NBER WORKING PAPER SERIES

MONETARY AND FINANCIAL SPILLOVERS:
NEW HISTORICAL EVIDENCE FROM GERMANY

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Working Paper 30485
http://www.nber.org/papers/w30485

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
September 2022, Revised September 2025

We thank Giancarlo Corsetti, Refet Gürkaynak, Leonardo Melosi, Eric Monnet, Emi Nakamura, Hélène Rey, Eric Swanson, Jón Steinsson, and Harald Uhlig as well as seminar participants at the Deutsche Bundesbank, the 29th CEPR European Summer Symposium in International Macroeconomics, the NBER Summer Institute 2023 and numerous other seminar participants for their comments. We thank the former Bundesbank President Jens Weidmann, the Presidential Office, and the Bundesbank Historical Archive for access to the briefing materials of the Central Bank Council meetings. We also thank Jihene Arfaoui, David Finck, Lora Pavlova, and Uliana Sulakshina for excellent research assistance. All errors are ours. The views expressed herein represent the authors' personal opinions and do not necessarily reflect the views of the Bank of England, Deutsche Bundesbank, the Eurosystem, or the National Bureau of Economic Research.

At least one co-author has disclosed additional relationships of potential relevance for this research. Further information is available online at http://www.nber.org/papers/w30485

Monetary and Financial Spillovers: New Historical Evidence from Germany
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NBER Working Paper No. 30485
September 2022, Revised September 2025
JEL No. E32, E52, F42, F44

ABSTRACT

Using newly identified exogenous variation in German monetary policy from 580 policy meetings between 1974 and 1998, we provide new evidence on the role of the exchange rate regime in monetary spillovers. Germany played a central role in the European Monetary System over these decades. Following a German monetary tightening, European countries pegged to the Deutschmark experienced unchanged nominal exchange rates, higher short-term interest rates and sizable economic contractions. In contrast, floating exchange rate economies in Europe saw a sizable depreciation of their currency vis-á-vis Germany, but limited short-run movements in interest rates, activity or prices. U.S. monetary tightenings had similar effects on both Deutschmark pegs and floats. Our findings are consistent with the predictions of the trilemma.

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1. Introduction

How does monetary policy affect the economy at home and spillover abroad? And how important is the exchange rate regime in the propagation of monetary policy across countries? These have long been important questions in macroeconomics and international economics from both theoretical and empirical perspectives.[1]

One of the most important theoretical predictions in international macroeconomics is the policy trilemma. An implication of the trilemma is that, under some degree of interest arbitrage, a country that fixes its exchange rate to some base country gives up domestic monetary autonomy. Monetary transmission from the base to those countries that peg to it should therefore be much stronger than to countries that float. In short, the choice of exchange rate regime should significantly affect the international transmission of monetary policy from the base country. In practice, however, the existence of "dirty" regimes complicates the mapping from the theory to the data, and these theoretical implications could also be overturned if other spillover mechanisms come into play. The empirical literature has therefore continued to search for evidence in favor, or against, the trilemma, and the importance of the exchange rate regime remains a highly debated question.

We bring new evidence to this debate from an important historical period in Europe. From the 1970s to the 1990s, Germany — a large G7 economy — played a central role in European economic policy. Many countries chose to adopt a de jure or de facto peg to the Deutschmark (henceforth, DM) which played the dominant role as the anchor currency within the basket-peg setup of the European Monetary System (EMS), an institutional setting we describe in more detail below. In contrast, some countries elected to float.

During this period Europe was already very liberalized in goods trade and removed its remaining capital controls in the 1980s. The Bundesbank (the German central bank) had also earned a reputation as a conservative and highly credible institution in an era of high inflation and German government bonds provided key benchmark interest rates in financial markets. As a result, this setting provides a fertile testing ground to examine the predictions of the trilemma.

To study the effects of Bundesbank monetary policy, both in Germany and abroad, the standard econometric problem is that we need some identified variation in German policy interest rates. Monetary policy — by its nature — responds to economic conditions and many interest rate changes will be correlated with other economic fluctuations. The construction of a new measure of monetary policy changes for Germany that can be used to disentangle cause and effect is our first order of business.

[1] See for example, Eichengreen (1985, 1996); Temin (1991); Obstfeld, Shambaugh, and Taylor (2004, 2005).

Our point of departure is the well-known Romer and Romer (2004) (RR) approach, which they developed to study the domestic effects of monetary policy in the United States. But, as will be explained momentarily, there are several important differences and extensions that are unique to our German setting. As in RR, our identification approach uses real-time historical central bank documents to capture the information set on which policy decisions were based. In our setting, we rely on previously unused archival evidence from the German Bundesbank, which reveals the precise real-time data available to policymakers at all 580 meetings of the Central Bank Council (*Zentralbankrat*), the body which set the German policy interest rate in the period of study. But these documents also contain daily information on financial market data and we incorporate a range of yield curve as well as exchange rate series in our data set. We use these data to condition on financial market information that is available right up to the day of the policy meeting. These data are naturally forward-looking. Thus, our approach incorporates aspects of the high-frequency approach to identification which isolates surprise movements in monetary policy from asset price movements.

Here, in our first step, a first-stage "cleaning" regression is used to orthogonalize policy rate changes with respect to the policymakers' information set. We treat the residuals of this regression as our newly-constructed series of German monetary policy shocks. The resulting shock series is a research contribution in its own right, a useful resource for future researchers interested in all kinds of questions related to the transmission and impact of German monetary policy. As diagnostic checks, we show that the shocks we construct generate statistically significant movements in financial markets around the policy decision, as they should, whereas the predictable component of the interest rate change does not; we also show that the shocks are unpredictable based on other macroeconomic indicators.

To study the spillover effects and the role of the exchange rate regime, we draw on institutional and historical aspects of European economic policy over this period, and carefully construct two groups of countries, one of DM pegs and another of DM floats. Together with a rich panel dataset covering all the major European economies, we then use our new German monetary shocks to assess the predictions of the trilemma.

We have three main results. First, we find that the domestic effects of monetary policy in Germany are reassuringly conventional: higher interest rates cause inflation to fall with a lag, output falls, and unemployment rises. These results are robust to a battery of checks, and also align with findings for other countries (e.g., Romer and Romer (2004) for the U.S.; Cloyne and Hürtgen (2016) for the U.K.; Champagne and Sekkel (2018) for Canada; and Holm, Paul, and Tischbirek (2021) for Norway).

Second, in line with the predictions of the trilemma, we show that European countries with DM pegs were much more exposed to German monetary shocks, while DM floats were not. Specifically, following a German monetary tightening, DM pegs see no response of their bilateral DM nominal exchange rate, higher domestic short-term interest rates, and a decline in economic activity and prices. In contrast, DM floats see a sizable depreciation of the bilateral nominal exchange rate, more limited interest rate movements, and no decline in economic activity or prices. These findings are robust to a broad range of robustness checks and alternative ways of classifying pegs and floats.

Third, we bring in the United States to conduct a form of placebo test. Making use of the RR shocks for a comparative exercise, we show that *in absolute magnitude* the spillovers from German shocks to Europe were at least broadly comparable (or for pegs, even larger) compared to the spillovers from U.S. shocks during this period. In addition, we show that U.S. shocks had broadly similar effects on DM pegs and DM floats, unlike German shocks. This provides further support for the trilemma given all European economies were floating relative to the U.S. over this period.

There is, of course, also a large literature focused on how to identify exogenous variation in monetary policy, although often these are papers with a more closed economy focus. One popular approach in recent years uses high frequency financial markets data and extracts the "surprise" movement in interest rates around policy decisions (notable examples include Kuttner (2001), Bernanke and Kuttner (2005), Gürkaynak, Sack, and Swanson (2005), Gertler and Karadi (2015) and Nakamura and Steinsson (2018)). One drawback of this approach is that very high frequency data are typically only available for recent years, and this limits how far back in history it can be applied, and this is the case for Germany. Older structural vector autoregression methods (for example, Christiano, Eichenbaum, and Evans (1999), among others) rely on timing assumptions and have sometimes produced some puzzling results (such as an increase in prices following a monetary contraction).

Instead, Romer and Romer (2004) use the Fed's Greenbook forecasts that are prepared ahead of each policy meeting to capture the information set of Fed policymakers at the time of their policy decision. In this spirit, we collect detailed historical data from the Bundesbank archive focusing on key macroeconomic indicators that were frequently discussed in the meeting itself, as evidenced in the minutes from the policy meetings, along with daily financial information on exchange rates and yield curves. This hybrid approach allows us to construct the first series of monetary shocks for Germany using a Romer-Romer-type methodology.[2] Given the nature of the historical documents, the lack of digitally available data and the large number of policy meetings over this period, this was no small task. We hope the historical data work conducted for this paper is an important and useful contribution in its own right.

We also obviously relate to the large international macroeconomics literature on monetary

[2]This approach is also related to Lennard (2018), who constructs a series of RR style shocks for the interwar period in the United Kindgom. Like us, Lennard (2018) also exploits offical historical documents from the Bank of England available up to the day of the policy decision.

policy spillovers and the role of the exchange rate regime. A number of papers have examined the trilemma view of monetary transmission, but many questions remain unsettled.

Many papers have studied U.S. monetary policy spillovers to the rest of the world, using large datasets that pool a heterogenous sample of advanced and emerging countries, and here there are mixed results. Early works include Dedola, Rivolta, and Stracca (2017) and Iacoviello and Navarro (2019). The former looks at 30 advanced and emerging economies, and concludes that "no clear-cut systematic relation emerges between country responses and likely relevant country characteristics, such as their income level, dollar exchange rate flexibility, financial openness, trade openness versus the U.S., dollar exposure in foreign assets and liabilities, and incidence of commodity exports." The latter looks at 50 advanced and emerging economies and argues in contrast that "trade openness with the U.S. and the exchange rate regime account for a large portion of the contraction in activity." Another study with an extension to a large advanced-and-emerging economy sample (Obstfeld, Ostry, and Qureshi, 2019) argues that the evidence that a floating exchange rate moderates spillovers from the base to the local economy. Recently, Degasperi, Hong, and Ricco (2024) report impulse responses for 30 advanced and emerging economies, but find mixed results, with more limited evidence that the exchange rate regimes mattered and a larger role for financial channels.[3]

Our focus is on a tighter and more homogeneous group of advanced economies: we look to Europe in a specific historical window and at a time when another influential central bank was also present and potentially generating spillovers. Here, important early findings for the EMS were presented by di Giovanni, McCrary, and von Wachter (2009). They look at contemporaneous real GDP spillovers in the 1973–1998 EMS era from German rates in quarterly data, finding evidence in support for the trilemma, although unlike our study they have no measure of an exogenous component in German rates, and simply use German rates as an instrument for local rates in other EMS members.

The most closely related recent paper is Corsetti, Kuester, Müller, and Schmidt (2024), who show that after 1999, euro area monetary policy shocks seem to have similar spillover effects to neighboring countries irrespective of their exchange rate regime. For this sample, floats act like pegs, and stabilize their exchange rate following ECB shocks. In our pre-Euro setting, floating regimes experience nominal exchange rate depreciations, whereas pegged regimes maintain a fixed exchange rate vis-à-vis the DM after a German monetary tightening. This contrast enables a direct test of the trilemma.

[3]Early works that studied Fed spillovers include Forbes and Chinn (2004), Canova (2005), and Ehrmann and Fratzscher (2009). Recent literature has also looked at spillovers from both the U.S. and the euro area, e.g., Ehrmann and Fratzscher (2005); Fratzscher, Duca, and Straub (2016); Brusa, Savor, and Wilson (2020).

While earlier studies provide valuable insights, many rely on reduced-form approaches or lack clearly identified monetary shocks, particularly in the European context. Our contribution is distinct in combining a newly constructed series of exogenous German monetary shocks with a rich historical setting that allows us to test the trilemma in a more causally credible way. This helps address concerns about endogeneity and omitted variable bias that may affect earlier findings.

Finally, we connect to the recent literature on the global financial cycle and U.S. global spillovers. This literature has emphasized that U.S. spillovers may play an outsized role in global monetary and financial outcomes in all economies, advanced and emerging, fixed and floating (Rey, 2015; Kalemli-Özcan, 2019; Miranda-Agrippino and Rey, 2020). We also find that U.S. monetary policy shock spillovers have sizable effects on Europe during our sample period, and that these effects are similar across DM floats and DM pegs. However, we also bring into this debate a new angle. When we account for monetary policy shocks emanating from more than one economy, how do their impacts on macroeconomic outcomes compare across exchange rate regimes? With a long time series of German monetary policy shocks in hand, we can now ask whether their influence was larger or smaller relative to the U.S. shocks, and whether they differ across third countries by exchange rate regime.[4] What we find is that U.S. monetary policy spillovers to Europe are broadly comparable in absolute magnitude to those from Germany, while German monetary policy spillovers vary markedly between DM pegs (stronger linkages) and DM floats (more insulation). To paraphrase Keynes, at least two countries over this period could be seen as conductors of the European orchestra—and there were also, in a sense, two orchestras.

The rest of the paper is structured as follows. In Section 2 we set out our econometric approach and describe in detail our new data set and the identification strategy. Section 3 examines the domestic effects of German monetary shocks. This section provides a number of results that are interesting in their own right, but also serves as a useful benchmark before moving to consider monetary spillovers. Section 4 then examines the monetary spillovers from Germany to countries with pegged versus floating exchange rates. We show a range of evidence that supports the hypothesis that DM pegs are more exposed to Germany monetary shocks. Section 5 puts our results in an international context by also examining U.S. spillovers to the Europe over this period. Section 6 concludes.

[4] Some recent papers have examined transmission from multiple monetary policy shocks, but not in the context of different exchange rate regimes. Some look at transmission to financial markets (Brusa, Savor, and Wilson, 2020; Boehm and Kroner, 2025), some include macroeconomic outcomes (Ca'Zorzi, Dedola, Georgiadis, Jarociński, Stracca, and Strasser, 2023), some examine transmission from unconventional monetary policies (Miranda-Agrippino and Nenova, 2022). These papers are all also focusing on the post-1999 period after the arrival of the euro.

2. Empirical Approach

This section explains how we identify historical variation in German policy rates. We then discuss our new archival data, the resulting monetary shock series and its properties.

2.1. Identification

Isolating causal effects requires identifying some exogenous variation in policy rates. In the monetary economics literature, two popular approaches are Romer and Romer (2004) (henceforth RR), who use real time and central bank historical forecast data to isolate unexpected movements in interest rates, and high frequency identification (see, for example, Kuttner (2001), Gürkaynak, Sack, and Swanson (2005), Nakamura and Steinsson (2018), and Bauer and Swanson (2023a,b)), which measures surprise movements in financial market data in narrow time windows around the policy decision. In a broad sense, both approaches aim to capture the predictable component of the policy decision, and use the residual variation for identification. This deviation from the expected policy outcome is treated as the exogenous surprise component of interest rate changes.

This paper applies the RR approach to Germany, while also incorporating insights from the high frequency literature. First, we construct a new real-time dataset to capture the information set of the policymakers right up to the day of the policy decision. Next, a "cleaning" regression is used to orthogonalize interest rate variation around each policy meeting with respect to this information set. In general, the RR approach requires careful analysis of policy decision dates, measurement of the change in the policy instrument, and the collection of real-time and/or forecast data for each meeting. It is time-consuming and requires careful historical analysis. As a result, cross-country monetary "shocks" identified using this type of approach are still relatively few. Germany is an excellent country for analysis. The Bundesbank Archives contain a rich source of real-time information about what policymakers knew at the time of the policy decision.

From the Bundesbank Archives, we analyze numerous historical documents including briefing materials containing real-time data for every policy meeting of the Central Bank Council, minutes of each council meeting, as well as policy reports and further data publications around policy meetings. Some documents contain large tables of raw data, so we carefully analyse the Bundesbank Central Bank Council minutes from the policy meetings to elicit the key data that were available and routinely discussed. Both inflation developments and real activity were closely monitored and debated during the policy meetings. In addition, the committee extensively analyzed money supply, especially since the Bundesbank started monetary targeting in December 1974. Furthermore, the Council also discussed financial market developments, in particular exchange rates and the domestic bond markets. These data are therefore the basis for our baseline "information set" relevant for each policy meeting.

Relative to the RR U.S. setting, one important difference is that the Bundesbank did not explicitly produce macroeconomic forecasts. Policymakers also did *not* analyze or discuss forecasts during the policy meeting, as can be seen from the minutes.[5] But this does not mean that policymakers, or the underlying policy rule, were backward looking. The Bundesbank had a medium-term mandate for price stability, which naturally required a forward-looking outlook.[6] And while formal forecasts were not produced for Central Bank Council meetings, policymakers did rely on a broad set of real-time backdata and financial market indicators—data that likely captured similar information to what would be included in a forecast exercise. RR use forecasts as "sufficient statistics" for the Fed's information set and the expected evolution of the economy.[7] Our approach seeks to capture the same concept, but by collecting a rich set of economic indicators that is designed to span the same information set that would be summarized by forecasts.[8] Moreover, a subset of these data are high-frequency financial markets variables, which *are* likely to capture expectations about future economic developments.

It is also worth noting that many of the variables in our data are measured right up to the day of the policy meeting itself, and we use the most relevant (for the policymaker) data "vintage" by design. Our use of high frequency economic and financial data available to the policymaker immediately prior to the policy meeting is also useful for similar reasons to those outlined in Bauer and Swanson (2023a,b) where, in the U.S. context, the Fed may respond to news that occurs close to the policy decision. Overall, our approach therefore combines the RR method with important insights from the high frequency identification literature.

[5] Mishkin and Posen (1997), in their discussion of Bundesbank processes, note "the Reports always deal with the current situation or assess past performance—no forecasts of any economic variable are made public by the Bundesbank, and private-sector forecasts or even expectations are not discussed. The Bundesbank makes itself accountable on the basis of its explanations for past performance, but does not leave itself open to be evaluated as a forecaster".

[6] While not the oldest central bank, it is noteworthy that the Bundesbank was the first central bank to be granted full statutory independence. Established in 1957, the Bundesbank operated free from direct political influence, with a clear legal mandate to ensure price stability. This institutional design set an important precedent for modern central banking and served as a blueprint for the ECB.

[7] The use of forecasts as "sufficient statistics" is emphasized by Cochrane (2004) in an insightful discussion of Romer and Romer (2004).

[8] Forecasts are, after all, projections based on current and historical information available to the modeller or policymaker. This information set should be rich enough to capture beliefs about future developments. While forecasts would have been efficient summary statistics, our approach uses the minutes and archival data to select and measure the key variables relevant to the policy decision. In contrast, typical VARs may contain too little information, and since any variable could potentially be important, this necessitates a sizable number of controls (see Cochrane, 2004). The VAR approach is also usually based on data of a specific frequency, e.g. monthly or quarter, and the data are not typically real-time. Our approach, works meeting by meeting.

2.2. Data Construction and Sources

To capture the Central Bank Council's real-time information set, we collect, construct and analyze data for 580 Bundesbank Central Bank Council meetings from December 1974 to December 1998. The Bundesbank started monetary targeting in December 1974 and joined the Eurosystem in January 1999. The Central Bank Council meetings were held every two weeks (more frequently than FOMC meetings), providing a considerable amount of potential variation over this period.[9]

As noted above, the new dataset draws on official historical Bundesbank documents that were available to Council members at the time of each policy decision, and obtained from the Bundesbank Archives.[10] We carefully analyse a range of historical documents and the minutes of the policy meeting itself. Our main data source is the meeting-by-meeting briefing material provided to the Council. These documents comprise numerous tables and charts that were internally dubbed *Statistical Overviews about the Monetary Policy Situation*, or in German, *Statistische Übersichten zur währungspolitischen Lage*, and which provide an excellent summary of the information available at the time. To our knowledge, this is the first paper to exploit these documents. Furthermore, we use the minutes of the policy meeting itself. All these documents are extremely detailed and are not digitized. In fact, almost all of our new data did not exist in electronic form.

Based on our reading of the meeting minutes, council members engaged in lively and substantive discussions about economic conditions, money growth and the real-time data more broadly. The structure of the minutes is consistent throughout our sample. Each document includes a dedicated section titled *Exchange of Views on Monetary and Credit Policy* (in German: Aussprache zur Währungs- und Kreditpolitik), which records the deliberation surrounding policy rate decisions and, at times, the voting outcomes. From the meeting minutes we identified which indicators were routinely presented and discussed in the policy meeting. Informed by this analysis, from the *Statistical Overviews* we digitized the consumer price index (CPI), the unemployment rate, the 12-month money growth rate and bond yield curve data. Exchange rates were also available in these briefing materials, but these were readily available in digitized format. Every month an additional set of real-time data was circulated in statistical appendices from the monthly reports (officially referred to as *Statistical Supplements to the Monthly Reports of the Deutsche Bundesbank. Series 4: Seasonally Adjusted Economic Data*). We used these data to occasionally fill some additional data points

[9] Unlike the FOMC in the U.S., there were no emergency meetings of Bundesbank Central Bank Council.

[10] We thank the staff of the Bundesbank Historical Archive for providing access to the data. We are also grateful to the former Bundesbank President Jens Weidmann, who allowed us to include data and minutes, which were not yet available given the official 30-year publication lag.

(e.g., when some backdata were missing in the *Statistical Overviews*). When incorporating multiple Bundesbank sources, we carefully align the publication dates to ensure the data were available at the time of the Council meeting and did not already contain the effects of the subsequent policy action. Appendix A provides a detailed description of the historical data set, and discusses how we deal with some specific technical issues, for example the German reunification of East and West Germany in 1990.

2.3. The "Cleaning" Regression

To orthogonalize the change in the policy instrument with respect to the data constructed in the previous section, we use the following "cleaning" regression. Note that, the goal is not to estimate a specific reaction function for the Bundesbank. Instead, the goal is to orthogonalize policy rate variation around meeting dates with respect to a broad range of indicators relevant and available to policymakers at the time.

We run the following regression:

$$\begin{aligned}
\Delta i_m \;=\;& \alpha + \beta_1\, i_{m-1} + \beta_2\, \Delta i_{m-1} \qquad (1)\\
&+ \sum_{p=2}^{4} \gamma_p\, \hat{y}_{m,t-p} + \sum_{p=2}^{4} \tilde{\gamma}_p\, (\hat{y}_{m,t-p} - \hat{y}_{m-1,t-p})\\
&+ \sum_{p=1}^{4} \varphi_p\, \pi_{m,t-p} + \sum_{p=1}^{4} \tilde{\varphi}_p\, (\pi_{m,t-p} - \pi_{m-1,t-p})\\
&+ \sum_{p=2}^{4} \rho_p\, u_{m,t-p} + \sum_{p=2}^{4} \tilde{\rho}_p\, (u_{m,t-p} - u_{m-1,t-p})\\
&+ \sum_{p=2}^{4} \theta_p\, \Delta^{12m} MS_{m,t-p} + \sum_{p=2}^{4} \tilde{\theta}_p\, (\Delta^{12m} MS_{m,t-p} - \Delta^{12m} MS_{m-1,t-p})\\
&+ \sum_{c=1}^{C} \iota_c\, \log(XR_{c,m,d-1}) + \sum_{c=1}^{C} \tilde{\iota}_c\, (\log(XR_{c,m,d-1}) - \log(XR_{c,m-1,d+1}))\\
&+ \beta_3\, AVG_BOND_YLD_{m,d-1} + \sum_{\substack{j=2y,4y,\\6y,8y}} \zeta_j\, BOND_YLD(j)_{m,d-1} + \epsilon_m\,.
\end{aligned}$$

This regression is run at a meeting-by-meeting frequency. The m subscripts therefore refers to a meeting date. i_m is the Bundesbank discount rate — the policy rate — decided at a particular policy meeting by the Central Bank Council. The subscript p denotes a month (quarter) of the data release relative to the meeting date and the subscript $t-1$ refers to information from the previous month (not information at the previous meeting). This more complex set of timing conventions allows us to incorporate a range of relevant real-time economic data that were relevant to meeting m but were released at different points in time.[11]

In the spirit for RR, we regress the change in the Bundesbank discount rate (Δi_m) around the policy decision (in practice, between two meetings) on real-time quarter-on-quarter GDP growth ($\hat{y}_{m,t-i}$), 12-month consumer price inflation ($\pi_{m,t-i}$), the unemployment rate ($u_{m,t}$) and 12-month money supply growth ($\Delta^{12m} MS_{m,t-i}$). Money growth is included given the focus on the money supply in this historical period in Germany.[12] In addition, we include the data revision between meetings (the second term in each row of Equation 1). To account for policy inertia we include not only the pre-meeting policy rate (as in Romer and Romer, 2004), but also one lag of the policy rate change.

