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Economic Synopsis
On how to assess the impact of monetary policy

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Abstract
Understanding the macroeconomic impact of a policy rate change is a complex and multifaceted challenge. Estimating the impact of interest rate policy in the real economy is not straightforward as changes in interest rates often reflect policymakers' responses to economic developments, and economic developments reflect the impact of policy choices. This synopsis overviews how the literature assesses the impact of monetary policy, both in statistical and structural models. To circumvent this simultaneity problem, researchers have focused on the impact of monetary policy shocks, i.e. the exogenous or unsystematic component of monetary policy. This literature has generally found that an unexpected increase in the policy rate induces a reduction in real activity and prices, but it shows variability on the magnitude and duration of this impact. To analyse the impact of monetary policy that includes the endogenous response to economic developments (the systematic monetary policy) the literature uses counterfactuals. These analyses generally show that the way the monetary policy reacts to economic developments is in itself important in shaping those developments. (JEL: E52, E58)

1. Introduction

In the aftermath of the pandemic crisis, the world economy experienced a considerable recovery, which coupled with substantial supply chain disruptions and an escalation of geopolitical conflicts, fuelled inflationary pressures. The global and strong rise in inflation from pre-pandemic lows compelled central banks to act. In the euro area inflation rose to 10.6% in October 2022 (Figure 1), prompting the European Central Bank (ECB) to hike interest rates from -0.5% to 4.0% between July 2022 and September 2023. The Bank of England raised its key interest rate from 0.1% to 5.25% from January 2022 to August 2023, while inflation peaked at 9.6% in October 2022. The

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FIGURE 1: Euro area inflation rate and policy rates

Sources: Eurostat and ECB.
Notes: Rates – end of period.

Federal Reserve increased the target for the fed funds rate from 0%-0.25% to 5.25%-5.5% between March 2022 and July 2023, while inflation peaked at 9% in June 2022.

Understanding the macroeconomic impact of a policy rate change is a complex and multifaceted challenge. This synopsis focuses on reviewing how the literature assesses the impact of monetary policy, on macroeconomic variables such as inflation and GDP. This is a question of interest, namely to the policy maker in order to assess the decisions taken as well as to inform future policy decisions. There are however other questions of interest that are outside the scope of this synopsis, namely what are the monetary policy transmission mechanisms. We focus on interest rate policy. Assessing the impact of unconventional policy measures is also of obvious interest, and understandably related with interest rate policy, but also beyond the scope of this synopsis.

Estimating the impact of interest rate policy in the real economy is not straightforward as changes in interest rates often reflect policymakers' responses to economic developments, and economic developments reflect the impact of policy choices. There is a problem of simultaneity, i.e. the fact that the policy variable of interest (in this case, the policy interest rates) is influenced by the variable they aim to affect, making it difficult to establish a causal relationship between them.

In the literature, it is common to describe interest rate behaviour by means of a Taylor-type rule (Taylor 1993). The behaviour of the policy interest rate is described by a combination of two components, a systematic and an unsystematic (or exogenous) component, as generally described in equation 1. The systematic component of the monetary policy rule is the "usual" reaction of the interest rate to macroeconomic developments. The unsystematic component is exogenous and corresponds to the part of the policy rate movements that deviates from the systematic component, usually named in the literature monetary policy shocks (or innovations). This rule can be written in general terms as:

$$i_t = f(X_t) + \varepsilon_t \tag{1}$$

where i_t is the nominal key policy interest rate, X_t is the information set of the policy maker, $f(X_t)$ is the systematic component, and ε_t is the unsystematic component, i.e., a monetary policy shock.

The literature analysing the macroeconomic impact of monetary policy has evolved significantly over time.[1] Economists rely on both statistical and structural models to perform their analyses. To circumvent the simultaneity problem described above, researchers have focused on the impact of monetary policy shocks, i.e. the exogenous ε_t term in equation 1. Even though these shocks account for a limited fraction of fluctuations in economic activity (generally not more than 25% for GDP and under 10% for inflation, and often much less than that, see for example Ramey 2016; Smets and Wouters 2005; Warne *et al.* 2008), the fact that this is an exogenous policy change allows to isolate its effect in the macroeconomy.

Shocks are not observable and need to be estimated. In the literature relying on statistical models, Vector Autoregressive (VAR) models are widely used to estimate monetary policy shocks and their impact on macroeconomic variables. The VAR model captures the linear relationships among multiple time series variables, but the coefficients of the VAR model do not have a structural interpretation. However, by imposing certain restrictions on the structure of the VAR model it is possible to identify the structural shocks affecting the system, namely a monetary policy shock, and how these affect other economic variables over time. By obtaining quantitative estimates of how monetary policy shocks affect the economy it also helps in validating structural models.[2] More recently, Local Projections (LPs) have also gained popularity in the estimation of the macroeconomic impact of shocks.

In the literature relying on structural models to assess the macroeconomic impact of monetary policy, Dynamic Stochastic General Equilibrium (DSGE) models are frequently employed. DSGE models allow to assess the macroeconomic impact

1. See Sims' Nobel Prize Lecture (Sims 2011) an historical context.

2. VAR models are also used to estimate other shocks, such as fiscal shocks (Blanchard and Perotti 2002) and productivity shocks (Gali 1999).

of structural shocks, including monetary policy shocks, and to understand their transmission mechanisms to the macroeconomy. The models are based on fundamental features, such as people's intertemporal choices and firms' production functions, so its structure will remain unchanged despite policy changes, providing a structural interpretation of the coefficients, unlike the statistical models described above. In other words, structural models are less vulnerable to the Lucas critique (Lucas 1976), which states that shifts in economic policies can alter the structure of the economy itself due to changes in agents' behaviour.

Despite ongoing debates about specific shock identification assumptions and model features, generally there is agreement on the main qualitative effects of monetary policy shocks in the short run. Contractionary shocks typically lead to an increase in short-term interest rates, which in turn decrease output, employment, and inflation.

The shock-based approach has been extremely useful to better understand of how monetary policy impacts macroeconomic variables. However, it does not directly address the issue of the impact of specific monetary policy actions, which include both exogenous changes in the policy rate but also endogenous or systematic changes. To assess the impact of alternative monetary policy rules or of specific policy paths, which include this systematic component, economists use counterfactual analyses in both statistical and structural models. This entails computing the economic outcomes that would have been achieved if different alternative policies had been followed and comparing them with the actual outcomes.

