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Matthias Neuenkirch

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Coordination: Bernd Hayo • Philipps-University Marburg
Faculty of Business Administration and Economics • Universitätsstraße 24, D-35032 Marburg
Tel: +49-6421-2823091, Fax: +49-6421-2823088, e-mail: hayo@wiwi.uni-marburg.de

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Matthias Neuenkirch

RWTH Aachen University and Philipps-University Marburg

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Corresponding author:

Matthias Neuenkirch
School of Business and Economics
RWTH Aachen University
D-52062 Aachen
Germany
Tel.: +49 - (0)241 - 80 - 96203
Fax: +49 - (0)241 - 80 - 693931
Email: matthias.neuenkirch@rwth-aachen.de

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Monetary Policy Transmission in Vector Autoregressions: A New Approach Using Central Bank Communication

Abstract

In this paper, we study the role played by central bank communication in monetary policy transmission. We employ the Swiss Economic Institute's Monetary Policy Communicator to measure the future stance of the European Central Bank's monetary policy. Our results indicate, first, that communication has an influence on inflation (expectations) similar to that of actual target rate changes. Communication also plays a noticeable role in the transmission of monetary policy to output. Consequently, future work on monetary policy transmission should incorporate both a short-term interest rate and a communication indicator. A second finding is that the monetary policy transmission mechanism changed during the financial crisis as the overall effect of monetary policy on (expected) inflation and output is weaker and of shorter duration during this period compared to the overall sample period.

Keywords: Central Bank Communication, European Central Bank, Monetary Policy Shocks, Monetary Policy Transmission, Vector Autoregression

JEL: E52, E58

1. Introduction

Ever since Sims's seminal paper (1980), monetary policy transmission typically has been studied using a vector autoregression (VAR) approach. In general, contractive monetary policy is found to decrease output and price level, with a maximum impact occurring after a time lag of 12–24 months (see, e.g., literature surveys by Leeper et al., 1996; Christiano et al., 1999). Several indicators of monetary policy stance have been tested over the past three decades: a monetary aggregate (Sims, 1980), an indicator based on minutes from meetings of the Federal Open Market Committee (Romer and Romer, 1989), non-borrowed reserves at the central bank (Eichenbaum, 1992), a surprise measure based on Federal funds futures (Faust et al., 2004), and the short-term interest rate (Sims, 1992), which is currently the most widely accepted single indicator (Bernanke and Blinder, 1992).

Over the past 15 years, *central bank communication* has evolved as an important tool for central bankers. By providing regular information about its economic outlook and the future stance of monetary policy, a central bank can influence the interest rate expectations of forward-looking agents before the interest rate actually changes.[1] As a consequence, there are fewer *unexpected* changes in monetary policy (Blinder et al., 2008) and studying actual interest rate shocks could thus result in a less than complete picture of the monetary transmission mechanism. Specifically, VAR models that neglect the role of communication may overestimate the effect of actual interest rate changes.

To date, however, the importance of central bank communication in the context of monetary policy transmission mechanisms has not been studied empirically,[2] even though analyzing the dynamics of the short-term interest rate, output, and inflation after (gradual) changes in communication could prove insightful. This paper fills this gap in the literature and employs the Swiss Economic Institute's (KOF) Monetary Policy Communicator (MPC) as an additional variable for measuring communication about the future course of European Central Bank (ECB) monetary policy. This indicator covers forward-looking information about risks to price stability as revealed in the ECB president's statement after each interest rate decision (KOF, 2007) and provides a quantitative assessment of the ECB's expected future interest rate plans. The indicator might explain transmission processes *prior to* actual interest rate movements.

[1] Theoretically, central bank communication matters (i) in the absence of a stationary economy or monetary policy rule or (ii) in the presence of non-rational expectations (Blinder et al., 2008).
[2] Note that Romer and Romer (1989) use central bank communication (minutes) to identify exogenous shocks in monetary policy. However, it is not clear why central bank communication should be treated as exogenous from macroeconomic developments or the short-term interest rate (Bernanke and Mihov, 1998). Therefore, this paper treats communication via post-meeting statements as an additional endogenous variable.