In terms of financial market indicators, bond yields and the exchange rate data were included in the briefing materials. Given the open economy focus of this paper and the fact that Germany is a much more open economy than the U.S., we include the log-level and log-difference of six bilateral nominal exchange rates (denoted XR in the equation above) the day before the current meeting and one day after the previous meeting, $m-1, d+1$, (i.e. commonly this amounts to the exchange rate change of the last 12-13 days) between the DM and the U.S. dollar, French franc, Italian lira, Spanish peseta, British pound sterling and the Japanese yen, where the index c denotes country. Exchange rates here are reported in price notation, with the foreign currency as the base (e.g., 1 GBP = x DM), so that an increase denotes a depreciation of the domestic currency.[13] In terms of bond yield data, we include the term structure of bond yields from two-year, four-year, six-year and eight-year bonds (variable *BOND_YLD* in the equation above); and we include the average bond yield (variable *AVG_BOND_YLD*).[14] In addition to featuring prominently in the briefing materials, these

[11]Based on our reading of the historical literature, we find little evidence to suggest there were breaks in the underlying Bundesbank reaction function over time (see Clarida and Gertler 1997; Clarida, Galí, and Gertler 1998; Gerberding, Seitz, and Worms 2005; Clausen and Meier 2005). The Bundesbank was often regarded as a stable and highly-credible central bank, with a clear focus on price stability, so much that Jacques Delors, a former President of the European Commission, noted in 1992 "Not all Germans believe in God, but they all believe in the Bundesbank" The Guardian (1992). Still, an important potential "break" was reunification of East and West Germany in 1990, which we will discuss in more detail in Section 3.3.

[12]Our baseline measure combines information on Central Bank Money and M3. More precisely, the Bundesbank targeted the growth rate of Central Bank Money from 1974 to 1987, and then shifted to targeting M3 growth from 1988 to 1998. The Committee for the Study of Economic and Monetary Union, *Report on Economic and Monetary Union in the European Community* (Luxembourg: Commission of the European Communities, 1989), later emphasized harmonized monetary aggregates and convergence criteria — consistent with a broad monetary target like M3. Appendix Figure B4 shows that results are nearly identical when allowing for separate coefficients for M3 and Central Bank Money in Equation 1.

[13]The inclusion of exchange rates for more open economies, also follows Champagne and Sekkel (2018) and Holm, Paul, and Tischbirek (2021) for Canada and Norway.

[14]The average bond yield is actually available at a higher (daily) frequency, whereas the yield curve

financial market variables are included as a way to capture forward-looking aspects of the economic outlook.

Given the large number of variables under consideration, the full results from estimating Equation 1 are shown in Appendix Table B1. Here we highlight some of the intuitive aspects of the results. The estimated coefficients have the expected signs. Summing up the coefficients on inflation, real GDP growth, and money growth yields — for each variable — we find a positive effect suggesting that the Bundesbank leaned against these macroeconomic developments. Similarly, higher unemployment rates are associated with an easing of the policy rate. Summing over the coefficients associated with bond yields leads, as expected, to a positive effect. When the DM weakened between two meetings (positive coefficient) against all currencies except the yen, the discount rate was tightened mildly. Finally, the coefficient on the lagged discount rate and the lagged change in the discount rate are negative, reflecting a mean-reversion in the policy rate. In terms of the relative importance of different factors, Appendix Table B2 shows that all the key sets of variables play an important role in the "cleaning" stage. Simpler specifications that omit information generate a lower R^2 and produce second stage impulse responses that exhibit bias.

The regression residuals, ϵ_m, in Equation 1 form our new measure of monetary policy "shocks." Since Equation 1 is a meeting-by-meeting regression, these shocks are summed up to monthly frequency for the main results in the following sections.

2.4. Properties of the New Shock Series

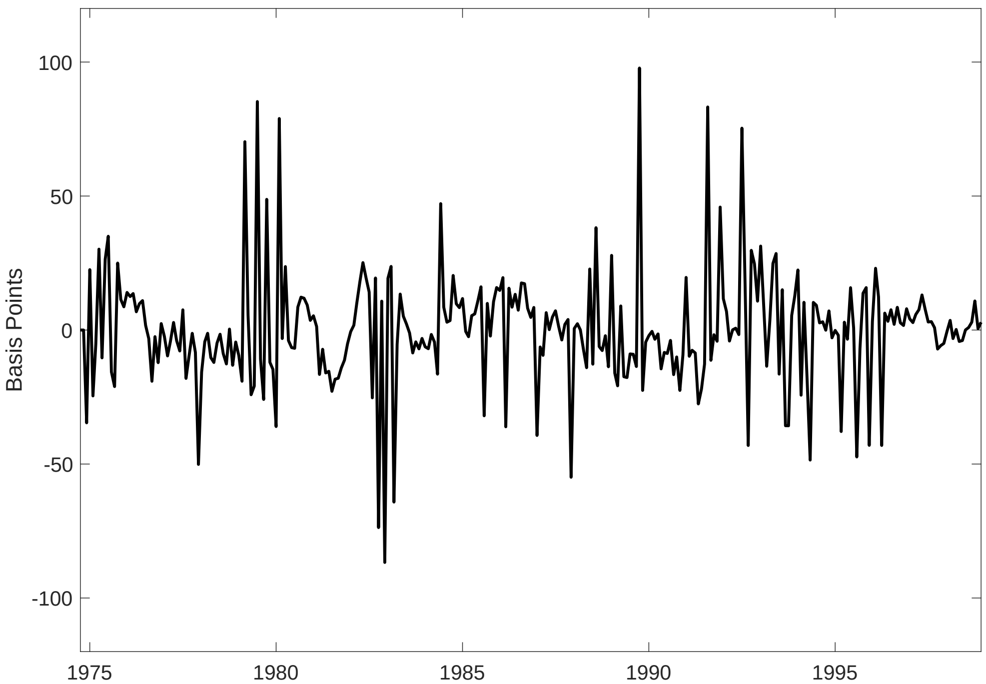
Before using our new shock measure, to analyze the macroeconomic and spillover effects of monetary policy, it is useful to inspect its properties. We start by plotting our new measure of monetary policy shocks in Figure 1. As can be seen from the figure, the new shock series has a mean of zero, by construction, and the shocks are spread out across the sample.[15] Consistent with the discussion earlier, there is also no obvious regime change around 1980 (as in, say, the U.S.), suggesting that the Bundesbank policy regime was relatively consistent throughout the sample period. Our sample covers — similar to the RR shocks for the U.S. — several larger policy changes exceeding 75 basis points in magnitude.

How do some of the most salient shocks in Figure 1 align with the history of German monetary policy over these years? The figure shows that there are some sizable tightening shocks around 1980 and 1990, as well as some sizable loosening events, for example in

information is based on an estimation procedure two to four days before the meeting.

[15]The standard set of test statistics are also in line with, for example (see, e.g., Romer and Romer, 2004), with $R^2 = 0.19$ and an F-statistic of 2.86. This indicates that all coefficients jointly explain a significant share of the discount rate changes, and a DW-statistic of 1.99 confirming no first-order autocorrelation.

Figure 1: *The Monthly Series of German Monetary Policy Shocks*



Notes: This figure shows our new monetary policy shock measure constructed using the regression outlined in Section 2.3. These can be seen as "exogenous" innovations to the policy rate as they come from a regression where the change in the policy rate around a policy meeting has been orthogonalized with respect to information available to the policymakers at that meeting. The units of the shocks are in basis points.

1983. In fact, contemporary newspaper coverage corroborates that these were perceived as unexpected by financial markets. Press reports retrieved from Factiva around these larger shocks, document surprise in the timing, size, or policy rationale. For example, following the March 1983 easing, press reports noted that "the full percentage point cut by the Bundesbank had not been expected." The large October 1989 hike "surprised [markets] by the increase's size," while the August 1991 adjustment prompted *The Economist* to suggest internal dissent within the Bundesbank Council constrained a more forceful move. In the next section, we will show formally that our shock series indeed captures monetary surprises.

2.4.1 Did the Shocks Surprise Financial Markets?

Given the nature of our identification approach, our shocks should surprise financial markets. We therefore formally examine whether this is indeed the case. To be precise, if our identification approach correctly isolates exogenous variation in the policy rate, we should observe two results. First, the shocks should produce a significant movement in financial market interest rates. Second, the implied systematic part of monetary policy — in Equation 1 this is $\Delta i_m - \varepsilon_m$ — should be correlated with market expectations of the policy decision. This idea is closely related to how high-frequency methods construct the surprise change in the policy rate.

Below we show that movements in the implied systematic part of policy changes *do not* lead to statistically significant movements in longer-maturity interest rates, which should be the case if the systematic part is indeed expected. In short, we confirm that (a) our policy shocks do lead to statistically significant movements in financial market variables; but, (b) the systematic part of policy does not. Although we cannot do high-frequency identification directly, as we lack historical tick data on futures contracts, these results provide further reassurance from financial markets that we are truly isolating monetary surprises.[16]

From the *Minutes* we inferred that many policy meetings ended in the afternoon, so markets may not necessarily have heard about a meeting's outcome before closing. Consequently, the bond yield at the decision day may not contain the policy decision. Thus, to be cautious, we employ the two-day bond yield change. First, we estimate the following regression to test whether the fitted policy change (denoted $\hat{\boldsymbol{\beta}}\boldsymbol{X}_t$) from Equation 1 induces a significant movement in bond yields:

$$\Delta AVG\_BOND\_YLD_{d+1:d-1} = \kappa_1 \hat{\boldsymbol{\beta}}\boldsymbol{X}_t + \eta_t . \tag{2}$$

We find that $\hat{\kappa}_1 = 0.0322$ (i.e., 3.22 basis points per 100) and is insignificant with a 95% confidence interval $[-0.0345, 0.0989]$. Thus, reassuringly, the implied systematic part of the policy change does not appear to lead to a significant bond yield change. Second, we check whether monetary surprises significantly move bond yields. We replace the fitted policy change with our monetary policy shock:

$$\Delta AVG\_BOND\_YLD_{d+1:d-1} = \kappa_2 \hat{\varepsilon}_m + \eta_t . \tag{3}$$

Reassuringly, we find that $\hat{\kappa}_2 = 0.0388$ and is significant with a 95% confidence interval $[0.0007, 0.0669]$. Thus, the shock leads to a significant bond yield change shortly after the policy decision.

We have records of when the Central Bank Council meetings ended, but we do not have precise records of when their decisions (or non-decisions) were communicated to the public. As a robustness check we treat meetings that ended before noon to be known to the public before bond markets closed the same day. In this case, bond prices should respond within a one-day window around the policy meeting. We confirm that our results also hold for this sample using $\Delta AVG\_BOND\_YLD_{d:d-1}$. Specifically, we estimate $\hat{\kappa}_2 = 0.0338$ and find that the

[16]We thank Refet Gürkaynak for this excellent suggestion.

monetary policy shock raises the bond yield significantly with a 95% confidence interval [0.0011, 0.0665]. Results are also robust when classifying 1 p.m. meeting ends as information revealed to financial markets the same day. Starting in 1991, 3-month and 6-month bond returns are available. In both cases the shock predicts a significant move in these returns. $\hat{\kappa}_2 = 0.08$ with 95% confidence interval [0.02, 0.15] and $\hat{\kappa}_2 = 0.08$ with 95% confidence interval [0.01; 0.15], respectively.

2.4.2 Are the Shocks Predictable?

If our shocks surprise markets, they should also be unpredictable from other information. We now consider whether our new series of shocks can be predicted based on lags of key ex-post macro and financial markets data. This might be the case if we have omitted important data from the information set in regression Equation 1. To do this we consider whether past economic data, denoted x_{t-j}, can predict our shock series ε_t. We run the following series of Granger causality-type tests:

$$\epsilon_t = \text{constant} + \sum_{j=1}^{J} \omega_j x_{t-j} + u_t \,. \tag{4}$$

We test whether the coefficients ω_j are jointly significant by applying a standard F-test for lag structures $J = \{3, 6, 12\}$. The full results are reported in Appendix Table B3. For all variables and lag structures the F-statistics are small. The associated p-values are all greater than 0.1, and in most cases considerably so. To summarize the key finding, the joint p-values across all variables are above 0.6 in every case. We therefore cannot reject the null of no predictability, providing additional statistical reassurance before proceeding with our analysis.[17]

3. The Domestic Effects of Monetary Policy

Before considering monetary spillovers, we first consider the domestic effects in Germany of a monetary tightening. Given our new shocks, these results are interesting in their own right. But, it is also important to document the impacts at home, before considering the nature of the spillovers abroad. We first present impulse response analysis, then consider some extensions and a range of robustness checks.

[17] Bauer and Swanson (2023a,b) emphasize that high-frequency monetary policy shocks may exhibit predictability if central banks systematically respond to incoming news and agents are learning about the policy rule. While we do not find evidence of predictability in our shocks, this concern is arguably less relevant here, as we condition on all information available to policymakers up to the meeting date.

3.1. Empirical Specification

To study the effects of a shock to monetary policy we estimate the impulse response function (IRF) for different variables of interest using a sequence of local projections:

$$y_{t+h} - y_{t-1} = \alpha_h + \boldsymbol{\Psi}_h(L)\,\mathbf{x}_t + \boldsymbol{\beta}_h\,\varepsilon_t + u_{t+h}\,, \tag{5}$$

where y_{t+h} is the dependent variable at horizon $t+h$, α_h is a constant and captures the mean of $y_{t+h} - y_{t-1}$ for horizon h, L is a lag polynomial for the control variables captured in $\mathbf{x}_t$, and ε_t is our monetary policy shock. This specification is very close to the local projection specification in Holm, Paul, and Tischbirek (2021) and the robustness section of Cloyne and Hürtgen (2016).[18]

The data are monthly and our sample runs from 1974:12 to 1998:12. The baseline specification includes three lags (one quarter) of all control variables. We also allow for twelve lags (one year) of the monetary policy shock.[19] The vector $\mathbf{x}_t$ contains (lags of): (log real) industrial production, the (log) consumer price index, the unemployment rate, (log nominal) loans, the (log real) effective exchange rate, and a (log) commodity price index. All variables are expressed in differences, except the unemployment rate. Our shocks should be capturing exogenous variation in monetary policy. As such, we do not impose the commonly employed timing restriction that monetary policy affects activity and prices with a lag (the so-called "recursiveness" assumption).[20]

3.2. Results

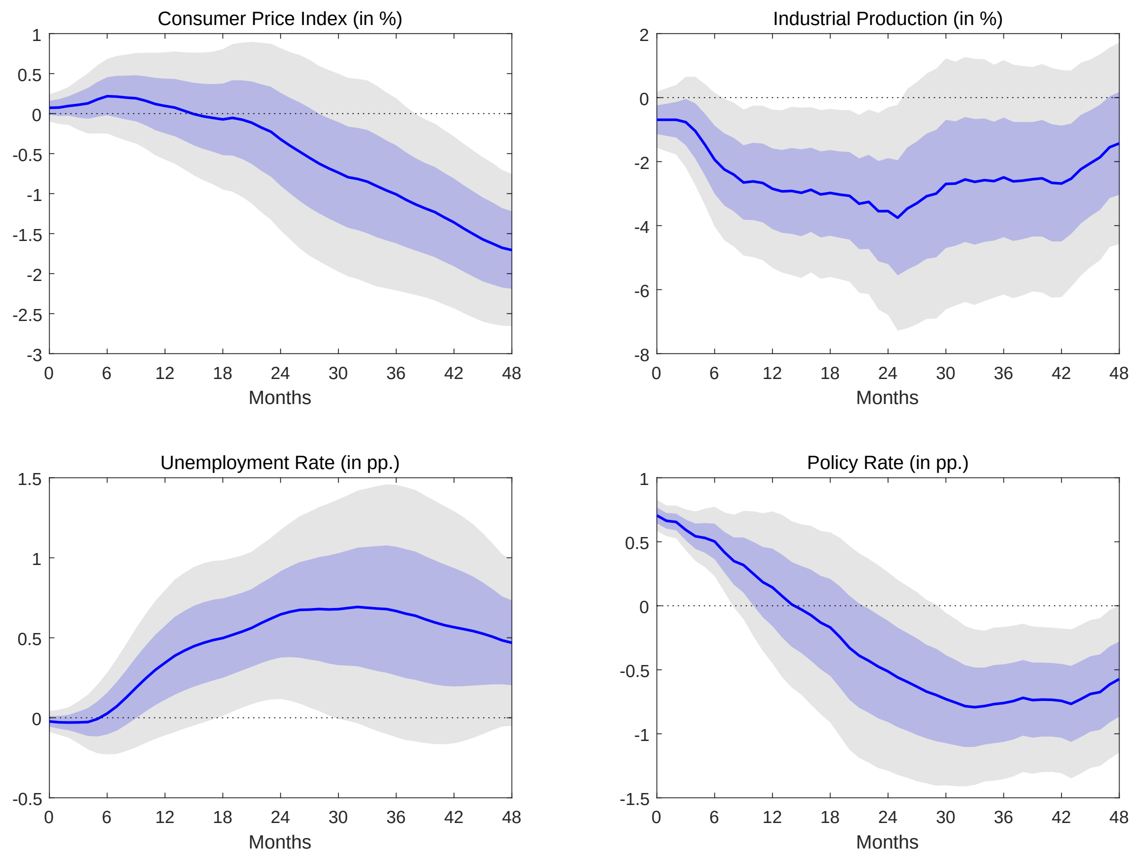
Figure 2 shows our baseline results for four key domestic macroeconomic outcomes: policy rates, output, unemployment and prices. The blue lines show the point estimates and the blue and gray shaded areas report the one and two standard error bands. Because the forecast errors in Equation 5 may be serially correlated, standard errors are calculated using the approach of Newey and West (1987). For presentation, the IRFs are smoothed using a 5 period

[18] Although an asymptotically equivalent approach would be to use a vector autoregression specification (Plagborg-Møller and Wolf (2021)), local projections are useful for capturing effects at longer horizons (Jordà, Singh, and Taylor (2024); Jordà and Taylor (2025)) and provide a straightforward way to estimate impulse responses in a panel setting and with non-linear effects, both of which will be important in the next section.

[19] This is conventional in the literature and will absorb any residual autocorrelation in the shocks that may occur in smaller samples.

[20] In the robustness section, however, we show that imposing this assumption does not affect our main conclusions. Miranda-Agrippino and Ricco (2023) raise concerns about findings that are sensitive to the imposition of this assumption. We also show that the main results are not materially affected by the choice of controls or the lags.

Figure 2: *Effect of a Monetary Tightening on Key Variables in Germany*



Notes: This figure shows the IRFs following a 100 bps contractionary monetary policy shock for a number of key variables for Germany. The regression includes 12 lags of the shock and 3 lags of the controls. The control variables include CPI, industrial production, unemployment rate, loans and the REER. Shaded areas are 95 and 68 percent confidence intervals calculated using the approach of Newey and West (1987). For presentation, IRFs are smoothed. See text for more details.

centered moving average filter, following the approach in Cloyne, Dimsdale, and Hürtgen (2025).[21] In addition, standard errors are similar when using the Huber-White estimator that is robust to heteroskedasticity.

Overall, Figure 2 shows that a 1 percentage point positive shock to the policy rate leads to sizable and persistent effects for all these variables in Germany. The bottom right panel shows the average monetary experiment in the data, that is, the own response of the policy rate itself. The policy rate increases, remains higher than originally expected for around 18 months and then the policy tightening is reversed.[22] This generates a contractionary effect

[21] For completeness, the raw and smoothed IRFs are shown in Appendix Figure C1.

[22] Note, the impact effect on the policy rate in Figure 2 is not exactly 1 pp for two reasons: (i) we report the smoothed IRFs; the raw impact response of the policy rate is 0.86 pp (see Figure C1) and (ii) we are considering the policy rate movement across the whole first month.

on the German economy over this period. Industrial production starts to decline relatively quickly, with a peak decline of around -3.7% about 2 years after the tightening. Much of the decline is felt in the first year. The unemployment rate also rises steadily, peaking at around 0.7 percentage points higher. The unemployment rate moves more slowly than industrial production, and the peak effects occur around 6 months later. Consumer prices also decline, although similar to results in Romer and Romer (2004) and Cloyne and Hürtgen (2016) prices do not seem to respond much over the first 18 months.[23] After 4 years, the overall decline in the price level is around -1.6%. Using the 12-month change in consumer prices directly, we document that CPI inflation declines significantly by around -0.7 percentage point (see Appendix Figure D1). The inflation rate returns to zero in the medium term, although this persistent decline in inflation leaves the price level permanently lower, at least at the 48 month horizon.[24]

How do these results compare to other papers in the recent literature? Comparisons are complicated by different empirical specifications (local projections versus VARs for example) and by different monetary experiments (for example, different papers may have different paths for the interest rate, as discussed in Cloyne and Hürtgen (2016)), but it is still interesting to make a few general comparisons. Our findings for Germany are a bit larger than the effects for the U.K. in Cloyne and Hürtgen (2016). In their local projection specification, a 1 percentage point rise in the policy rate lowers industrial production by around 2%, although the dynamics are similar to those presented here. In terms of the U.S., Romer and Romer (2004) also report a decline in industrial production of more than 4%, although Coibion (2012) compares estimates across a range of specifications and reports a number of results around -2%. Holm, Paul, and Tischbirek (2021), using a similar local projection specification to ours, also report a decline in industrial production of around -4% for Norway (and with similar policy rate dynamics). Champagne and Sekkel (2018) for Canada report a peak decline in real GDP of around -1%. There is clearly variation across countries in the magnitude of the peak effect, which is potentially to be expected, but broadly these papers all tell a similar story regarding the large and persistent real effects of monetary policy changes.

[23]For the EMS period beginning in April 1979, prices start to decline somewhat sooner, with the cumulative decline being of a similar order of magnitudes (see Figure D4).

[24]Figure 2 focuses on four standard domestic macroeconomic outcome variables. In the next section we will consider open economy outcomes. Appendix Figure C2 also includes the IRFs for the additional controls in the regression specification from this section. In particular, nominal credit also declines sharply, by around 5% after 3 to 4 years, and the monetary tightening generates a steady appreciation of the effective real exchange rate (REER). Note, however, that the REER is an average of exchange rates for many countries, including both DM pegs and floats, so it is not well suited to studying the trilemma. We include it here as a broad open economy control for the average real exchange rates. In the next section, we will explore the response of nominal bilateral exchange rates in more detail when examining the spillover effects and the relevance of the trilemma.

Given the results above, a natural question is: how important were these monetary shocks for the business cycle in Germany over this period? Appendix Figure C3 shows the forecast error variance decomposition for the contribution of these monetary policy shocks to each of the variables studied in Figure 2. To calculate the FEVD in a local projections environment, we apply the approach of Gorodnichenko and Lee (2020). Appendix Figure C3 shows that monetary policy shocks account for around 40% of the variation in industrial production and 30% of the unemployment rate. The contribution for consumer prices peaks at around 35%. To help benchmark these numbers, Gorodnichenko and Lee (2020) find that Romer and Romer (2004) monetary policy shocks in the U.S. account for around 25% of the volatility of real GDP and around 50% of the volatility of inflation.

