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RESEARCH ARTICLE

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The effects of shocks to interest rate expectations in the euro area: Estimates at the country level

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Abstract

We estimate the effects of shocks to interest rate expectations on the four largest euro area economies. We identify these shocks in a Bayesian vector autoregressive (BVAR) model augmented by survey expectations. We separate the expectations shocks from standard monetary policy shocks by assuming that they do not affect the current policy rate. Our sign restrictions also ensure that these shocks do not contain central bank information shocks. We find that an expected decline in the future short-term rate leads to an increase in output and prices. The increases do not become larger for changes to interest rate expectations further in the future, that is, we do not find evidence of a forward guidance puzzle. Using the multicountry structure of our model, we test for cross-country differences in the shocks' effects and find output and price effects to be greatest in Germany. We also compare the effects of shocks to interest rate expectations to those of standard monetary policy shocks and show the first type to affect output and prices more strongly in Germany and France.

KEYWORDS

Bayesian vector autoregression, euro area, expectations, forward guidance, regional effects of monetary policy, unconventional monetary policy

1 | INTRODUCTION

In the aftermath of the financial crisis and the euro area sovereign debt crisis, the European Central Bank (ECB) reduced its policy rates to exceptionally low levels. With short-term interest rates at or close to the effective lower bound, the ECB turned to unconventional monetary policies to provide additional monetary stimulus. In July 2013 the ECB introduced forward guidance—explicit communication about the future path of policy rates. The Federal Reserve had begun using forward guidance as a policy tool already early in the financial crisis, whereas the Bank of England started using this instrument later, in August 2013. Over time, the ECB's forward guidance underwent some changes. For example, with the start of the ECB's quantitative easing program in January 2015, forward guidance on interest rates was linked to the duration of asset purchases. With the end of the first round of quantitative easing in December 2018, forward

The data and codes are available upon request.

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guidance on future interest rates became an important policy instrument on its own, again.[1]

In this paper, we estimate the effects of forward guidance, or more specifically, of shocks to expectations about future interest rates, on the four largest euro area countries (Germany, France, Italy, and Spain). We use the approach of D'Amico and King (2017) who estimate the effects of shocks on expectations about future policy interest rates in the United States.

We identify forward guidance shocks as shocks to interest rate expectations within a Bayesian vector autoregressive (BVAR) model augmented by survey expectations. Following D'Amico and King (2017), we separate expectations shocks from standard monetary policy shocks by assuming that expectations shocks cause changes in expected short-term interest rates but leave the current short-term interest rate unchanged. We use a multicountry model which includes macroeconomic time series for the four largest euro area countries as well as euro area aggregate variables but impose identification assumptions only on the euro area aggregates or on country averages.[2] Thus, we remain relatively agnostic about the effects of the shocks at the individual country level. We estimate positive effects on output and consumer prices in Germany and France. In Italy and Spain, we find positive median effects, but the uncertainty bands are particularly wide for Spain.

Comparing the effects of shocks to interest rate expectations across different expectation horizons, we do not find evidence of a "forward guidance puzzle." According to our estimates, the effects of shocks to expected interest rates do not increase if the shock applies to interest rate expectations further in the future.

The multicountry structure allows us to test for possible cross-country differences in the effects in a statistically rigorous way (Mandler et al., 2022; Mandler & Scharnagl, 2020). We show that both output and prices respond more strongly in Germany to shocks to interest rate expectations than in the other three countries. By extending our baseline model, we show that these differences are related to a stronger response in financing conditions (financing cost and credit volume), as well as investment, in Germany.

Finally, we compare the effects of a shock to interest rate expectations to a shock to the current policy rate. Our results indicate stronger effects of a shock to the expected interest rate on output and prices compared to an unexpected change in the actual short-term interest rate in Germany and France.

Our paper is most closely related to D'Amico and King (2017). They extend a vector autoregressive model for the United States by survey expectations and identify shocks to expected interest rates using sign restrictions. They find that a decline in interest rate expectations has an expansionary effect on output and prices and that this effect is broadly similar across different expectation horizons. We follow their identification approach but shift our focus to the euro area and use a multicountry model, which allows us to analyze the question of cross-country heterogeneity in the effects of forward guidance. We also address the question of whether the effects depend on the expectation horizon more explicitly by comparing the distributions of cumulated impulse responses across expectation horizons.

Other studies have relied on high frequency or external instrument identification of shocks to interest rate expectations. Gürkaynak et al. (2005) extract two common factors from surprise components in announcements of the Federal Open Market Committee of the Federal Reserve, measured by the changes in Federal Funds Futures and in asset prices caused by these announcements. From these surprises, they construct two factors by rotation. Although the first factor ("target factor") affects both the current and the future expected federal funds rate, the second factor ("path factor") does not affect the current federal funds rate. They show the path factor to have a stronger effect on the long end of the yield curve than the target factor but a smaller effect on stock prices. They argue that this is due to path shocks revealing central bank private information about the future state of the economy to market participants, which causes them to revise their expectations about future economic developments. Thus, shocks to the path factor contain both, revisions in interest rate expectations representing exogenous changes to future monetary policy not related to the future state of the economy and changes to future monetary policy due to changes in the projected path of the economy. Although the first type of shock causes negative co-movement of expected interest rates on one side, and stock prices and current and future expected output and inflation on the other side, the second type of shock causes positive co-movement. Our identification restrictions require a negative shock to anticipated interest rates to have expansionary effects on output and prices, that is, we rule out the second type of path shocks. This is motivated by the fact, that we are interested in the macroeconomic effects of exogenous changes to expectations about future monetary policy in form of forward guidance, that is, the central bank announcing that policy rates will be lower in the future.

[1]For a more detailed discussion of the ECB's forward guidance, its purposes, and its adjustments, see Hartmann and Smets (2018) and Rostagno et al. (2021).

[2]This approach follows Mandler and Scharnagl (2020).

Campbell et al. (2012) distinguish "Delphic" and "Odyssean" forward guidance. "Delphic" forward guidance conveys the central bank's private information about the future state of the economy and how it expects to react with its policy instruments. "Odyssean" forward guidance, by contrast, represents a commitment by the central bank to a path for its policy instruments. They model forward guidance shocks as Gürkaynak et al. (2005)-type path shocks and estimate their effects on revisions to the Blue Chip consensus forecasts of the unemployment rate and the consumer price index. In their sample period, a positive surprise to the expected federal funds rate causes a decline in the unemployment rate and an increase in consumer price inflation. They conclude that path shocks predominantly contain "Delphic" forward guidance. Nakamura and Steinsson (2018) obtain similar results. Campbell et al. (2017) revisit the results in Campbell et al. (2012) and isolate the Delphic component in forward guidance shocks. They show that this component of monetary policy surprises causes positive comovement of forward guidance shocks and output in bivariate regressions but accounts for only a small portion of the variance in monetary policy surprises.