This synopsis reviews the literature on how to assess the impact of a monetary policy rate change. Section 2 introduces the statistical and structural approaches to analysing monetary policy shocks. Section 3 examines the literature about counterfactual analyses. Finally, section 4 adds some concluding remarks.

2. The macroeconomic impact of monetary policy shocks

The literature about the macroeconomic impact of monetary policy shocks is vast. The VAR and, more recently, the LP frameworks are fundamental tools to estimate the responses of key variables to shocks. Structural models like DSGE models, rooted in economic fundamentals, not only allow to analyse the economic impact of shocks but also to understand the transmission mechanisms of shocks.

2.1. Statistical models

Since the seminal work of Sims (1980), VAR models became a core tool in the macroeconomic literature. VAR models represent multivariate time series through a system of linear equations where each variable is regressed on its lags and the lags of all other variables in the model, and on an unpredictable component, the residuals.[3] The residuals are combinations of the underlying structural economic shocks, which are

3. For more details about VAR models see for example Kilian and Lutkepohl (2017).

assumed to be orthogonal to each other. To be able to extract an economic interpretation from the residuals in VAR models, it is essential to identify the structural shocks (see, e.g., Christiano *et al.* 1996, 1999). Achieving this requires certain assumptions to properly disentangle the shocks and to convey an economic meaning to them. Structural VAR models have enough restrictions to identify the structural shocks. Once the structural shocks are identified, the VAR model allows for the estimation of the impact of these shocks on the variables of interest, usually called impulse response functions (IRFs).

There are several types of identification assumptions that can be used and eventually combined to identify structural shocks in VAR models (see Ramey 2016 for a survey). Probably the most common approach is to restrict the contemporaneous interaction among some model variables, referred to as short-run restrictions (Sims 1980). A popular type of short-run restriction is the Cholesky decomposition (Sims 1980; Bernanke and Mihov 1998), which assumes that some variables, such as prices, do not respond to the shock within the period, while others such as financial variables, do. Even though the Cholesky decomposition and, in general, short-run restrictions are convenient, clear, and easy to compute, many issues arise as their logic is many times hard to defend and the results are often at odds with prior views on the impact of shocks. In some cases, contractionary monetary policy shocks raise, rather than lower, prices and inflation (the "price puzzle"). Although refinements to VAR models identified with short-run restrictions are possible, other approaches became widely used in the literature.

An alternative identification assumption is to restrict the long-run response of the model variables to some shocks, called long-run restrictions (Blanchard and Quah 1989). This type of assumption is appealing since the long-run behaviour of the economy may be more consensual among economists than its short-run behaviour. For instance, the long-run response of real GDP to a monetary policy shock is assumed to be null (King and Watson 1997).

In general, these types of restrictions are disputable. Typically, economic theory offers insights about the signs of the responses of variables to impacts. Thus, a strand of the literature identifies structural shocks through sign restrictions, as introduced by Uhlig (2005). For instance, there is an extensive range of theories that hint that monetary stimulus will not have a negative effect on economic activity in the short run. However, since sign restrictions are inequality restrictions ("higher/lower than" restrictions), the structural VAR models are not exactly identified, instead we can only narrow each estimate to a range of values.

Some approaches in the literature identify structural shocks without imposing direct restrictions on a VAR model. Instead, these approaches use external sources, thus reducing the reliance on these potentially controversial identifying restrictions. They rely on external data that is exogenous to the other variables in the model. One example of this method is the narrative approach, formalized by Romer and Romer (1989), but dating back to Friedman and Schwartz (1963), that uses sources such as transcripts of policy meetings to identify exogenous changes (i.e. surprises) in the policy variable. Then, the constructed shock series is used in a statistical model to estimate the IRFs of macroeconomic variables (see Romer and Romer 2023 for more details and for an update of their previous paper). In a similar spirit, Aruoba and Drechsel (2024) employed natural language processing techniques to analyse documents prepared by Federal Reserve staff prior to policy decisions, and identify shocks by predicting changes in the fed funds rate based on the information contained on these documents. They compute the IRFs of the macroeconomic variables to these monetary policy shocks, using the shock series as an external instrument. High-Frequency Identification (HFI) involves using financial markets data (available at a high frequency) and event-study methodologies (Faust *et al.* 2004; Kuttner 2001; Jarocinski and Karadi 2020). The idea is that financial markets incorporate quickly unexpected information about monetary policy into asset prices. Thus, the difference between the actual policy rate change and the expected change (implied for instance by an interest rate future) is interpreted as the monetary policy shock.

VAR models estimation techniques have also been extended along several other dimensions (see Stock and Watson 2016 or Kilian and Lutkepohl 2017 for a survey), including Bayesian Vector Autoregressive models (BVARs, see Koop and Korobilis 2010), Factor-Augmented Vector Autoregressive models (FAVARs, see Bernanke *et al.* 2005) and Time-Varying Parameter Vector Autoregressive models (TVP-VARs, see Primiceri 2005). These variations of the typical VAR model must also be combined with the previously described identification techniques to disentangle the underlying structural shocks from the residuals and obtain the IRFs.

Jorda (2005) introduced an alternative method for estimating IRFs, the LP, which has been increasingly used in the literature. The idea of this method consists of directly estimating the effects of a shock at each horizon of interest, instead of inferring into more distant horizons from given models, like VAR models. This "horizon-by-horizon" approach avoids certain structural assumptions required in VAR models, providing an alternative that is less susceptible to misspecification errors (Jorda 2005). For example, in a VAR framework, the IRFs are estimated by deriving a recursive system of equations, which implies that the estimated responses at distant horizons are conditional on the responses at shorter horizons. This dependence on the underlying model structure can lead to significant issues if the VAR model is misspecified or if its assumptions are violated (Stock and Watson 2018). In contrast, LPs estimate each horizon individually, which allows for more flexibility in the estimation process, especially when dealing with non-linearities, structural breaks, or other complex dynamics that are hard to capture in a single model. Researchers have also extended LP methods to capture nonlinearities, asymmetries, and other dynamic complexities, further expanding their applicability beyond traditional linear IRFs settings (Jorda and Taylor 2024).