3.3. Robustness Exercises

Before moving on to consider monetary spillovers, we now summarize the range of robustness exercises conducted for the domestic results. In particular, Appendix D shows that very similar results to those in Figure 2 are obtained when we use different variations of the empirical specification. In the appendix we show results (i) using inflation rather than log CPI (Appendix Figure D1); (ii) using different lag lengths of the shocks and the controls (Appendix Figure D2 and Appendix Figure D3); (iii) restricting the sample period to 1979:4 to 1998:12 when Germany was in the EMS (this is the sample we will focus on in the next section to analyze spillover effects) (Appendix Figure D4); (iv) considering the pre-reunification sample ending in 1990 (Appendix Figure D5); (v) a local projection specification in log levels rather than differences (Appendix Figure D6); (vi) imposing the (common) timing assumption that monetary policy does not affect output or inflation in the first period (Appendix Figure D7); and (vii) the counterparts of our results above using quarterly data (Appendix Figure D8) to study the response real GDP, which declines markedly by up to –2% at the peak.

4. Monetary Spillovers

So far, we have shown that our newly constructed interest rate shocks for Germany deliver conventional domestic effects. In this section, we can now ask: Did German monetary policy changes spill over abroad? And, if so, do the results align with the predictions of the trilemma, namely, that DM pegs should be more exposed than DM floats? We first sketch out the theoretical predictions of the trilemma and how this relates to Europe during the EMS era from 1979 to 1998. Next, we discuss our measurement of pegs and floats and the broader empirical strategy. We then present our results, followed by a range of robustness checks.

4.1. Testing for the Trilemma in Europe

In standard open economy macroeconomics, interest rate changes in a large economy like Germany should have spillover effects abroad. But the exchange rate regime plays an important role in determining the nature of these spillovers. With perfect open capital markets and a credible peg, the famous trilemma arises: participation in a fixed exchange must equalize short rates by interest parity, as the two currencies are perfect substitutes, and thus domestic monetary sovereignty is lost. If the trilemma strictly holds, the transmission of interest rates from a center or "base" currency — for example, the DM — should be much stronger to a partner that pegs credibly to the base as compared to one that floats (Obstfeld and Taylor, 1998). The differences will be sharpest for hard pegs (strict alignment to the base country's exchange rate) and pure floats (no exchange rate management at all). Results would tend to be weaker for more complicated cases involving, for example, "dirty" pegs and managed floats, or in situations with capital market frictions.

In theory, the basic intuition for spillovers under the trilemma comes from the interest rate channel. Suppose country A has a hard peg to the DM and there is a German policy rate shock (tightening), causing a contraction for Germany. Then country A also has to raise its policy rate, via interest parity. This generates a monetary tightening, and a contraction, for country A. Now suppose country B has a free float versus the DM. Then country B is free to adjust monetary policy autonomously, and under a typical domestic policy regime would try to smooth out the shock, as best it can, subject to its domestic objectives and constraints.

Going beyond the interest rate channel, however, the full implications for real or financial outcomes in the partner country will in general depend on the presence of other mechanisms; the magnitudes and signs of these additional effects can potentially vary and are extensively studied in an ongoing strand of the literature.[25] As a result, it remains an important empirical question to ascertain the degree to which the exchange rate regime, and the trilemma, are quantitatively relevant, if at all.

[25]For example, in a simple Mundell-Fleming model (see, e.g., Degasperi, Hong, and Ricco, 2024), the direction of transmission via the trade channel will depend on elasticities, as well as on the domestic policy regime. For country B above, if we were to assume a fixed home interest rate, a German tightening for a DM peg would entail export demand shrinkage, but at the same time B's currency will see an offsetting devaluation against the DM, with an ambiguous net demand effect depending on the relative strength of income and substitution effects (and the nature of pass through). In contrast, under a peg, as in country A, the effect of the devaluation offset is absent, and the contraction is amplified by the forced home tightening. Still, early work in this literature was consistent with substantial insulation for floaters (di Giovanni and Shambaugh, 2008). The sharp predictions of the interest rate channel could also be overturned if other mechanisms come into play, e.g., financial channels where additional effects might work through credit conditions and/or risk premia. In this setting, a suitably augmented Mundell-Fleming model can make this intuition clear, too (Degasperi, Hong, and Ricco, 2024). If these other forces are very strong, the exchange rate regime may come to matter less (Rey, 2015; Obstfeld and Taylor, 2017; Miranda-Agrippino and Rey, 2020; Kalemli-Özcan, 2019).

Our new German monetary shocks, and the historical period we focus on, is very well-suited to testing the predictions of the trilemma. As we discussed in the introduction, European economies were very liberalized in goods markets over this period and the Bundesbank played a central role in European economic policy, being widely regarded as a conservative and highly credible central bank. German government bonds provided key benchmark interest rates in financial markets and the role of safe DM assets grew. This credibility, helped create an anchor or center currency role for the DM.[26] Many countries therefore pegged their currencies to the DM, whether de jure or de facto, via the DMs role as the acknowledged center currency in the European Monetary System (EMS), and did so hoping to gain access to Germany's monetary credibility. This process reached its limit with the launch of the euro in 1999, thus marking the end point of our study.[27]

4.2. Empirical Strategy and Data

To examine the importance of the trilemma, we proceed as follows. First, we collect data for a broad range of European economies from the 1970s to the 1990s. Second, we accumulate evidence to isolate two groups, a group we identify as DM pegs and a group we identify as DM floats. Finally, we use a panel local projections framework to examine the response of economic outcomes across the two groups following a Germany monetary tightening. In line with the interest rate channel discussed above, we test the hypothesis that DM pegs should see no change in the bilateral exchange rate with the DM, a rise in their own short-term interest rate, and an economic contraction that resembles the domestic effects in Germany. DM floats should see a depreciation of the bilateral exchange rate, a less tight relationship between interest rates, and insulation from the real effects of the German monetary contraction.

[26]This point is well illustrated by a quote from Anders Fogh Rasmussen, a former Danish Minister of Economic Affairs in 1991 "If the Bundesbank's Directorate even blinks, it sends shock waves through the capital markets across the whole of Europe without us having even the slightest means of intervention" (Rasmussen, 1991, quoted in Deutsche Bundesbank n.d.).

[27]To be more precise, the European Economic Community (EEC), as part of the European Monetary System (EMS), created the European Currency Unit (ECU) in 1979. The ECU functioned as a unit of account for EMS operations and was defined as a weighted basket of EEC member currencies, with the largest weight assigned to the DM. Although the ECU was officially multilateral in nature, in practice the EMS operated de facto under a DM-based system. Member currencies effectively targeted their bilateral rates against the DM, and German monetary policy exerted an outsized influence on interest rate setting across the bloc. The Bundesbank's credibility as an inflation anchor reinforced this asymmetry, making the DM the de facto core of the EMS.

4.2.1 Data

We compile a monthly panel of macroeconomic and financial variables for 15 European economies over the period April 1979 to December 1998.[28] Industrial production is taken from FRED and the OECD Main Economic Indicators and is seasonally adjusted at the source. Consumer prices are from the BIS and seasonally adjusted using X-13-ARIMA. Unemployment rates are constructed from quarterly data provided by the Deutsche Bundesbank and FRED, interpolated to monthly frequency using cubic splines, and are seasonally adjusted. Bilateral exchange rates are from Deutsche Bundesbank. Short-term interest rates come from a recent database constructed by Forbes, Ha, and Kose (2024). Full details are provided in Table A3.

We also use a set of German and U.S. control variables comprising industrial production, consumer prices, commodity prices and the unemployment rate. We include U.S. Romer-Romer monetary shocks from Coibion, Gorodnichenko, Kueng, and Silvia (2017). A detailed list of sources is provided in Table A2 and Table A3.

4.2.2 DM Pegs versus Floats

Next, we need to define the two groups of DM pegs and DM floats, to provide us with the necessary sample split. Unlike in the simple textbook cases, however, the distinction between pegs and floats is not always so binary in reality. At the most basic level in our case, an EMS peg was actually an exchange rate band, or a "target zone" (Krugman (1991); Svensson (1991)). Furthermore, the permitted band widths in practice varied across time and across countries. The band began quite narrow in the 1970s ($\pm$2.25%), but ended up wide ($\pm$15%) in 1993 after the speculative attacks of the ERM crisis. And over time countries' desire to utilize some or all of their permitted band width also varied.

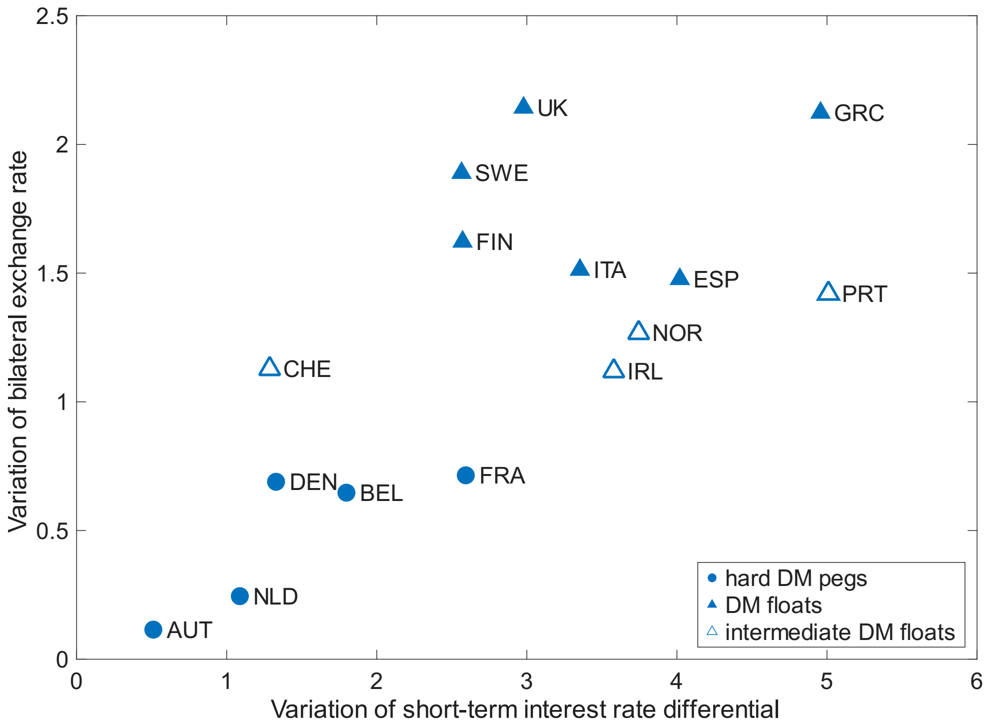
For our baseline strategy we therefore construct a set of countries we refer to as "hard pegs". These were economies that pegged to the DM and followed Bundesbank monetary policy very closely, i.e., tended to adhere to the narrow band, and should therefore provide the sharpest test of the trilemma.[29] Later we broaden the set of countries to include more intermediate cases and different groupings. Initially, however, our goal is to focus on countries that more clearly align with the binary textbook distinction and we opt for a time-invariant classification for each country for our baseline.[30]

[28] The start of the European Monetary System was on March 13th 1979, and January 1st 1999 was the start date of the European Single Currency.

[29] Note, although we are trying to measure pure floats as best as possible, we are less concerned about the "purity" of the floats categorization. To the extent that we see substantial differences between the hard pegs and the floats, this would be evidence consistent with the trilemma, even if some countries in the floating group occasionally did engage in some exchange rate management.

[30] We relax the assumption of a time-invariant classification in the robustness section.

Figure 3: *Exchange Rate and Interest Rate Differential Variation*



Notes: The x-axis shows the standard deviation of the short-term interest rate differential: short-term interest rate abroad minus Bundesbank discount rate (both in pp.); the y-axis shows the standard deviation of the bilateral exchange rate vis-à-vis the DM. Filled circles denote baseline DM pegs; filled triangles denote baseline DM floats. Hollow triangles indicate countries included in a robustness check with all countries under fixed exchange rate regimes (see Appendix Figure E4).

To create our groups, we start by inspecting the correlation between the variation in the DM bilateral exchange rate and the variation in the interest rate differential. This is shown in Figure 3. Interestingly, there is a clear upward sloping relationship between bilateral exchange rate variation and variation in the interest rate differential. We think this is a novel and useful sense check but further diagnostics are clearly warranted.

Next, given that exchange rate regimes in practice are not as binary as in the theory, we opt for a stricter criterion for the peg group.[31] From Figure 3, we observe a substantial increase in exchange rate volatility from France to Ireland and Switzerland. This empirical gap suggests a clear breakpoint, which aligns with the bottom tercile of the exchange rate volatility distribution. The remaining countries we regard as floats, but there is also some variation in the degree of floating among this group. We therefore split this into two groups: "intermediate floats" and "floats". The "floats" group are all countries with an exchange rate volatility more than twice that of the most volatile "hard peg" (France).

[31] There is, of course, a trade-off to ensure a reasonable number of countries within each group.

On balance, our baseline group of "hard pegs" consists of Austria, the Netherlands, Belgium, Denmark and France, the solid circles in Figure 3. The floats are Sweden, Finland, Italy, Spain, Greece and the United Kingdom (shown by the solid triangles in Figure 3). The intermediate floats are excluded for now, but these are Switzerland, Ireland, Norway and Portugal (hollow triangles in Figure 3). Note that, all the pegs and floats under this definition were members of either the European Economic Community (EEC) or the European Free Trade Association (EFTA) around the start of our sample, or in the years shortly after.[32]

As a further sense check, we also compare our "hard pegs" classification with the exchange rate regime classifications in Ilzetzki, Reinhart, and Rogoff (2019) (henceforth IRR).[33] IRR classify countries into 15 categories based on the "degree of floating". It is not obvious how to determine the most appropriate "threshold", countries can move categories over time, and the dataset is not specifically focused on identifying *DM pegs*. Above, we deliberately adopt a strict classification of pegs to ensure that the included countries were indeed closely anchored to the DM. Still, using an IRR threshold of 7 or less (7 refers to a de facto crawling peg, and values less than 7 are stricter forms of exchange rate pegs) we would obtain the same five countries as the "hard pegs" above. Moreover, during the EMS era, the average IRR classification of hard DM pegs is 4.5, while it is 9.0 for the floats.[34] We view these checks as supporting our classification choices.

Before turning to the panel results, we provide a final validation check to demonstrate that our exchange rate regime classification effectively distinguishes between pegged and floating currencies. In Figure 4, we show the peak bilateral exchange rate responses vis-à-vis the DM within the first 18 months following a 100 basis point Bundesbank policy tightening. Here, and for the remainder of this paper, exchange rates are reported in quantity notation, quoting the number of foreign currency units per Deutschmark (e.g., 1 DM = x GBP). A higher value indicates an appreciation of the DM and a depreciation of the foreign currency.

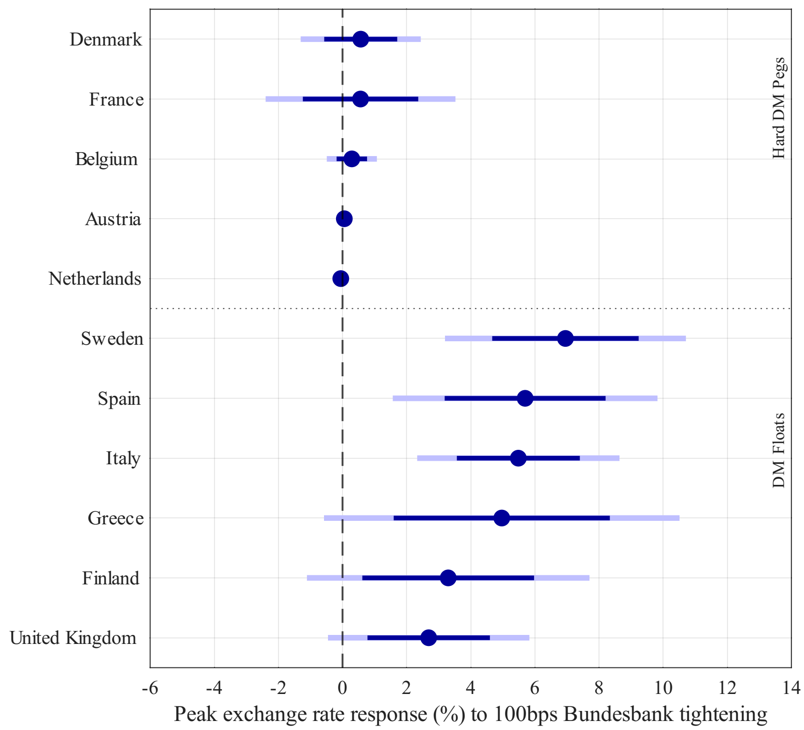
Crucially, in Figure 4, we observe that the countries coded as "hard pegs" exhibit negligible exchange rate reactions, consistent with tightly managed or fixed exchange rates. This reassures us that the peg classification captures genuine constraints on monetary autonomy. By contrast, the "DM floats" show clear depreciations vis-à-vis the DM, albeit with heterogeneity in the magnitude of the response. These findings confirm that our coding strategy creates a suitable empirical setting to test the trilemma, with a clean separation between

[32]As we show in the robustness checks below, our results are not driven by the specific stage of economic integration. For instance, even when restricting the comparison of pegs versus floats to EEC member countries — arguably the more economically integrated group — the findings remain consistent with our baseline results.

[33]The IRR classification, together with DM bilateral nominal exchange rate dynamics are shown in Appendix Figure E1. Later, we will also conduct a robustness check using this classification.

[34]Note, results are robust to using the IRR classifications directly, but for the reasons outlined above our baseline classification focuses on the specific relationship of a country to Germany.

Figure 4: *Peak Exchange Rate Responses to Bundesbank Tightening*



Notes: The figure shows the peak bilateral exchange rate responses of European countries to a 100 bps Bundesbank tightening estimated via local projections at the country level. The specification includes 3 lags of the exchange rate, 12 lags of the shock, and 3 lags of German macro controls. The peak effect is identified over a horizon of up to 18 months. Dots denote point estimates; vertical bars indicate 90 and 68 percent confidence intervals calculated using the approach of Newey and West (1987). Countries are grouped into "DM Pegs" and "DM Floats" based on our exchange rate regime classification.

DM pegs and floats.[35] In the next section, we build on this distinction and estimate panel regressions to systematically compare the transmission of monetary shocks across the two regimes.

4.2.3 Empirical Specification

We estimate spillovers to European partner countries from German monetary policy shocks by estimating the following series of local projections using data from 1979:4 to 1998:12:

$$
\begin{aligned}
y_{n,t+h} - y_{n,t-1} \;=\; \alpha_{n,h} \;+\; (1-\mathbb{I}_n)\left(\boldsymbol{\Psi}_h^{peg}(L)\,\mathbf{x}_{n,t} + \beta_h^{peg,DE}\,\epsilon_t^{DE}\right) \\
+\; \mathbb{I}_n\left(\boldsymbol{\Psi}_h^{float}(L)\,\mathbf{x}_{n,t} + \beta_h^{float,DE}\,\epsilon_t^{DE}\right) \;+\; u_{n,t+h}\,,
\end{aligned}
$$

[35]For completeness, the four intermediate float countries show a significant peak exchange rate response at the 90% confidence level. Later, as a robustness check, we combine the intermediate floats with the floats and confirm that the results remain robust.

where $y_{n,t+h}$ is the outcome variable of interest in country $n \in \{1, ..., N\}$ at horizon h and $\boldsymbol{\epsilon}_t^{DE}$ is the key variable in our analysis, our new German monetary policy shock series. Variable $\mathbb{I}_n$ is an exchange-rate regime indicator for a country which is floating with respect to the DM. The key impulse responses of interest for the groups are $\boldsymbol{\beta}_h^{peg,DE}$ and $\boldsymbol{\beta}_h^{float,DE}$. For the baseline specification, this exchange-rate regime indicator $\mathbb{I}_n$ is time-invariant.[36]

A lag polynomial, $\boldsymbol{\Psi}_h^k(L)$, of additional control variables for each $k = peg, float$ is also included. This includes the endogenous outcome, as well as lags of the shocks, and U.S. monetary policy shocks following Romer and Romer (2004), ϵ_t^{US}, which will also be useful later.[37] In $\mathbf{x}_{n,t}$ we include 3 lags of the endogenous variables, 3 lags of German and U.S. control variables, and 12 lags of the monetary shocks. All controls are included in log-differences except for the unemployment rate, which is in levels.[38] Finally, $\alpha_{n,h}$ are country fixed effects at horizon h.

To sum up, as a result of the above choices, we have deliberately adopted a highly-saturated empirical specification by design, which allows for regime-specific effects of the shocks and regime-specific effects of the control variables including lagged outcomes.[39]

4.3. Does the Exchange Rate Regime Matter for Spillovers?

Our baseline spillover results are shown in Figure 5, using our baseline categorization of hard pegs and floats above. The top row shows local projection estimates of the impulse responses for the hard peg countries ("pegs" for short); the bottom row shows the impulse responses for our baseline floating exchange rate group ("floats" for short). The first column in the figure shows the response of the bilateral nominal exchange rate against the DM for each group, where an increase means a depreciation of the foreign currency against the DM. The second column shows the short-term interest rate response, and the following three columns show the response of industrial production, consumer prices and unemployment in each group, variables that we also considered for Germany in Figure 2.

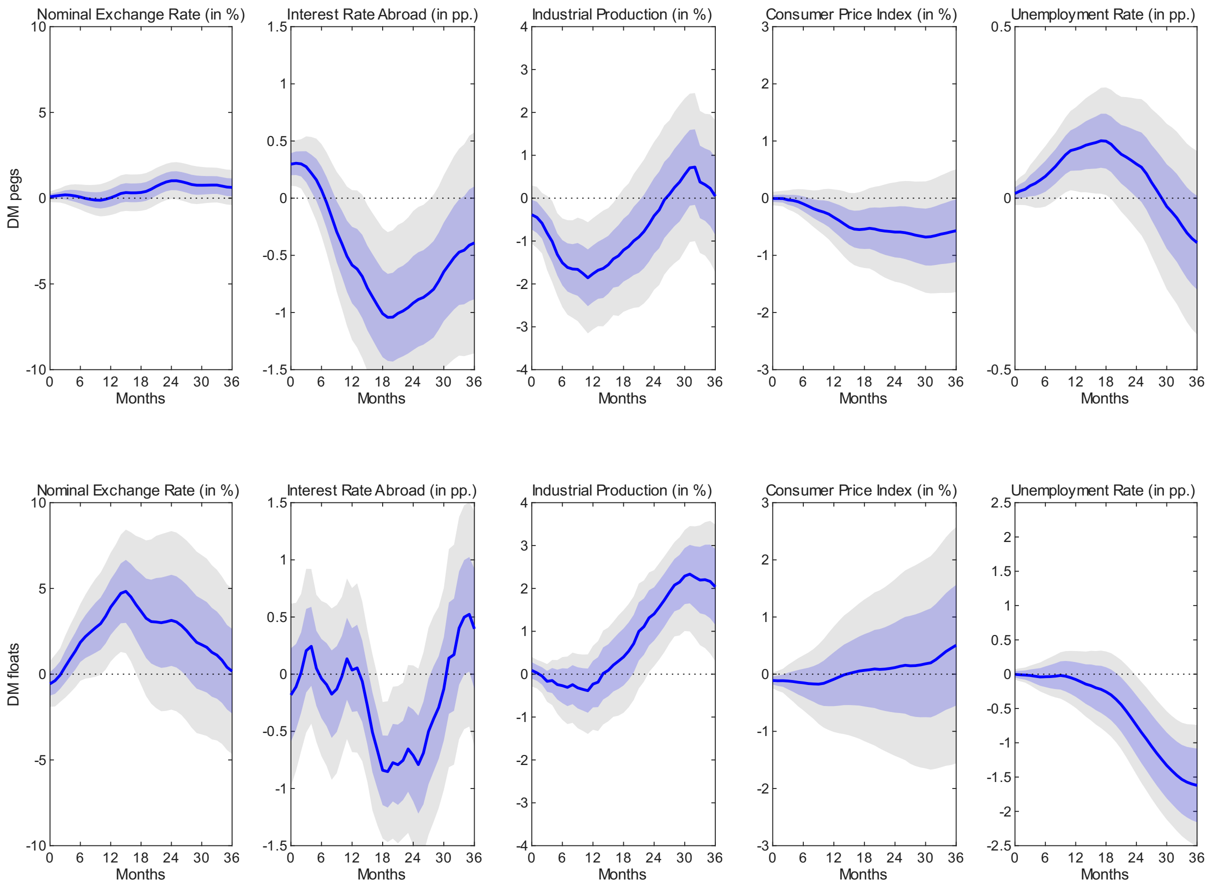
[36]As noted above, we will also relax this assumption later, and allow for time-varying regime definitions. But the results are practically unchanged.