By contrast, Bundick and Smith (2020) estimate that lower expected future policy rates, that is, a decline in the path factor, lead to an expansion in economic activity and an increase in the price level in the United States. They explain their different results from Campbell et al. (2012, 2017) by differences between the path factors used in the analyses.

Turning to the euro area, Andrade and Ferroni (2021) show forward guidance shocks, defined as positive shocks to the path factor, to affect inflation expectations positively, consistent with these shocks mainly reflecting central bank information shocks or the "Delphic" component of forward guidance. However, from 2012 onward, an unexpected decline in the path factor leads to an increase in inflation expectations, which indicates the shock representing a "true" monetary policy surprise or the "Odyssean" component of forward guidance. Altavilla et al. (2019) extend the methodology of Gürkaynak et al. (2005) to the euro area and extract three factors from surprise movements in the term structure around ECB monetary policy decisions: a target factor, a "timing" or "forward guidance" factor and a "quantitative easing" factor. The latter two factors do not affect the current short-term rate.

Jarocinski and Karadi (2020) separate monetary policy surprises into central bank information shocks, that is, changes in current and future expected interest rates caused by a reassessment of the current or expected future state of the economy, and monetary policy surprises, which are unrelated to new information about the economy. Empirically, this separation is based on the stock market effect of monetary policy surprises: Interest rate surprises correlated positively with changes in stock prices are categorized as being caused by information shocks while those with a negative correlation are caused by "true" monetary policy surprises. Although an increase in the short-term interest rate due to the latter causes output and prices to decline, an increase due to an information shock leads to an increase in output and prices. Kerssenfischer (2022) follows a similar approach and disentangles monetary policy surprises from central bank information shocks using sign restrictions. In our paper, both the conventional monetary policy shock and the shock to expected interest rates we identify are, in this sense, monetary policy surprises and not information shocks. Our identification also distinguishes between shocks to the current policy rate and shocks that only affect anticipated interest rates, whereas Jarocinski and Karadi (2020) and Kerssenfischer (2022) do not include the latter ones.

Our paper is also related to the literature on heterogeneous effects of monetary policy across regions,[3] specifically to multicountry analyses of the effects of the ECB's monetary policy. Differences in the effects of conventional (interest rate) policy in the euro area are studied by Georgiadis (2015) using a global VAR (GVAR) model and Mandler et al. (2022) using a multicountry BVAR model. Burriel and Galesi (2018) (GVAR model) and Mandler and Scharnagl (2020) (BVAR model) present evidence on heterogeneous effects of unconventional monetary policy across euro area countries.

The remainder of the paper is structured as follows: Section 2 outlines the estimation approach and the identification strategy. Section 3 presents our results concerning possible differences across expectation horizons and across countries and the comparison of the effects of conventional monetary policy shocks to those of shocks to interest rate expectations. Section 4 provides some results on potential explanations for the cross-country differences in the effects of the expectations shocks, and Section 5 concludes.

2 | ECONOMETRIC APPROACH AND DATA

2.1 | BVAR model and data

The model follows D'Amico and King (2017) in augmenting a BVAR model by survey data. The basic structure of the BVAR model builds on Mandler et al. (2022) and

[3]See Mandler et al. (2022) for a survey.

Mandler and Scharnagl (2020) and combines a block of euro area variables with a block of country-specific variables for the four largest euro area countries (Germany: DE, Spain: ES, France: FR, and Italy: IT).

We estimate the BVAR model using the approach of Giannone et al. (2015). They propose a hierarchical prior that treats the hyperparameters controlling the prior distributions of the VAR parameters as parameters that are to be estimated. They summarize prior beliefs about these hyperparameters by "hyperpriors."[4]

The VAR model for n variables $y_t = (y_{1,t},...,y_{n,t})'$ is given by

$$y_t = c + A_1 y_{t-1} + ... + A_p y_{t-p} + \varepsilon_t \qquad \varepsilon_t \sim N(0,\Sigma). \tag{1}$$

c is a vector of intercepts, A_i is a $n \times n$ matrix of coefficients on lag i, p is the number of lags, and ε_t is a vector of serially uncorrelated residuals with mean zero and covariance matrix Σ. The prior in Giannone et al. (2015) is of the Minnesota type and assumes all variables to follow independent random walks: The coefficient on the first own lag of each variable has a prior mean of one and all other coefficients have a prior mean of zero. This implies a prior mean of the coefficients in A_1 of

$$E[A_{s,ij}|\Sigma,\gamma] = \begin{cases} 1 & \text{if } i=j \text{ and } s=1 \\ 0 & \text{otherwise} \end{cases}, \tag{2}$$

conditional on the vector of hyperparameters γ and on the covariance matrix Σ.

The prior covariance of the coefficients in A_1 is

$$\operatorname{cov}[A_{s,ij}, A_{r,hm}|\Sigma,\lambda,\Psi] = \begin{cases} \lambda^2 \dfrac{1}{s^2}\dfrac{\Sigma_{ih}}{\Psi_{jj}} & \text{if } m=j \text{ and } r=s \\ 0 & \text{otherwise} \end{cases}, \tag{3}$$

with the hyperparameters λ and Ψ as elements of the vector γ.

The prior distribution of the covariance matrix is inverse Wishart:

$$\Sigma \sim IW(\Psi, d), \tag{4}$$

where $d = n+2$ represents the degrees of freedom. The scale matrix Ψ is diagonal, with the diagonal elements, ψ_i, being treated as hyperparameters.

Giannone et al. (2015) derive a decomposition of the joint prior distribution of the VAR parameters and the hyperparameters as

$$p(A_1,...,A_p,c,\Sigma,\gamma) = p(A_1,...,A_p,c|\Sigma,\gamma)\,p(\Sigma|\gamma)\,p(\gamma). \tag{5}$$

γ collects all the hyperparameters, $p(\Sigma|\gamma)$ is given by (4), and $p(A_1,...,A_p,c|\Sigma,\gamma)$ is given by (2) and (3). Conditional on the hyperparameters γ, the VAR parameters have a normal-inverse Wishart prior distribution. However, the posterior distribution also takes into account the uncertainty about the hyperparameters. Giannone et al. (2015) specify the hyperprior for λ as a Gamma distribution with a mode equal to 0.2.