Plagborg-Moller and Wolf (2021) formally established the equivalence between VAR and LP models under traditional identification approaches. They show that structural identification using VAR models—whether through short-run, long-run, or sign restrictions—can also be effectively conducted with LPs. Among these approaches, the use of instrumental variables in LPs to address identification issues through a two-stage least square regression stands out as particularly intuitive. This method, known as LP-IV, was first introduced by Jorda *et al.* (2015) and has since become a widely adopted tool in applied macroeconomics.

2.1.1. Main results of statistical models

There is a vast literature on the identification of monetary policy shocks and its transmission to the macroeconomy focusing on different economies. The chapter in the *Handbook of Macroeconomics* by Christiano *et al.* (1999) is a seminal reference that provided a benchmark framework for identifying monetary policy shocks and their effects. The authors used a recursiveness assumption (short-run restrictions) and their results, for the US, showed that following a contractionary monetary policy shock, there was a sustained decline in real GDP that is (inverted) "hump-shaped", with the largest decline occurring roughly a year to a year and a half after the shock. Also, after an initial delay, the policy shock generated a decline in prices. However, the literature has evolved considerably since their contribution. A well-known compilation of results from the literature, mainly using statistical models, including those of Christiano *et al.* (1999), is provided by Ramey (2016).[4] This survey for the US indicates that the short-run effect on economic activity of a 100 basis points[5] positive shock in interest rates is in general negative, but the maximum impact varies considerably across studies, ranging from -5% to close to zero within 8 to 24 months. This effect is usually temporary. The effect on prices tends to be negative, but in some cases, the price puzzle (a monetary contraction raising the price level in the short run) is observed. Moreover, the response of prices takes longer to manifest than the response of activity. While these were the main results of this survey of the literature, Ramey (2016) re-estimated the specifications in three of the papers surveyed with a more recent data sample and found more muted effects of monetary policy shocks, including in the Christiano *et al.* (1999) specification. Relatedly, Havranek and Rusnak (2013) also review a large number of studies for several countries that employ VAR models to investigate the effects of monetary policy shocks on the price level. They find that the average transmission lag is 29 months, with considerable variability.

There are also studies that estimate monetary policy shocks and their macroeconomic impact for a panel of countries. An example focusing on a recent period is Deb *et al.* (2023), which uses local projections and a sample of 33 advanced and emerging market economies for the period from the second quarter of 1991 to the second quarter of 2023.[6] They find that following a 100 basis points monetary policy shock, real GDP declines by 0.3% within two quarters, and the effects remain persistent through eight

4. In this compilation, the results are standardized by normalizing the peak response of the federal funds rate to the shock to 100 basis points. This standardization does not control for differences in the persistence of the response. These ranges include results using identification assumptions such as short-run restrictions, sign restrictions, and external instruments (HFI and the narrative approach), as well as VAR models such as SVAR, FAVAR, BVAR, and Bayesian FAVAR models.

5. The literature that compares the impact of different monetary policy shocks often relies on a shock of this magnitude. One should, however, stress that the one-standard deviation monetary policy shock is generally estimated to be smaller than that.

6. Monetary policy shocks are identified in two steps: (i) forecast errors in short-term rates are computed by subtracting interest rate forecasts from realized interest rates; and then (ii) the part of these forecast errors that is orthogonal to the state of the economy is extracted by regressing the forecast errors on changes and forecasts of growth and inflation, as well as other pre-determined macroeconomic variables.

quarters. At the same time, the effects on consumer prices take time to fully materialize, peaking after around a year and a half, and are not statistically significant in the first quarters. Also, there exists significant heterogeneity in the transmission of monetary policy across countries and time. Almgren *et al.* (2022) employ the LP-IV model and show heterogeneous effects of monetary policy shocks on output and inflation across euro area countries.

Even though the quantification of the impact of monetary policy shocks is not an objective of this synopsis, as an illustration, we replicated the results of a widely cited paper, Jarocinski and Karadi (2020), which uses two strategies to identify the impact of monetary policy shocks. They identify monetary policy shocks for the euro area using HFI and estimate their macroeconomic impact through VAR models. They use two strategies. In the first, it is assumed that when there is a monetary policy announcement, the change in a short-maturity rate over a limited time frame (a half-hour window starting 10 minutes before and ending 20 minutes after the announcement) results from a monetary policy shock. Then, its macroeconomic impact is estimated in a VAR model, using a Cholesky decomposition.[7] These results are shown in the left column of Figure 2. The second strategy assumes that the change in the same rate over the same time frame results from a monetary policy shock and a communication shock (to purge the effect of the information regarding the economy that central banks convey to the public during policy announcements from the commonly used monetary policy shocks).[8] The macroeconomic impact of these shocks is estimated in a VAR model. The results are shown in the central column of Figure 2. To enrich this analysis, we added the estimates of an LP-IV specification based on Almgren *et al.* (2022) (right panel of Figure 2), using the same dataset as Jarocinski and Karadi (2020), including their monetary policy shock series adjusted for the central bank's informational effect. The charts show the median responses (yellow dots), and the bands represent the 90% confidence intervals. The dataset covers the period from January 1999 to December 2016. This chart illustrates that the estimated impacts depend on the different types of identification methods, even when using the same model and dataset. Still, qualitatively, there are similarities that deserve to be highlighted. A contractionary monetary policy shock that, on impact, causes a 100 basis points[9] increase in a short-term interest rate induces a fall in real GDP that reaches its trough within the first year. The shock also pushes inflation (measured by the change in the GDP deflator) down. Results should be interpreted carefully, as most of the 90% confidence bands show that responses are statistically insignificant, especially in the case of VAR models.

7. To account for the time when the policy rate was constrained by the zero lower bound, the authors use a longer-maturity rate in the VAR model, specifically, the German one-year government bond.

8. Bauer and Swanson (2023) provide evidence in favor of this component resulting from a response to news by the Fed instead of an information effect.

9. Similarly to what is done in Section 2.1.1, we consider a contractionary monetary policy shock that initially induces a 100-basis point increase in the annualised short-term interest rate, as this is commonly done in the literature comparing different studies.

