MPS, while there is no differentiation for unemployment if policy is expansionary.

To get a sense of the general dispersion and trends for the banking sector concentration in the EA, we use the data on the country-specific share of assets of the five largest CIs from ECB (2025g). The series ranges from 2000 to 2023 and is measured annually. In Figure 3, we can see that both the weighted and unweighted averages have increased, meaning that the banking sector as a whole has got more concentrated in the EA. The weighted average starts out at around 40%, about 20 percentage points lower from the unweighted one. This difference was the smallest in 2010, when the banking sectors in Germany and Italy consolidated to some extent, but started to rise again until the end period. While the whole sample standard deviation has fallen by 1.1 percentage points and the distribution has shrunk a bit, there are still two distinct groups of countries that have converged considerably.

Figure 3: Assets of the 5 Largest Credit Institutions (% of Total Assets) - Distribution Over Time (Left) and Country-Level Averages and Endpoints (Right)



Note: Sample includes 17 EA countries excluding Ireland, Estonia and Croatia and ranges from 2000 to 2023. Upper and lower values of whiskers are determined by the last values inside the range of 1.5 times the interquartile range from the boxes' ends. Outliers lie outside of the whiskers and are represented by black dots. Standard deviations in the right graph are unweighted.

Source: Own work based on ECB (2025g).

The bottom five countries have ended up in the 30% to 50% range, whereas the previous lowest value (recorded for Germany) was around 20%. Spain has consolidated markedly and joined the upper group of countries. Among the highest-ranking countries, the shares have remained relatively stable (except for Greece), while the middle countries like Latvia and Cyprus saw much larger gains of about 30 percentage points. This dynamic contributes to the increased asymmetry of the distribution in the final period, with the median higher by about 12 percentage points compared to 2020. Notably, there are no clear outliers, and larger countries generally exhibit a more competitive banking environment compared to smaller ones.

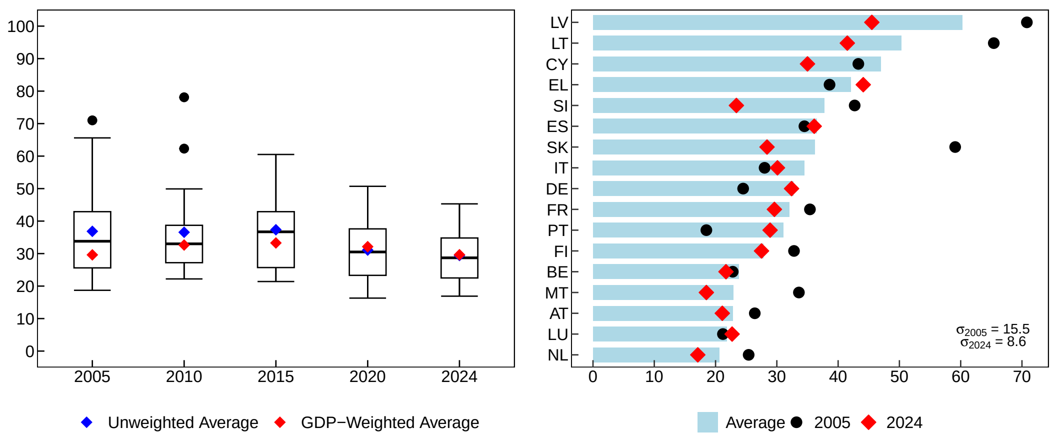
3.4 Liquidity-Constrained Households

In the literature, liquidity-constrained HHs are discussed as hand-to-mouths (hereinafter: HtMs). Empirically, HHs are classified as HtM if their net liquid wealth (e.g. the value of checking accounts less the outstanding credit card balance) is close to zero when positive, or close to their credit limit when negative (Kaplan et al., 2014). Specifically, this distance should not be larger than half of their earnings per pay period. With these conditions in place, HHs that spend all their cash-on-hand or borrow up to their limit in each period are isolated. In the event of an adverse shock, consumption smoothing is not possible (either due to expensive interest rates or the credit constraint) and the marginal propensity to consume out of transitory income shocks will be higher. The difference between poor and wealthy

HtMs is only that the latter hold a positive amount of net illiquid wealth (e.g. current price of household main residence less the remaining mortgage amount owed). Although it could be sold to counter income uncertainty, this is not optimal because of large transaction costs and forfeited future higher return, leading to lower long-run consumption. A stronger reaction to an unexpected transitory change in income for both groups was shown in Kaplan et al. (2014) based on US data. What's more, they also found that the share of HtM differs substantially between countries and the wealthy HtM are actually more numerous than the poor.

Almgren et al. (2022) come to the same conclusion for the EA, constructing their HtM dataset based on the Eurosystem Household Finance and Consumption Survey and applying the criteria of Kaplan et al. (2014). Although this approach allows for precise classification, the underlying micro data is not readily accessible. Fortunately, they also try to proxy their measure of HtM using the European Union Survey of Income and Labor Statistics, the results of which are found on Eurostat (2025f), and find that it exhibits a strong and positive correlation with the baseline one. In this case, HHs are classified as HtM if they report being unable to cover an unexpected, necessary financial expense equivalent to the national monthly at-risk-of-poverty threshold. Due to public availability and close alignment with the series based on micro data, we take this as our measure of liquidity-constrained HHs. It is measured annually as a percentage of total HHs and spans from 2005 to 2024. Furthermore, Almgren et al. (2022) show that the peak output response to a MPS is statistically significantly correlated with the share of HtMs across the member states. County-level heterogeneous responses of employment to uniform MPSs were also found by Bellifemine et al. (2023) for the US.

Figure 4: Liquidity-Constrained Households (% of Households) - Distribution Over Time (Left) and Country-Level Averages and Endpoints (Right)



Note: Sample includes 17 EA countries excluding Ireland, Estonia and Croatia and ranges from 2005 to 2024. Upper and lower values of whiskers are determined by the last values inside the range of 1.5 times the interquartile range from the boxes' ends. Outliers lie outside of the whiskers and are represented by black dots. Standard deviations in the right graph are unweighted.

Source: Own work based on Eurostat (2025f).

On average, country size does not appear to be correlated with the share of HtMs. This is evident from the close proximity of the GDP-weighted and unweighted averages in Figure

4, which converge to around 30% in the last two periods and are nearly indistinguishable. What's more, the big four countries occupy the middle. At the beginning of the sample, the distribution is much wider, with Latvia standing out as the sole outlier. It is also more asymmetric compared to later periods. Interestingly, it had shrunk significantly by 2010 after the Great Recession when Lithuania joined Latvia as an outlier. Afterwards, the distribution stretched upwards, likely reflecting the impact of the sovereign debt crisis.

Intuitively, this may indicate that the share of HtMs is countercyclical. As credit constraints tighten and unemployment rises, more HHs become HtMs. Cyprus was severely hit, but ended up in a much better position than before the crisis. On the other hand, Portugal's HtM share has remained elevated, which is evident from the close proximity of the average and last year's value. Looking at standard deviations and interquartile ranges, countries have converged to a great extent, with most of them finishing much lower than at the start. It seems that HHs were not strongly impacted by the pandemic and the surge in inflation, or if they were, governments and central banks insured that the impact was muted. This does not hold for Germany, whose HtM share increased by 11.6 percentage points in 2020, persisting at its higher level thereafter.

3.5 Interest Rate Structure

We consider the loan interest rate structure a key determinant of monetary policy transmission through the cash-flow channel, as highlighted in the housing market literature. Because mortgages represent a major liability in the HH balance sheet, they likely play an important role in the transmission process (Di Maggio et al., 2017). In particular, the general conclusion seems to be that a higher share of adjustable rate mortgages leads to stronger effects of monetary policy. As interest rate changes affect repayment costs more broadly, disposable income rises relatively more and so does consumption (Casola, 2023). In principle, lower rates could also provide a relief to borrowers with fixed rate mortgages, but this would require a decline in the long-term rate (which is less responsive to policy) and refinancing. Since expansionary policy is normally associated with downturns, both are harder to materialize due to declining housing prices and tighter credit standards (Campbell et al., 2021).

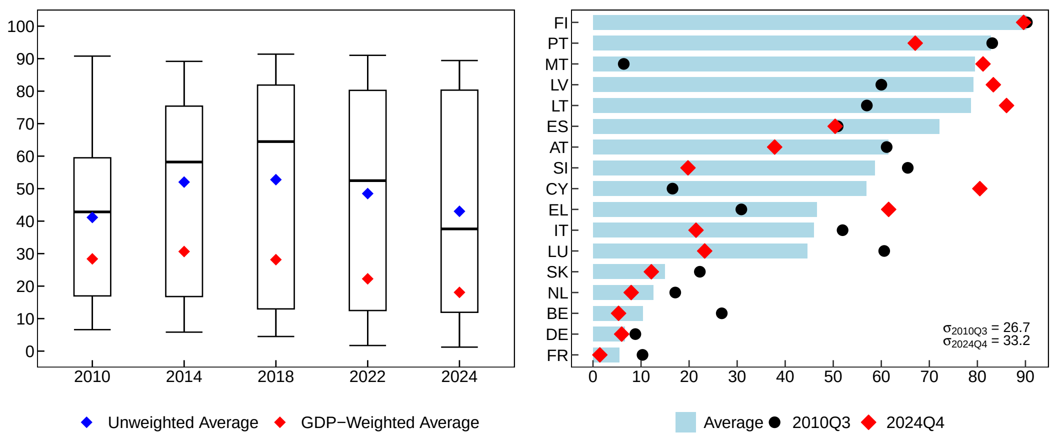
Based on data for 12 EA countries, Pica (2021) has found that the correlation between the peak response of consumption and share of adjustable rate mortgages is statistically significant, strong and positive. Casola (2023) also comes to the same conclusion on a larger sample of EA countries. For the US, Di Maggio et al. (2017) have found that after the interest rate reset for adjustable rate mortgages originating between 2005 and 2007, there was a bigger decline in the average mortgage rate for regions with a higher share of adjustable rate mortgages, leading to a relatively larger increase in consumption. However, what drives the decision between fixed and variable rate mortgages? Albertazzi et al. (2024) show lower historical inflation volatility, lower financial literacy and higher negative correlation between unemployment and the short-term rate all seem to be positively correlated with the share of fixed rate mortgages. As for intertemporal variation, term spread seems to an important factor, otherwise negatively correlated with the share of fixed rate mortgages.