As in standard BVAR models, the joint posterior distribution of the VAR parameters in $A_1,...,A_p,c$ and Σ conditional on the hyperparameters can be estimated using the Gibbs sampler. The posterior distribution of the hyperparameters can be decomposed as

$$p(\gamma|y) \propto p(y|\gamma)\,p(\gamma), \tag{6}$$

with y representing the data. The hyperprior $p(\gamma)$ is known but not the marginal likelihood $p(y|\gamma)$. Giannone et al. (2015) obtain an analytical solution for the marginal likelihood. Their suggested MCMC algorithm combines a Metropolis–Hastings step for drawing the hyperparameters using (6) with a Gibbs sampler for drawing the VAR coefficients and covariances conditional on the hyperparameters.[5]

Our model uses quarterly data from 1999Q1 to 2018Q4. The euro-area block consists of euro area aggregate real GDP, the harmonized index of consumer prei HICP, stock prices, the euro area average 5-year government bond yield,[6] and the 3-month interest rate (3-month Euribor) as a policy indicator. To these variables, we add consensus forecasts of real GDP, consumer

[4]In the previous literature, different approaches have been used to "optimize" the hyperparameters. Litterman (1980) and Doan et al. (1984) set the hyperparameters to minimise the forecast errors over a training sample. Bańbura et al. (2010) run a grid search and select those values for the hyperparameters that result in an in-sample fit for the BVAR identical to that of a small VAR estimated by OLS.

[5]For the estimation of the model, we used a modified and extended version of the code from Giorgio Primiceri's website: http://faculty.wcas.northwestern.edu/~gep575/GLPreplicationWeb.zip
For models of the size used in this paper's application, the algorithm converges only very slowly. The results presented in this paper are based on a simplified algorithm fixing the hyperparameters at their values maximizing the marginal likelihood but not drawing from their posterior distribution. We also eliminate unstable draws of VAR coefficients and apply the identification algorithm only to draws with a maximum eigenvalue of less than 1.015.

[6]This is the yield on a benchmark government bond with a maturity of five years and is provided by the ECB.

prices (HICP), and the 3-month interest rate two, four, or six quarters ahead.[7] Because consensus forecasts are available for the 3-month interest rate but not for the overnight rate (EONIA), we use the 3-month rate as a proxy for the monetary policy rate. The country-specific variables in the second block include real GDP and HICP for DE, ES, FR, and IT. Finally, we also include oil prices and the 5-year U.S. government bond yield with the latter variable controlling for possible spillover effects from U.S. monetary policy and capital markets. All variables except for interest rates enter the model in log levels, whereas spreads and interest rates are in decimal figures. The specification uses five lags.

2.2 | Identification of shocks to expected interest rates

We identify two structural shocks using zero and sign restrictions: a conventional monetary policy shock and a shock to interest rate expectations. We implement the sign restrictions using a modified version of the algorithm of Arias et al. (2014, 2018). We assume that the conventional monetary policy shock causes a decline in the euro area 3-month interest rate and in the 5-year government bond yield, an increase in euro area output, consumer prices, and stock prices. We do not require output and prices to increase in each of the four countries but impose the restriction that output and prices should increase on average, that is, we impose positive sign restrictions on real GDP-weighted linear combinations of the country-specific output and price level responses. This allows for more heterogeneity in the effects of monetary policy on individual countries.[8] For the anticipated interest rate shock, we follow D'Amico and King (2017) and identify the shock using survey expectations: an expansionary shock to the anticipated policy rate implies a decline in the expected euro area 3-month rate and in the 5-year bond yield, an increase in euro area output (both actual and expected), price level (both actual and expected), and stock prices. Furthermore, we impose a zero restriction on the actual 3-month rate, that is, the shock does not move the current policy rate. Similar to the conventional shock, we do not impose sign restrictions on the country-specific output and price variables but on the cross-country averages. All sign and zero restrictions apply to the impact period only. Table 1 summarizes the identification restrictions.

Following D'Amico and King (2017), we also impose consistency of expectations and actual variables. These restrictions require the changes in the actual variables to match the changes in their survey expectations at the horizon of the expectations. For example, for a shock to interest rate expectations k quarters ahead, the impulse response of the 3-month interest rate itself k quarters ahead must be identical to the initial response of the expected interest rate. We impose similar restrictions on the output and price level expectations, and we impose these restrictions not only for the forward guidance shock but also for the conventional monetary policy shock. Furthermore, as an extension, we impose the restriction that the cross-country average output and price level responses k quarters ahead should be consistent with the impact effect of the shocks on expectations of euro area aggregate output and prices, as well.

TABLE 1 Sign and zero restrictions on monetary policy shocks.

Variable	Conventional monetary policy shock	Anticipated interest rate shock
Euro area block		
Real GDP	+	+
HICP	+	+
3 M-rate	−	0
5Y bond yield	−	−
Stock prices	+	+
Expected real GDP		+
Expected HICP		+
Expected 3 M-rate		−
Oil price		
U.S. bond yield		
Country block		
Country real GDP	+ (average)	+ (average)
Country HICP	+ (average)	+ (average)

Restrictions imposed on impact; "average" indicates a sign restriction on the GDP-weighted cross-country average; additional restrictions require that the responses of output and price level k periods ahead are identical to the impact responses of the respective expectations.

[7]We transform the survey expectations of real GDP growth and inflation into expected levels.

[8]Imposing sign restrictions on the country-specific variables would imply a prior assumption of similar responses across countries. One possible concern about our approach of using GDP-weighted averages for imposing some of the sign restrictions is that the different weights across countries might result in stronger effects of the shocks in larger countries. For example, a draw with a positive effect of the shock on output in DE but a negative effect in IT is more likely to be accepted than the other way around because the response in DE has a larger weight. We have investigated this concern by a robustness check using equal weights for all countries and found the results for the cross-country differences as in Figure 2 to be visually almost identical to those obtained by using GDP weights.

3 | RESULTS

3.1 | Effects of shocks to anticipated interest rates at different horizons

We estimate the impulse responses to a shock to interest rate expectations using three model specifications, alternatively including survey expectations two, four, and six quarters ahead. The right panels in Figure S.1 in the online appendix show impulse response functions (IRFs) to a one-standard-deviation shock to the expected policy rate four quarters ahead. The size of the median shock to interest rate expectations is relatively small and about 1.7 basis points (bp). Both the median shock size and the 68% bands are similar to the results in Figure 3 in D'Amico and King (2017) for the United States. The shock leads to a median increase in euro area aggregate output and price expectations by about 4 and 5 bp on impact, which is smaller than the impact effects in D'Amico and King (2017).

For comparison, the left panels in Figure S.1 show the IRFs to a conventional monetary policy shock. Overall, the effects of the shock to interest rate expectations are more persistent. The likely reason for this is that it causes a decline in the short-term interest rate that lasts for about 2 years. By contrast, the conventional policy shock only leads to a temporary decline in the 3 M rate, which is reversed quickly.