To sum up, there is a vast empirical literature on the impact of monetary policy shocks. This literature has generally found that an unexpected increase in the policy rate induces a reduction in real activity and prices, but it shows variability in the magnitude and duration of this impact. In addition, while earlier studies seemed to identify more significant impacts of monetary policy, it seems to have become harder to identify shocks in more recent periods, at least in advanced economies. Arguably, this may be the result of monetary policy being conducted in a more systematic way, i.e., in a fashion that is closer to a rule-type behaviour (Ramey 2016).

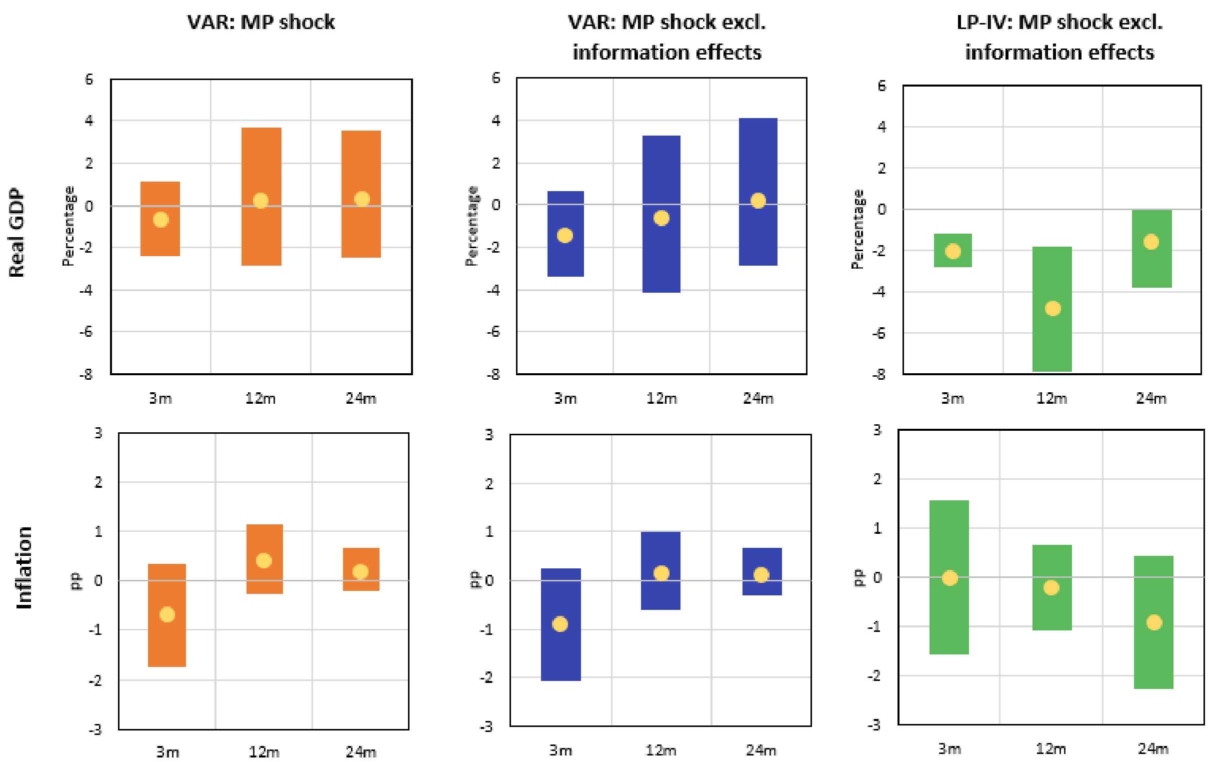

FIGURE 2: Monetary policy shock in statistical models - euro area main variables

Sources: Author's calculations.
Notes: The graphs on the left and centre are based on Jarocinski and Karadi (2020). The graphs represent the IRFs of a euro area's real GDP and GDP deflator inflation (both interpolated to monthly frequency) to a monetary policy shock leading to a surprise of 100 basis points in the 3-month interest rate. The BVAR model used to estimate the IRFs includes 12 lags and the following monthly variables: surprises in the 3-month EONIA interest rate swaps and the EURO STOXX 50, German one-year government bond yield, BBB bond spread, the blue-chip STOXX 50 index and real GDP (level) and GDP deflator (annualized 3-month moving average) series. The dataset contains data from January 1999 until December 2016. The graphs on the right are based on Almgren *et al.* (2022)'s specification and use the dataset described above. Yellow dots: median response. Bands: 90% confidence interval.

2.2. *Structural models*

The macroeconomic impact of monetary policy shocks can also be assessed in structural models, such as DSGE[10] models. While statistical models excel at fitting the data by capturing historical patterns, they do not necessarily explain the channels behind the complex dynamics at play. DSGE models are laboratories to analyse relevant policy questions that have the key advantage of not being vulnerable to the Lucas critique, as explained in the introduction.

In its early stages[11], structural microfounded models, namely Real Business Cycle (RBC) models introduced by Kydland and Prescott (1982) and Long and Plosser (1983), were based on simplifying assumptions and did not account for many features of the data. They assumed that markets were perfectly competitive and there were no short-run frictions. As such, macroeconomic variables could efficiently adjust to structural shocks, like for instance technology shocks, leading to the conclusion that there was no need for policy intervention. More realistic models where monetary policy has effects and can improve economic efficiency were developed, and currently, the analysis of monetary policy, namely at central banks, relies largely on large-scale semi-structural models, which are models that have some characteristics based on micro-foundations but also *ad-hoc* features that improve the adherence to the data but are not immune to the Lucas critique.

Significant developments in the DSGE models literature followed, owing to advances in computational capacity, improvements in simulation techniques, and the proliferation of datasets. Modern New Keynesian DSGE models were developed, building on the RBC core (see Smets and Wouters 2003, 2007; Christiano *et al.* 2005). These models incorporate more realistic assumptions, including frictions such as imperfect markets and slow price adjustments, and are better at capturing the dynamics of macroeconomic variables and explaining the short-run effects of monetary policy observed in the data.[12] While early models were mostly calibrated, that is, parameter values were chosen according to evidence in the literature or to replicate empirical unconditional moments, the parameters of modern DSGE models are frequently estimated.

2.2.1. *Main results of structural models*

IRFs to a monetary policy shock derived from structural models are qualitatively in line with the statistical models' approach, as they are often informed by the evidence

10. DSGE models are the leading theoretical framework for monetary policy analysis, characterized by integrating economic agents' constraints, describing individual preferences and firm objectives, assuming forward-looking behaviour, incorporating exogenous shocks, and using mathematical formalization (Sbordone *et al.* 2010).