Since we do not have granular data on the interest rate structure of outstanding mortgage contracts, our indicator $ARL(\%)$ is broader in scope, encompassing the share of outstanding adjustable rate loans to HHs. The mechanism should be roughly the same, and in either case, mortgages should represent a substantial amount of these loans, given that 78.7% of the outstanding stock of loans to HHs consisted of mortgages in the last month of 2024 (ECB, 2025d; ECB, 2025e). As adjustable rate loans (ARL), we take the stock of those whose original and remaining maturities are longer than a year with the interest rate reset within the next 12 months following Albertazzi et al. (2024). We then divide them by the stock of all outstanding loans to HHs (TL) in the EA to get the relevant share:

$$ARL(\%) = \frac{ARL}{TL} \tag{7}$$

The quarterly series on adjustable rate loans is collected from ECB (2025f), whereas it is only available at monthly frequency for total loans (ECB, 2025e). Because we work with quarterly frequencies, we aggregate the latter by averaging the respective months. The proxy is constrained by the availability of the stock of adjustable rate loans, ranging from 2010Q3 to 2024Q4.

Figure 5: Adjustable Rate Household Loans (% of Total Household Loans) - Distributions Over Time (Left) and Country-Level Averages and Endpoints (Right)



Note: Sample includes 17 EA countries excluding Ireland, Estonia and Croatia and ranges from 2010Q3 to 2024Q4. In the left graph, the first and last box plot represent the distribution of initial and final quarters, respectively, whereas the remaining ones correspond to the first quarter. Upper and lower values of whiskers are determined by the last values inside the range of 1.5 times the interquartile range from the boxes' ends. Outliers lie outside of the whiskers and are represented by black dots. Standard deviations in the right graph are unweighted.

Source: Own work based on ECB (2025e) and ECB (2025f).

In Figure 5, we can see that HHs generally took advantage of comparatively lower adjustable rates at the start of the sample period which is in line with the analysis of Albertazzi et al. (2024). As monetary policy hit the effective lower bound and quantitative easing began, fixed rate loans became attractive as the term spread narrowed substantially. The associated decrease in the share of adjustable rate loans had persisted until the end. The lowest value has gone from just below 10% in Germany to around 1% in France, while Finland has consistently exhibited the highest share at roughly 90%. The rankings seem to be in line with the historical inflation volatility argument of Albertazzi et al. (2024), who find that the periphery countries had substantially higher volatility than the core. This manifests in commercial banks being more biased towards adjustable rates and this proclivity is somewhat sticky. There have been no outliers and the distribution has got more asymmetric and dispersed through time as evident by the increase in standard deviation and interquartile range. Sizable decreases in the shares of Slovenia, Italy and Luxembourg have contributed to the lower median value of around 38%. The decreasing dynamic of the core (already positioned at the bottom) and Italy has resulted in a growing divergence between both averages from 13 to 25 percentage points.

4 HIGH FREQUENCY IDENTIFICATION: THEORY AND USE

As per Ramey (2016), the literature on identification of macroeconomic shocks is wide and ever-evolving. Over the course of the last century, it developed as a part of a broader effort to understand the inherent dynamics of business cycle fluctuations, with its focus primarily on policy shocks. Undoubtedly, the field was revolutionized by Christopher A. Sims with the introduction of VARs in 1980, a statistical framework heavily built upon in the last few decades. In particular, restrictions grounded in economic theory can be used to constrain some of the parameters in the model to identify structural shocks and impulse responses. Indeed, a structural VAR can nest a variety of alternative identification schemes, including contemporaneous, long-run and sign restrictions. What's more, a part of the literature has also tried to achieve better identification, enriching models with external series by way of factor augmentation, narrative or high-frequency identification.

Papers like Mihov (2001) and Georgiadis (2015) relied on structural VARs to research heterogeneity in transmission. This encompassed the collection of troughs or peaks of either cumulative or per horizon output, inflation or consumption impulse responses and their use in correlation analysis with structural characteristics, whereby statistical significance was based on a t-test. The same holds for Carlino and Defina (1998), Vespignani (2015), Dedola and Lippi (2005) and Guo and Masron (2017) as well, who statistically tested for potential sources of cross-sectional variation in impulse responses using linear regression estimation. Peersman and Smets (2002) instead relied on single equation coefficient estimates, measuring the output response of various industries in multiple countries to an aggregate MPS, and conducted a cross-sectional linear regression analysis after the fact. For the purposes of robustness, they also conducted a one-step analysis by estimating a panel model.

Similarly, contemporary literature also conducts a one-step analysis, but in the form of LPs. Examples include Gödl-Hanisch (2022), Mermelas and Tagkalakis (2024), Altavilla et al. (2024), Holm-Hadulla and Thürwächter (2020) etc. Almgren et al. (2022) also use LPs to estimate consumption responses, but do a correlation analysis akin to the two papers mentioned in the previous paragraph. Their main advantages over VARs are flexibility as they are more suitable for panels and assessment of state-dependence, parsimoniousness and robustness to misspecification, whereas the quantitative equivalence under certain conditions between the two was already formally established (Jordà & Taylor, 2024). Nevertheless, VARs do have the possibility of within-model structural identification schemes listed above, while LPs rely on exogenous external data for identification. With regard to this, high-frequency identified MPSs are certainly the most widespread in applied LP literature.

4.1 Literature Review

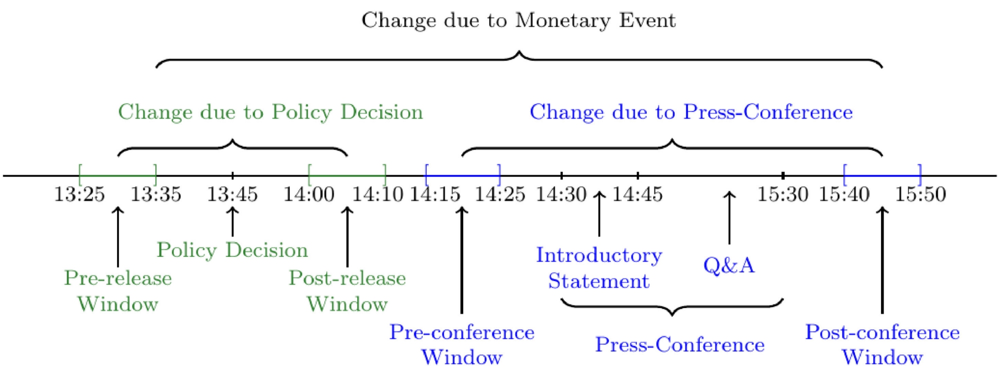
The idea of constructing a MPS series using high frequency data can be traced back to the early 2000s, with an important contribution from Kuttner (2001), who extracted surprises, a proxy for shocks, from changes in FFR futures in connection to Federal Open Market Committee meetings. Here, a surprise is defined as the unanticipated change in the FFR reflected in the change of futures' value from the day prior to the knowledge of the rate change. This greatly improved the perceived responses of market interest rates to the changes in the target rate in comparison to earlier literature, whose proxy was the FFR change alone. Kuttner (2001) correctly pointed out that using the latter attenuates the coefficients since it also contains the anticipated part of the action.

His analysis was expanded by Gurkaynak (2005) who used recursive regressions to extract orthogonal timing, level and slope shocks, bringing the concept of multi-dimensionality of policy shocks to the forefront. Intuitively, timing shocks should only relate to the change in expectations regarding the timing of the FED's actions, whereas the other two reflect the more permanent effects of monetary policy on expectations regarding future rates. One year later, the same methodology for the EA was used by Brand et al. (2006) using changes in forward rates at different horizons for calculating various surprises, affirming their interpretation. Importantly, the slope or path shock of monetary policy in the EA was linked to the second part of the ECB monetary event since it informs agents' expectations about future policy actions.

However, using recursive regressions is not the only way of obtaining orthogonal shocks. Indeed, in the literature concerning the EA, taking advantage of factor models completely superseded it. The method proposed by Gürkaynak et al. (2005) combines the test of minimum discrepancy proposed by Cragg and Donald (1997), principal components analysis and matrix rotation to achieve a structural interpretation of factors. As it stands, this is the dominant apparatus for measuring shocks in the EA. Examples include papers such as Altavilla et al. (2019), Fanelli and Marsi (2022), Motto and Özen (2022) and Andrade and Ferroni (2021). Although it has already been used in Jardet and Monks (2014), the main paper in the field of high-frequency identification was written by Altavilla et al. (2019), setting the stage for further up-to-date analyses.