Figure S.2 shows the impulse responses for real GDP and consumer prices from the right panel of Figure S.1 together with those to shocks to expectations two and six quarters ahead, that is, from BVAR models that replace the four-quarter ahead expectations by two- or six-quarter ahead expectations. Qualitatively, the impulse responses are very similar to those for the four-quarter horizon but the uncertainty bands shrink somewhat as the expectation horizon lengthens.[9]

We compare the estimates across the models with different horizons for the survey expectations in order to analyze whether the effects of shocks to anticipated interest rates depend on how far in the future the interest rate is expected to shift downward. For this, we first normalize the size of the anticipated interest rate shock to −10 bp in all models. Instead of a visual inspection of the impulse responses as in D'Amico and King (2017), we use a simple metric of the strength of the effects of the shock: We select the peak effect, that is, the maximum impulse response of output or the price level for each draw of the model. Figure 1 plots the posterior density of these peak effects for each country's real GDP (top four panels) and HICP (bottom four panels). Different symbols indicate the posterior density for the different expectation horizons. Overall, the comparison of the peak impulse distribution over the different expectation horizons does not indicate marked differences. For peak impulse responses up to 1%, which is the range where most of the probability mass tends to concentrate, the density of the maximum peak effect distribution tends to increase from two to four and to six quarters. This suggests that, if there is any difference at all, peak impulse responses seem to become somewhat smaller with increasing expectations horizon. An alternative to the comparison of the peak impulse response is comparing the cumulated output or

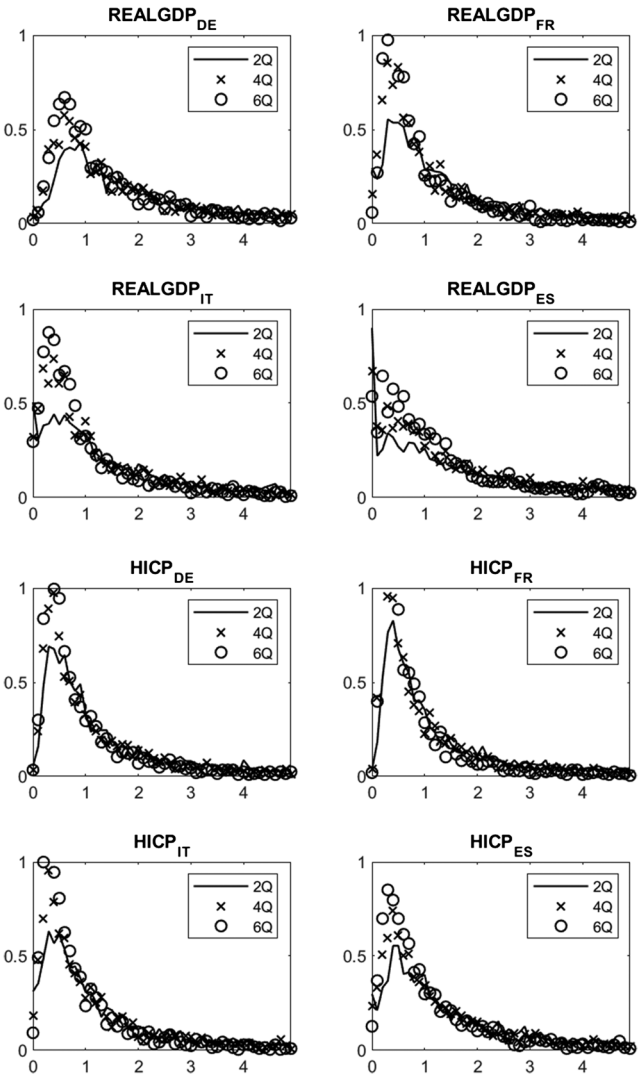


FIGURE 1 Comparison of posterior densities of peak impulse responses across expectation horizon (impulse response to −10 bp shock to expected 3 M interest rate, horizontal axes show peak impulse responses in percentage points).

[9]Note that, since the model is re-estimated for each expectation horizon, the effects of the conventional monetary policy shock are not necessarily identical in this exercise. However, the impulse response distributions turn out to be very similar across these models.

price level effect over the impulse response horizon. Figures S.3 and S.4 in the online appendix compare the posterior densities of the cumulated impulse responses (cumulated over two or over six quarters). The implications of these results are very similar to those presented in Figure 1: There is little evidence of the size of cumulated impulse responses to change with the expectation horizon. The broad similarity of the effects of shocks across expectation horizons corresponds to the finding in D'Amico and King (2017) for the United States.

Our result is related to the so-called "forward guidance puzzle." In structural macroeconomic models, it manifests in a bigger increase in output and inflation in response to an announced future cut in the monetary policy rate if the interest rate cut is announced for a date further in the future (e.g., Del Negro et al., 2015), that is, the effects of forward guidance rise the further into the future the announcement applies to.[10] Our estimates do not show this positive correlation between the effects of changes in interest rate expectations with the expectation horizon. If there is any relationship, our results point more to the reverse.

3.2 | Do the effects differ across countries?

In this subsection, we analyze whether shocks to expected interest rates affect the four countries in our data set differently. For this analysis, we employ the methodology from Mandler et al. (2022): For each draw from the structural BVAR, we construct the impulse responses of each country's real GDP and HICP to a −10 bp shock to the expected short-term interest rate and compute the difference between these impulse responses for each possible country pair. This yields the posterior distributions of the cross-country difference in impulse responses.[11] Based on the location of these distributions relative to zero (which implies no difference), we can assess whether there is evidence of different effects of shocks to anticipated interest rates across countries. Positive values indicate that the impulse response of the specific variable in the first country is above that of the second country.

Figure 2 shows the posterior distributions of the cross-country differences in the response of real GDP and the HICP to the shock to anticipated interest rates. A positive difference indicates the impulse response in the first country being greater, that is, more positive or less negative than in the second one. By contrast, a negative difference shows the impulse response in the first country to be smaller, that is, less positive or more negative than in the second one. The percentiles of the posterior distribution provide a simple way to compute probability ratios of a bigger versus a smaller response in the first compared to the second country: If the 33rd (66th) percentile is above (below) zero, the probability ratio for the response in the first country being above (below) that in the second is at least 2:1. If the 25th (75th) percentile is above (below) zero the probability ratio for the response