Our sample period begins with the inception of the ECB in January 1999 and ends in December 2012 (168 monthly observations). Econometrically, we use VAR models to address the following research question: Does central bank communication play any role in the transmission of ECB monetary policy to inflation expectations, actual inflation, and output? Our prior is that communication fosters anticipation of future interest rate changes and is thus an important policy tool in monetary policy transmission. Since our sample covers the recent financial crisis we are also able to test whether the monetary policy transmission mechanism was different during that time span compared to the overall sample period.

The reminder of the paper is organized as follows. Section 2 introduces the dataset. Section 3 describes the econometric methodology. Section 4 discusses the empirical results. Section 5 concludes.

2. Data

We utilize two variables to measure monetary policy stance. In addition to the ECB's main refinancing rate (MRR), [3] we employ the KOF MPC. This indicator is based on a quantification of statements made by the ECB president at monthly press conferences.[4] As the ECB's primary objective is to maintain price stability over the medium term, the indicator is based on statements revealing the Governing Council's assessment of developments that directly affect future price stability. It is constructed by balancing statements implying either (i) upside risks or (ii) downside risks to price stability against all statements on the topic of future price stability (KOF, 2007).[5] Therefore, changes in this indicator can be interpreted as changes in the ECB's inflation expectations. Conrad and Lamla (2010) use the KOF MPC to show that the EUR/USD exchange rate responds to ECB communication. Sturm and de Haan (2011) find this indicator useful in predicting the ECB's next policy decision—even when the interbank rate is included in a Taylor (1993) rule model. Thus, the indicator appropriately captures ECB communication and is of relevance to financial agents.

Figure 1 plots the MRR and the KOF MPC. Although the KOF MPC anticipates changes in the future target by two to three months (KOF, 2007), the correlation to the MRR

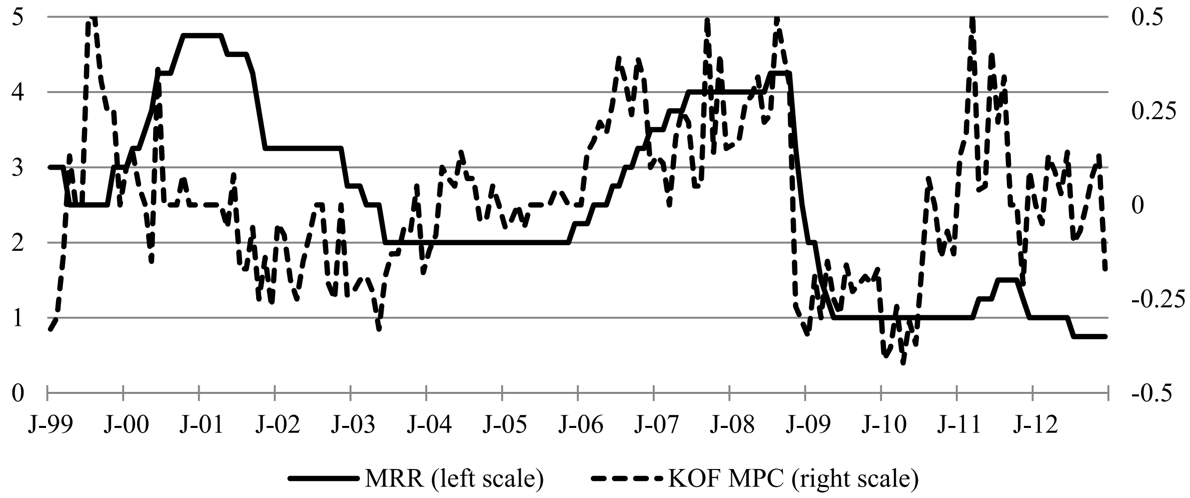
[3] Note that most of the literature employs a three-month interest rate as an indicator of monetary policy stance. This choice is based on the assumption that the central bank has direct influence on interest rates beyond its target rate. However, there is sometimes a remarkable gap between the 3-Month Euro Interbank Offered Rate (Euribor) and the ECB's MRR, particularly during the recent financial crisis. Consequently, we choose the MRR as an indicator of monetary policy stance and use the 3-Month Euribor only for robustness tests. In general, use of the 3-Month Euribor supports our conclusions regarding the role of communication. The reaction of all three variables to shocks in the KOF MPC is larger compared to when the MRR is employed. All omitted results are available on request.