In the EA, it is customary to use overnight index swap rates (as a risk-free proxy) to gauge the changes in expectations due to a monetary event, i.e. the ECB policy communication following the Governing Council meetings. An event study is conducted around both, the press statement and press conference (see Figure 6). Like in Brand et al. (2006), novel literature connects the conventional policy rate shock to the press statement, whereas forward guidance and quantitative easing shocks emanate from the conference. Crucially, calculating surprises at intra-daily frequency preserves the two assumptions with regard to MPSs. On the one hand, changes in asset prices can only be the result of a monetary policy decision, but also, monetary policy does not respond to asset price changes within the day, allowing only for one-way causality (Altavilla et al., 2019).

Figure 6: ECB Monetary Event



Source: Altavilla et al. (2019).

Apart from MPSs, communication tends to transmit information and risk premium shocks. The former are well known in the literature, whereas the latter are especially talked about in the context of the sovereign debt crisis in the EA, e.g. nice expositions are done by Motto and Özen (2022) or Fanelli and Marsi (2022). To distinguish between the three types of shocks, authors employ different identification schemes, requiring the data on stock indices and sovereign yields in addition to the aforementioned overnight index swap rates. This differentiation is important, since MPSs are otherwise not orthogonal and generate unsatisfactory impulse responses. Cieslak and Schrimpf (2019) summarize the different identification schemes as follows:

– Monetary policy shock: $\uparrow$ yields, $\downarrow$ stock prices (discount rate effect)

– Information shock: $\uparrow$ yields, $\uparrow$ stock prices (cashflow effect)

– Risk premium shock: $\downarrow\downarrow$ long-term yields, $\downarrow$ stock prices (risk-premia effect)

The real value of these shocks, however, is their use in macroeconomic models to gauge the effects of monetary policy. The study of the effects of MPSs sourced as external series on macroeconomic variables has already been conducted in Cochrane and Piazzesi (2002), using a standard single regression framework, whereby the shock was the change in 1M Eurodollar rate surrounding the target rate change. Here, they considered the effect on employment and the consumer price index. Two years later, Faust et al. (2004) used a VAR in conjunction with an external shock and impulse matching. The variables used were the industrial production index, consumer price index, sensitive commodity price index, FFR, nonborrowed reserves and total reserves. Furthermore, Barakchian and Crowe (2013) used Cholesky identification in a three variable VAR with output, prices and a newly constructed shock measure. Today, however, the most widespread method of external series inclusion in the VAR framework is the proxy VAR or instrumental variable structural VAR introduced in Stock and Watson (2012), but popularized by Gertler and Karadi (2015).

Note that the discussion about estimating the effects of MPSs on macroeconomic variables assumes at least monthly data frequency. As high frequency identification is necessarily done at daily or intra-daily frequency, the literature proposed two different aggregation techniques to reconcile this mismatch, either simple summation as in Jarociński and Karadi (2020) or weighted averaging as in Gertler and Karadi (2015). There is still no consensus on the optimal method of aggregation.

4.2 Local Projections

In addition to proxy VARs, LPs are also a great and robust way of generating impulse responses of variables of interest to external shocks. The method itself was coined by Jordà (2005) and entails direct horizon-by-horizon regression estimation. In the case of external shocks, these can be inserted directly into the equation or used to instrument a policy variable, producing a two-stage estimation akin to the proxy VAR. Our setup follows the recent review of Jordà and Taylor (2024) who point out that estimation in levels:

$$y_{t+h} = \tilde{\alpha}^h + \tilde{\beta}^h s_t + \tilde{\gamma}^h y_{t-1} + u_{t+h} \tag{8}$$

leads to a substantial bias in smaller samples. This is why long-differences specification is usually preferred and dominant in the literature. We can write the general model as follows:

$$y_{t+h} - y_{t-1} = \alpha^h + \beta^h s_t + \gamma^h \Delta y_{t-1} + u_{t+h} \tag{9}$$

where the left-hand side corresponds to long-differences in the dependent variable, starting with the first difference. The coefficient of interest β^h traces the cumulative impact of shock s in t on our dependent variable, amounting to the impulse response $\mathscr{R}_{s \to y}$. In empirical work, (9) is usually augmented with controls. Indeed, even Jordà and Taylor (2024) define LPs as a sequence of regressions where the outcome, dated at increasingly distant horizons, is regressed on an intervention, conditional on a set of controls that include lags of both the outcome and intervention, as well as other exogenous or predetermined variables. Thus, the baseline model can actually be rewritten as:

$$y_{t+h} - y_{t-1} = \alpha^h + \beta^h s_t + \gamma^h \boldsymbol{x}_t + u_{t+h} \tag{10}$$

where $\boldsymbol{x}_t$ is a group of control variables. Furthermore, it can be shown that u_{t+h} is likely to be serially correlated up to h lags, or in other words, error terms in LPs for horizons greater than zero are inherently autocorrelated (Lusompa, 2023). Using recursive substitution and a stylized AR(1) process, it follows that:

$$y_t = \phi(\phi y_{t-2} + u_{t-1}) + u_t \tag{11}$$

where we used the fact that $y_{t-1} = \phi y_{t-2} + u_{t-1}$. Simplifying this expression gives us:

$$y_t = \phi^2 y_{t-2} + \phi u_{t-1} + u_t \tag{12}$$

and repeating this process for h periods allows us to write (11) more generally:

$$y_t = \phi^h y_{t-h} + \phi^h u_{t-h} + ... + \phi u_{t-1} + u_t \tag{13}$$

Still, we can rewrite this to get a more sensible representation of LP by replacing every t with $t+h$:

$$y_{t+h} = \phi^{h+1} y_{t-1} + \phi^h u_t + ... + \phi u_{t+h-1} + u_{t+h} \tag{14}$$

where the resulting first term $\phi^h y_t$ is normally replaced by $\phi^{h+1} y_{t-1}$ to capture the autoregressive nature of the process, but also because right-hand side of (11) is not changing through the iterative estimation. Other terms represent a composite error w_{t+h}, which is a weighted average of past errors and therefore autocorrelated. Although Montiel Olea and Plagborg-Møller (2021) show that lag-augmentation can actually simplify the computation of standard errors by only using a heteroskedasticity-robust estimator like White correction, Newey-West errors with maximum lag of $h-1$ are still used in practice even in the presence of lags on the right-hand side. Due to the absence of autocorrelation in errors, the preferred specification can be tested with information criteria for $h=0$ and then carried forward for each iteration of estimation (Jordà & Taylor, 2024). LPs can also be easily extended to panel data which is far more convenient than estimating a system of panel regressions like in the case of a VAR. A typical specification could look like:

$$y_{i,t+h} - y_{i,t-1} = \alpha_i^h + \delta_t^h + \beta^h s_{i,t} + \gamma^h \boldsymbol{x}_{i,t} + u_{i,t+h} \tag{15}$$

where α_i^h are unit-specific and δ_t^h are time-fixed effects. Here, a shock is specified as unit-specific, though in our case it will be the same for all units. Furthermore, time-fixed effects are only seldom used in the literature. As far as inference is concerned, in standard macroeconometric panels where $T >> N$, Driscoll and Kraay (1998) robust standard errors are used to adjust for both heteroskedasticity and autocorrelation. Again, the maximum lag is set to $h-1$. Because lags of the endogenous variable are often included in $\boldsymbol{x}_{i,t}$, potential incidental parameter biases could arise in short panels with a highly serially correlated endogenous variable. This would call for generalized method of moments estimation (Jordà, 2023). If the time dimension of the panel is large, the literature proceeds with fixed effects estimation since bias is mitigated as shown in Nickell (1981).

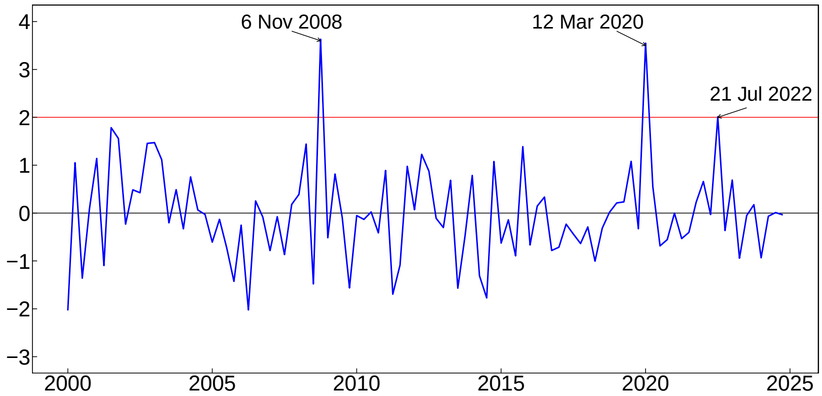
4.3 Shock Analysis

Our monetary shock is sourced from Jarociński and Karadi (2020) due to two reasons. Firstly, the shock is broad, encompassing conventional policy and forward guidance elements, but not asset purchases. This was expanded upon in Boeckx et al. (2019) in response to Elbourne and Ji (2019), who made an assertion about the failures of contemporary literature trying to identify unconventional MPSs. Part of their argument was also based on non-existent correlation with the MPS of Jarociński and Karadi (2020). The counterargument presented by Boeckx et al. (2019) was that these two shocks are qualitatively different. While Jarociński and Karadi (2020) rely on identification based on the Euro Overnight Index Average or overnight index swap rates, and by extension policy rates, the literature on unconventional policy measures formulates identification around the balance sheet as a policy instrument. The goal of these measures is to provide liquidity to constrained financial markets, manifesting itself in lower interest rate spreads and risk premia, which have real effects on the economy. It is unclear why this would influence movements in short-term swap rates. Furthermore, Altavilla et al. (2019) also show that quantitative easing only affects long-term yields with mild assumption of orthogonality and variance.