[37]In the next section we will use ϵ_t^{US} as a form of placebo test, where we will show that U.S. monetary shocks have similar effects across DM pegs and floats. Since our sample period goes beyond the original Romer and Romer (2004) dates, we use the extended dataset from Coibion et al. (2017). Our main conclusions remain unaffected when we exclude the U.S. shocks.

[38]We use three lags of industrial production, consumer prices, and the unemployment rate. In addition, we include U.S. and German control variables using log differences of consumer price indices, commodity price indices, and industrial production, as well as the level of the unemployment rates. We do not include data on loans as these are not available at monthly frequency for all countries.

[39]This is a more saturated choice of regressors than, say, Corsetti, Meier, Müller, and Devereux (2012). Saturation with a large number of lags is important to ensure correct recovery of the IRF at large horizons (Jordà, Singh, and Taylor, 2024; Montiel Olea and Plagborg-Møller, 2021).

Figure 5: *Monetary Spillovers to Major European Economies: Pegs vs. Floats*



Notes: This figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for key macroeconomic variables depending on whether a country was pegged to the DM (top row) or whether the exchange rate was floating (bottom row). In the first panel, an increase in the nominal exchange rate means a depreciation of the foreign currency. Shaded areas are 95 and 68 percent confidence intervals using the approach of Driscoll and Kraay (1998). Panel estimation is conducted with regime-specific controls and starting the sample in April 1979 to align with the start of the EMS. The main specification includes 12 lags of the shocks and 3 lags of the controls. See text for more detail.

We should focus on very short horizons if judging the trilemma. Here, the responses are striking. First, consider the effects of a 100 bps contractionary monetary shock in Germany on the bilateral nominal exchange rate (column 1) and the short-term interest rate abroad (column 2).

For pegs, the nominal exchange rate does not respond significantly at any horizon. The short-term interest rate, on the other hand, resembles the response of the German policy rate in Figure 2. In the first 2–3 months, there is a significant increase in the short-term interest rate abroad for pegs. We can see that the movement is not, however, one-for-one with the German discount rate. But a pass-through less than 1 is not surprising in a band system. Obstfeld, Shambaugh, and Taylor (2004) simulate a Krugman-Svensson target zone model with a tight 1% band and some desire for wiggle room by policymakers; the space for leaning against the center country's policy shocks is exploited, and a pass-through to domestic policy rates of about 0.5 is achieved in a reasonable calibration; with wider EMS bands, the pass through would be smaller. For the reasons discussed earlier in footnote 22, as to why the average effect on the German interest rate in the first month is less than 1, we would also not expect the effect for the pegs to be equal to 1 in the first row of Figure 5.

For floats, the story is very different. Strikingly, there is essentially no effect on the short-term interest rate of the floats on impact. Nor is there any statistically significant movement in the short-term interest rate for floats over the first 12–18 months. This highlights the fact that the float group did not follow the Bundesbank. Over the same period, there is a clear depreciation of the nominal exchange rate for the floats. The cumulative differences across pegs and floats differ significantly with p-values < 0.1 at the one and two year horizons. Overall these findings align with the predictions of the trilemma: a policy tightening and no exchange rate response for pegs, and a depreciation with little interest rate response for floats.[40]

Given these differential movements in the exchange rate and the short-term interest rate abroad, the next question is: What happens to activity and prices in the pegs and the floats? Columns 3 to 5 in Figure 5 show the responses of industrial production (IP), consumer prices and unemployment abroad. It is interesting to note that the policy tightening on impact is about half the magnitude of the Bundesbank tightening in Germany, and — consistently — the macroeconomic effects abroad are roughly half the magnitude of the domestic effects on the German economy. Countries pegged to the DM see a clear contraction in economic activity. IP falls and unemployment rises, echoing the domestic impacts in Germany. Prices also decline, as in Germany, although the effect is not statistically significant at 5%.[41] The floats, by contrast, see essentially no response of IP, consumer prices or unemployment in the first 12-18 months. Again, these predictions align with the those of the trilemma: a contraction for pegs, and insulation for floats. The cumulative differences between the IRFs for pegs and floats are also statistically significant, again with p-values < 0.1 at various horizons.[42]

[40]Note that after 18 months, all short-term interest rates show a decline, and this aligns with the reversal of the Bundesbank policy rate shown earlier in Figure 2. Also note that, the decline for floats is consistent with the subsequent rise in economic activity shown in columns 3 to 5. For pegs, however, activity remains relatively depressed for essentially the entire period, but with gradually improving real activity (IP and unemployment rate) in the second half of the IRF horizon.

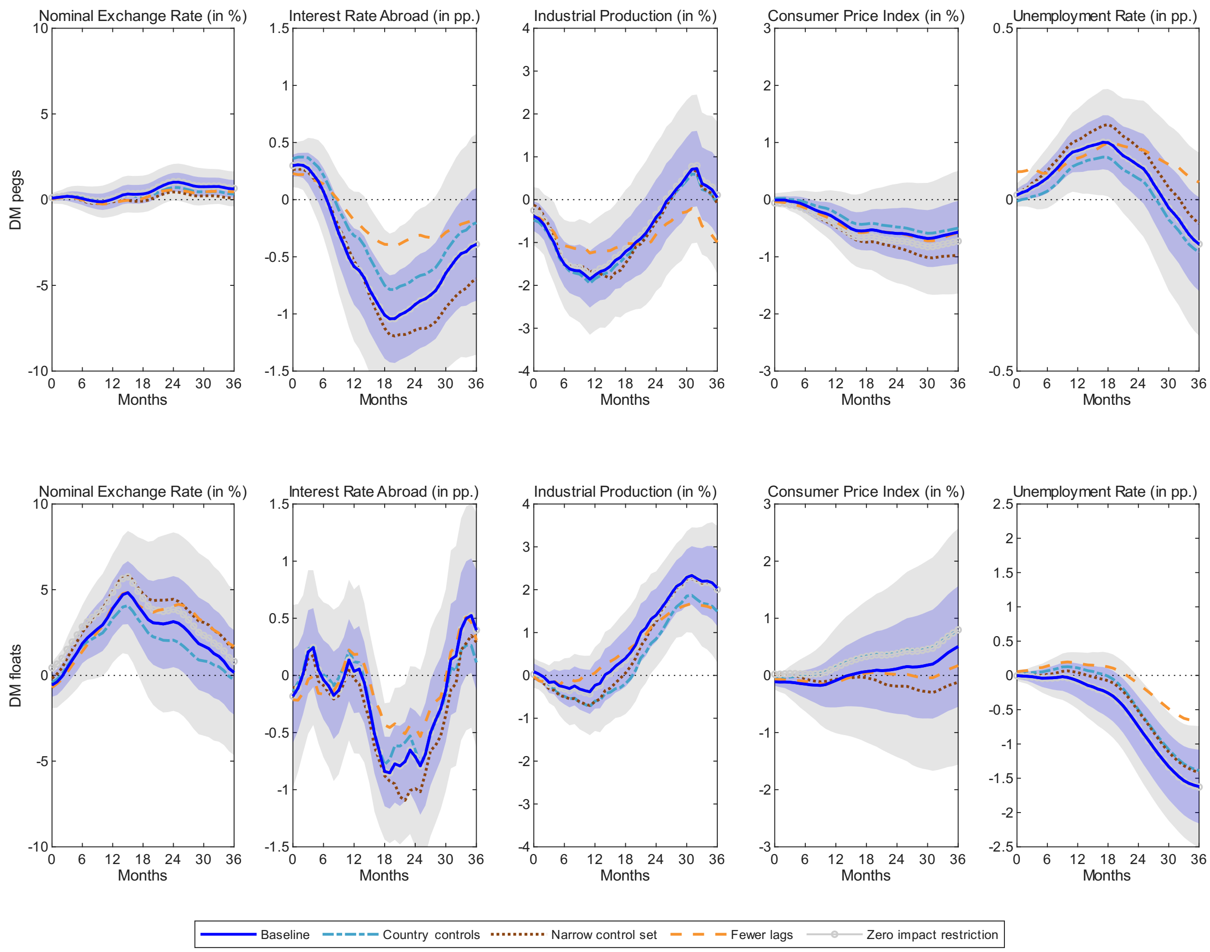
[41]Appendix Figure E5 also shows responses calculated based on the 12-month growth rate (YoY) in consumer prices rather than the monthly index used in the main text.

[42]More specifically, industrial production shows significant differences at one-, two-, and three-year horizons (p = 0.05, 0.04, and 0.07, respectively). Price levels, interest rates, and unemployment exhibit significant differences at the three-year horizon (p = 0.07, 0.07, and 0.01, respectively). The test statistics reported in this section are based on the smoothed IRFs for consistency with the figures presented, although results are similar when using the raw IRFs.

4.4. Robustness

We now conduct a range of robustness checks. Figure 6 and Figure 7 summarize a set of exercises varying the empirical specification and the sample. Figure 8 considers the robustness of our pegs versus floats categorization to potential time variation. The Appendix includes some additional robustness exercises, which we will also summarize below at the relevant points.

Figure 6: *Baseline and Robustness Specifications: Control Set Variations*



Notes: The figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for key macroeconomic variables depending on whether a country was pegged to the DM (top row) or whether the exchange rate was floating (bottom row). In the first panel, an increase in the nominal exchange rate means a depreciation of the foreign currency. Solid lines show the baseline results and standard error bands from Figure 5. The other lines display robustness checks. The zero impact restriction does not apply to the short-term interest rate abroad and it thus not shown. See text for more detail.

4.4.1 Varying the Controls and the Sample

Starting with Figure 6, we assess the robustness of our results to alternative empirical specifications. The solid line (in blue) and shaded bands repeat the main results from Figure 5, while the additional lines represent a range of robustness checks. Each line corresponds to a different specification of the control variables.

In the baseline setup the coefficients $\mathbf{\Psi}_h^k(L)$ vary across the exchange rate regime bins with $k = peg, float$. The dot-dashed line (in light blue) uses a more flexible approach that allows the coefficients $\mathbf{\Psi}_h^k(L)$ to vary across countries ($k = country$), although this increases the number of parameters to estimate. Next, we consider a narrow control set with 12 lags of the shocks and 12 lags of the endogenous variable (i.e. dropping the other three endogenous variables as controls). This is shown in the dotted line (in brown). The dashed line (in orange) shows responses calculated with a shorter lag structure consisting of just 2 lags of the shock and regime-specific controls. The line with circles (in gray) restricts the impact effect on activity and prices to zero, as would be conventional in structural VAR approaches following Christiano et al. (1999).[43] All these lines are very similar to the baseline results, and most fall within one standard error of the original estimates.

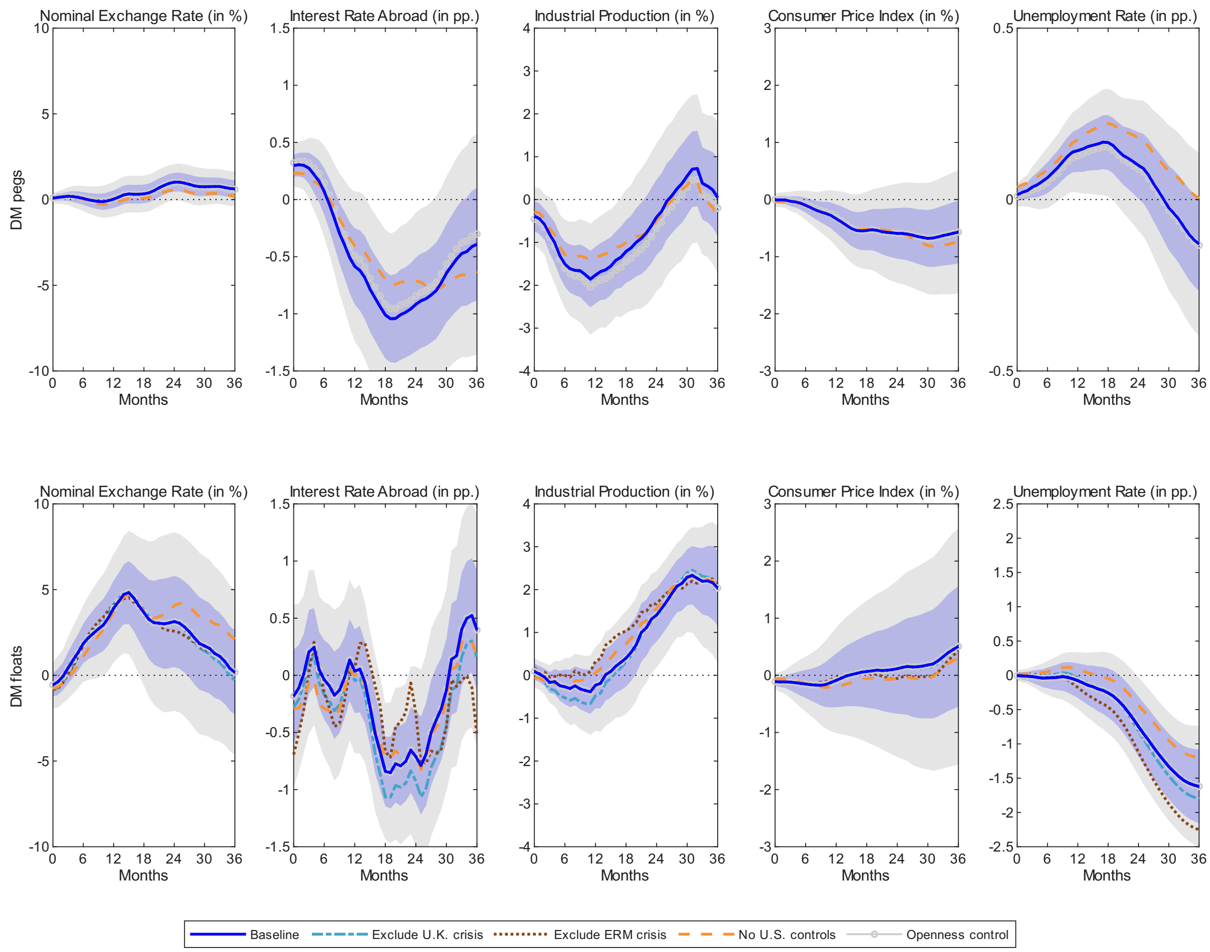
Figure 7 considers four further exercises relative to our baseline results. As before, each exercise largely falls within one standard error of our baseline results. Specifically, we first drop the U.K. exchange rate crisis (1987M1 to 1993M3) from the U.K. sample (dot-dashed line, in light blue). Second, we drop the whole period of the Exchange Rate Mechanism crisis (dotted line, in brown). In this case we also drop the U.K. (as before) as well as Sweden, Italy and Spain from 1992M1 until the end of the sample. Third, we confirm our results are robust to excluding the U.S. controls (macro data and U.S. monetary shocks). This is the dashed line (in orange). Fourth, to control for the possibility that economic proximity to Germany might be more important than the exchange rate regime, we construct, and control for, a measure of each country's trade openness with Germany.[44] The lines with circles (in gray) shows the results including openness as a regime-specific control with 3 lags.

In Appendix Figure E3, we also consider different samples of countries, and show that our baseline results remain robust to excluding particular countries or sets of countries. Within the group of DM floats, we first exclude Spain, which did not join the EEC until 1986. We also jointly exclude Spain, Finland, and Sweden — countries that, while not EEC members during

[43] Note that because of the smoothed presentation of the IRFs, this is not exactly zero in the figure.

[44] This is defined as the sum of exports and imports divided by GDP. For bilateral trade flows, we use the monthly International Trade in Goods Statistics (IMTS) from the International Monetary Fund. To obtain monthly nominal GDP series, we interpolate annual nominal GDP using the Denton method, with industrial production and consumer price indices as indicators. Also, note that, even if a country is more closely integrated with Germany, if it had a floating exchange rate, the trilemma would still predict insulation.

Figure 7: *Baseline and Robustness Specifications: Other Control Sets and Excluding Crises*



Notes: The figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for key macroeconomic variables depending on whether a country was pegged to the DM (top row) or whether the exchange rate was floating (bottom row). In the first panel, an increase in the nominal exchange rate means a depreciation of the foreign currency. Solid lines show the baseline results and standard error bands from Figure 5. The other lines display robustness checks. Exclude UK crisis and exclude ERM crisis only affects results for DM floats; for clarity we omit showing the results for DM pegs. See text for more detail.

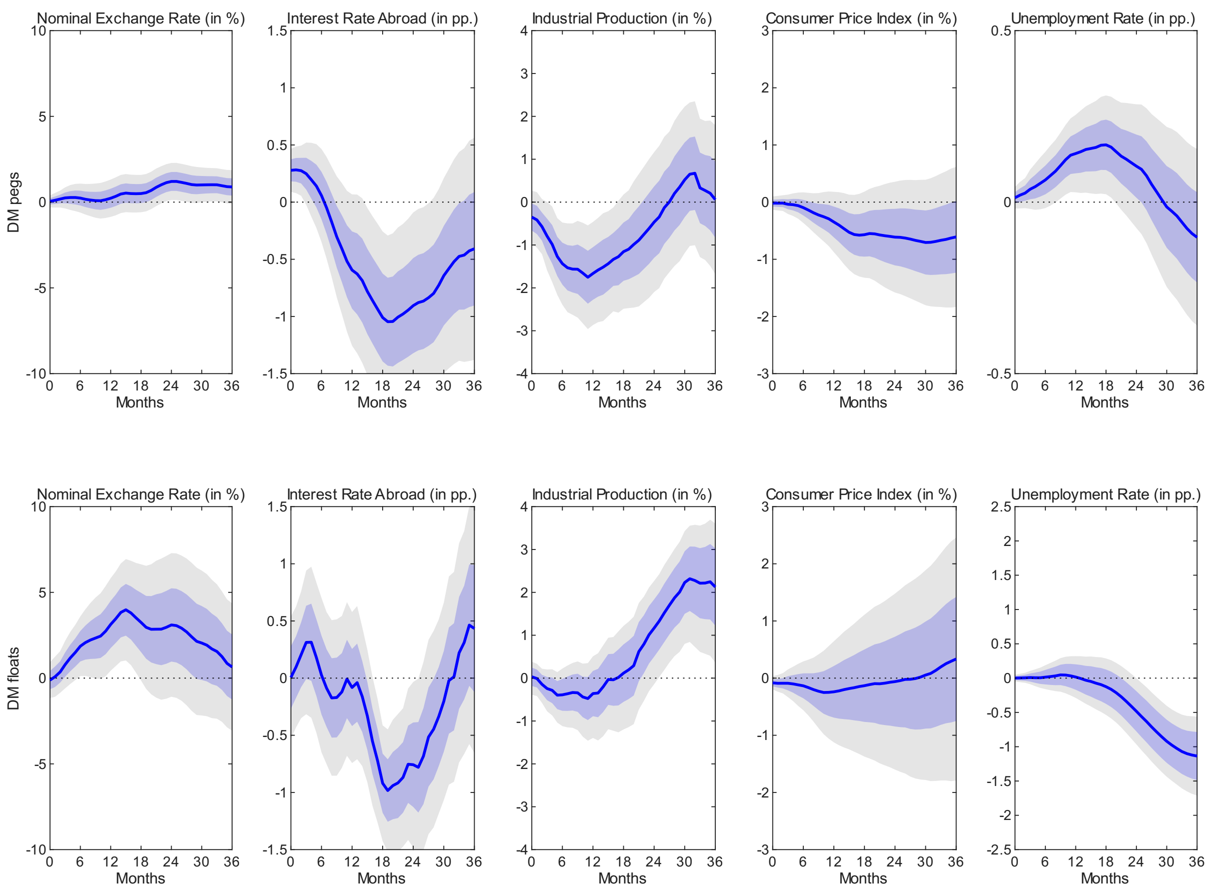
most of the sample, still participated in EFTA. Even after these exclusions, the remaining and more integrated EEC member floats continue to differ from the DM pegs, consistent with the trilemma. Among the DM pegs, we then exclude Austria, which was not an EEC member but belonged to EFTA. Finally, we confirm robustness to directly excluding the three countries with the highest bilateral trade openness to Germany — Austria, Belgium, and the Netherlands. In the next section, we turn to our extended sample of European countries and we allow for time-variation in the exchange rate regime classification.

4.4.2 Time-varying Exchange Rate Regime Classification: All Countries

As a further robustness check we consider time-variation in the exchange-rate regime in Figure 8. To do this, we draw on the fine exchange rate classification by Ilzetzki, Reinhart, and Rogoff (2019) mentioned earlier. We illustrate in Appendix Figure E1 the time-varying regime classifications alongside normalized exchange rates against the DM.

Our baseline approach to exchange rate regime classification focused on a stricter set of countries that were more clearly pegs or floats, and this assignment was used for the full sample period. We now report the results of a more general classification that uses all 15 European countries in our dataset. This allows us to see if our main conclusions remain

Figure 8: *Monetary Spillovers to European Economies: Time-varying Regimes Pegs vs. Floats*



Notes: The figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for key macroeconomic variables depending on whether a country was pegged to the DM (top row) or whether the exchange rate was floating (bottom row). In the first panel, an increase in the nominal exchange rate means a depreciation of the foreign currency. The sample includes all European countries and using time-varyring regimes (peg: IRR ≤ 7). Shaded areas are 95 and 68 percent confidence intervals using the approach of Driscoll and Kraay (1998). See text for more detail.

after incorporating the intermediate float group of countries. In addition, there is some time variation in the exchange rate regime in few countries, which we now also accommodate and is a useful robustness check in its own right. In Equation 6 we now introduce time-varying regimes $\mathbb{I}_{n,t-1}$.[45]

Following the earlier discussion in Section 4.2.2, we again classify countries in categories 1–7 as DM pegs and those in 8–15 as DM floats. Since the highest regime value observed in our sample is 14, the cut-off at 7 effectively splits the sample. In addition, based on the exchange-rate path and historical context, we classify Greece as a DM float until end of 1995, reflecting a clear depreciation against the DM.[46] Conditional on all countries and time-varying regimes the average IRR classification for pegs is 4.6 and for floats is 9.2. As mentioned earlier, we intend to strictly isolate DM pegs from the floats to provide a clean testing ground for the trilemma.

As shown in Figure 8, the key findings of the baseline specification remain robust using time-varying regimes with all European countries. On the other hand, the results are slightly less sharp, which is to be expected given that the groups are less "clean" compared to the baseline sample.[47]

5. German spillovers in a global context: a placebo test

Given the sizable literature on U.S. monetary spillovers, a natural question that arises from the results in Section 4 is: How do spillovers from Germany to Europe compare to spillovers from the U.S. to Europe during this period. This is interesting for at least two reasons.

First, Germany is a large open economy with substantial influence in Europe during the 1970s, 80s and 90s. It is very possible that German monetary policy could have been at least as important for Europe as monetary spillovers from the U.S. economy. To paraphrase Keynes, there may have been more than one "conductor" of the international (or, more specifically, European) orchestra.

Second, U.S. spillovers provide an interesting "placebo test". During our sample period all European countries floated their currencies vis-à-vis the U.S. dollar. The trilemma therefore

[45] To be cautious, we interact the lagged regime, but results are virtually unchanged to interacting the regime contemporaneously.