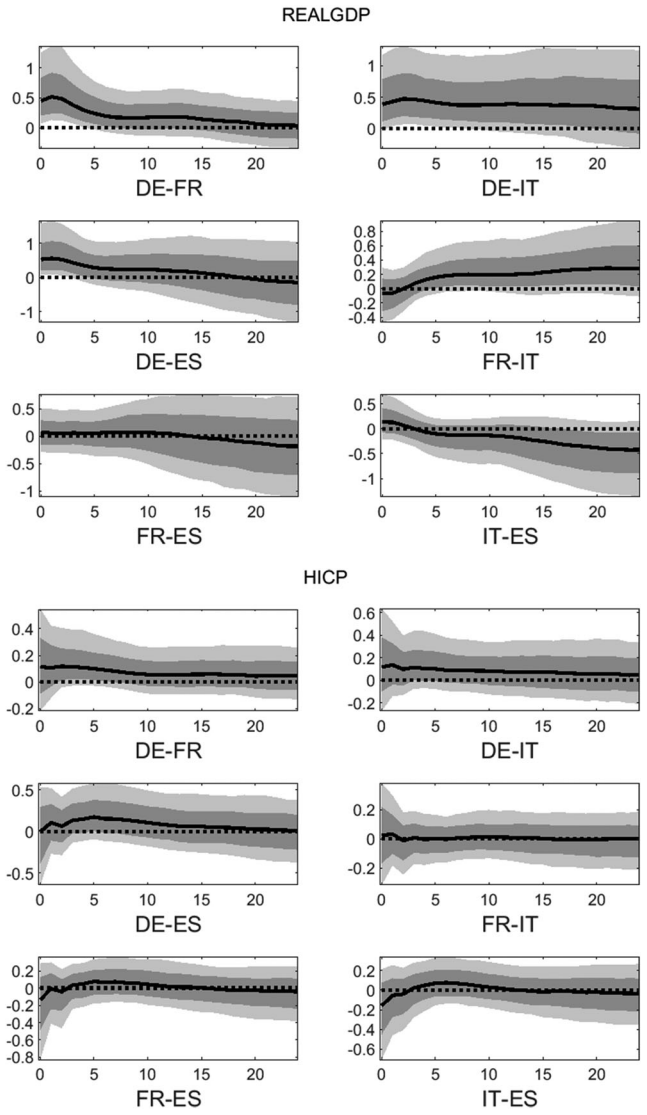


FIGURE 2 Cross-country differences of impulse response to a −10 bp shock to four-quarter ahead expectation of the 3 M interest rate (percentage points, median, 25th, 33rd, 66th and 75th percentiles of posterior distribution).

[10]For a discussion of the mechanisms that underpin the forward guidance puzzle in structural models and of possible modelling approaches to its alleviation, see, for example, G. Coenen, C. Montes-Galdón, A. Saint Guilhem, J. Hutchinson, and R. Motto (2022), Section 3.

[11]In contrast to comparisons of distributions of impulse responses, this approach allows for probabilistic statements.

in the first country being above (below) that in the second is at least 3:1.

The upper panel of Figure 2 shows output to expand more strongly in DE than in FR or IT for about 2 years. The difference between the output responses in DE and ES is positive for about 1 year indicating a stronger output increase in DE in the short term. The comparison among the other three countries is not as clear-cut. The output expansion in FR turns out to exceed the one in IT after about five quarters, and the output reactions in FR and ES are broadly similar, that is, the distribution of the differences is roughly symmetrical around zero. The difference between IT and ES is positive only in the very short run and turns to negative after about 2 years. Overall, these results suggest the ranking DE > ES, FR > IT.

The cross-country differences are less pronounced for consumer prices, but the lower part of Figure 2 indicates a stronger increase in the HICP in DE than in the other three countries. There is no systematic difference in the price level response in FR and IT, but consumer prices rise somewhat stronger in both countries than in ES at a horizon of about six quarters while the price level increase is somewhat weaker on impact. However, the probability ratios for the comparison between FR, IT, and ES generally do not exceed 2:1. Thus, our overall ranking is DE > ES, FR, IT. Figures S.5 and S.6 in the online appendix show the results for the cross-country differences using two- and six-quarter ahead expectations, respectively. They yield the same country ranking as the four-quarter expectations, but the differences turn out to be somewhat less marked for the two-quarter and somewhat stronger for the six-quarter horizon.

3.3 | Do the effects of shocks to interest rate expectations differ from standard monetary policy shocks?

Figure 3 compares the effects of a shock to policy rate expectations to those of a conventional monetary policy shock, that is, a shock to the current policy rate. This requires making the two shocks comparable by normalization. Here, we normalize based on the shocks' effects on the 5-year government bond yield.[12] We scale the conventional monetary policy shock and the shock to interest rate expectations to both imply a cumulated change in the 5-year government bond yield of −50 bp over the first eight quarters. This is similar to forcing both shocks