The second reason is that the shock is purged of central bank information effects, which can attenuate the effects of MPSs and make them insignificant as already discussed in Section 4.1. This concern is expressed in Altavilla et al. (2019), whose forward guidance and quantitative easing shocks were later shown to be correlated with central bank information shocks of Jarociński and Karadi (2020) in Gnewuch (2022). In-depth description of the decomposition methodology for the series at hand is available in Jarociński (2022). The author essentially decomposes a matrix of surprise series for an interest rate measure and stock index such that they are equal to a weighted sum of two orthogonal shocks. For this, he uses the fact that a MPS should lead to negative co-movement between the two, whereas it should be positive for the central bank information shock. The series is orthogonal by construction and calculated based on the first principal component of 1M, 3M, 6M and 1Y overnight index swap rates, and the EURO STOXX 50 index. Of course, the decomposition necessitates capturing surprises across the whole monetary event. This is because the economic outlook is usually commented on in the press conference.

Figure 7 plots the standardized MPS aggregated from monthly to quarterly frequency. We follow the aggregation technique of the authors themselves and sum the values for the corresponding months. The shock series ranges from 2000Q1 and 2024Q4. Notable positive (restrictive) realizations of the shock, all at least two standard deviations from the zero mean, occurred in 2008Q4, 2020Q1 and 2022Q3 in relation to the three crises of the last two decades. On 6 November 2008, markets reacted forcefully after the 50 basis points cut by the ECB did not meet expectations raised by the sharp 150 basis points rate cut of the Bank of England on the same day despite the recognition that financial market turmoil is broadening and will likely spill over to the real economy (Badinger & Schiman, 2023). On 12 March 2020, the ECB decided to leave their policy rate unadjusted although financial markets expected a decrease of the deposit rate by 10 basis points to -0.6% or even lower as the potential consequences of the coronavirus pandemic became clearer (Smith, 2020). Lastly, on 21 July 2022, the policy rate was increased by 50 basis points to decisively counter rising inflation which surprised the markets who expected a lower 25 basis points increase (Amaro, 2022). A narrative analysis of this kind can at least in part confirm the sensibility of the sourced MPS.

Figure 7: Standardized Monetary Policy Shock



Source: Own work based on Jarociński & Karadi (2020).

4.3.1 Aggregate Impulse Responses

We also look at the responses of a wider range of macroeconomic and financial variables to gauge whether the shock's effects are theoretically consistent. We do this by estimating LPs based on aggregate EA data before moving on to a panel framework in the next chapter. To test this, we use the following model:

$$y_{t+h} - y_{t-1} = \alpha^h + \beta^h \varepsilon_t^{MP} + \gamma^h \boldsymbol{x}_{t-1} + \delta^h COVID_t + u_{t+h} \tag{16}$$

where the dependent variables include the aggregate real GDP, HICP, the unemployment rate, EURO STOXX 50 index, the real effective exchange rate and loans to EA HHs. On the right hand side, we include a constant term, the standardized MPS (ε^{MP}) and control variables. These include one lag of the standardized MPS, our current dependent variable, but independently of this, we always control for economic activity (GDP), the labor market (the unemployment rate), prices (HICP) and the bond market (sovereign yields) with one lag of each. The latter provides valuable information and hence improves identification of monetary policy effects, especially for financial variables. We also control for the exogenous COVID shock in 2020Q2 and the following base effect in 2020Q3 with two dummy variables akin to Andres-Escayola et al. (2024).

Specification is determined based on two factors: 1. unreliable estimates in the presence of too many parameters and 2. endogeneity by including variables in time t on the right hand side. Firstly, albeit we do not have a system of equations as in a VAR, equation-by-equation estimation still cuts into the sample with each iteration which is why longer horizon might be poorly estimated. Thus, we orient ourselves so that we always have between 5 to 10 observations per parameter. Secondly, we avoid making causal statements for any other variable except the MPS by not including contemporaneous values of controls. As Jordà and Taylor (2024) state, the opposite would directly correspond to making the causal ordering assumption in a typical VAR. For inference, we construct 90% confidence bands using Newey-West errors as normally done in the LP literature (Mermelas & Tagkalakis, 2024; Gödl-Hanisch, 2022; Holm-Hadulla & Thürwächter, 2020). In constructing the code and figures, we helped ourselves with Generative Artificial Intelligence. This is also true for our panel data estimation in the next chapter.

Table 1 provides more details on the data used beside the MPS. The data that is not originally measured quarterly is aggregated by averaging the corresponding months. The model is estimated on a sample ranging from 2004Q4 to 2024Q4. To construct long-differences, every series is sourced in levels and log-differenced, except for the unemployment rate for which the differences are absolute. On the right-hand side, variables enter in (log) first differences with the exception of yields which enter in levels as in Jordà et al. (2020). The data is sourced from Eurostat and the ECB Datawarehouse.

Table 1: Aggregate Euro Area Data Description

Description	**Frequency**	**Unit**	**Transformation**
Real Gross Domestic Product, SCA	Q	mio EUR	$\Delta \ln$
Harmonised Index of Consumer Prices, WDA and SCA	M	–	Avg, $\Delta \ln$
Unemployment Rate, SA	Q	%	Δ
Real EUR Effective Exchange Rate	M	–	Avg, $\Delta \ln$
EURO STOXX 50 Equity Index	M	–	Avg, $\Delta \ln$
Loans to Households (outstanding stock)	M	mio EUR	Avg, $\Delta \ln$
10Y Spot Nominal Government Yield	D	%	Avg
Monetary Policy Shock	Q	std. dev.	–

Note: SA - Seasonally Adjusted, SCA - Seasonally and Calendar Adjusted, WDA - Working Day Adjusted and Avg - Averaged. $\Delta \ln$ and Δ indicate first differences applied when the variables are used as regressors. When used as dependent variables, these are cumulated. All variables are averaged to quarterly frequency. Methodology for the monetary policy shock is discussed in Section 4.3.

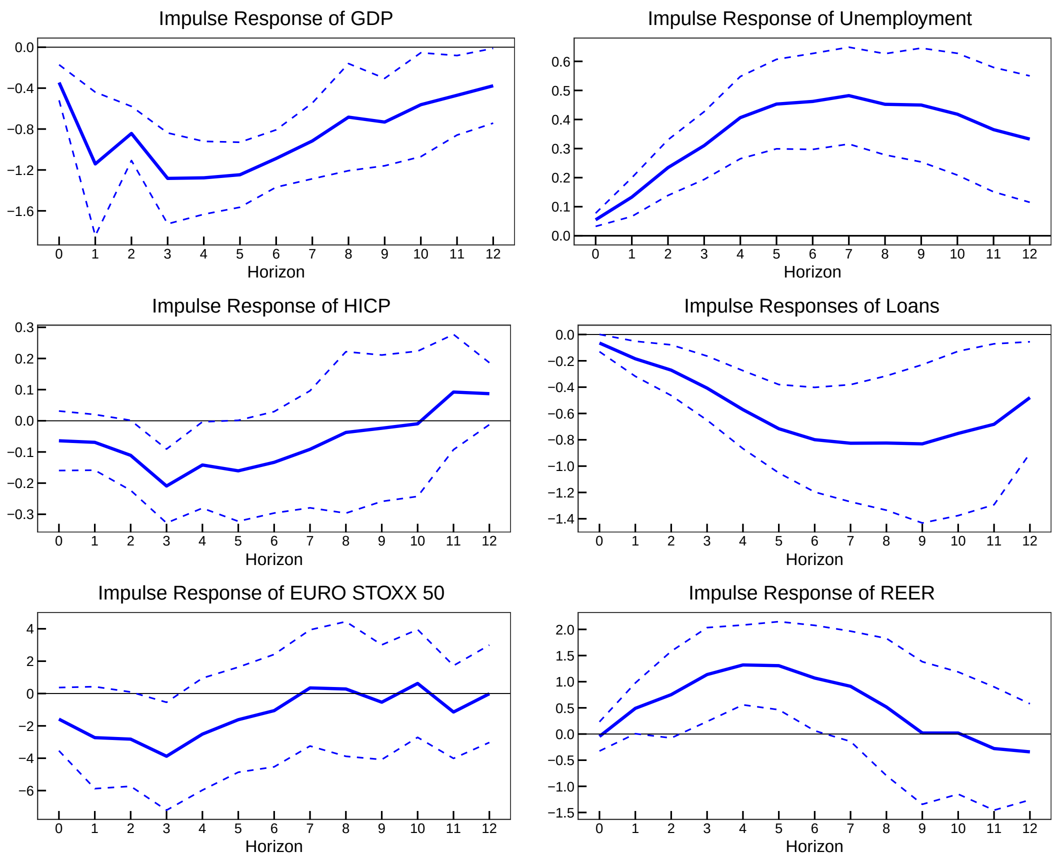
Source: Own work based on ECB (2025a), ECB (2025b), ECB (2025c), ECB (2025e), ECB (2025h), Eurostat (2025d), Eurostat (2025g), Eurostat (2025h) and Jarociński & Karadi (2020).