11. See Christiano *et al.* (2018) for a description of the evolution of the DSGE models.

12. Notable extensions have been developed, such as the introduction of financial frictions (Christiano *et al.* 2014; Gertler *et al.* 2016), the introduction of a more detailed labour market (Christoffel *et al.* 2009; Christiano *et al.* 2016; Linde and Trabandt 2018), or the introduction of heterogeneous agents (Kaplan *et al.* 2018).

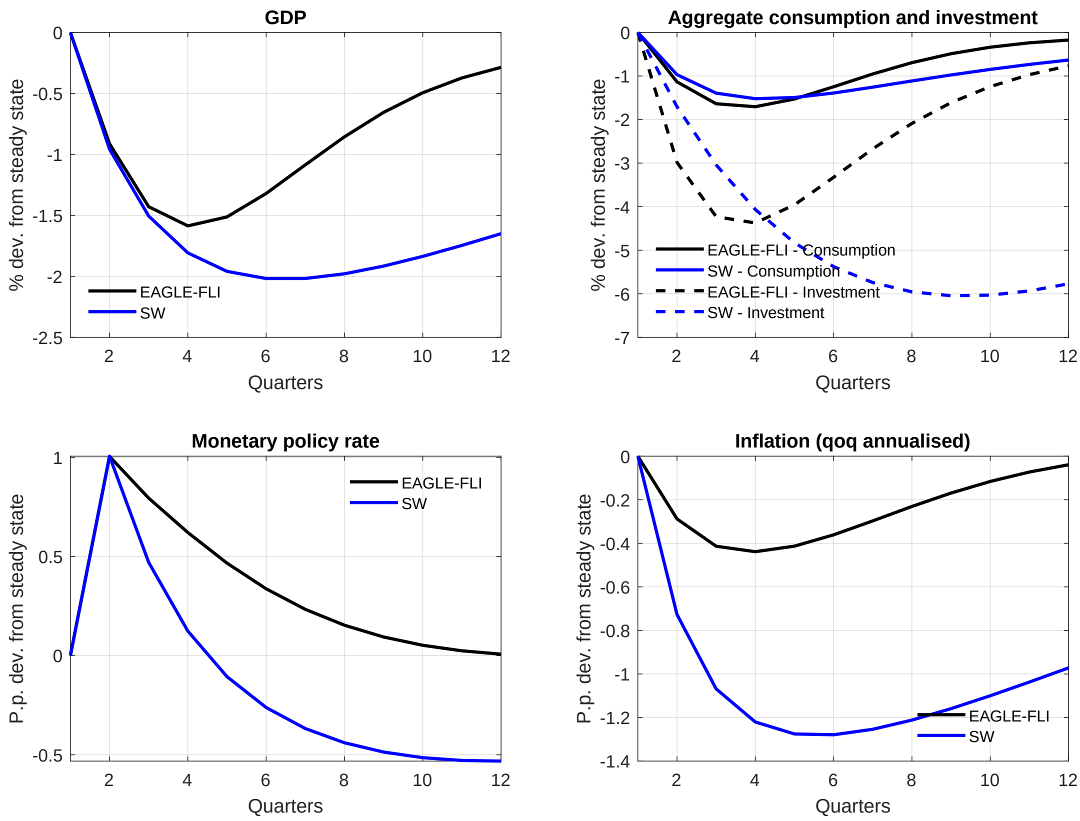

FIGURE 3: Monetary policy shock in two euro area structural models
Source: Authors computations.

from those models. As an illustration, Figure 3 shows the IRFs of key euro area macroeconomic variables to a temporary monetary policy shock in the EAGLE-FLI model (Bokan *et al.* 2018) and the Smets and Wouters (2003) model (SW model henceforth). The EAGLE-FLI is a calibrated multi-country open economy structural model of the euro area within the world economy. The model features several frictions such as price and wage rigidities, consumption habits, and investment adjustment costs, as well as financial frictions. The SW model is an estimated closed economy model of the euro area that also features several frictions, but it does not include financial frictions as in the EAGLE-FLI model. It is also worth mentioning that there are several features of the models that are different, besides the lack of financial frictions in the SW model and the closed versus open economy settings, and these will have an impact on the shape and magnitude of the responses. For example, some modelling choices, such as the monetary policy rules[13], the parametrization, and the degree of price and wage indexation, are different.

13. In the SW model, the monetary policy rule gradually responds to deviations of lagged annualised quarterly inflation from the inflation objective and the lagged output gap, defined as the difference between actual and potential output (i.e., the level of output that would prevail under flexible prices and wages in the absence of the three cost-push shocks). There is also a short-run feedback from the current changes in

Following the monetary policy shock, the (annualized) policy rate increases by about 100 basis points on impact (by construction) and then gradually returns to its steady-state level (according to the model's interest rate feedback rules). Output's response to the temporary contractionary monetary policy shock is hump-shaped and hits the trough after around one year to one and a half years, afterwards returning to the steady-state level. In the EAGLE-FLI model, the GDP trough is at -1.5% below its steady-state level, whereas in the SW model, it is around -2%. In terms of domestic demand components, consumption and investment also fall, with the latter showing a response of larger magnitude. Though not shown, in the EAGLE-FLI model, exports and imports also fall following the shock. Inflation shows a gradual and long-lasting decrease. In the EAGLE-FLI model, the trough effect happens around 1.5 years after the shock, reaching approximately -0.4 percentage points, while in the SW model, it is considerably more pronounced.

3. The macroeconomic impact of systematic monetary policy

As described in the previous sections, to analyse the macroeconomic impact of monetary policy research has focused on the unsystematic (i.e., exogenous) part of monetary policy. However, policymakers are often interested in understanding the impact of their systematic actions, that is, of pursuing a different policy or even of implementing a specific interest rate path. This question, despite being challenging to answer, is obviously relevant since most monetary policy actions are not exogenous. In fact, a policy rate change is typically the monetary authority "usual" response to economic movements, past, current, and expected, that are a result of a variety of shocks that hit the economy at that time and in the past.