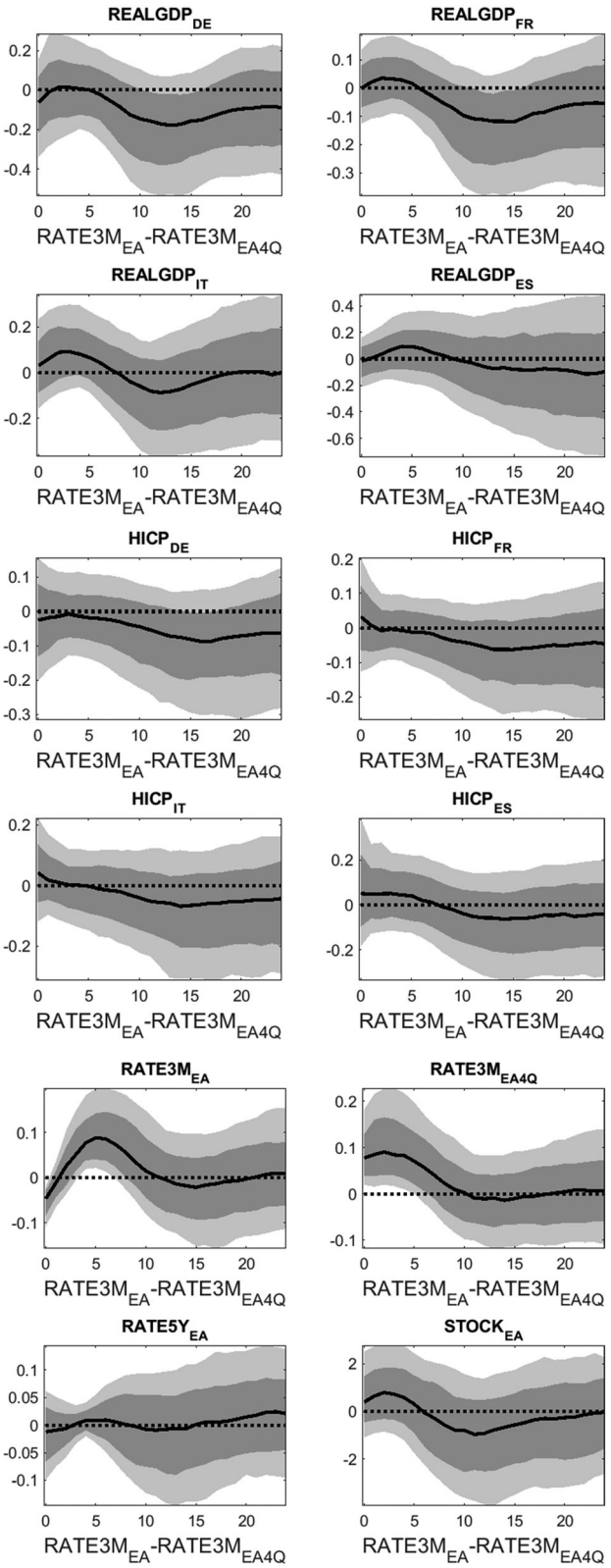


FIGURE 3 Posterior distribution of the difference between impulse response to conventional monetary policy shock and shock to expectations about four-quarter ahead short-term interest rate (percentage points, median, and 25th, 33rd, 66th and 75th percentiles of posterior distribution).

[12]We are indebted to an anonymous referee for this suggestion.

to result in the same value for the integral over the bond yield's impulse response over the first eight quarters.[13] For each draw of the model, we normalize the impulse responses as explained and, for each variable, compute the difference between the impulse responses to the two shocks. Using this procedure for all draws of the model yields the posterior distribution of the difference in each variable's response to the two shocks. Figure 3 shows selected percentiles of the posterior distribution of these differences for selected variables.

For DE and FR, there is evidence of a negative difference after about 2 years. This implies that output increases less after a conventional shock than after a shock to interest rate expectations. The delayed emergence of this difference indicates that, in the short run, both shocks have similar effects. We find similar results for the HICP: although there is no systematic difference in the HICP impulse responses to both shocks up to about 2–3 years, the shock to expected interest rates causes a stronger increase in consumer prices than the shock to the current rate in DE and FR for longer horizons. A possible explanation for these differences is shown in the second part of Figure 3: Between about two to eight quarters after the shocks occur, the short-term interest rate is higher for the conventional monetary policy shock than for the expectations shock, which pushes output and prices down. Although the expectation shock leads to a decline in the short-term interest rate at this horizon, the conventional shock has already caused the short-term rate to reverse its initial decline because of the expansion in output and prices.

Figures S.7 and S.8 in the online appendix repeat the analysis for the two- and six-quarter ahead expectations and show similar results. The output and price level differences turn out to be somewhat more pronounced for the four- and six-quarter horizons than for the two-quarter horizon. This is probably due to the fact that for very short expectation horizons, the expectation shock becomes more and more similar to a shock to the current rate.[14]

4 | ROBUSTNESS CHECKS AND INVESTIGATION OF POSSIBLE CAUSES FOR CROSS-COUNTRY DIFFERENCES

As a robustness check, we extend the benchmark model for an expectation horizon of four years by adding the Euro–U.S. dollar exchange rate, the excess bond premium measured by the spread between corporate and government bonds from Gilchrist and Mojon (2018), and the 2-year government bond yield for the euro area.[15] We impose the sign restrictions that both the standard monetary policy shock as well as the shock to interest–rate expectations cause a depreciation of the Euro against the U.S. dollar, a decline in the excess bond premium, and a decline in the 2-year government bond yield. We then repeat the analysis of the cross-country differences from Section 3.2 and of the differences in the impulse responses to the two shocks from Section 3.3. The results are shown in the online appendix (Figures S.12–S.14) and are in line with the results for our baseline specification.[16]

Our results in Section 3.2 show that shocks to interest rate expectations affect output more strongly in Germany than in other countries. What might be the explanation for these cross-country differences? In Mandler et al. (2022), we present evidence of conventional monetary policy shocks having stronger effects on output in Germany than in the other three countries. We discuss possible structural explanations for regional differences in the effects of monetary policy offered in the literature

[13]Since we only impose a sign restriction on impact, it is possible for the cumulated impulse response to a negative shock to be positive (if the 5-year bond yield's response turns sufficiently positive when the sign restriction does no longer apply). We have to discard these draws as a normalization to a −50 bp negative cumulated impulse response would require "flipping" the sign of the shocks from expansionary to contractionary. This requirement is equivalent to additional sign restrictions on the cumulated sum of the impulse responses. Thus, we only retain those draws, for which the cumulated impulse response of the bond yield to both shocks is negative. This analysis, therefore, uses only a subset of the draws used by the analyses in the previous sections. Figure S.10 in the appendix shows the results we obtain if we normalize only on the shocks' impact effect on the 5-year bond yield. Since this is always negative, because of the sign restriction, we retain the full set of draws. The results for this exercise are very similar to those in the main text, indicating that the additional restriction implied by the normalization over eight quarters does not have marked effects on the results.

[14]The appendix also shows results for a normalization on the cumulated impulse function of the bond yield over 24 quarters (Figure S.9). Figure S.11 shows results from the comparison of a −10 bp shock to the 3 M interest rate to a −10 bp shock to interest-rate expectations, that is, from making the shocks identical in size. Again, the results turn out to be very similar.

[15]This is the yield on a 2-year benchmark government bond provided by the ECB.

[16]The estimation of the extended model yields only very few stable draws for the reduced form coefficients. We modify the estimation approach described in Section 2.1 by no longer optimizing over the hyperparameters ψ_i of the prior for the covariance matrix but setting them based on residual variance from individual AR(1) regressions for each equation. Re-estimating our baseline model using this modification shows that the small differences in the results of the extended model compared to our baseline results can be mostly attributed to this change.

TABLE 2 Model variants.

Model variant	Added country-specific variables	Sign restriction
(i)	2Y bond yield	−
(ii)	Excess bond premium	−
(iii)	Bank loans to nonfinancial corporations	+
	Bank lending rate to nonfinancial corporations	−
(iv)	Investment	+

Note: Sign restrictions in addition to those from Table 1; imposed on impact and on GDP-weighted cross-country averages; sign restrictions apply to both the conventional monetary policy shock and the anticipated interest rate shock. Both shocks are separated by the restrictions in Table 1.