In Figure 8, we can see the impulse responses of our dependent variables to a one standard deviation MPS. Note that responses of log-transformed aggregates are multiplied by 100 to reflect percent changes. We can see that responses are broadly in line with theory. On impact, GDP decreases by approximately 0.4%, reaching a peak negative effect of 1.3% after three quarters. In contrast, the unemployment rate increases more gradually, peaking at around 0.5 percentage points after approximately two years. Thus, its response is somewhat more sluggish compared to that of economic activity. Nevertheless, both responses are strongly statistically significant. This is not the case for HICP, which exhibits a statistically significantly decline of 0.2% after three quarters, but otherwise responds weakly to our shock. As we will show, this pattern continues to hold when using a panel framework.

Moving on, the outstanding amount of loans to HHs significantly decreases as expected by

0.8%, reaching the bottom after two years. The response of the stock market is the largest in absolute terms, albeit only significant in the third quarter, as it declines by about 4%, but then quickly returns back to the null. Lastly, the real effective exchange rate increases as the euro appreciates against other currencies, with the peak cumulative effect of monetary policy reaching about 1.5% in the fourth quarter. This effect subsequently dissipates by the third year. With this in mind, we now turn to the panel setting. We begin by discussing the specification, followed by an analysis of the responses as a function of structural indicators and an assessment of whether these align with expectations.

Figure 8: Impulse Responses of Euro Area Aggregates



Note: REER - real effective exchange rate. Dashed lines represent 90% confidence intervals constructed with Newey-West errors, choosing a maximum lag of $h-1$. Horizons are equal to quarters and the y-axis values are in percent, except for the unemployment rate which is in percentage points. The sample ranges from 2004Q4 to 2024Q4.

Source: Own work.

5 ASSESSING HETEROGENEITY IN THE EURO AREA

Three conditions must be met for a common monetary policy to succeed without causing frictions among member states (Guiso et al., 2000). Firstly, there must be an agreement on the ultimate goal to be achieved through monetary policy. In the case of the EA, this was settled through the Maastricht Treaty. Secondly, to the extent that business cycles are well aligned, monetary policy is easier to implement. This is related to the theory on optimal currency areas. In short, there exist some characteristics whose cross-country heterogeneity could increase the likelihood of asymmetric shocks. If this is the case, there ought to be some mechanisms by which the shocks can be ameliorated. Note that there is no clear consensus on whether the advantages of the euro outweigh its disadvantages (Baldwin & Wyplosz, 2019). Lastly and topical for our thesis, even if business cycles are aligned, possible differences in the transmission of MPSs make the judgment about the size and timing of a response much harder.

Older and current studies have shown that the single monetary policy has varying impacts across the EA, which is in part due to structural differences between the economies. That being said, there are incongruent results with regard to the rankings of countries in terms of their sensitivity to monetary policy. Therefore, such results should not be overstated as they have been shown to be sensitive to the estimation period, model structure, identification assumptions etc. The relative standings may also change through time due to other factors such as structural reforms. While at its core, the ECB mandate of price stability is tied to the EA as a whole, this need not to apply to the modelling framework. In fact, country-specific data provide important information for monetary policy decision-making since they help to understand dynamics at the aggregate. This also involves using multi-country structural models and the aggregation of individual country forecasts at the EA level (Deutsche Bundesbank, 2023).

In the following chapter, we estimate a panel LP model with interaction terms. We present the data and methodology, impulse responses of GDP, HICP and the unemployment rate, and try to establish some policy implications by providing a cross-sectional and an intertemporal analysis of our estimates. Rather than focusing on the overall sensitivity of different countries to monetary policy, our aim is to question whether certain characteristics entail heterogeneous responses and simultaneously assess what is their marginal impact (in size and sign) on transmission. While monetary policy can partly shift the values of certain characteristics, other policies, particularly national ones, are also important determinants (Deutsche Bundesbank, 2023). Of course, this discussion is outside the scope of our analysis.

5.1 Data and Methodology

To estimate our model, we use the data listed in Table 2. Overall, the dataset is similar to the one used in the aggregate model. Apart from leaving out financial variables (except for sovereign yields), we include the series for our structural characteristics laid out in detail in Chapter 3. While GDP is already seasonally and calendar adjusted for each country in the sample, this is not true for the HICP. To do this, we use the X-13ARIMA-SEATS method of the US Census Bureau (Sax & Eddelbuettel, 2018). Again, both are log-differenced, while the change in the unemployment rate is absolute. When used as dependent variables, this still holds, but the differences are cumulated. Like yield data, all variables pertaining to structural characteristics enter the model in levels. In the case of annual data, the value is simply equal for all corresponding quarters, whereas monthly data is averaged to obtain a quarterly measure. All series are taken from Eurostat or the ECB Datawarehouse.

We do not include Ireland due to peculiar movements in GDP, sectoral gross VA and trade flows as alluded to in Andersson et al. (2023), which could bias our results. What's more, we also exclude countries if they would shorten the time dimension too much or the data is simply not present. For example, we limit ourselves to 17 member states, excluding Estonia and Croatia as well due to shorter financial data series. For clarity, countries and periods included in the estimation sample will be noted under each figure.

Table 2: Panel Data Description

Description	**Frequency**	**Unit**	**Transformation**
Real Gross Domestic Product, SCA	Q	mio EUR	Δln
Harmonised Index of Consumer Prices	M	–	SA, Avg, Δln
Unemployment rate, SA	Q	%	Δ
10Y Government Bond Yield	M	%	Avg
Share of Services VA, SCA	Q	%	–
Trade Openness Index, SCA	Q	%	–
Share of Assets of the 5 Largest Credit Institutions	A	%	–
Share of Liquidity-Constrained Households	A	%	–
Share of Adjustable Rate Loans to Households	Q	%	–
Monetary Policy Shock	Q	std. dev.	–

Note: SA - Seasonally Adjusted, SCA - Seasonally and Calendar Adjusted and Avg - Averaged. Δln and Δ indicate first differences applied when the variables are used as regressors. When used as dependent variables, these are cumulated. All variables are averaged to quarterly frequency. For structural indicators and the monetary policy shock, the data sources and methodology are discussed in the relevant sections of Chapter 3 and Section 4.3, respectively.

Source: Own work based on ECB (2025e), ECB (2025f), ECB (2025g), Eurostat (2025a), Eurostat (2025b), Eurostat (2025c), Eurostat (2025d), Eurostat (2025e), Eurostat (2025f), Eurostat (2025g) and Jarociński & Karadi (2020).

To measure potential cross-country heterogeneity in transmission, we rely on interaction terms. We can show this by expanding (15) with an additional term and simplifying by making the shock variable country-invariant and omitting time-fixed effects:

$$y_{i,t+h} - y_{i,t-1} = \alpha_i^h + \beta^h s_t + \theta^h s_t z_{i,t} + \gamma^h \boldsymbol{x}_{i,t} + u_{i,t+h} \tag{17}$$

where the marginal effect (hereinafter: ME) of a MPS on the long-difference in our dependent variable at period h would be equal to the baseline effect of the shock (β^h) added to the IC (θ^h), which is multiplied by the value of the corresponding structural indicator (z):

$$\frac{\partial \Delta_h y_{t+h}}{\partial s_t} = \beta^h + \theta^h z_{i,t} \tag{18}$$

With this, the effects of monetary policy may differ with the variation in our structural indicators. In essence, (18) represents our impulse responses for $h = 0, ..., 12$ or three years since we are working with quarterly data. We will distinguish between the 10^{th} and 90^{th} percentile impulse responses and construct 90% confidence intervals using the Driscoll-Kraay robust standard errors. Given that we use interaction terms, their construction is a bit more involved. For this, we follow Leeper (2023) who shows how to calculate variances of MEs with the delta method. These vary in a non-linear fashion with the value of the structural characteristic and the same holds for the resulting confidence intervals. Our specification is an extension of (17) and its variations have already been used in papers like Gödl-Hanisch (2022), Altavilla et al. (2024) and Holm-Hadulla and Thürwächter (2020):

$$
\begin{aligned}
y_{i,t+h} - y_{i,t-1} = \alpha_i^h + \sum_{j=0}^{3} \beta_{j+1}^h \varepsilon_{t-j}^{MP} + \theta^h \varepsilon_t^{MP} z_{i,t-1} + \phi^h z_{i,t-1} \\
+ \sum_{j=1}^{3} \gamma_j^h \boldsymbol{x}_{i,t-j} + \delta^h COVID_t + u_{i,t+h}
\end{aligned}
\tag{19}
$$