Given the relevance of systematic monetary policy, macroeconomists have analysed the effects of alternative monetary policy rules or specific paths of the monetary policy rate (that may however be a mix of systematic and unsystematic policy) by relying on counterfactuals to produce "what if" scenarios. The key idea of a policy counterfactual analysis is to compare the economic outcomes of an alternative path for the policy instrument with the ones in the benchmark scenario to understand the relevance of monetary policy actions. Models where counterfactuals are implemented should be invariant to changes in policy, to render the analysis meaningful.

In the literature, counterfactual analysis has been conducted using both statistical models and structural models. The next subsections review how.

3.1. Statistical Models

Statistical models, such as VAR models, have been used in the literature to build policy counterfactuals. The appeal in using these models relies on their adherence to the data, but also on the fact that one does not have to take a stance on the appropriate model

inflation and the output gap. In the EAGLE-FLI model, the monetary policy rule gradually responds to year-on-year inflation deviations from the objective and output growth.

structure to describe reality. As the researcher does not have to choose a particular parametric model and its structural shocks, concerns about misspecification are avoided. However, the analyses based on these models are often criticised because the model structure is not invariant to policy changes (the Lucas critique).

Most contributions to this literature used monetary policy shocks to construct counterfactuals in VAR models as this was seen as informative regarding the assessment of the impact of different policy paths. Seminal contributions are Sims and Zha (1998) and Bernanke *et al.* (1997). Sims and Zha (1998)[14] use a VAR model to assess the impacts of systematic monetary policy by comparing the effects of non-policy shocks on the macroeconomic aggregates without restricting the monetary policy response, with the effects of a no monetary policy response scenario (i.e., assuming that monetary policy is unresponsive to other variables in the system, so the policy rate is kept constant while all other equations are the same). This method is equivalent to combining the non-policy shock with a series of (unexpected) monetary policy shocks that in each period offset the systematic policy response, so that the counterfactual rule (of no response) holds. In other words, economic agents are repeatedly surprised by the lack of a monetary policy reaction to the non-policy shock which is highly unlikely to happen. Despite this, the authors argued that it would take time for individuals to realise that policy is not responding as usual and as such their results are still of interest. Bernanke *et al.* (1997) offer an alternative to the approach of Sims and Zha (1998), by distinguishing between the impact of anticipated and partially unanticipated policy changes. Leeper and Zha (2003) propose a framework for conducting counterfactual analysis with statistical models, arguing that it is immune to the Lucas critique if the policy intervention is modest, not significantly shifting agents' beliefs about the policy regime. More recently, following the same intuition as Leeper and Zha (2003), Jorda and Taylor (2024) provide a framework for counterfactual analysis using LPs and relying on the method's asymptotic characteristics.

Recent contributions propose a framework to construct counterfactual exercises in VAR models that are robust to the Lucas critique. Notable examples include McKay and Wolf (2023) and Caravello *et al.* (2024). McKay and Wolf (2023) show that, across the commonly used macroeconomic models, the causal effects of (both contemporaneous and news) shocks to a given policy rule can be sufficient to construct counterfactuals for different policy rules. Instead of using a series of unexpected monetary policy shocks along the period under analysis to implement the counterfactual monetary policy response (as in Sims and Zha 1998), they introduce multiple distinct monetary policy shocks in the initial period. In this way, they can enforce the counterfactual monetary policy rule both *ex post* along the equilibrium path and *ex ante* in private-sector expectations.[15] The drawback of this methodology is the amount of evidence required

14. Even though this working paper has been published as Sims and Zha (2006), the working paper is commonly cited.

15. The analysis builds on a general linear data-generating process (a feature shared by many models), with one key added restriction: policy is allowed to affect private-sector behaviour only through the current and future expected path of the policy instrument. For example, for monetary policy, the private sector only

on the initial date policy shocks. In practice, the researcher only has a limited number of distinct policy shocks associated with different paths for the policy instrument, implying that some counterfactuals cannot be implemented perfectly. McKay and Wolf (2023) provide some applications using two different monetary policy shock series, those of Romer and Romer (2004) and Gertler and Karadi (2015)[16], to implement counterfactual scenarios regarding the monetary policy response to a non-policy shock, in particular an investment-specific technology news shock. The authors conclude that in most cases the two policy shocks considered can implement reasonably well the counterfactuals considered. The contemplated counterfactuals can imply very different behaviours of the macro variables. Finally, Caravello *et al.* (2024) propose an approach to surpass the implementability problem of McKay and Wolf (2023). The authors demonstrate that within a wide array of linearized and invertible structural macroeconomic models, policy counterfactuals can be determined using two "sufficient statistics"[17]: a set of reduced-form projections (IRFs of macroeconomic variables or, in the case of conditional counterfactuals, forecasts)[18], and the set of dynamic causal effects of changes in policy on current and future macroeconomic aggregates that can be estimated with structural VAR models. In case this information is insufficient, models of policy transmission may be used to complete the information needed (through IRF matching). The authors consider three episodes (the average U.S. post-war business cycle, the Great Recession and the post-COVID inflation period) and use as the counterfactual monetary policy rule an optimal rule.[19] The authors find that the counterfactual policy could have achieved substantially lower output gap volatilities and slightly more stable inflation, at the cost of only moderately more volatile nominal interest rates in the U.S. post-war business cycle. During the Great Recession, the main result is that the unconventional monetary policy response was insufficient—an additional stimulus of around 400 basis points in the nominal interest rate would have been necessary. In the post-COVID inflation period, it is found that the counterfactual policy would have succeeded in reducing

cares about the current and expected future path of the nominal interest rate, and not whether this path is the result of the systematic component of policy—i.e., the policy rule—or due to shocks to a given rule. The authors show this is a property shared by many business cycle models.

16. They interpret the Romer and Romer (2004) shock as being more transitory and the Gertler and Karadi (2015) shock as having a larger forward guidance component and being more long-lived.

17. Barnichon and Mesters (2023) were pioneers of the sufficient statistics approach for macro policy. Still, their focus is on evaluating whether a given policy decision is optimal (i.e., a policy that minimizes the loss function), and if not how to improve upon it.

18. Importantly, the approach relies on the assumption of "invertibility", i.e. that the unknown true structural shocks are a one-to-one function of reduced form forecast shocks. So, given this assumption, correctly predicting how reduced-form projections change is equivalent to correctly predicting the counterfactual propagation of the true (unknown) structural shocks.