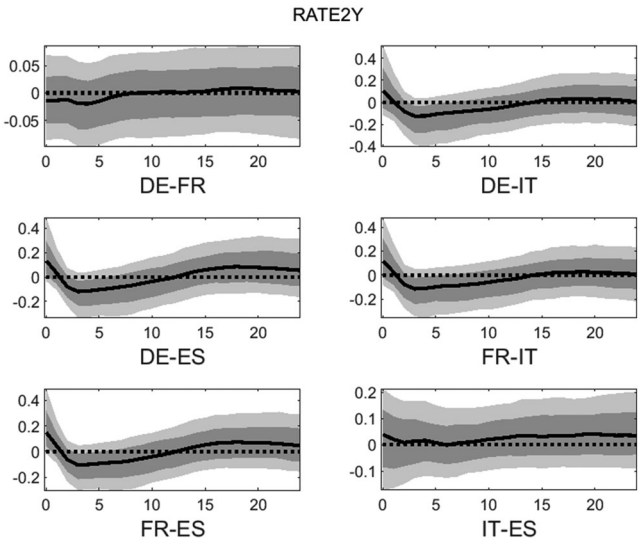


FIGURE 4 Cross-country differences of impulse response to a -10 bp shock to four-quarter ahead expectation of the 3 M interest rate—model with 2-year government bond yields—(percentage points, median, and 25th, 33rd, 66th, and 75th percentiles of posterior distribution).

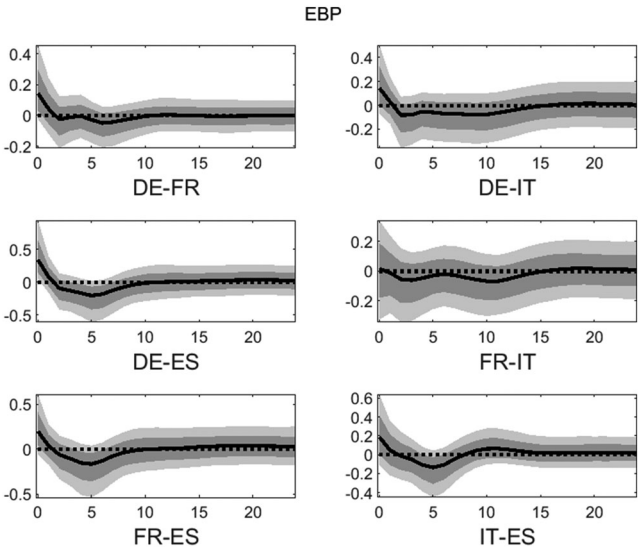


FIGURE 5 Cross-country differences of impulse response to a −10 bp shock to four-quarter ahead expectation of the 3 M interest rate—model with excess bond premium—(percentage points, median, and 25th, 33rd, 66th, and 75th percentiles of posterior distribution).

and provide some evidence of which structural differences might explain this result. We find that a stronger effect of monetary policy shocks on output in Germany is consistent with a higher manufacturing share in Germany and stronger competition in the banking sector, enhancing the interest rate channel of monetary policy. Other possible explanations are a higher export share, which might strengthen the exchange rate channel, and a more flexible labor market.

In this paper, we complement this analysis by investigating some possible transmission mechanisms that might lie behind the cross-country differences. For this, we repeat our empirical analysis across a range of extended versions of our baseline model, which uses the four-quarter ahead expectations. More specifically, we augment the baseline model from Section 2 by the Euro-U.S. dollar exchange rate and by a set of country-specific variables, namely, (i) each country's 2-year government bond yields, (ii) excess bond premia,[17] (iii) bank loans to nonfinancial corporations and the corresponding lending rates, and (iv) investment. Adding all these 21 variables simultaneously would make our model too large and result in excessively wide uncertainty bands. Therefore, we estimate four different extended models (see Table 2). Our identification uses the sign restrictions given in Table 1 and adds the sign restriction(s) shown in Table 2 for the additional variables. The additional sign restrictions are imposed on the GDP-weighted cross-country averages of the impulse responses, as we have done for real GDP and the HICP in our baseline model.

For each of the variant models, we repeat the analysis from Section 3.2. The results for the cross-country differences in the effects of shocks to interest rate expectations on output and prices are almost identical to those shown in Figure 2.[18] Figures 4–7 present the results for the cross-country differences of the effects on the

[17]The source for these is Gilchrist and Mojon (2018).

[17]The source for these is Gilchrist and Mojon (2018).

[18]These results are available upon request.

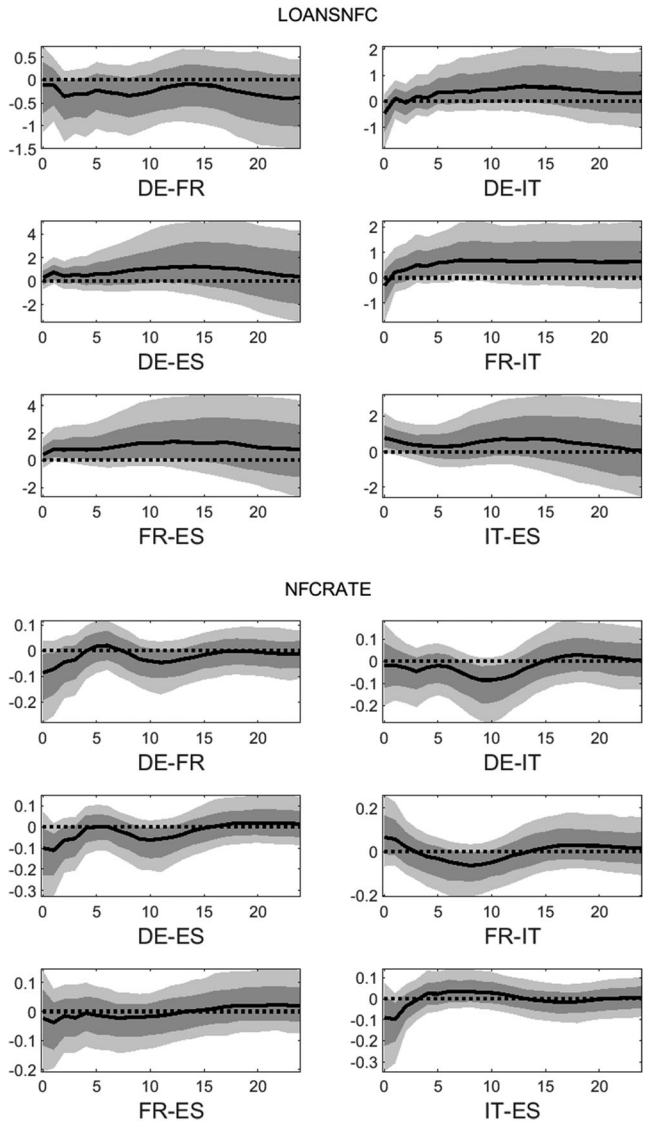


FIGURE 6 Cross-country differences of impulse response to a −10 bp shock to four-quarter ahead expectation of the 3 M interest rate—model with loans and lending rates—(percentage points, median, and 25th, 33rd, 66th, and 75th percentiles of posterior distribution).