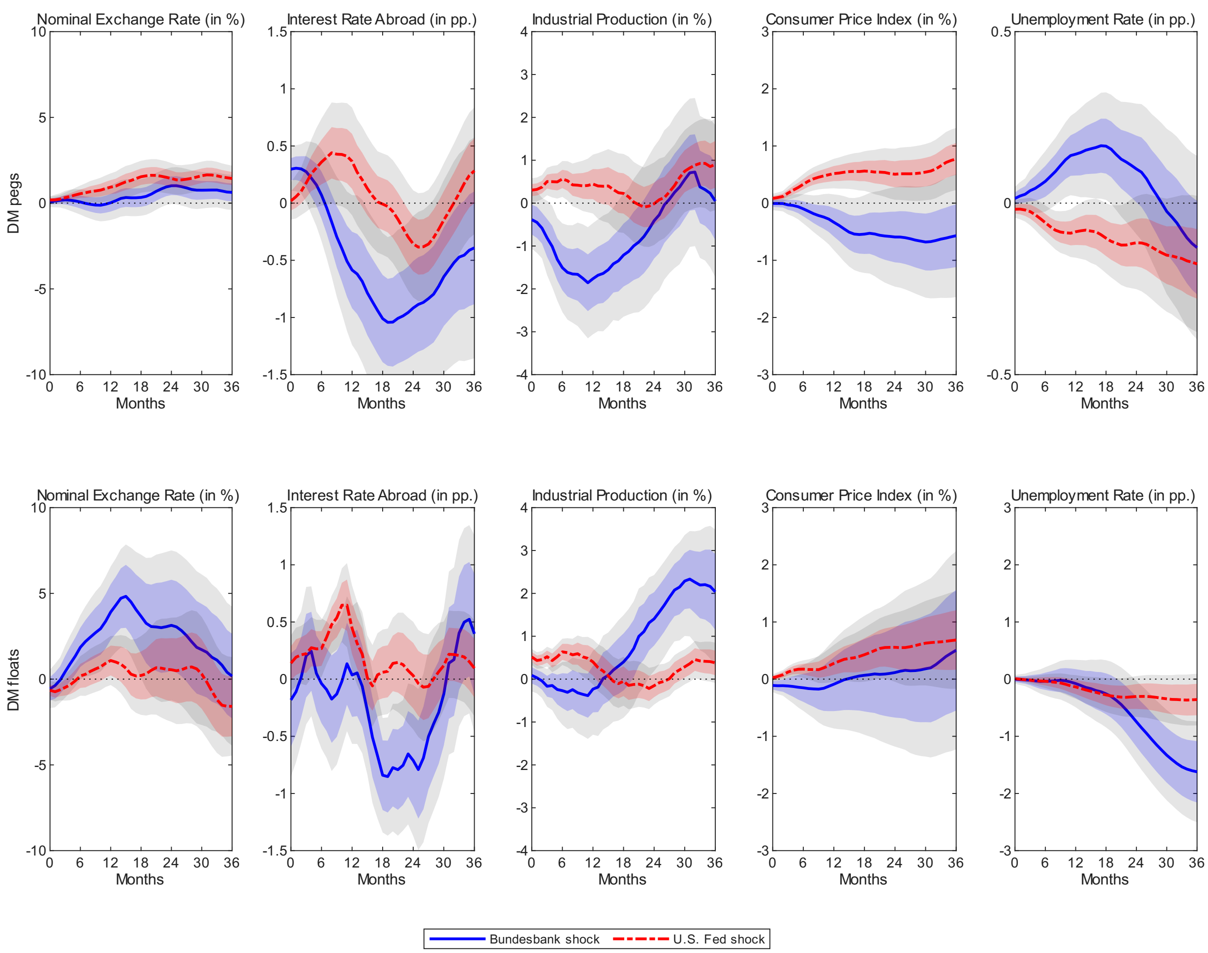
[46] Switzerland, which was excluded from the baseline, is a more ambiguous case: while its exchange rate was stable vis-à-vis the DM—suggesting a peg — the IRR dataset classifies it as a DM float, but also as DM anchor starting in October 1981. On balance, and given that the exchange rates depreciates significantly to a Bundesbank tightening, we include Switzerland as a DM float in this robustness exercise, but results hardly change including Switzerland as a DM peg.

[47] For completeness, Figure E4 shows results using all European countries, but with fixed (not time-varying) regimes. As indicated in Appendix Figure 3 we add Switzerland, Ireland, Norway and Portugal as DM floats. The results are again very similar.

predicts (i) that DM pegs should respond more to German shocks, but (ii) that DM pegs *and* DM floats (all countries in our sample are U.S. dollar floats) should respond similarly to a U.S. monetary tightening.

As discussed in our earlier literature review, we are not aware of any prior research addressing these questions. In Figure 9 we can show the results of this empirical exercise, using our new shocks for Germany and the Romer and Romer (2004) shocks for the U.S. The figure allows us to compare the responses in the DM pegs and DM floats, respectively, to the monetary policy shock originating in each of the two central banks. In detail, the figure displays the response of domestic conditions in Europe following a 100 bps contractionary

Figure 9: *Monetary Spillovers from Germany and the U.S. to European Countries: Pegs vs. Floats*



Notes: The figure shows the IRFs following a 100 bps contractionary monetary policy shock in Germany (solid blue lines) and the U.S. (dashed red line). Shaded areas are 95 and 68 percent confidence intervals using the approach of Driscoll and Kraay (1998). Panel estimation is conducted with regime-specific controls and starting the sample in April 1979 to align with the start of the EMS. The main specification includes 12 lags of the shocks and 3 lags of the controls. See text for more detail.

U.S. monetary policy shock, shown in the dashed lines (in red). The solid lines (in blue) with standard errors again, for comparison, report our baseline results for the Germany monetary tightening. As before European countries are split into hard DM pegs and floats using our baseline categorization.

Turning to the results, the responses to both shocks in both sets of countries are large in absolute (peak) magnitudes. Yet, whereas a Bundesbank tightening showed clear differences between DM pegs and DM floats, these same two groups exhibit nearly identical responses to a U.S. monetary policy shock. Indeed, the cumulative IRFs are statistically indistinguishable across the two groups. As noted above, the similarity across DM pegs and floats serves as a form of "placebo test". Because none of the European countries were pegged to the U.S. dollar, no systematic peg-versus-float differential emerges following U.S. monetary policy shocks. This outcome reinforces the interpretation that the divergent responses observed for German monetary shocks are driven by the DM as the nominal anchor currency, rather than inherent differences between the two country groups.

While the focus in this paper has been on the differences between DM pegs and DM floats to Bundesbank spillovers, Figure 9 still shows that the responses for industrial production and prices are flat or rising, and unemployment is falling to a U.S. monetary tightening. These findings are also consistent with Ilzetzki and Jin (2021) (for their post-1990 sample), who look at U.S. monetary spillovers to a broad range of (European and non-European) countries using the Romer and Romer (2004) U.S. monetary shocks. Given the sizable effects of both German and U.S. monetary shocks, both the Bundesbank and the Fed therefore played an influential role in shaping economic outcomes in Europe during the EMS era.

6. Conclusions

This paper revisits a classic question in macroeconomics: how do monetary policy changes affect outcomes at home and abroad? The trilemma posits that economies that peg are likely to be more exposed to base country policy rate changes than those who float. We examine this hypothesis by focusing the monetary arrangements within Europe during the latter decades of the 20th century. Germany during the EMS era from the 1970s to the 1990s is an excellent country for such analysis. Several European countries pegged their exchange rate effectively to the DM, while others maintained a flexible exchange rate.

Addressing this question requires a measure of exogenous variation in the base country's policy rate. We construct a new series of monetary policy shocks for Germany from 1974 to 1998. Our identification approach draws on extensive and previously unused archival data from the Bundesbank to help us capture the policymakers' information set at the time of the policy decision. These materials include the original briefing materials of the central bank council, such as real-time data and minutes of the policy meetings. This approach allows us to isolate exogenous variation in the Bundesbank's policy rate at each policy meeting. A Bundesbank tightening significantly reduces economic activity and prices in Germany.

Turning to Bundesbank spillovers, we find evidence in favor of the trilemma in Europe over this period. In particular, a Bundesbank tightening led to contractions for European countries pegged to the DM, but not to those with floating exchange rates. This result is robust to different definitions of DM pegs and DM floats, and to a wide range of robustness checks. In contrast, U.S. monetary policy shocks have similar effects on both DM pegs and DM floats, also in line with the trilemma.

At a time where monetary spillovers remain a hugely important topic, we hopefully provide a timely contribution from an important period of post-WWII history. In addition, we hope our monetary shocks, the new historical, real time and financial data set, and the associated histiographical analysis, will also be of use for a broad range of future research topics.

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ONLINE APPENDIX

A. Data Appendix

A.1. Data Sources and Data Construction

This section provides further detail on how we tackled specific challenges in constructing the historical meeting-by-meeting real-time database. Data sources are summarized in Table A1.

The core of our historical real-time data set comes directly from internal briefing documents of the Deutsche Bundesbank, formally titled *Statistical Overviews about the Monetary Policy Situation* (in German: *Statistische Übersichten zur währungspolitischen Lage*). These *Statistical Overviews* were prepared for each policy meeting and provide a comprehensive snapshot of the monetary and macroeconomic landscape as perceived in real time. Specifically, these documents comprised around 40 to 60 pages of real-time data illustrated in tables and charts and are structured in a similar way across our sample period between December 1974 and December 1998. These materials contain the most recent data available to policymakers.

The data presented to the Central Bank Council in the *Statistical Overviews* (described below and in Table A1) contain further data on public finances, business cycle indicators such as the Ifo Business Climate Index, current account data, industrial production or the number of cars sold. However, most of these data were not provided at every meeting and/or were subject to non-trivial data transformations over the sample (e.g. from non-seasonally-adjusted to seasonally-adjusted data, changes from monthly to quarterly growth rates, the frequency of the data was too low, variable definitions changed, some data was only summarized in charts etc.) restricting us to distill a consistent and complete time series.

In addition to the briefing materials, the Bundesbank Historical Archive also provided the minutes of each Central Bank Council meetings. As mentioned in the main text, the minutes are important to elicit which economic and financial indicators were discussed and that we therefore included in the first-stage regression.

Since the *Statistical Overviews* were not available in electronic format, we manually digitized key series, including the cost-of-living index for all households, the central bank money stock, money stock M3, the average yield on federal government bonds, estimates of the yield curve, and the unemployment rate. Exchange rates were included in the *Statistical Overviews*, but they are also available in digitized form from internal archives, which we used where possible. Some of the more recent bond yield data were retrieved directly from the Bundesbank's internal database.

In rare instances, historical data points were missing or incomplete. To address such cases, we relied on the *Statistical Supplements to the Monthly Reports* of the Deutsche Bundesbank (specifically *Series 4: Seasonally Adjusted Economic Data*). These supplements, published around the time of the monetary policy meetings, allowed us to consistently backfill missing observations, while maintaining a real-time perspective. This was particularly relevant for the unemployment rate, which — when not available in the *Statistical Overviews* —

was reconstructed either from the *Statistical Supplements* or, if necessary, directly from the *Bundesbank Monthly Report* itself. In each case we ensured that the *Statistical Supplements* or the *Monthly Report* were published before the Central Bank Council meeting. In very rare cases where neither source provided the required data point, we used a simple AR(1) model based on the available real-time backdata to impute the missing value. This ensured that the real-time nature of the series was preserved even in the presence of occasional gaps.

A further challenge relates to the timing of real GDP growth data releases. The problem with GDP data taken from the Bundesbank's real-time data base is that the vintages are only matched to a month, but not to a precise publication date.[48] Thus, it is not clear whether the vintage data from a specific month, for example March 1983, were known at the meeting on March 6th, the one on March 20th, or only at the April 10th meeting. Therefore, we use the source information of the real-time database which is based on the *Statistical Supplements of the Bundesbank Monthly Reports* to identify the exact publication date. In this way we can safely match the vintage data to a specific Central Bank Council meeting. In this particular example the data was published on March 18th, so we can safely assume that this particular GDP vintage was known at the March 20th meeting. By this procedure we refined the real-time database from a specific month to a specific date. In doing so we were also able to fill some gaps in the data set using the *Statistical Supplements to the Monthly Reports*. In reading the minutes of the meetings we confirmed that the most recent data were indeed discussed.

As noted in the main text, one potential challenge concerns possible adjustments due to the reunification of Germany in 1990. The largest part of our sample covers the time before reunification and for this period we naturally use data for West Germany. After reunification the economy of East Germany was very small compared to the economy of West Germany.[49] In addition, data availability for East Germany was very scarce and imprecise in the first years after reunification, whereas data for West Germany was regularly reported until the end of our sample. Furthermore, data for unified Germany was thus often reported with a time lag compared to more readily available data for West Germany. Some real-time variables, such as GDP, are not available for unified Germany before September 1995.[50]

[48] Gerberding et al. (2005) constructed a Bundesbank real-time data base to estimate a Bundesbank reaction function using quarterly data. They stress that using real-time data yields markedly different results compared to ex-post finalized data.

[49] East Germany's GDP in the first quarter of 1991 was less than 8 percent of GDP in unified Germany, according to the September 1995 vintage — the first vintage that includes data for unified Germany.

[50] Bundesbank staff that prepared real-time information for the Bundesbank council in the 1990s have witnessed the process. According to their assessment: "The assumption that policy makers at the Bundesbank still focused on output data for West Germany in the early years after reunification can be justified on at least two accounts. First, because the relevant data for East Germany were either non-existent or not sufficiently reliable and, second, because eastern Germany's structural problems could not be solved by monetary policy. See Deutsche Bundesbank (1999). Further details on the underlying datasets can be found in Gerberding et al. (2004) and Gerberding, Kaatz, Seitz, and Worms (2005)." Gerberding et al. (2005), footnote 9.

On balance, to ensure the largest and most complete real-time data set, including the most recent information ahead of the policy decision, we decided to use data for West Germany for GDP, unemployment rate, and CPI. A further, related challenge is that the money supply experienced a "money jump"; that is, the Bundesbank increased the money supply by 15 percent in July 1990. The Central Bank Council also incorporated this adjustment factor into their decision-making process and smoothed money supply; for example, a 12-month money growth of 19.6 percent was effectively treated as 4.6 percent money growth in periods bracketing the jump. We follow this practice to smooth the transition in the same way as the central bank committee did around the meeting time when the jump occurred in our data series.

A.2. Data Description: Historical Meeting-by-Meeting Real-Time Dataset

Table A1: *Data Description for First-Stage Regression*

Variable	Period	Description	Source
Discount Rate	Dec 1974 - Dec 1998	daily, percentage points	Deutsche Bundesbank
Real GDP (RNGP until 1992); West Germany	Jan 1974 - Dec 1998	monthly, quarter-on-quarter growth rates, in %	Bundesbank Real-time Database; Statistical Supplements to the Monthly Reports of the Deutsche Bundesbank: Series 4
Cost-of-living index for all households; West Germany	Dec 1974 - Dec 1998	monthly, not seasonally adjusted, 12-month change, in %	Central Bank Council: Statistical Overviews
Unemployment rate in percent of dependent labor force; West Germany	Dec 1974 - Dec 1998	monthly, seasonally adjusted, in percentage points	Central Bank Council: Statistical Overviews; Monthly Reports; Statistical Supplements to the Monthly Reports of the Deutsche Bundesbank: Series 4
Central bank money stock; West Germany	Dec 1974 - Mar 1989	monthly, year-on-year, seasonally adjusted	Central Bank Council: Statistical Overviews
Money stock M3; West Germany and from 1991 unified Germany	Dec 1974 - Dec 1998	monthly, year-on-year, seasonally adjusted, in percentage points	Central Bank Council: Statistical Overviews
Bilateral exchange rates of DM against U.S. dollar, Japanese yen, British pound sterling, Italian lira, Spanish peseta, and French franc	Dec 1974 - Dec 1988	daily data	Deutsche Bundesbank, ZIS; Central Bank Council: Statistical Overviews
Average bond yield of central government debt	Dec 1974 - Dec 1998	daily, percentage points	Central Bank Council: Statistical Overviews; Deutsche Bundesbank ZIS
Bond yield curve of central government debt	Dec 1974 - Dec 1998	bi-monthly, percentage points	Central Bank Council: Statistical Overviews

A.3. Data Description: Germany

Table A2: *Data Description for Second-Stage Regression: Germany*

Variable	Period	Description	Source
Discount Rate	Dec 1974 - Dec 1998	monthly, percentage points	Deutsche Bundesbank
Industrial production	Dec 1974 - Dec 1998	monthly, calendar and seasonally adjusted	Deutsche Bundesbank
Consumer price index	Dec 1974 - Dec 1998	monthly, calendar and seasonally adjusted	Deutsche Bundesbank
Unemployment rate, West Germany	Dec 1974 - Dec 1998	monthly, calendar and seasonally adjusted, in percentage points	Deutsche Bundesbank
Unemployment rate, unified Germany	Dec 1991 - Dec 1998	monthly, calendar and seasonally adjusted, in percentage points	Deutsche Bundesbank
Nominal credit: bank loans to domestic enterprises and households	Dec 1974 - Dec 1998	monthly	Deutsche Bundesbank
Commodity price index	Dec 1974 - Dec 1998	monthly, seasonally adjusted	Barakchian and Crowe (2013) converted to DM
DM/USD exchange rate	Dec 1974 - Dec 1998	monthly	Deutsche Bundesbank
Narrow real effective exchange rate: 27 economies	Dec 1974 - Dec 1998	monthly	BIS

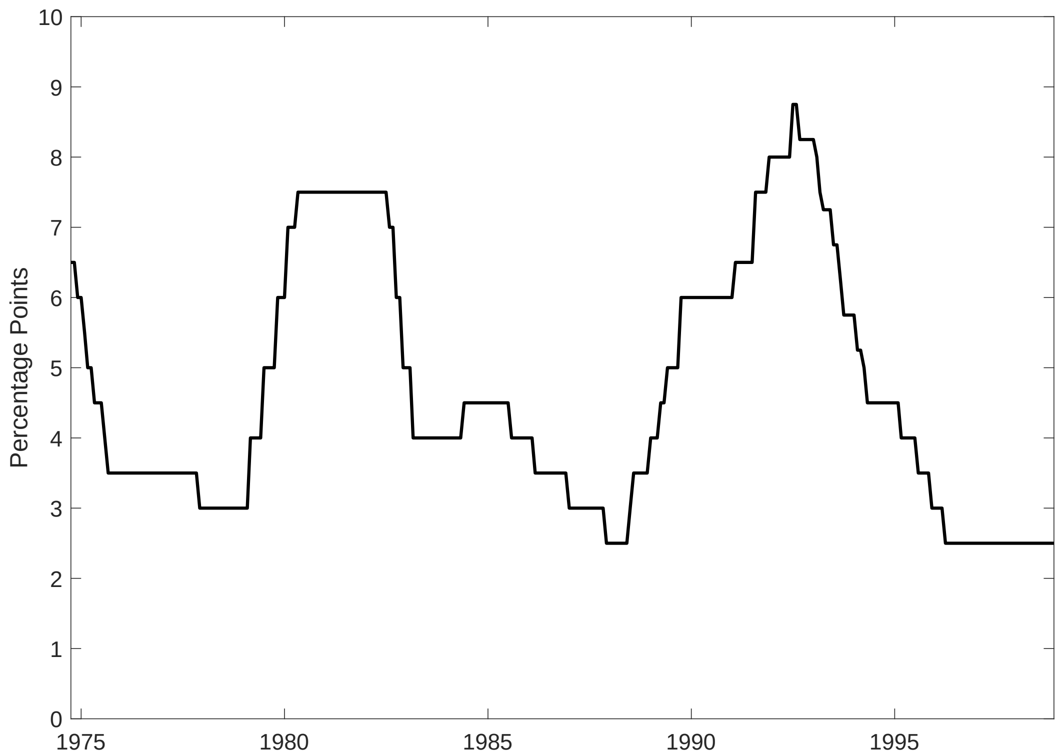
A.4. Data Description: Other Countries

Table A3: *Data Description for Second-Stage Regression: Panel Data*

Variable	Period	Description	Source
Industrial production	Apr 1979 - Dec 1998	monthly, seasonally adjusted	FRED, OECD Main Economic Indicators
Consumer price index	Apr 1979 - Dec 1998	monthly, seasonally adjusted in Eviews with X-13-ARIMA	BIS
Unemployment rate	Apr 1979 - Dec 1998	cubic interpolation from quarterly to monthly frequency, seasonally adjusted	Deutsche Bundesbank, FRED
Commodity price index	Apr 1979 - Dec 1998	monthly, seasonally adjusted	Barakchian and Crowe (2013) transformed into national currencies using bilateral exchange rates
Bilateral exchange rates	Apr 1979 - Dec 1998	monthly	Deutsche Bundesbank
Short-term interest rates	Apr 1979 - Dec 1998	monthly	Forbes, Ha, and Kose (2024)
U.S. Romer-Romer monetary policy shocks	Apr 1979 - Dec 1998	monthly	Coibion, Gorodnichenko, Kueng, and Silvia (2017)

A.5. German Monetary Policy Rate

Figure A1: *German Monetary Policy Rate*



Note: This figure shows the Bundesbank Discount Rate from 1974:10 to 1998:12. The units are in percentage points.

B. The Monetary Policy Shocks

B.1. First-Stage Regression Results

Table B1: *First-Stage Regression Results*

	$\pi_{m,t-p}$	$\Delta\pi_{m,t-p}$	$\hat{y}_{m,t-p}$	$\Delta\hat{y}_{m,t-p}$	$\Delta^{12m}MS_{m,t-p}$	$\Delta\Delta^{12m}MS_{m,t-p}$	$u_{m,t-p}$	$\Delta u_{m,t-p}$			
$p = 1$	0.036	-0.052									
	(0.29)	(0.093)									
$p = 2$	-0.002	0.122	0.009	-0.011	-0.015	0.396	0.039	-0.164			
	(0.039)	(0.132)	(0.007)	(0.090)	(0.014)	(0.241)	(0.075)	(0.285)			
$p = 3$	-0.031	-0.179	0.006	0.062	0.026	-0.119	-0.100	0.059			
	(0.038)	(0.128)	(0.007)	(0.070)	(0.021)	(0.261)	(0.116)	(0.311)			
$p = 4$	0.008	-0.051	0.002	0.011	-0.011	-0.396	0.035	0.002			
	(0.027)	(0.039)	(0.008)	(0.015)	(0.013)	(0.196)	(0.073)	(0,411)			
	$XR_{m,d-1}$	$\Delta XR_{m,d-1:m-1,d+1}$	$AVG\_B\_YLD_{m,d-1}$	$B\_YLD(2y)_{m,d-1}$	$B\_YLD(4y)_{m,d-1}$	$B\_YLD(6y)_{m,d-1}$	$B\_YLD(8y)_{m,d-1}$	*const.*	i_{m-1}	Δi_{m-1}	
GER			-0.096	0.032	0.559	-0.995	0.543	0.396	-0.077	-0.112	
			(0.135)	(0.120)	(0.458)	(0.650)	(0.307)	(0.281)	(0.014)	(0.043)	
USA	-0.006	0.006									
	(0.032)	(0.004)									
JPN	0.069	-0.006									
	(0.071)	(0.004)									
FRA	-0.005	0.004									
	(0.006)	(0.012)									
ITA	0.076	0.001									
	(0.094)	(0.007)									
ESP	-0.062	0.005									
	(0.079)	(0.006)									
GBR	-0.013	0.004									
	(0.037)	(0.007)									

Notes: $R^2 = 0.19$, $D.W. = 1.99$, $F-Statistic = 2.86, N = 580$. Sample: covers all Central Bank Council meetings between 1974:12 and 1998:12.