[4] Coding of the statements was done by Media Tenor, a media research institute (http://www.mediatenor.de).

[5] Further information on the KOF MPC can be found at: http://www.kof.ethz.ch/en/indicators/monetary-policy-communicator.

is only 0.28 over our sample period. Communication does capture information about monetary policy beyond the MRR and, as a consequence, by including ECB communication in our model, we may gain further insight into monetary policy transmission.

Figure 1: MRR and KOF MPC



Source: ECB and KOF.

3. Econometric Methodology

3.1. Benchmark Specification Without Central Bank Communication

Econometrically, we employ a VAR model introduced by Sims (1980). In the benchmark case without central bank communication, we estimate the five-variable model,

$$(1)\ y_t = \sum_{i=1}^{k} \alpha_i\, y_{t-i} + \mu_t,$$

where y_t is a 5×1 vector of endogenous variables containing the industrial production index (IP, in logs), the harmonized index of consumer prices inflation rate, the monetary aggregate M3 (in logs), and the MRR.[6] Given the emphasis the ECB puts on expectations in the transmission of monetary policy to real macroeconomic variables, we include the 12-month-ahead expected inflation rate provided by *The Economist* poll of forecasters in addition to these standard variables.[7]

[6] Data source: ECB. As part of our robustness tests, we considered other variables in the VAR setup: EUR/USD exchange rate, euro nominal effective exchange rate, U.S. short-term interest rate, and price indicators for commodities, housing, and oil. The results presented in Section 4 are robust to the inclusion of these variables. To optimize the degrees of freedom in our estimations, we retain the parsimonious specification. All omitted results are available on request.

[7] The ECB provides a schematic illustration of its view of monetary policy transmission at: http://www.ecb.europa.eu/mopo/intro/transmission/html/index.en.html.

All variables enter the system as level variables (Sims and Uhlig, 1991). The number of lags is determined by a battery of lag-length selection criteria (sequential modified likelihood ratio test statistic, final prediction error, Akaike information criterion, Schwarz information criterion, and Hannan-Quinn information criterion). These criteria indicate that three lags (at most) are appropriate to capture the dynamics in the *benchmark* VAR. The same lag structure is found appropriate for all *augmented* specifications, too.

To study the dynamic impact of monetary policy on inflation and output, we simulate their reaction to shocks in the short-term interest rate. These impulse response functions are obtained using the Cholesky decomposition. The underlying assumption is that monetary policy shocks affect inflation expectations immediately, whereas there is no contemporaneous impact on output, inflation, and money. Accordingly, the Cholesky ordering in the benchmark model is as follows: IP, inflation, M3, MRR, and inflation expectations.

3.2. Augmented Specification Including Central Bank Communication

In a second step, we add the KOF MPC to the vector of endogenous variables to test its influence on the monetary policy transmission process. We simulate the reaction of inflation and output to shocks in the MRR and the KOF MPC. The underlying assumption for the Cholesky ordering in this six-variable VAR is that the ECB decides on the tone of its statement taking the interest rate decision as given, i.e., the MRR has a contemporaneous effect on the KOF MPC but the latter affects the MRR only after a time lag. This is in line with Sturm and de Haan (2011), who find that the ECB systematically uses communication to prepare for *upcoming* interest rate decisions. Both variables, the MRR and the KOF MPC, affect inflation expectations immediately, but have an influence on output, inflation, and money only after a time lag. Thus, the Cholesky ordering in the augmented case is as follows: IP, inflation, M3, MRR, KOF MPC, and inflation expectations.