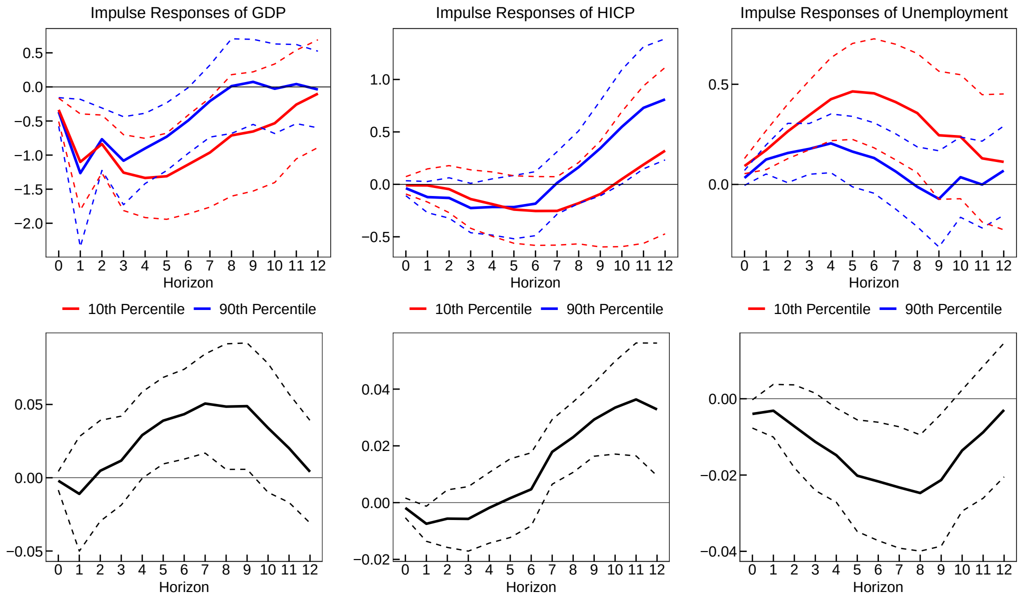
In order to keep the lag structure the same between models and follow the convention of lag uniformity in the literature, we compromise between Bayesian and Akaike information criteria by including two lags of the shock and three lags of the dependent variables and controls. Note that, in general, results are robust to other specifications in sign. A richer lag structure is possible due to a higher number of observations. We do not include time-fixed effects since their inclusion could absorb all aggregate variation, including the MPS (Sekkel et al., 2024). We use the least squares dummy variable estimator, by including individual country dummies. For every structural indicator, we look at the responses of GDP, HICP and the unemployment rate to a one standard deviation MPS. Controls include all of the above alongside sovereign yields as a proxy for the financial market dynamics due to a strong improvement in identification of the effects as in the case of aggregate LPs. A novel feature is the interaction term between the MPS and structural indicators.

To robustify our estimates, we include the latter as a standalone term as in Altavilla et al. (2024) and both are predetermined (enter in $t-1$) to avoid endogeneity concerns as pointed out in Gödl-Hanisch (2022). In principle, monetary policy could also impact these indicators in t, but since they are fairly slow moving, this impacts the estimates only marginally. As mentioned before, we have an unbalanced panel, meaning the effective sample will change depending on the structural indicator used. We plot two figures for each dependent variable. Impulse responses at the 10^{th} and 90^{th} percentiles are in the first row, whereas the ICs are underneath to show whether the differentiation is statistically significant. Note that GDP and HICP responses are multiplied by 100 to reflect percent changes.

5.2 Impulse Response Analysis

Starting our analysis with the responses conditional on the share of services VA, it seems like a smaller share leads to a stronger and more persistent GDP response (see Figure 9). The two responses start to diverge in the third quarter, with the 10^{th} percentile response reaching the bottom of -1.34 percent in the next. The IC is statistically significant, reaching around 0.05 after two years. This means that in roughly two years, the response of output is in absolute value smaller by 0.05 percentage points for an additional percentage point in the share of services VA. On the other hand, HICP responses behave even worse than in the aggregate case. One would expect a bigger persistent decrease. Still, whereas responses are counterintuitive in the first half, the IC has a sensible sign and is statistically significant in the second. Lastly, the unemployment rate responses tell the same story as those for GDP. The higher the share of services VA, the weaker the response. The IC bottoms out at around -0.025 percentage points, suggesting that a marginal increase of a percentage point in the share of services VA leads to a 0.025 percentage points decrease in the response after two years. At that point, the difference between the 90th and 10th percentile responses is about 0.35 percentage points.

Figure 9: Impulse Responses of GDP, HICP and Unemployment by Share of Services Value Added (Top) and Corresponding Interaction Coefficients (Bottom)



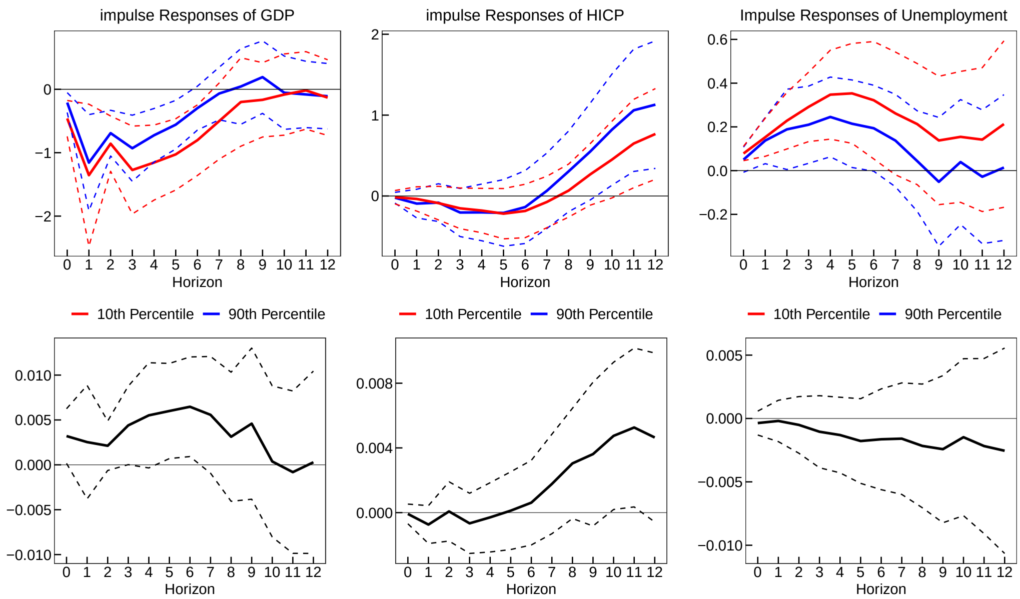
Note: Dashed lines represent 90% confidence intervals constructed with Driscoll-Kraay errors, choosing a maximum lag of $h-1$. Horizons are equal to quarters and the y-axis values are in percent, except for the unemployment rate which is in percentage points. The sample ranges from 2003Q1 to 2024Q4, excluding Ireland, Estonia and Croatia.

Source: Own work.

In Figure 10, we can see the responses conditional on extra EA trade openness. Here, only the IC for GDP is statistically significant and sensible in sign, if only barely so in the first half of the second year after the impact of the shock. This points to a weaker effect of monetary policy in the case of higher trade openness. The IC is equal to around 0.006 percentage points. At the beginning, responses for both percentiles are close, but drift apart in the second year after the shock, with the largest difference being around 0.5 percentage points. Concerning HICP, responses are insignificant, except for the last three periods, but overall do not behave as one would assume. As for unemployment, impulse responses are again in line with theory, but no statistically significant difference was found on the margin.

As can be seen in Figure 11, the marginal difference in the response of GDP is statistically significant only one period after the impact, with the IC amounting to around -0.007. It then starts to converge to zero, becoming positive in the second year, but stays insignificant until the end.

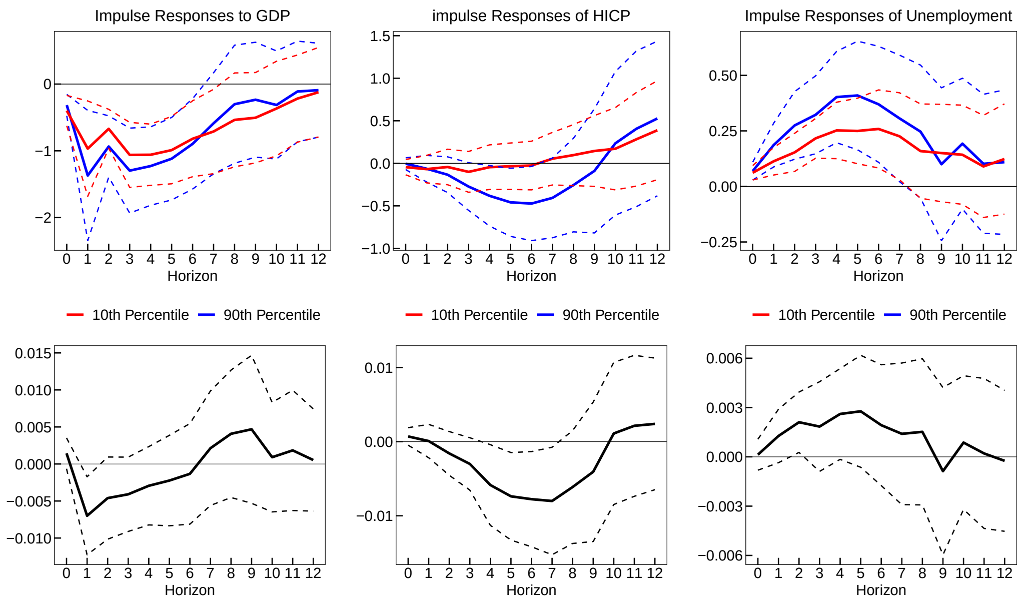
Figure 10: Impulse Responses of GDP, HICP and Unemployment by Trade Openness (Top) and Corresponding Interaction Coefficients (Bottom)



Note: Dashed lines represent 90% confidence intervals constructed with Driscoll-Kraay errors, choosing a maximum lag of $h-1$. Horizons are equal to quarters and the y-axis values are in percent, except for the unemployment rate which is in percentage points. The sample ranges from 2008Q1 to 2024Q4, excluding Ireland, Estonia and Croatia.

Source: Own work.