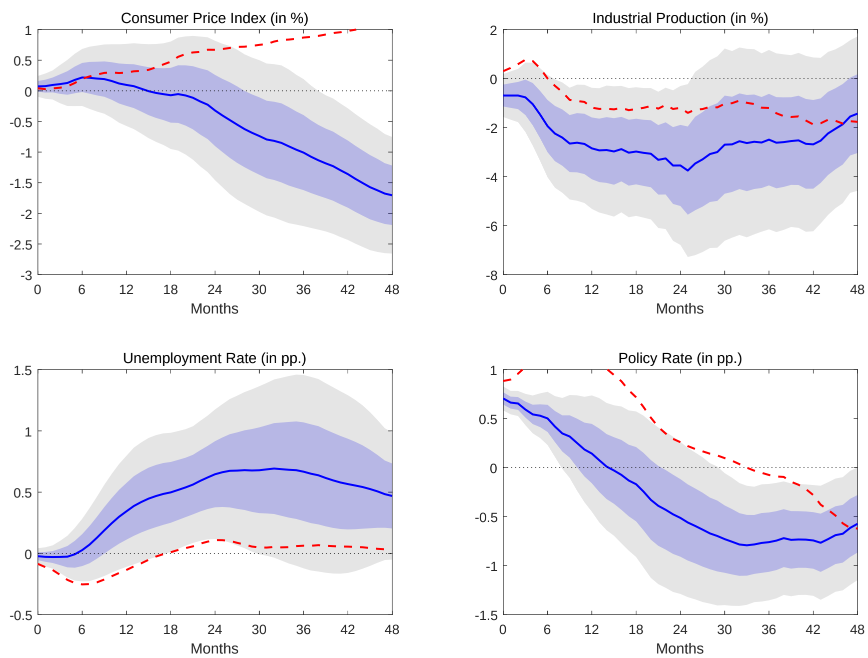
B.2. Alternative First-Stage Regression Specifications

Table B2: *Alternative First-Stage Regression Specifications*

	(1) Baseline	(2) Lagged interest rate only	(3) Baseline w/o financial market data	(4) Baseline w/o historical macro data
R^2	0.197	0.002	0.111	0.154
F-Statistic	2.92	0.58	2.45	5.37
p-value	0	0.56	0	0
RSS	14.23	17.69	15.76	14.99

Notes: Financial market data refers to yield curve data and exchange rate data. Historical macro data refers to the archival and real-time macroeconomic indicators discussed in the text.

Figure B1: *Results Using Shocks from Specification (2)*



Notes: This figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate on a number of key variables for Germany. Relative to the main result in the text (solid blue line), we estimate the first-stage regression using a constant and lagged policy rate. The regression here includes 12 lags of the shock and 3 lags of the controls. The control variables include CPI, industrial production, unemployment rate, loans, and the real effective exchange rate. Shaded areas are 95 and 68 percent confidence intervals calculated using the approach of Newey and West (1987).

Figure B2: *Results Using Shocks from Specification (3)*

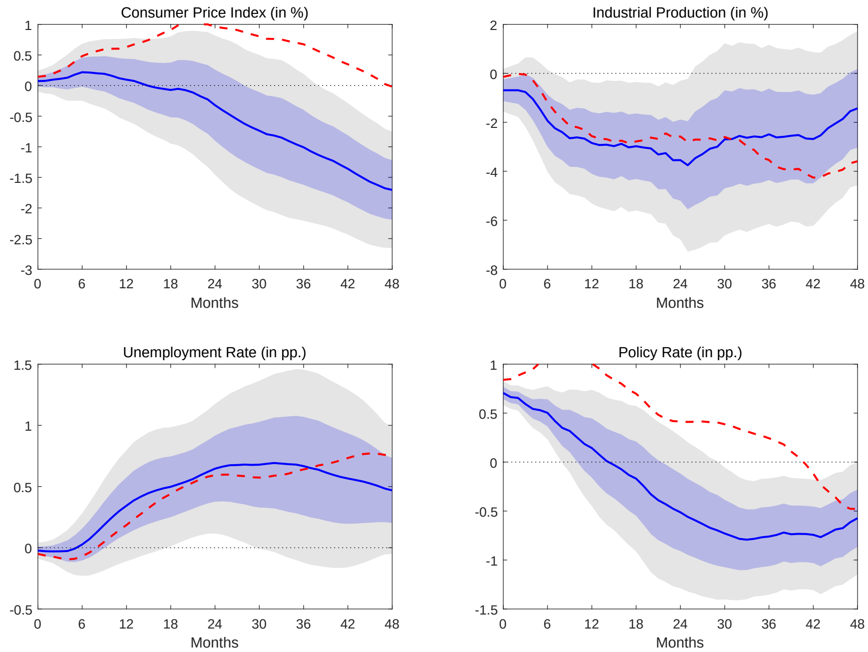
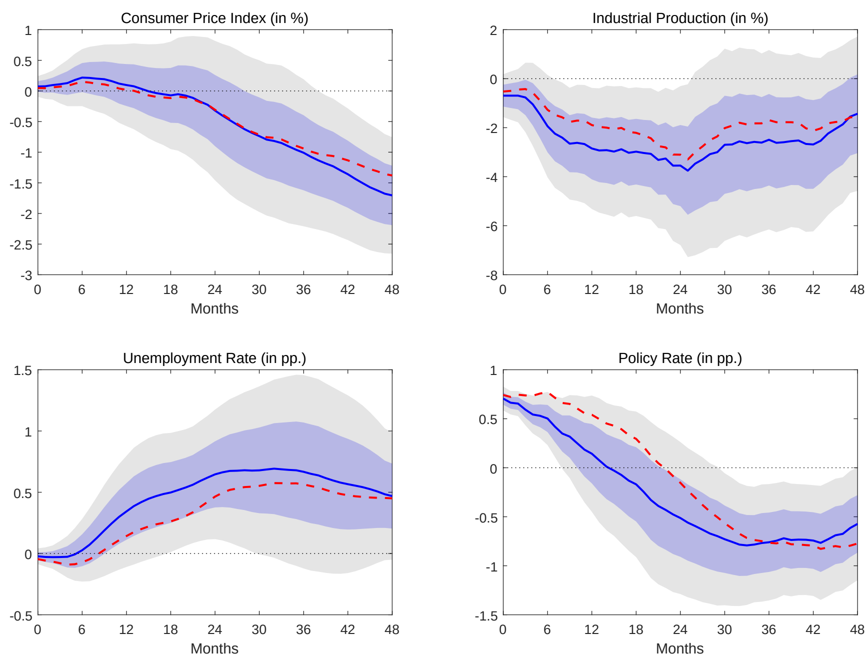


Figure B3: *Results Using Shocks from Specification (4)*



Notes: This figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for a number of key variables for Germany. Relative to the main result in the text (solid blue line), we estimate the first-stage regression using a restricted set of variables as shown in the table above. The regression here includes 12 lags of the shock and 3 lags of the controls. The control variables include CPI, industrial production, unemployment rate, loans, and the real effective exchange rate. Shaded areas are 95 and 68 percent confidence intervals calculated using the approach of Newey and West (1987).

B.3. Detailed Granger Causality Results

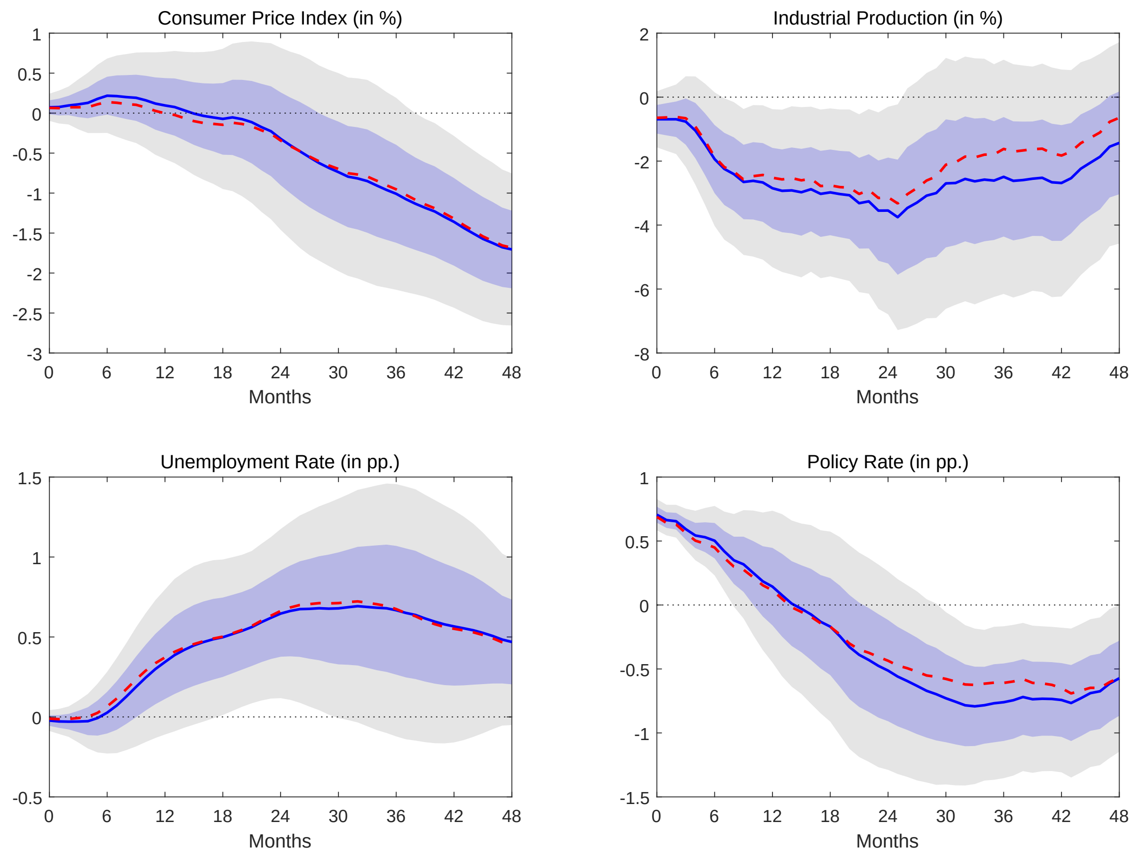
Table B3: *The table reports tests of the null that* $\widehat{\omega}_1 = \ldots = \widehat{\omega}_J$

	J = 3 lags		J = 6 lags		J = 12 lags	
Variable	F–stat.	p–val.	F-stat.	p-val.	F-Stat.	p-val.
Unemployment	0.41	0.75	0.56	0.77	0.98	0.47
Monthly Inflation	0.59	0.63	0.41	0.87	0.57	0.87
Growth of Ind. Production	1.09	0.35	0.68	0.66	0.54	0.89
GDP Growth	0.15	0.93	0.26	0.95	0.53	0.90
Growth of Money M3	0.30	0.83	0.40	0.88	0.38	0.97
Change in REER	1.12	0.34	1.43	0.20	0.81	0.64
Monthly growth rate in oil price (DM)	1.41	0.24	1.18	0.32	1.03	0.42
All variables	0.85	0.65	0.82	0.78	0.88	0.79

Notes: The table reports F-statistics and p-values for the null hypothesis that all coefficients $\widehat{\omega}_j$ are equal to zero. The standard errors are corrected for the possible presence of serial correlation and heteroskedasticity using a Newey and West (1987) variance covariance matrix.

B.4. Robustness Using Different Money Growth Specifications

Figure B4: *First-Stage Regression with Separate Estimates for Central Bank Money and M3*

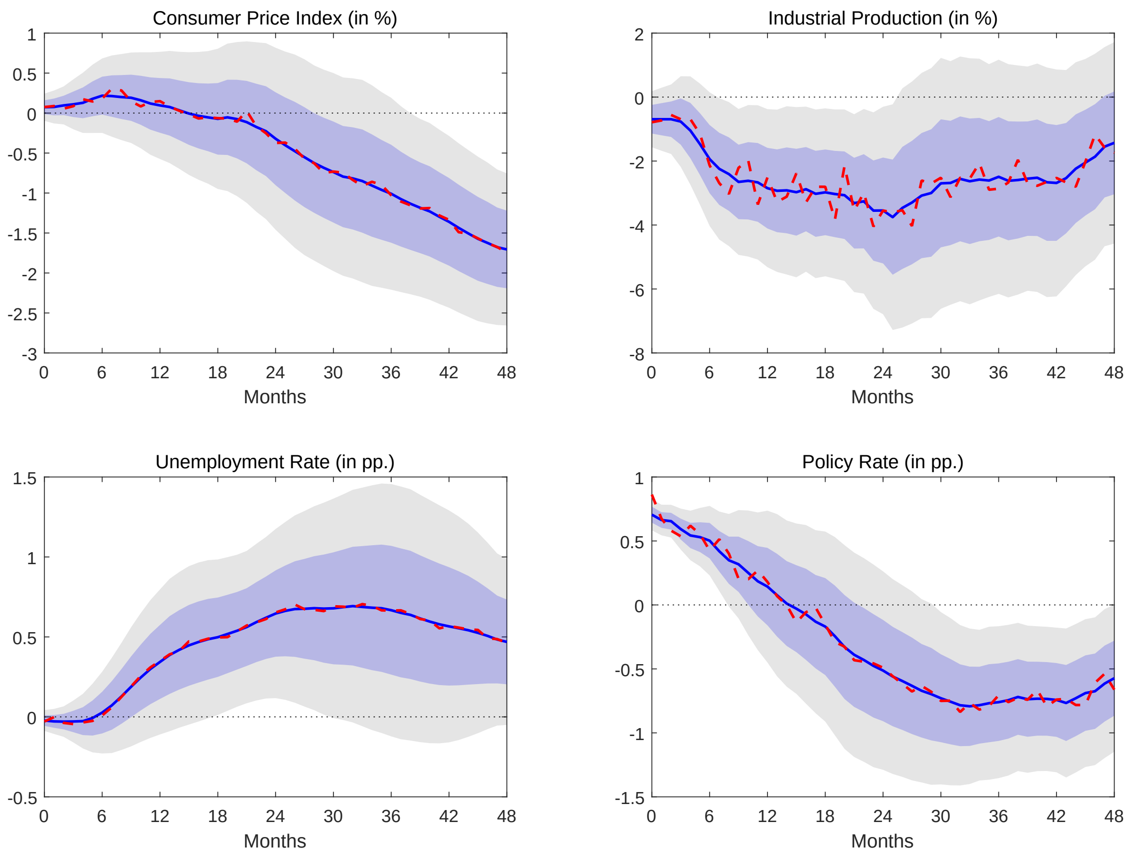


Notes: This figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for a number of key variables for Germany. Relative to the main result in the text (blue line), we estimate the first-stage regression with different coefficients for central bank money and M3. The regression includes 12 lags of the shock and 3 lags of the controls. The control variables include CPI, industrial production, unemployment rate, loans, and the real effective exchange rate. Shaded areas are 95 and 68 percent confidence intervals calculated using the approach of Newey and West (1987).

C. Further Domestic Results

C.1. Raw and Smoothed IRFs: Baseline Results for Germany

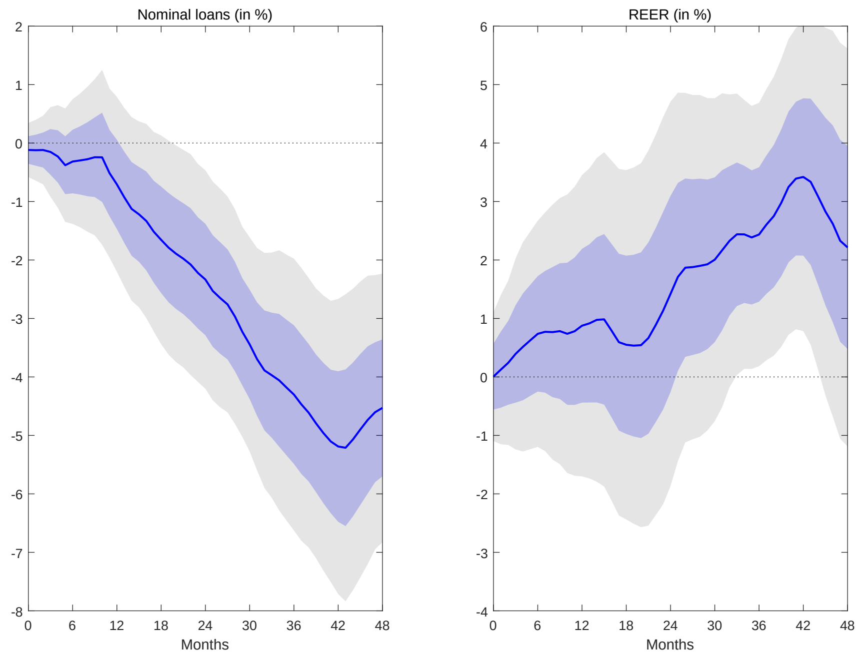
Figure C1: *Raw and Smoothed IRFs*



Notes: This figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for a number of key variables for Germany. The figure compares the baseline smoothed results with the raw IRFs (dashed lines in red). The regression includes 12 lags of the shock and 12 lags of the endogenous variables. Shaded areas are 95 and 68 percent confidence intervals calculated using the approach of Newey and West (1987).

C.2. The Response of Loans and the REER

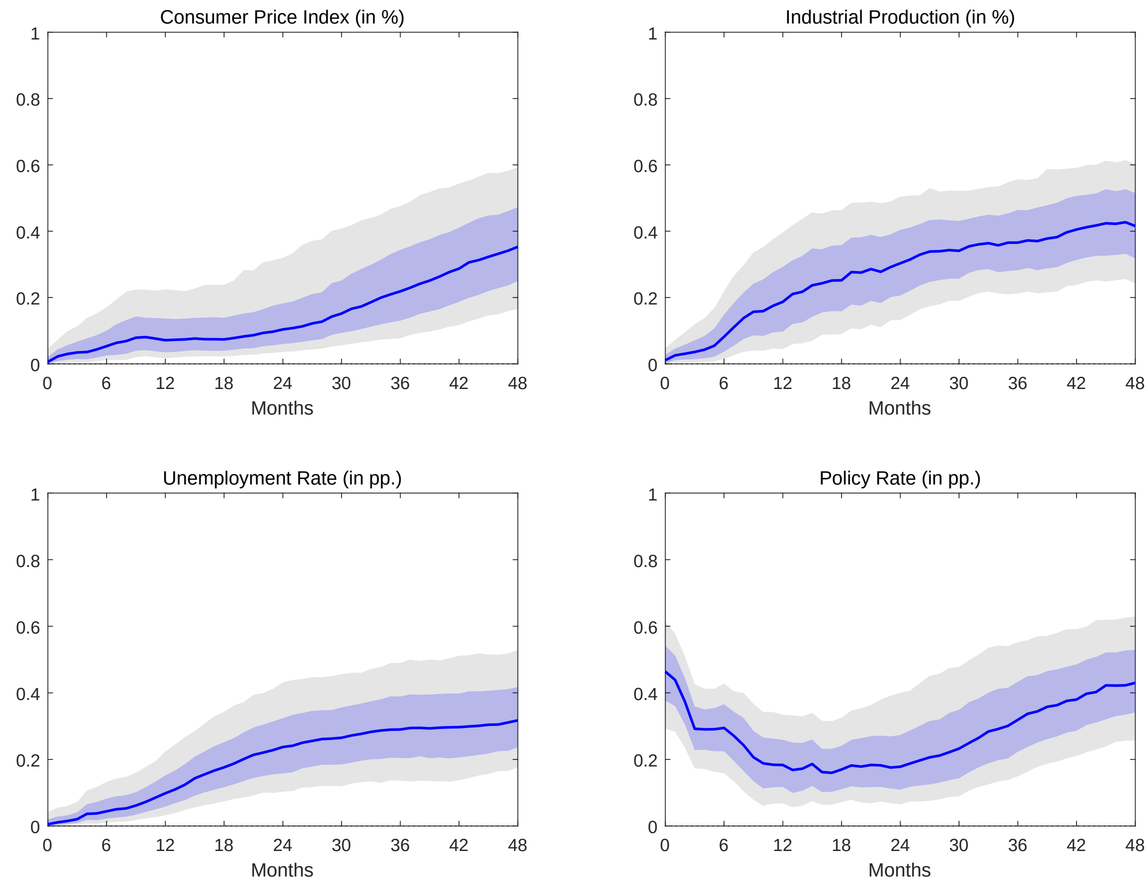
Figure C2: *Further Variables*



Notes: This figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for the real effective exchange rate and total loans in Germany. A rise in the exchange rate means an appreciation. The regression includes 12 lags of the shock and 12 lags of the endogenous variables. Shaded areas are 95 and 68 percent confidence intervals calculated using the approach of Newey and West (1987).

C.3. Forecast Error Variance Decomposition

Figure C3: *Contributions to Macroeconomic Volatility*

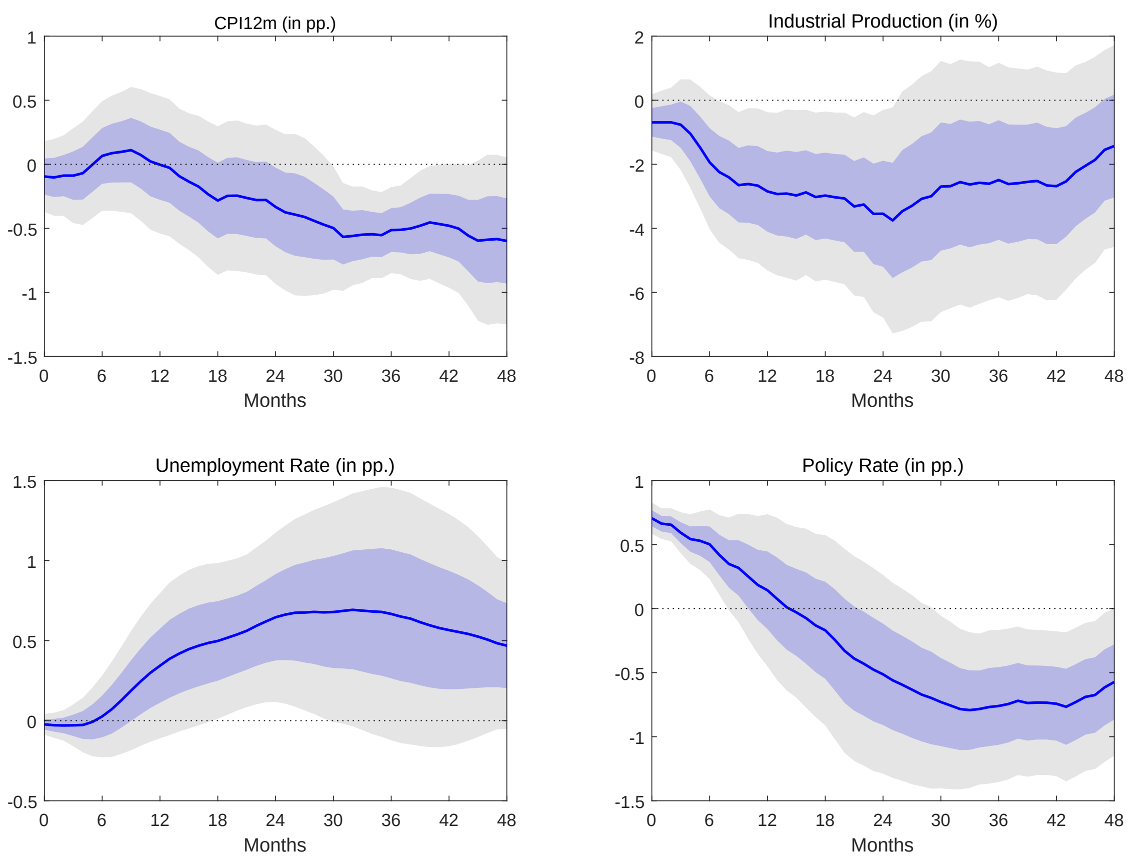


Notes: This figure shows the FEVD for the contribution of monetary shocks to a number of key variables for Germany. The regression includes 12 lags of the shock and 3 lags of the controls. The control variables include CPI, industrial production, unemployment rate, loans, and the real effective exchange rate. Shaded areas are 95 and 68 percent confidence intervals calculated using the bootstrap approach of Gorodnichenko and Lee (2020).