19. The first input of this exercise is a reduced-form VAR that contains the output gap, inflation, and the nominal interest rate as well as other macro variables that are useful to predict them. As referred above, this VAR is used to provide forecasts. The second input is the monetary policy evidence. The monetary policy shock used is Aruoba and Drechsel (2024), which updates the Romer and Romer (2004) shock. This transitory shock is used in a VAR to get the causal effects on inflation, output gap and nominal interest rates. The last input is the information provided by four different DSGE models. These models are used to match and then extrapolate beyond the empirical VAR evidence on monetary policy transmission.

inflation sharply with only a small reduction in output and with a lower interest rate path.[20]

3.2. *Structural models*

Structural models, such as DSGE models, are particularly well-suited for analysing the impact of different monetary policy choices as they rely on micro-foundations. However, there is no consensus on the appropriate structural model to use for a certain economy, so concerns of model misspecification are inevitable. While these models are founded on structural features and as such are well suited for policy analysis, they rely on assumptions that may be criticized and can exhibit inconsistencies with data. Therefore, the outcomes of counterfactual experiments using these models must be interpreted cautiously, as their usefulness depends on the robustness of the underlying model.

After selecting a model which describes the behaviour of the economy of interest, it is possible to analyse the impact of a different systematic response to economic developments or to analyse a specific path for policy rates. There are some examples in the literature regarding the impact of alternative policy rules for economic developments. Crump (2023) and De Fiore *et al.* (2023) analyse the role of alternative monetary policy rules in the US after the pandemic while Darracq-Paries *et al.* (2024) focuses on the euro area. Crump (2023) use the New York Fed DSGE model to explore what would have happened if the Federal Reserve had adopted an average inflation targeting reaction function since the second quarter of 2021, when inflation began to rise, instead of maintaining the federal funds rate unchanged until March 2022, followed by aggressive rate increases. They show that the actual policy was more accommodative in 2021 than implied by the counterfactual reaction function and then more contractionary in 2022 and beyond. On net, the effect of monetary policy on the level of GDP, when measured relative to the counterfactual, was positive throughout the horizon, due to the impact of keeping the fed funds rate near zero in 2021. De Fiore *et al.* (2023) use a medium-scale DSGE model similar to the New York Fed's model to analyse the impact of an aggressive inflation targeting framework or an interest rate peg (i.e., the continuation of the previous accommodative monetary policy stance) until the second quarter of 2025, followed by a return to a standard inflation targeting strategy. The authors find that none of these rules would have prevented inflation from surging initially. For the euro area, Darracq-Paries *et al.* (2024) assess how the economy would have performed since mid-2021 under alternative monetary policy strategies, using the ECB's workhorse estimated DSGE model (NAWM II, see Coenen *et al.* 2018). The analysis contrasts actual policy conduct against alternative strategies which differ in their "lower-for-longer" commitment as well as policymakers' preferences regarding inflation and output volatility. The results show that an earlier tightening would have minimised the peak of inflation and achieved convergence to the target faster, but

20. The authors believe this counterintuitive result for the interest rate path reflects the extremely forward-looking nature of some of the DSGE models used. Moreover, there is a large uncertainty about the response of the interest rates.

the forceful tightening that was actually implemented prevented higher inflation from becoming entrenched.

One should note that selecting an appropriate counterfactual scenario may present a significant challenge, as it requires making assumptions about what is the relevant alternative policy path. Suppose that the policy question is what would have been the behaviour of macroeconomic variables of interest in the recent hiking cycle if the monetary policy had increased rates later as done in one of the scenarios in Darracq-Paries *et al.* (2024). In that scenario, interest rates would have been unchanged at around their lower bound since September 2019 until early 2024. This seems an unreasonably long period of unchanged interest rates at levels well below those compatible with the 2% inflation target. This questions the interest of implementing such a counterfactual scenario.

There is also a large literature on how the monetary policy rule changes the transmission of other shocks.[21] For example, there are several studies analysing in what manner the monetary policy affects the macroeconomic impact of fiscal shocks, such as Christiano *et al.* (2011), Eggertsson (2011), Woodford (2011), and Coenen *et al.* (2012). Coenen *et al.* (2012) analyse the macroeconomic impact of different expansionary fiscal shocks (government consumption and investment spending, lump-sum transfers, and different taxes) in seven DSGE models used by policymaking institutions as well as two prominent academic DSGE models. As a counterfactual, they simulate the impact of the same fiscal shocks when monetary policy does not react, to illustrate the fact that fiscal policy is most effective if the monetary authority keeps policy rates unchanged as opposed to following the usual monetary policy rule. In a similar spirit, Bonam *et al.* (2024) analyse the impact of an exogenous increase in public investment (of 1% of pre-shock GDP over eight quarters) in a wide range of models, under the models' monetary policy rule and an alternative (counterfactual) scenario of unchanged policy for 2 years. Results show that a temporary euro area-wide public investment shock implies larger expansionary effects when there is no monetary policy response (as opposed to the baseline case where a tightening of monetary policy suppresses aggregate demand). These results are illustrated in Figure 4 for the case of the EAGLE model.

The analysis of the impact of policy paths that were actually implemented is a question with obvious policy interest but also obvious difficulties, for several reasons already discussed. Even if one has the model (or models) that perfectly describes an economy, it is of utter difficulty to find a realistic counterfactual scenario to run such an experiment. An example is Darracq-Paries *et al.* (2023), which evaluates the macroeconomic impact of the ECB's monetary policy tightening since December 2021 up to the time of writing in a suite of models (two DSGE models and a semi-structural one). The authors choose as the relevant counterfactual scenario the interest rate path expected at the time of the ECB's December 2021 projections. The results generally show

21. With this analysis, we are not attempting to determine the most appropriate monetary policy rule in response to a given shock. Rather, we argue that changing the rule alters the transmission of non-policy shocks, and this difference reflects the effect of systematic monetary policy. The rule can be state-contingent, responding differently to various types of shocks.