Figure 11: Impulse Responses of GDP, HICP and Unemployment by Share of Assets of the 5 Largest Credit Institutions (Top) and Corresponding Interaction Coefficients (Bottom)



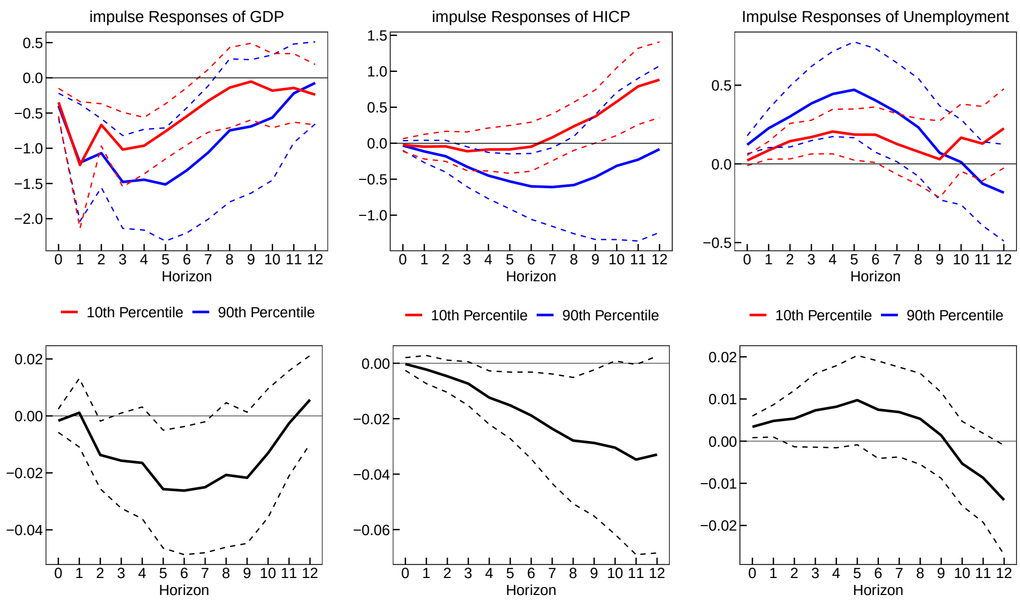
Note: Dashed lines represent 90% confidence intervals constructed with Driscoll-Kraay errors, choosing a maximum lag of $h-1$. Horizons are equal to quarters and the y-axis values are in percent, except for the unemployment rate which is in percentage points. The sample ranges from 2003Q1 to 2023Q4, excluding Ireland, Estonia and Croatia.

Source: Own work.

Although HICP responses become positive at the end yet again, there seems to be a strong differentiation on the margin in the second year when the IC reaches the value of -0.008, statistically significantly so. It seems that stronger concentration of the banking sector might result in stronger transmission, confirming the recent findings of Mermelas and Tagkalakis (2024). Note that only the 90$^{\text{th}}$ percentile response is statistically significant during the observed horizon. At the trough of the IC, the difference is equal to around 0.45 percentage points. The unemployment rate responses are marginally different conditional on varying degrees of the share of the five largest CIs in total assets after two quarters, whereby the IC is equal to around 0.002. This means that an additional percentage point in the share of the five largest CIs in total assets leads to a 0.002 percentage points larger response in the unemployment rate after two quarters.

We continue by looking at the impulse responses conditional on the share of liquidity-constrained HHs in Figure 12. Although responses of GDP coincide on impact and in the first quarter, they quickly decouple. Notice that the 90$^{\text{th}}$ percentile response only reaches the bottom after five quarters, 0.75 percentage points lower than its 10$^{\text{th}}$ percentile counterpart.

Figure 12: Impulse Responses of GDP, HICP and Unemployment by Share of Liquidity-Constrained Households (Top) and Corresponding Interaction Coefficients (Bottom)



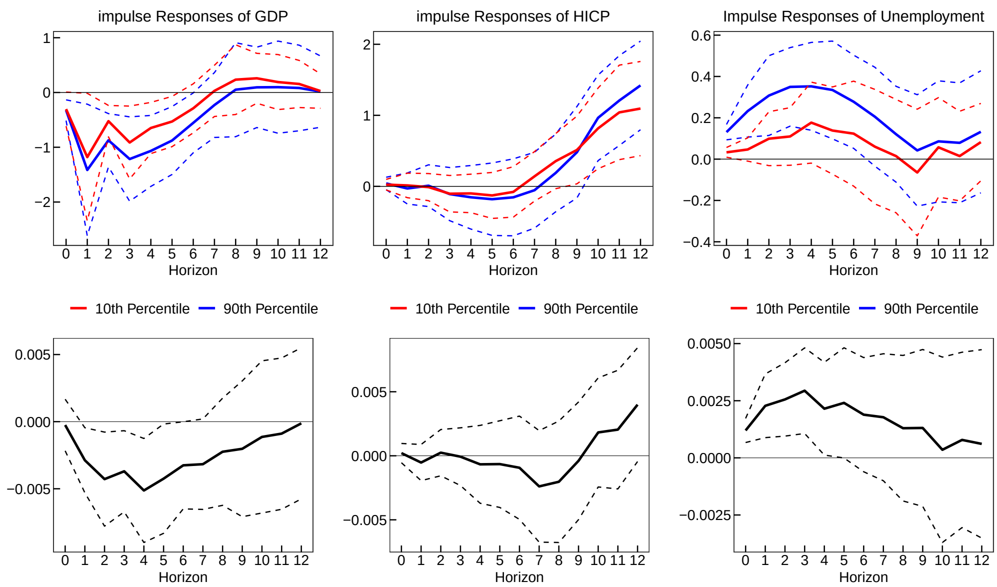
Note: Dashed lines represent 90% confidence intervals constructed with Driscoll-Kraay errors, choosing a maximum lag of $h-1$. Horizons are equal to quarters and the y-axis values are in percent, except for the unemployment rate which is in percentage points. The sample ranges from 2005Q1 to 2024Q4, excluding Ireland, Estonia and Croatia.

Source: Own work.

The IC becomes statistically significant, adding -0.025 percentage points to the ME for every percentage point increase in the share of liquidity-constrained HHs. This effect is even larger and continuously increasing (in absolute terms) for HICP, making the difference between the two impulse responses more pronounced with each horizon. The coefficient is statistically significant until the start of the third year, amounting to -0.028. Lastly, the IC for the unemployment rate is significant only until the end of the first quarter. In general, results point to a stronger monetary policy when the share of liquidity-constrained HHs is larger.

To conclude, we focus our attention on impulse responses conditional on the share of adjustable rate loans to HHs (see Figure 13). The responses of GDP differ somewhat. A percentage point increase in the share at hand strengthens the negative response by about 0.005 percentage points, but only in the first year. Otherwise, the IC is not statistically significant and the same holds for the impulse responses themselves. Again, the impulse responses of HICP are insignificant and follow an untypical trajectory. In the first two years, the IC is theoretically sound in sign, but insignificant nonetheless. For the unemployment rate, the IC conforms with our assumption, meaning that responses rise conditional on the share of adjustable rate loans. It peaks at around 0.003 after three quarters, before converging back to zero and becoming insignificant. At that point, the difference between the two impulse responses is around 0.25 percentage points, with the 90$^{\text{th}}$ percentile impulse response almost reaching 0.4 percentage points.

Figure 13: Impulse Responses of GDP, HICP and Unemployment by Share of Adjustable Rate Loans to Households (Top) with Corresponding Interaction Coefficients (Bottom)



Note: Dashed lines represent 90% confidence intervals constructed with Driscoll-Kraay errors, choosing a maximum lag of $h-1$. Horizons are equal to quarters and the y-axis values are in percent, except for the unemployment rate which is in percentage points. The sample ranges from 2010Q3 to 2024Q4, excluding Ireland, Estonia and Croatia.

Source: Own work.

5.3 Assessment of Transmission Dynamics

In the previous section, we have shown that certain structural characteristics play a role in the transmission of monetary policy. This is most consistently reflected in GDP responses, followed by those for the unemployment rate. For HICP, which is at the core of the ECB mandate, statistically significant ICs were only found when conditioning on the share of liquidity-constrained HHs and the five largest CIs in total assets. Otherwise, responses barely react to the MPS, dropping slightly but then quickly overshooting in the second half of the observed horizon. In some part, the erratic behavior may be due to inflation volatility of the past few years. For all three macroeconomic aggregates, statistically significant ICs are always in line with theoretical predictions.

Looking at Table 3, we can see that a larger share of services VA and higher trade openness both lead to a lower response in GDP. On the other hand, the other three indicators all exacerbate it. This happens with varying degrees. The marginal increase in the response is the biggest for the indicators connected to sectoral composition (0.05) and liquidity-constrained HHs (-0.025). The implication is that the level of dispersion does not necessarily directly correlate with the differences in transmission. We remind the reader that their standard deviation was always below 20 or even 10 percentage points. The relatively smaller ranges are also apparent from Table 3. The variation in the other three leads to an order of magnitude lower absolute change in the GDP response. Nevertheless, MEs are of similar size. These observations are also true for the unemployment rate, but with ICs lower by a factor of two. Where the response of HICP does differ significantly, the IC approximately reaches the same value as in the case of GDP.