3.3. Augmented Specification—Financial Crisis Subsample

Since our sample covers the recent financial crisis, we also explore whether and, if so, to what extent, the crisis influenced the monetary transmission mechanism. We chose October 2008 as the starting point for the financial crisis subsample as the coordinated interest rate cut on October 8, 2008 was the first clear indication that the financial crisis was affecting the ECB's interest rate policy. Before that date, the ECB had been continuing its gradual tightening

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Note that other inflation forecasts, for instance, the ECB's staff macroeconomic projections and ECB's Survey of Professional Forecasters are available at quarterly frequency only. Monthly CPI inflation forecasts by Consensus Economics (since December 2002) are not are available for the full sample period.

policy even though several other central banks, for instance the U.S. Federal Reserve, began reducing interest rates right after the beginning of the money market crisis in August 2007. Hence, we estimate a separate six-variable VAR model for the period October 2008–December 2012 and compare the impulse responses to those obtained for the full sample period.

3.4. Augmented Specification—Alternative Identification Scheme

Finally, we explore the robustness of the Cholesky identification scheme as outlined in Section 3.2. We use financial market expectations to create an alternative indicator for interest rate shocks. Reuters conducts a poll of financial experts one week before each meeting of the Governing Council. We use the median expected MRR from this survey and create an indicator for MRR surprises by deducting it from the actual MRR announcement. Then, we add this indicator as exogenous variable in the six-variable VAR and study the impact of actual interest rate surprises (at least as perceived by financial experts) compared to those of shocks identified by means of the empirical model.

This conservative measure for interest rate shocks reveals that only 12 interest rate decisions came as a surprise to financial experts. Consequently, we expect inflation and output to have a more pronounced reaction in comparison to the Cholesky identification. Put differently, these impulse responses could be interpreted as an “upper bound” of the possible effect of “true” interest rate surprises. Unfortunately, this type of analysis is restricted to interest rate decisions since there are no financial expert expectations concerning the upcoming ECB statement.