D. Robustness: Domestic Results

D.1. Results Using Inflation rather than the Price Level

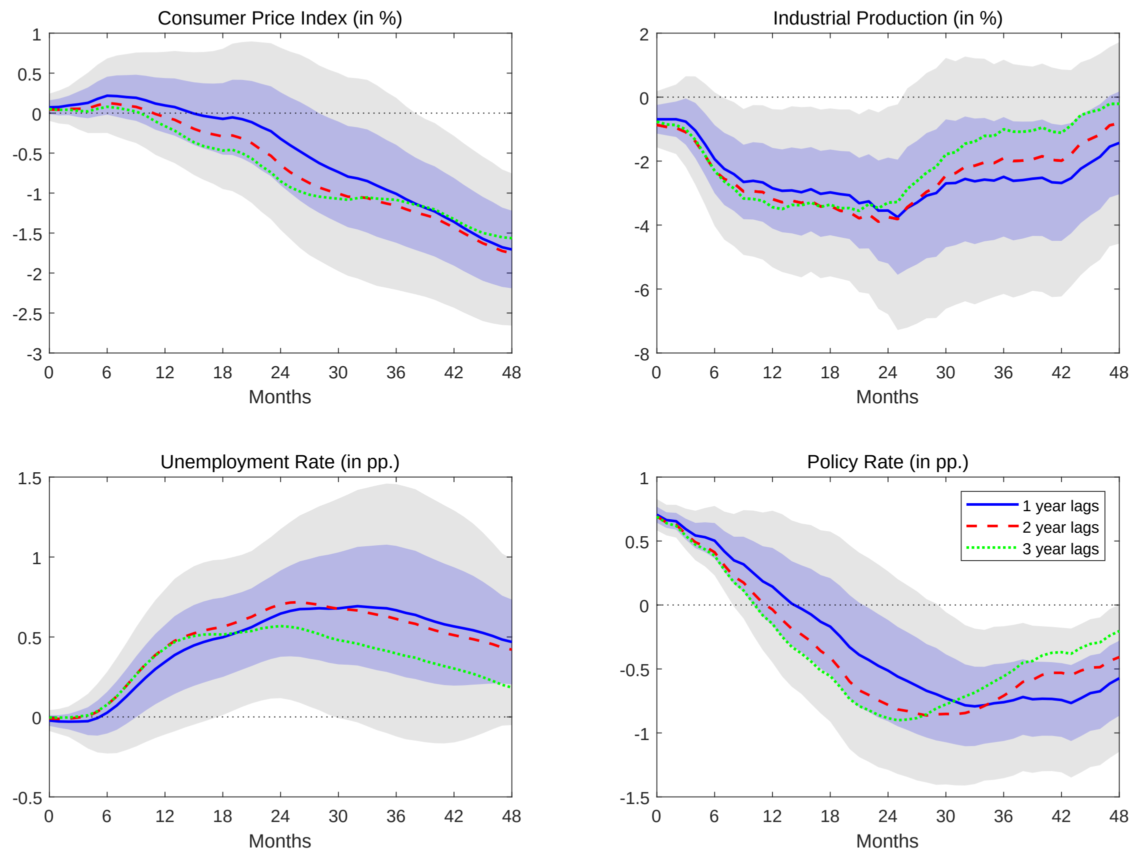
Figure D1: *Baseline Results Using Inflation*



Notes: This figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for a number of key variables for Germany. Relative to the main result in the text, the figure shows the results for CPI inflation, rather than the percentage response of the level. The regression includes 12 lags of the shock and 3 lags of the controls. The control variables include CPI, industrial production, unemployment rate, loans, and the real effective exchange rate. Shaded areas are 95 and 68 percent confidence intervals.

D.2. Lag Length Sensitivity

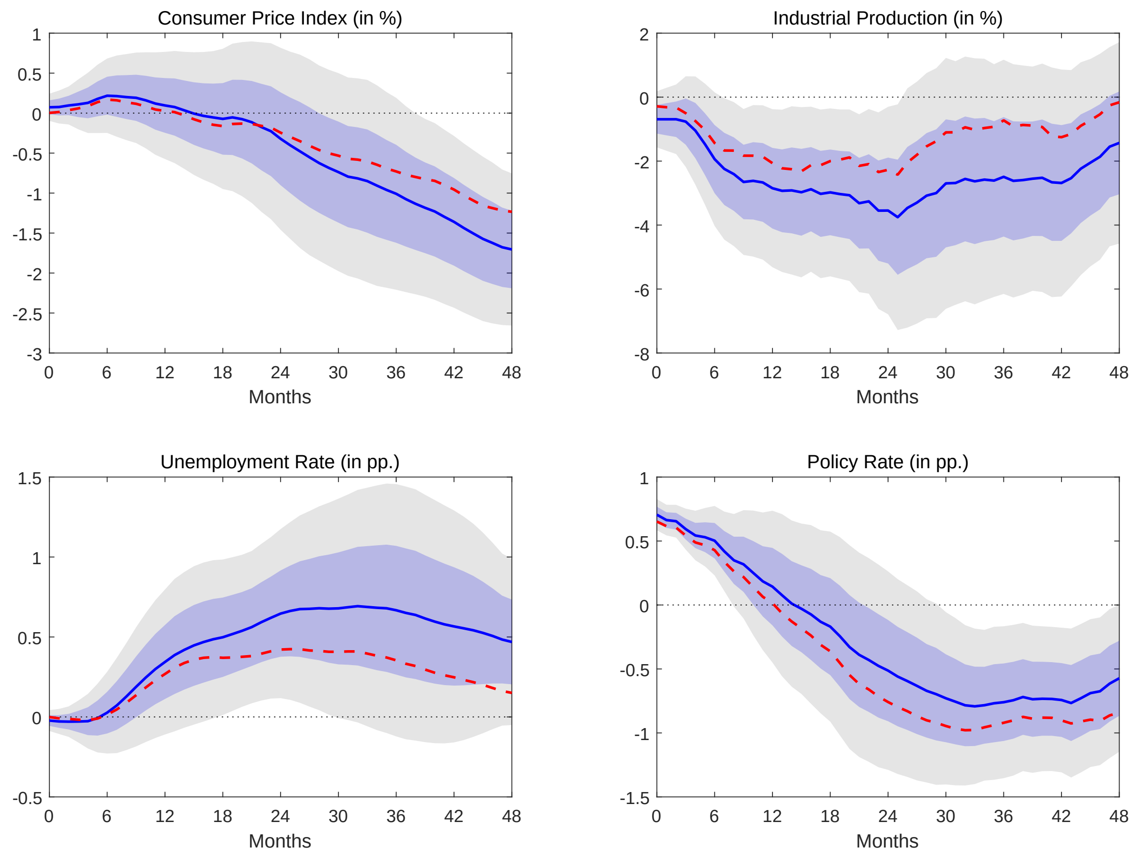
Figure D2: *Effect of a Monetary Tightening on Key Variables in Germany – Lag Length*



Notes: This figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for a number of key variables for Germany. Relative to the main result in the text, the figure shows (in red dashed and blue dotted lines) alternative lag structures. The regression includes 12 lags of the shock and 3 lags of the controls. The control variables include CPI, industrial production, unemployment rate, loans, and the real effective exchange rate. Shaded areas are 95 and 68 percent confidence intervals calculated using the approach of Newey and West (1987).

D.3. Fewer Control Variables

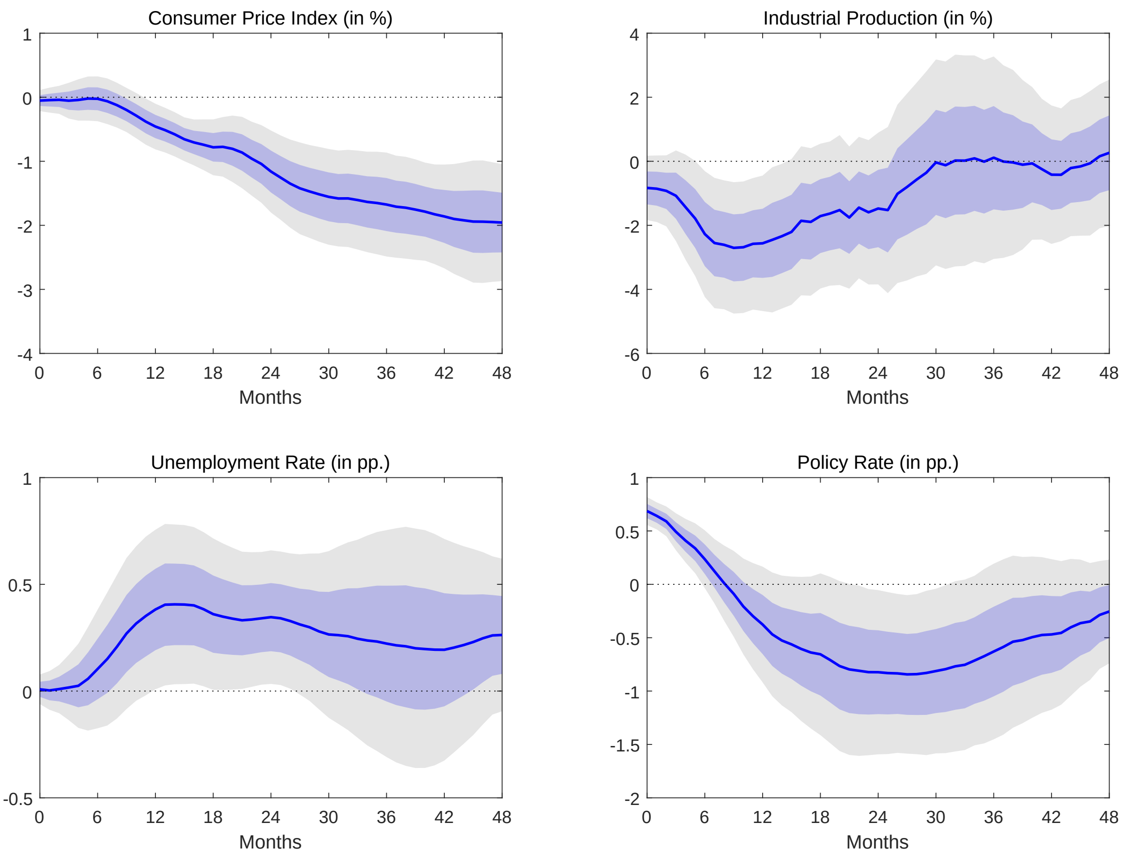
Figure D3: *LPs using 12 Lags for the Endogenous Variables and 12 Lags for the Shocks*



Notes: This figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for a number of key variables for Germany. Relative to the main result in the text (blue line), we estimate the first-stage regression with fewer control variables. The regression includes 12 lags of the shock and 12 lags of the endogenous variables. Shaded areas are 95 and 68 percent confidence intervals calculated using the approach of Newey and West (1987).

D.4. Results Using the EMS Sample: 1979:4 to 1998:12

Figure D4: *Baseline Results using the EMS Sample: 1979:4 to 1998:12*

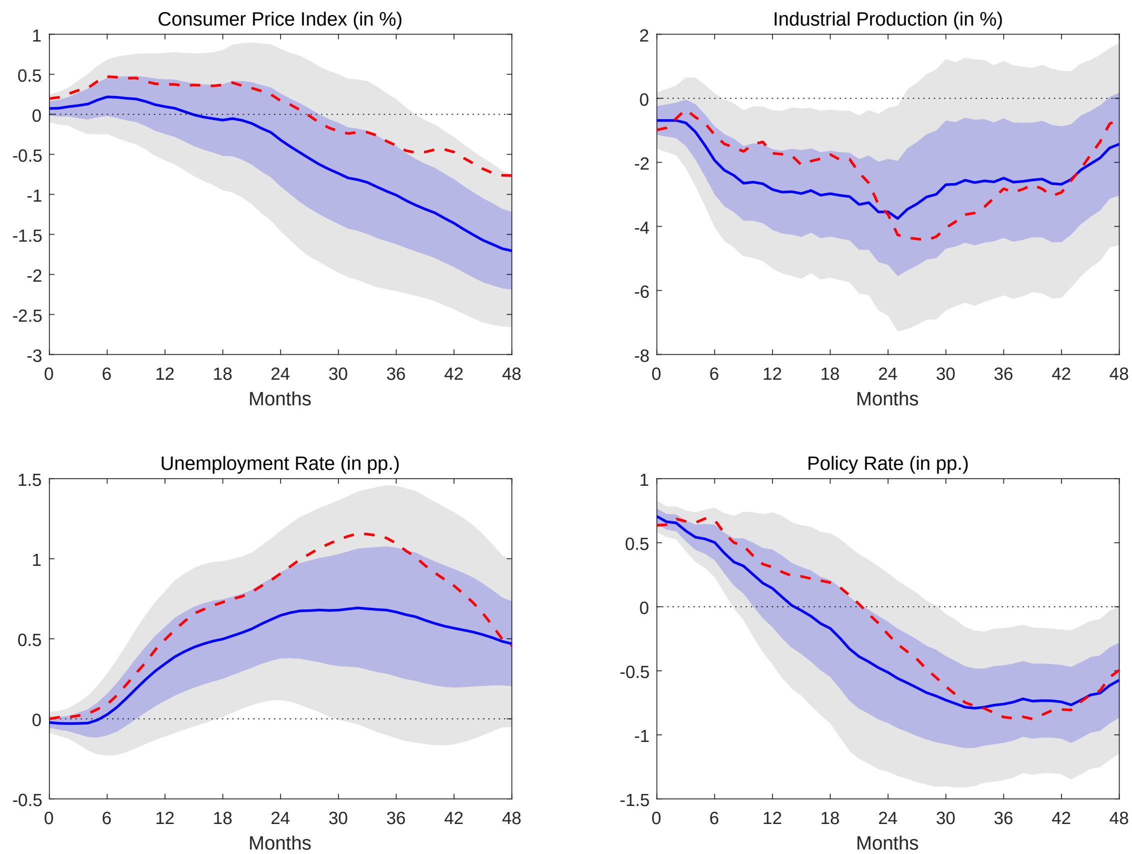


Notes: This figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for a number of key variables for Germany. Relative to the main result in the text, the figure uses a slightly shorter sample period when Germany was in the European Monetary System. The regression includes 12 lags of the shock and 3 lags of the controls. The control variables include CPI, industrial production, unemployment rate, loans, and the real effective exchange rate. Shaded areas are 95 and 68 percent confidence intervals calculated using the approach of Newey and West (1987).

D.5. Sample Restricted to Pre-Reunification

This section presents a robustness check centered on German reunification. In Figure D5, we restrict the sample to data up to June 1990 to estimate IRFs for the pre-reunification period. Due to the shorter sample, this specification employs fewer lags.

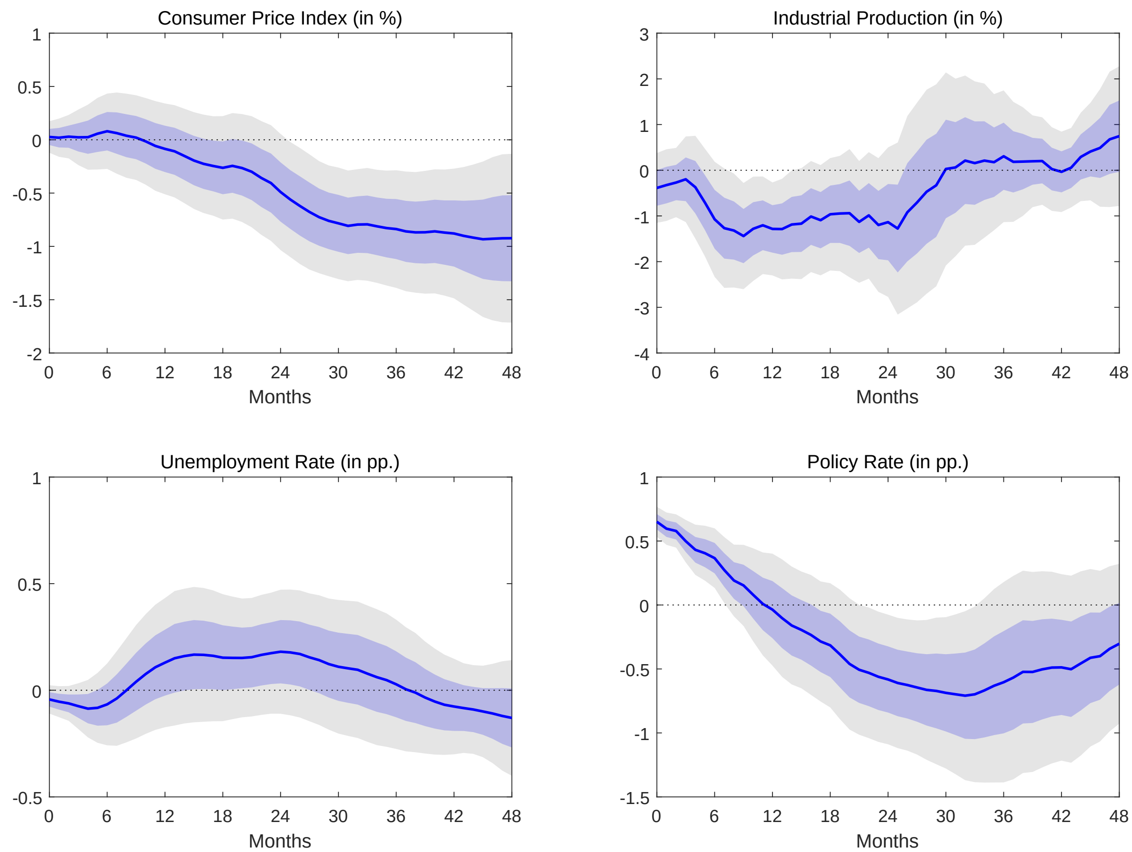
Figure D5: *Effect of a Monetary Tightening on Key Variables in Germany – Pre-Reunification*



Notes: This figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for a number of key variables for Germany. Relative to the main result in the text, the figure shows the results restricting the sample to the pre-reunification period ending in June 1990. The regression includes 3 lags of the shock and 1 lag of the controls. The control variables include CPI, industrial production, unemployment rate, loans, and the real effective exchange rate. Shaded areas are 95 and 68 percent confidence intervals calculated using the approach of Newey and West (1987).

D.6. Levels Specification

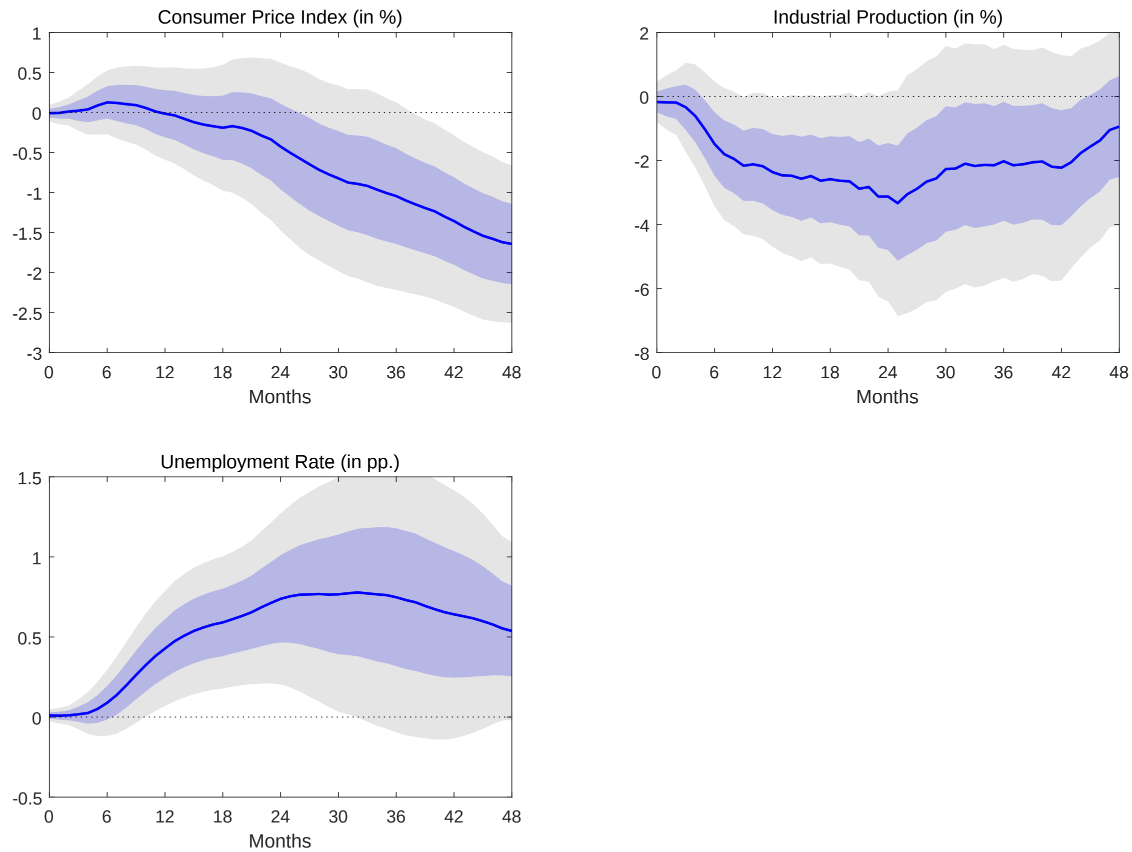
Figure D6: *IRFs Based on Level Specification*



Notes: This figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for a number of key variables for Germany. Relative to the main result in the text, the figure shows the results using a levels-with-trend specification similar to those in Ramey (2016). Specifically: $y_{t+h} = \alpha_h + \tau_h t + \boldsymbol{\Psi}_h(L)\mathbf{x}_t + \boldsymbol{\beta}_h \boldsymbol{\varepsilon}_t + u_{t+h}$,. As usual, The regression includes 12 lags of the shock and 3 lags of the controls. The control variables include CPI, industrial production, unemployment rate, loans, and the real effective exchange rate. Shaded areas are 95 and 68 percent confidence intervals calculated using the approach of Newey and West (1987).