Table 3: Conditional Cross-Country Marginal Effects on GDP

Structural Indicator	**Country**	**Value**	**Interaction Coefficient**	**Marginal Effect**
Share of Services Value Added	SI	48.6	0.05 (7)	-0.995
	MT	70.6		0.093
Trade Openness Index	PT	32.7	0.006 (6)	-0.790
	LU	168.1		0.023
Share of Assets of the 5 Largest Credit Institutions	LU	32.3	-0.007 (1)	-0.978
	EL	95.6		-1.421
Share of Liquidity-Constrained Households	NL	16.9	-0.025 (6)	-0.453
	LV	45.3		-1.176
Share of Adjustable-Rate Loans to Households	FR	1.2	-0.005 (4)	-0.616
	FI	89.4		-1.057

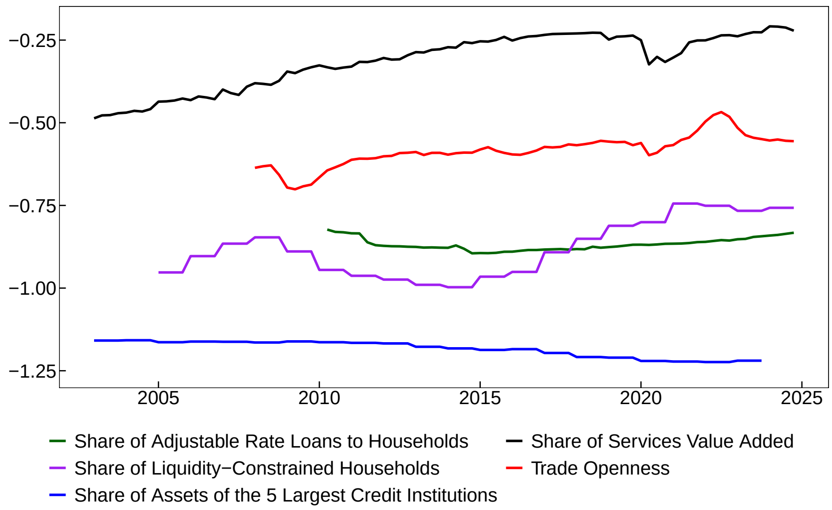
Note: Values of structural indicators for each country refer to the last period in the sample (taken from Chapter 3). The first country represents the minimum and the one below the maximum. Values of the interaction coefficient are absolute maxima with the corresponding period in parentheses. To get the marginal effects, interaction coefficients are multiplied with the indicator values and added to the baseline effect β_1^h of the monetary policy shock in t from (19). For example, if the interaction coefficient refers to $h = 1$, we use β_1^1.

Source: Own work.

We combine our results with the latest data for specific countries to get a sense of the differences inter and intra structural indicators. For example, services accounted for the smallest (largest) share of VA in Slovenia (Malta). Although the interaction coefficient is the same (0.05), their corresponding values lead to a larger than a percentage point difference in the response of GDP until the seventh quarter after the shock ($-0.995 - 0.093 = -1.088$).

If the average quarterly growth of GDP is around 0.53% and 3.77% is the compounded growth after seven quarters, this differential effect is equal to approximately 29%, making it economically meaningful. Nonetheless, as shown in Chapter 3, the distributions of countries with respect to indicators differ, so it might be that these differences are primarily driven by outliers. Significant differences between the impulse responses are quite persistent, stretching even into the third year after the shock. Generally, the differences are the smallest at the start, but grow larger in the first half and then start to converge. This also holds for unemployment. The exceptions would be the response of GDP conditional on the share of the five largest CIs in total assets and the HICP response conditional on the share of liquidity-constrained HHs.

Figure 14: Evolution of Marginal Effects for the Euro Area



Note: Marginal effects are constructed by taking the interaction coefficient from Table 3, multiplying it by the sample average of the respective indicator for each period and adding it to the baseline effect β_1^h of the monetary policy shock in t from (19). For example, if the interaction coefficient refers to period $h = 1$, we use β_1^1.

Source: Own work.

Besides looking at the MEs in the cross-section, we apply them to the sample average, a proxy for the EA, in Figure 14. We use the unweighted average to match the nature of our estimation. Additionally, different lengths reflect the variation in effective samples. The data for structural indicators follows directly from Chapter 3, whereas the ICs are taken from Table 3. Because they correspond to various periods, MEs vary in size. For example, in 2000, EA GDP would decrease by 0.5% conditional on the services VA share after seven quarters and 1.16% conditional on the share of the five largest CIs in total assets after one. But we are more so interested in the movements over time since this is relevant for policy. The trends in the share of services and liquidity-constrained HHs have contributed to lower sensitivity of the EA to monetary policy. The respective MEs have decreased by 0.28 and 0.19 percentage points. For trade openness, the decrease was minimal as was the increase for adjustable rate loans share. The higher banking sector concentration increases the negative response by 0.06 percentage points.

Notice that some of the indicators behave more cyclically such as trade openness and the share of liquidity-constrained HHs. The first has clear bumps in times of the financial crisis, pandemic shock and recovery. On the other hand, the second one has been most affected by the sovereign debt crisis, but subsequently fell to new lows. This might make monetary policy stronger in general, but may also contribute to larger cross-country differences in MEs when crises are asymmetric in nature. Particularly for the latter, the response of GDP would be larger by about 0.14 percentage points in 2014 in comparison to 2008. Furthermore, a drop was also recorded in the services sector due to the pandemic, which limited the amount of social interaction.

In thinking about the causes of the crisis of the previous two decades, regulation, supervision and fiscal policy surely also determine the strength of transmission as does monetary policy itself. For example, it seems like the interest rate structure of loans, although fairly stable, is somewhat influenced by the term spread, and therefore agents' expectations about inflation and policy. As the demand for fixed rate loans increased in the low interest rate environment, the potency of transmission has weakened. Looking ahead, the natural drift to a service-based economy will result in a weaker monetary policy. Of course, this is only one of many channels that influences transmission. On the other hand, the banking sector's proclivity to consolidate will work in the other direction.

6 CONCLUSION

The stated purpose of the thesis was to gauge whether monetary policy produces heterogeneous responses conditional on certain structural characteristics in the EA and what were the associated policy implications. The findings are only credible after demonstrating that the shock and by extension monetary policy have theoretically consistent effects, however. To this end, we provide an overview of the transmission channels in Chapter 2 and do an impulse response analysis at the end of Chapter 4. To answer our first research question, we firstly conduct a narrative analysis, showing that the largest deviations of the shock overlap with market surprises in times of crises. This is followed by an impulse response analysis based on aggregate EA data and cross-sectional LPs. We show that the effects of monetary policy are statistically significant and quantitatively in line with theory. Output and prices contract, unemployment rises and so does the exchange rate. Credit activity seems to shrink and the stock market plunges. Still, there are differences in the degree of significance and persistence. Whereas GDP, the unemployment rate and the stock of loans to households maintain significance throughout the entire horizon, this is not true for the other three. Stock market valuation changes the most, with a decline of 4% only three quarters after the impact.

Having confirmed that the MPS generates plausible responses, we proceed with panel LPs combined with ICs to address two subsequent research questions that remain underexplored in the literature and are the focus of ongoing research. Our benchmark for evaluation are the proposed mechanisms in the literature that were discussed in Chapter 3. We have found that GDP responds differently with statistical significance conditional on five structural characteristics. For the unemployment rate, this was true for only three, and two for HICP. All are in line with previous findings in the literature. In general, a higher services VA share makes economies less sensitive to monetary policy, while the opposite could be said for the share of adjustable rate loans to HHs and liquidity-constrained HHs. GDP also responds less conditional on trade openness, but the result is not equally convincing. Banking sector concentration also exacerbates the effect after one quarter, but is more so an outlier with regard to HICP. A persistent differential impact for HICP was also found conditional on the share of liquidity-constrained HHs. We follow the standard representation of taking the 10$^{\text{th}}$ and 90$^{\text{th}}$ percentile impulse responses and plot them to show the difference that the ICs produce. However, because these are not applied to any single period, the relevance for monetary policy is hard to conceptualize.

To address this, we conduct an intertemporal and cross-sectional analysis, by applying the ICs from the GDP LPs at their largest (in absolute terms) and significant value throughout the observed horizon to the latest period's country extremes of structural indicators. We show that the conditional differential effects are sizable, for services VA share amounting to more than a percentage point, which is quantitatively relevant in terms of compounded average quarterly GDP growth. Comparing the absolute size of ICs, services VA share contributes to the largest conditional heterogeneity on the margin, with responses decreasing by 0.05 percentage points for every percentage point rise in the share. For the share of liquidity-constrained HHs, the effect is twice as low and negative. Still, all the other indicators lead to substantially lower marginal changes in responses. Apart from being significant, differential effects are also persistent, leading to discrepant responses even three years after the shock. The same ICs were also applied to the unweighted average of our sample for periods that were used in the estimation process. Over time, the increasing share of services VA and banking sector concentration have contributed to weaker monetary policy transmission. Given their persistent trends, we expect this to continue in the future. Other indicators such as trade openness and the share of liquidity-constrained HHs are more cyclical, which might point to asymmetric effects of monetary policy over the cycle as well as between countries, to the extent that the impact of crises is not uniform as well. Here, other economic policies have an important role as they shape the environment in which the transmission process happens. The movement of the share of adjustable rate loans to HHs also speaks to the endogenous effect of monetary policy by affecting expectations about policy and inflation.

Our analysis could be extended in several dimensions. Firstly, it may be informative to distinguish between the effects of contractionary and expansionary monetary policy shocks using state-dependent local projections. For instance, the varying degrees of banking sector concentration could lead to different transmission dynamics for each type of shock. Secondly, there are many additional characteristics that could influence transmission, which is to say that our thesis offers only a partial analysis of heterogeneity. Particularly, data related to non-financial corporations could also be utilized and institutional arrangements such as labor market regulation might also be an important determinant. Lastly, to determine whether our results are robust, we could reproduce them by using other shocks, preferably not biased by central bank information effects.

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