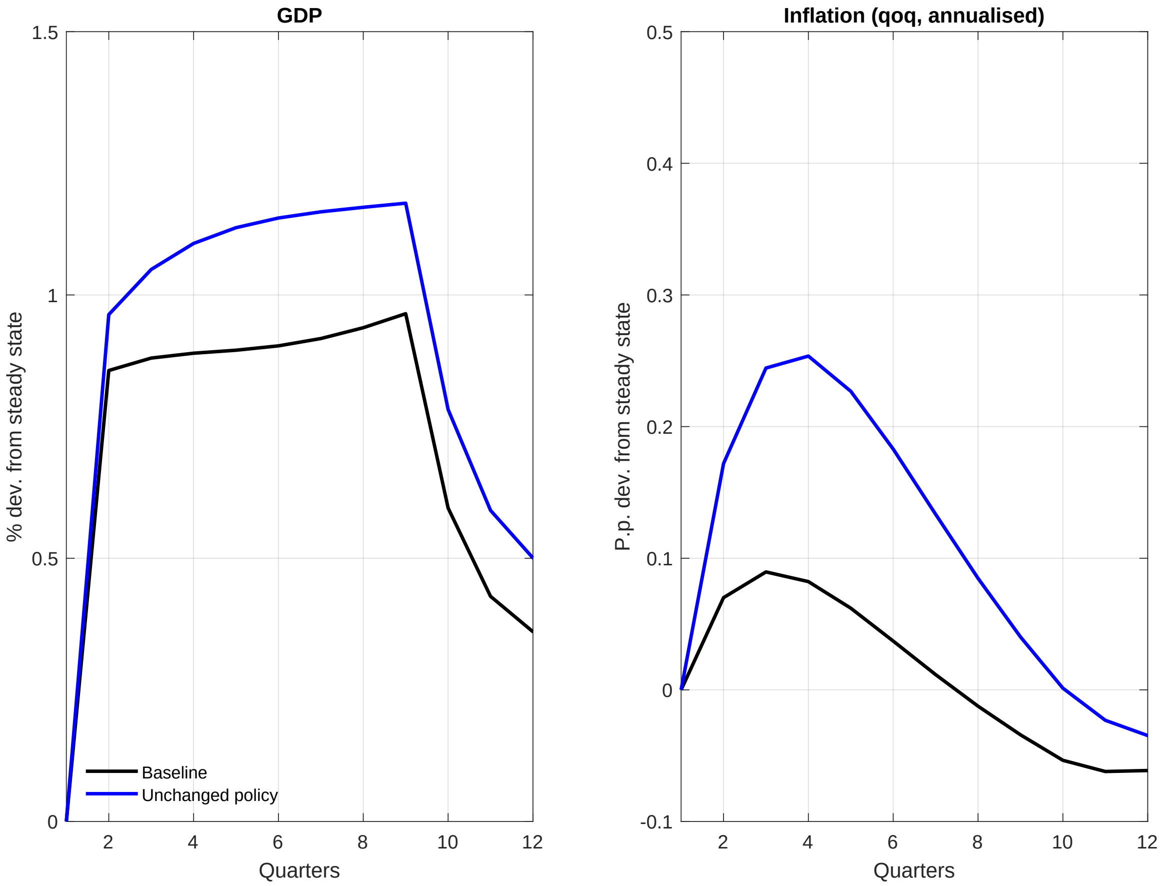

FIGURE 4: Monetary policy and the impact of a government investment shock

Sources: Authors' calculations.
Notes: Based on the analysis in chapter 3 of Bonam *et al.* (2024). The graphs represent the impulse response functions of euro area's real GDP (in % deviations from steady state) and inflation (p.p. deviations from steady state) according to the EAGLE model. The baseline simulation includes the model's interest rate rule whereas the Unchanged policy rate simulation considers that in the first two years policy rates are kept constant whereas after that the policy rule holds again.

that the increase of the policy tightening implied a negative impact both on inflation and economic activity over the three years following the first increase.[22] Still, the analysis shows some quantitative differences in the estimated impact across the different models used. Note that, again, the counterfactual scenario would imply policy rates at levels well below those compatible with the inflation target for a prolonged period, which may put into question the reasonability of the results.

There is a vast literature that emphasizes the importance of following a systematic monetary policy (see for example, Adão *et al.* 2011). In a formal model, if monetary policy is systematic, then the economy can achieve an equilibrium with anchored inflation

22. Note that the authors consider the impact on short-term rates that reflects actual and expected increases in policy rates but also the impact on long-term rates that results from revisions to expected asset holdings. As the authors do not show the effects separately, we abstract from this in our comments.

expectations and economic stability.[23] The intuition is that such policies, by providing a clear framework for how the central bank will change the interest rate in response to economic changes, reduce uncertainty. Economic agents benefit from predictable interest rates and stable inflation as it helps them make more informed investment and saving decisions. However, not all systematic monetary policies produce the same economic outcomes. The literature on monetary policy counterfactuals suggests that different monetary rules can produce very different economic outcomes, which are associated with different welfare levels. This is a topic of research that has seen important recent developments, and the uncertainty surrounding the current results indicates that more empirical work on the causal effects of persistent changes in monetary policies is important.

4. Final remarks

This synopsis focuses on how to assess the impact of conventional monetary policy, which relies on setting short-term risk-free interest rates. Estimating the impact of monetary policy on the real economy is not straightforward. Changes in interest rates often reflect policymakers' responses to economic developments, while economic developments, in turn, reflect the impact of policy choices. This synopsis explores various methodologies used in the literature to assess the impact of monetary policy.

To be able to address causality, the literature has focused on monetary policy shocks, defined as exogenous movements in policy rates. There is a vast literature on the macroeconomic impact of monetary policy shocks, which has generally found that an unexpected increase in the policy rate induces a reduction in real activity and prices. However, the magnitude and duration of these effects vary, among other things, on the type of model used, the sample period, or the countries analysed, compelling cautious interpretation of the results. Also, identifying monetary policy shocks has become increasingly difficult in recent periods, arguably due to the more systematic nature of monetary policy frameworks.

Given the importance of systematic monetary policy, the literature has also used counterfactual analysis to assess the impact of monetary policy. Recent developments in statistical models have incorporated more rigorous consideration of the Lucas critique. Counterfactual analysis is extensively used but choosing the appropriate counterfactual scenario entails challenges.

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23. If the rule obeys the Taylor principle, the economic models will have a unique and stable equilibrium. This prevents extreme inflationary or deflationary cycles, which can harm economic growth.

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