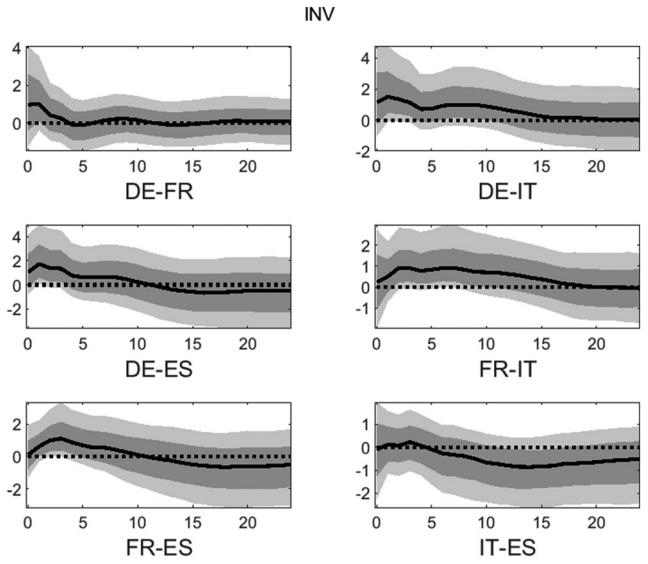


FIGURE 7 Cross-country differences of impulse response to a −10 bp shock to four-quarter ahead expectation of the 3 M interest rate—model with investment—(percentage points, median, and 25th, 33rd, 66th, and 75th percentiles of posterior distribution).

additional variables, which can provide some insights into possible causes for the differences in the output effects.

Figures 4 and 5 show that the 2-year bond yield and the excess bond premium decrease more on impact in ES and IT than in DE. After about two quarters, the pattern reverses and the results show a negative difference, that is, a stronger decline in DE than in ES and IT, which persists for about 1 year. Figure 6 also shows that the bank lending rate declines more strongly in DE than in other countries (negative difference). All these results are consistent with a stronger reduction in financing costs in Germany following a change in interest rate expectations, which suggests a stronger interest rate channel. Furthermore, Figure 6 also indicates that bank lending to firms expands more in DE (positive difference after a delay) than in IT and ES with the strongest increase showing in FR. Similar to the other results this points to a more beneficial effect of the shock on financing conditions in the German economy than in IT and ES. The results for investment in Figure 7 indicate a stronger expansion in investment in DE (and FR) than in IT and ES.

Overall, this evidence is consistent with a decline in expected short-term interest rates being more expansionary in DE than in IT and ES because of a more pronounced easing of financing conditions (financing costs, in particular bank lending rates, and lending volume) which results in a stronger expansion in investment. Of course, our investigation focuses on a few selected mechanisms and does not rule out that additional channels contribute to the cross-country differences in the responses to the shock.

5 | DISCUSSION AND CONCLUSIONS

We provide a cross-country comparison of the macroeconomic effects of shocks to expectations about future short-term interest rates. We separate shocks to expected short-term interest rates, that is, to expectations about future monetary policy, from conventional or standard

monetary policy shocks by assuming that the expectations shock does not affect current short-term interest rates. We assume that expansionary shocks of both types raise output and prices on average across countries. However, we do not impose the restriction that these variables increase in each country. Our evidence shows that an exogenous decline in expected euro area short-term interest rates leads to an increase in consumer prices and output in Germany and France. The median effects of the shock on output and prices in Italy and Spain are positive, as well, but the uncertainty bands for the results for Spain are relatively wide.

Following our identification assumptions, the conventional monetary policy shock moves the current interest rate but affects interest rate expectations, as well. The interest rate expectation shock, in contrast, does not affect the current short-term policy rate. This distinction is similar to the separation of "target shocks" and "path shocks" in Gürkaynak et al. (2005): Their "target shocks" affect both the current and the future expected federal funds rate, whereas "path shocks" do not affect the current federal funds rate. The path factor contains revisions in interest rate expectations representing exogenous changes to future monetary policy as well as changes to future monetary policy due to a reassessment of the future state of the economy. Since our identification restrictions require a negative shock to anticipated interest rates to have expansionary effects on output and prices, we rule out the second type of path shocks.

Forward guidance about future monetary policy is not modeled consistently in the literature. Concerning structural (DSGE) models, our interpretation of forward guidance shocks as shocks to anticipated future interest rates corresponds to that in, for example, Del Negro et al. (2015). Their forward guidance shock lowers the expected policy rate at a specific future date but until this point in time is reached the actual policy rate is allowed to respond endogenously to the fluctuations caused by the announcement, that is, the actual policy rate does not remain fixed. By contrast, in other analyses, for example, Levin et al. (2010) or McKay et al. (2016), interest rate expectations decline following the announcement, whereas the current policy rate remains on the same path as was originally expected until the date referred to in the announcement occurs.

We compare the effects of shocks to interest rate expectations across different expectation horizons and find no evidence of a "forward guidance puzzle" that occurs in structural (DSGE) models. In our empirical analysis, the effects on output and inflation do not increase if the shock applies to interest rate expectations further in the future. However, the limited expectation horizons provided by the consensus forecasts restrict our analysis to a few, relatively short expectation horizons (two, four, and six quarters). Comparing the effects of a shock to interest rate expectations to a shock to the current policy rate, we estimate the expectations shock to have stronger effects on output and prices than the unexpected change in the actual short-term interest rate in DE and FR.

Our multicountry model enables us to compare the effects of shocks to interest rate expectations across countries. We find these shocks to have stronger effects on output and prices in Germany than in France, Italy, and Spain, that is, the German economy is more strongly affected by shocks to expected short-term interest rates. The results from augmenting our model by additional country-specific variables point to a more pronounced easing of financial conditions in Germany and a stronger increase in investment after the shock.

Our results suggest that the centralized monetary policy in the euro area influences the euro area countries differently. As a consequence, the costs and benefits of economic stabilization could also be asymmetric between countries. However, a thorough investigation of the policy implications of the heterogeneous effects of monetary policy in a currency union also has to take into account differences in costs and benefits from monetary policy stabilization that result from countries being affected differently by other shocks, unrelated to monetary policy.[19] Furthermore, regional differences in the effects of monetary policy are not surprising, given different structural characteristics across regions. Potentially, increased economic integration could reduce some of these differences over time.[20]

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[19]The VAR literature shows monetary policy shocks as only a minor source of macroeconomic fluctuations.

[20]For example, increasing financial integration could reduce the differential impact of monetary policy on the financing conditions of the nonfinancial sector.

DATA AVAILABILITY STATEMENT

The data on survey expectations that support the findings of this study can be obtained under license from Consensus Economics. The other data are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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