D.7. Restricting the Impact Effect

Figure D7: *Baseline Results Forcing the Impact Effect to Zero*

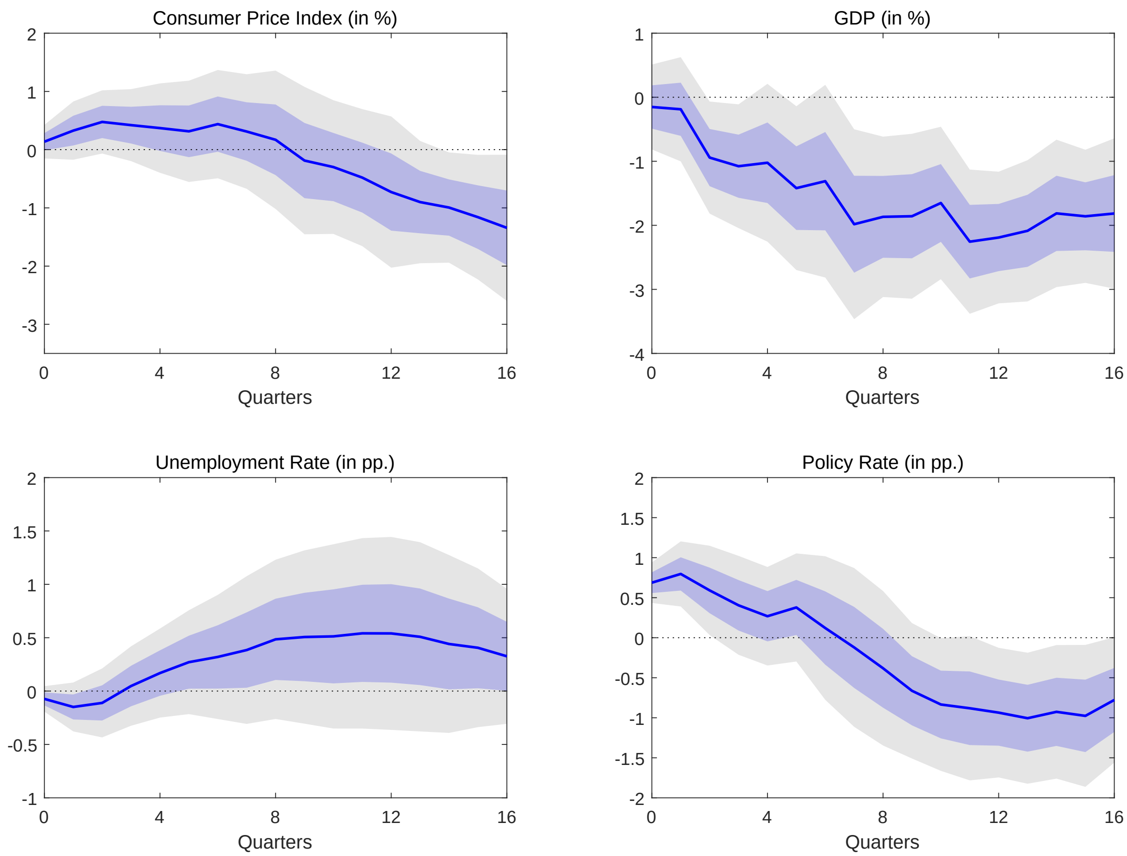


Notes: This figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for a number of key variables for Germany. Relative to the main result in the text, we include contemporaneous variables in x_t to force the impact effect to zero. The regression includes 12 lags of the shock and 3 lags of the controls. The control variables include CPI, industrial production, unemployment rate, loans, and the real effective exchange rate. Shaded areas are 95 and 68 percent confidence intervals calculated using the approach of Newey and West (1987).

To implement the impact restriction, we follow Ramey (2016) and include the *contemporaneous* variables in the control set $\mathbf{x}_t$, including for the dependent variable $y_t - y_{t-1}$. This means that we are then controlling for any variation in the shocks that might still be driven by these additional controls. Current period outcomes can potentially influence ε_t. The assumption is that the shocks ε_t do not affect these variables contemporaneously. By including $y_t - y_{t-1}$ directly on the right hand side, $\boldsymbol{\beta}_0$ is then being forced to zero. These are the same assumptions that are usually imposed in a VAR via a Cholesky decomposition: variables can affect policy contemporaneously, but policy does not affect the outcome variables in the first period.

D.8. Results Using Quarterly Data

Figure D8: *Baseline Results using Quarterly Data and Real GDP*

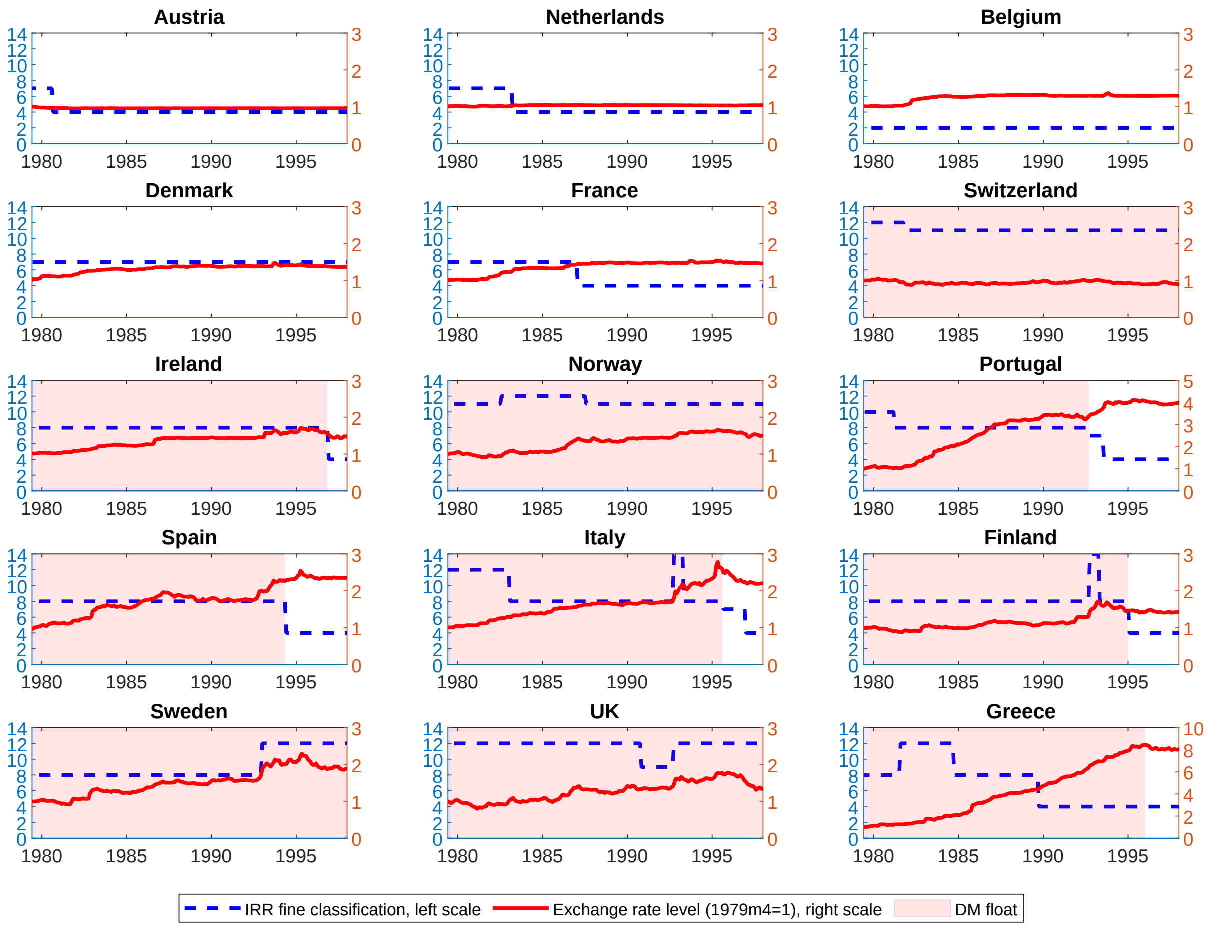


Notes: This figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for a number of key variables for Germany. Relative to the main result in the text, we use quarterly data and real GDP. The regression includes 4 lags of the shock and 1 lags of the controls. The control variables include CPI, industrial production, unemployment rate, loans, and the real effective exchange rate. Shaded areas are 95 and 68 percent confidence intervals calculated using the approach of Newey and West (1987).

E. Monetary Spillovers: Additional Figures and Robustness

E.1. Exchange Rate Outcomes vs. Regimes

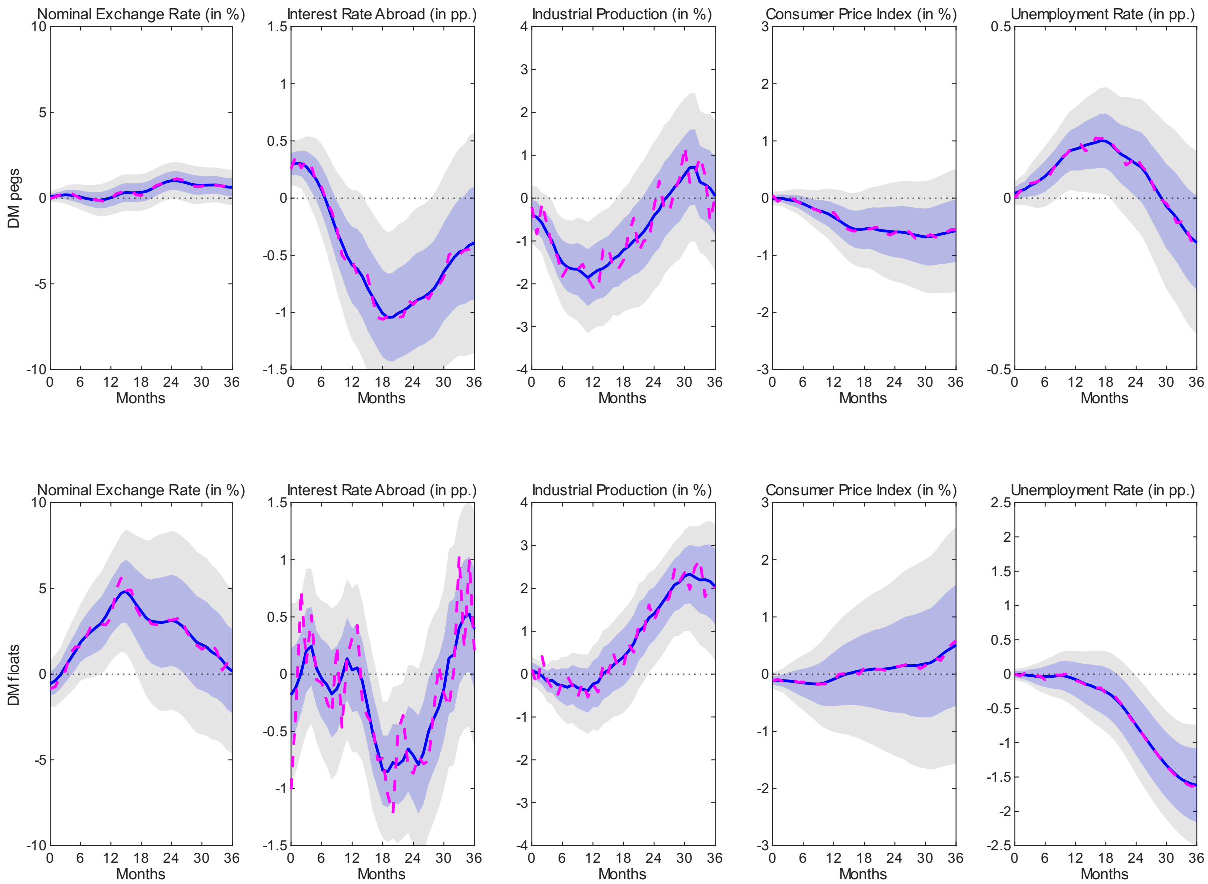
Figure E1: *Exchange Rate against DM (red, right scale) and Exchange Rate Regimes*



Notes: The dashed line shows the fine exchange rate classification based on Ilzetzki et al. (2019). The red shaded area depicts DM floats: these are countries that are classified ≥ 8 by IRR, and as DM peg for IRR classification ≤ 7. The only exception is Greece in the early 1990s which experienced large exchange rate fluctuations The solid line shows the nominal bilateral exchange rate against the DM normalized to one in April 1979 — the start of the EMS era. Exchange rates are in quantity notation, such that a higher value indicates an appreciation of the DM.

E.2. Raw and Smoothed IRFs

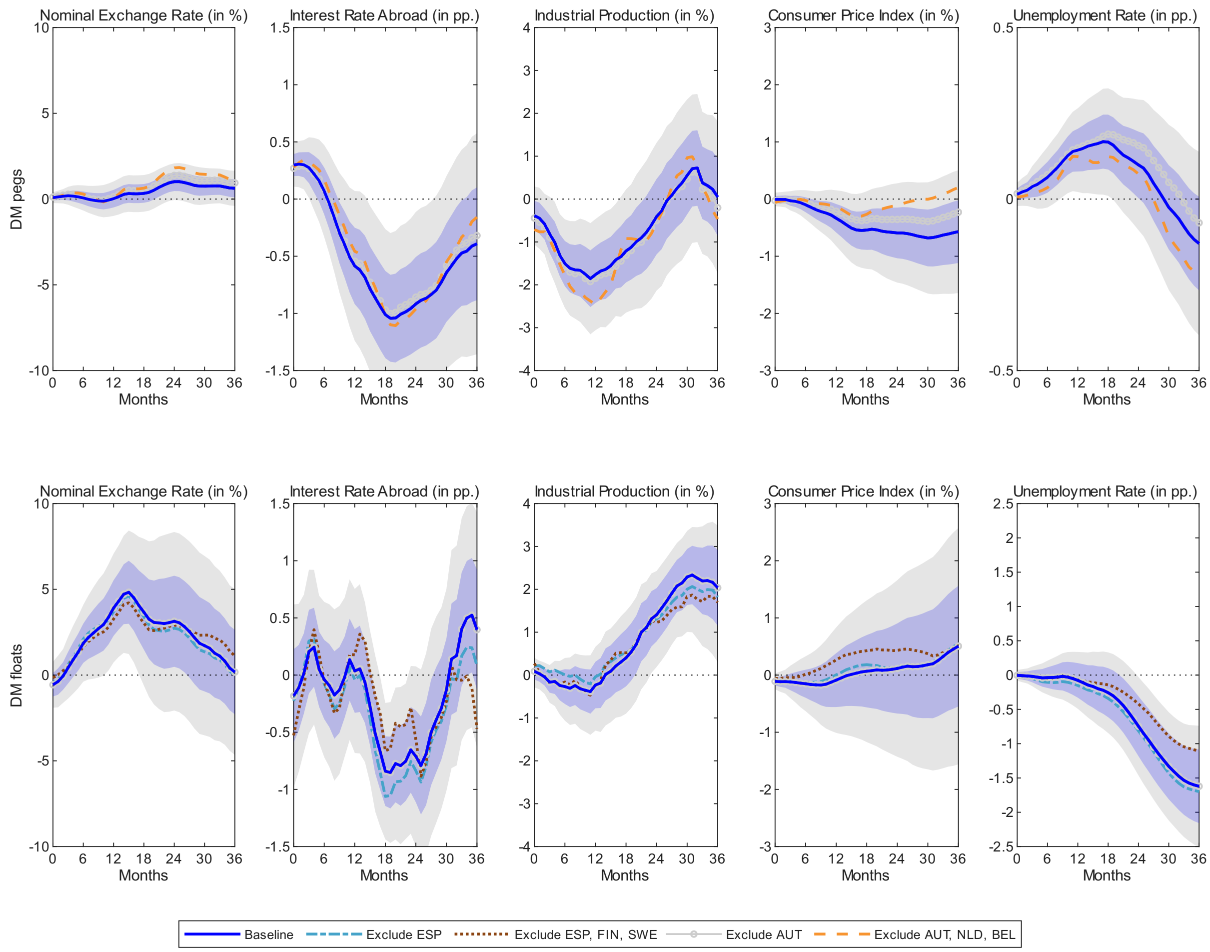
Figure E2: *Baseline Raw IRFs Overlaid*



Notes: The figure shows the IRFs to a 100 bps shock to the policy rate for the response of key macroeconomic variables depending on whether a country was pegged to the DM (top row) or whether the exchange rate was floating (bottom row). We show responses for the baseline specification (solid lines) with smoothed IRFs vs. the raw IRFs (dashed line). Shaded areas are 95 and 68 percent confidence intervals using the approach of Driscoll and Kraay (1998).

E.3. Baseline and Robustness Specifications: Excluding Countries

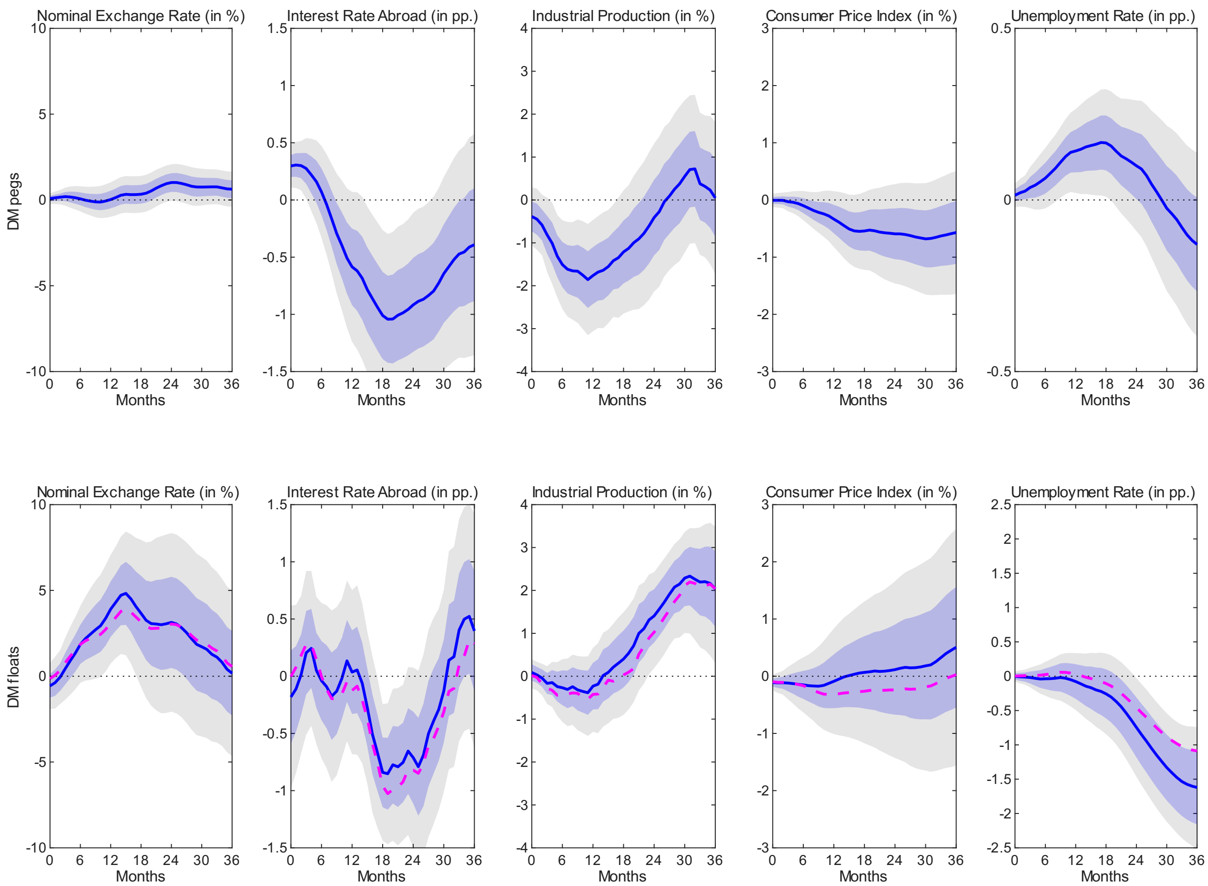
Figure E3: *Baseline and Robustness Specifications: Excluding Selected Countries*



Notes: The figure shows the IRFs following a 100 bps contractionary shock to the Bundesbank policy rate for key macroeconomic variables depending on whether a country was pegged to the DM (top row) or whether the exchange rate was floating (bottom row). In the first panel, an increase in the nominal exchange rate means a depreciation of the foreign currency. Relative to Figure 5, solid lines show the baseline results and standard error bands. The other lines display robustness checks: (1) excluding Spain, which did not join the EEC until 1986; (2) excludes countries that were not EEC members for most of the period; (3) excludes Austria, which did not join the EEC; (4) excludes the most open economies with Germany. Note, excluding Spain, Finland and/or Sweden does not affect DM pegs and we do not show the lines in the top panel. Excluding Austria, Belgium or the Netherlands does not affect the results for DM floats and, hence, we do not show the lines in the bottom panel. See text for more detail.

E.4. Panel Results with All Countries and Fixed Regimes

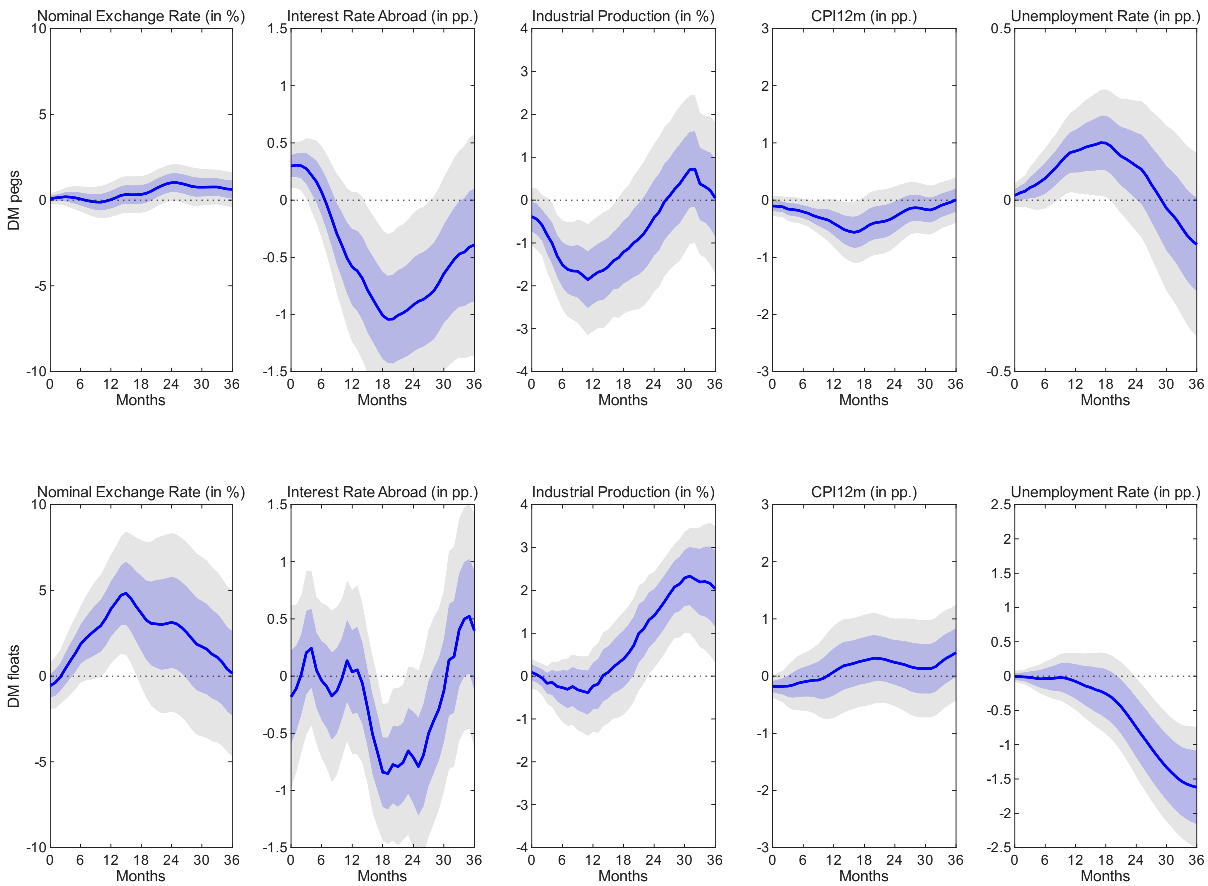
Figure E4: *Baseline Result using all Countries and Fixed Regimes*



Notes: The figure shows the IRFs to a 100 bps shock to the policy rate for the response of key macroeconomic variables depending on whether a country was pegged to the DM (top row) or whether the exchange rate was floating (bottom row). We show responses for the baseline specification (solid lines) and alternative specification (dashed line). In addition to the baseline specification we add Switzerland, Ireland, Portugal and Norway as DM float. Shaded areas are 95 and 68 percent confidence intervals using the approach of Driscoll and Kraay (1998).

E.5. Panel Results using CPI Inflation instead of the Price Level

Figure E5: *Baseline Results using Inflation*



Notes: The figure shows the IRFs to a 100 bps shock to the policy rate for the response of key macroeconomic variables depending on whether a country was pegged to the DM (top row) or whether the exchange rate was floating (bottom row). We show responses for the baseline specification (solid lines) and alternative specification (dashed line). Shaded areas are 95 and 68 percent confidence intervals using the approach of Driscoll and Kraay (1998).