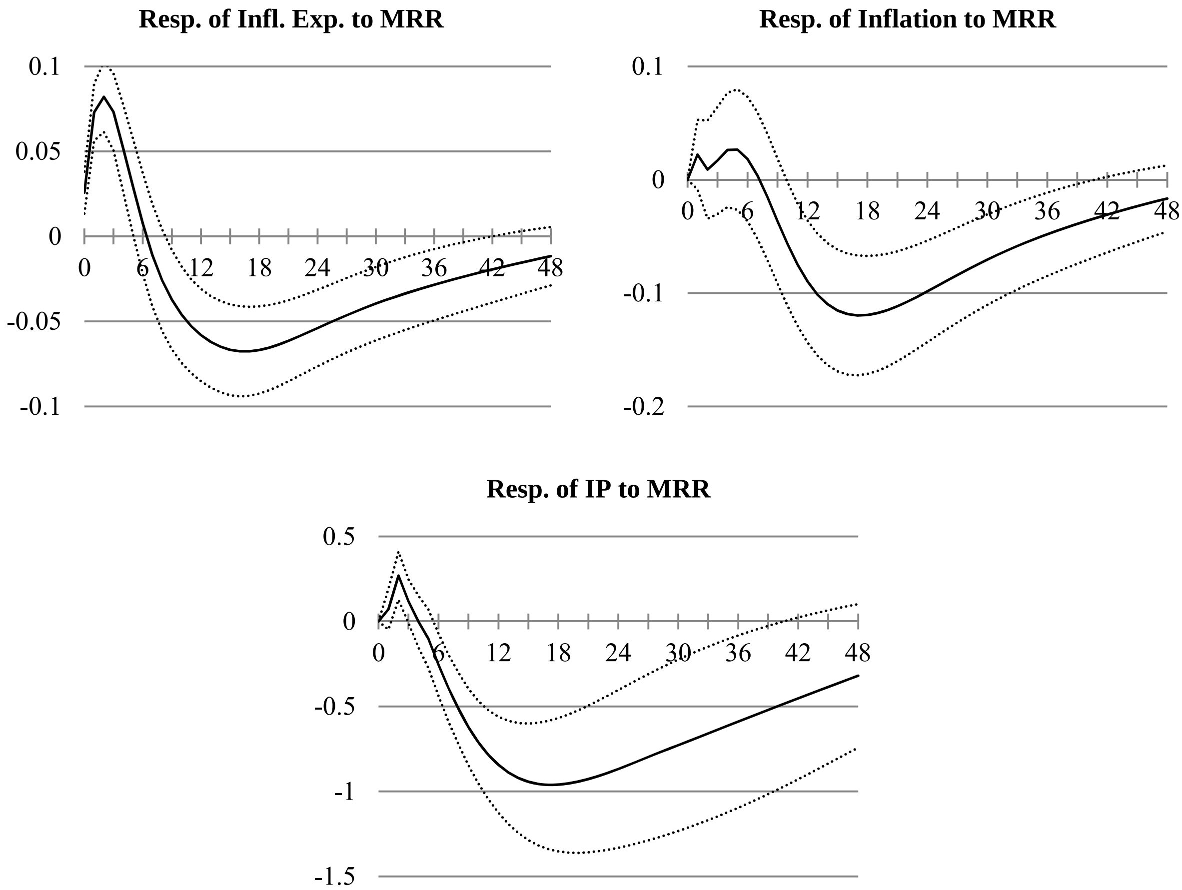
4. Results

4.1. Benchmark Specification Without Central Bank Communication

Figure 2 shows the impulse responses for the benchmark model that includes the MRR but no central bank communication variable. Error bands show one standard error (SE) deviations in each direction.

A 25 basis points (bps) shock in the MRR initially leads to an increase in inflation expectations. Arguably, agents interpret an unexpected increase in the MRR as a consequence of the ECB’s attempt to address an unforeseen threat to price stability and revise their expectations about future inflation upward for five months. However, there is a significant and lasting decrease in inflation expectations after nine months, which reaches its maximum of 7 bps after 17 months. A decrease in actual inflation can be observed after 10 months, with a maximum impact of 12 bps after 17 months. The fact that actual inflation reacts more strongly than inflation expectations indicates that the latter are well anchored in the euro area. Industrial production is affected similarly. After six months, output decreases significantly; the maximum drop of 96 bps after a 25 bps shock occurs after 17 months.

Figure 2: Benchmark Specification—Impulse Responses



Note: The figure shows selected impulse responses to a 25 bps innovation in the MRR. Cholesky decomposition is based on the ordering: IP, inflation, M3, MRR, and inflation expectations. Error bands are one standard error deviations. Full set of impulse responses is available on request.

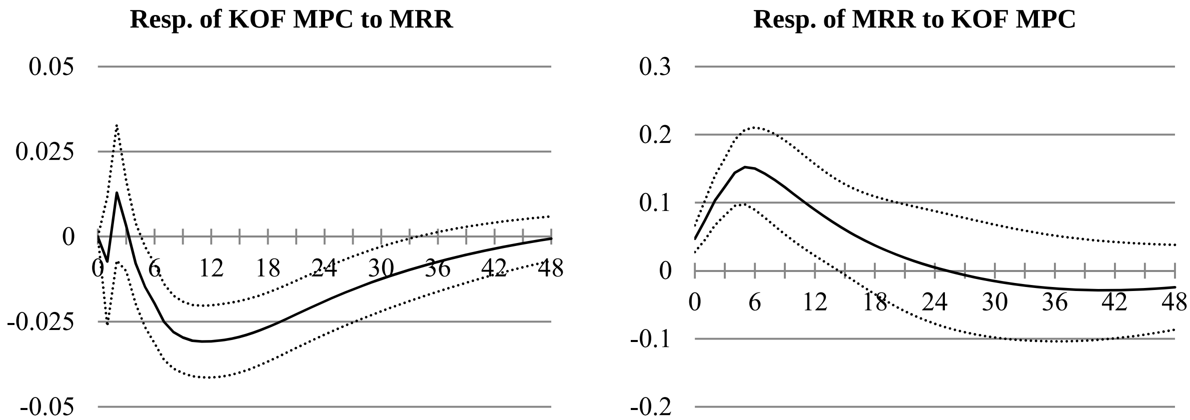
Concerning the monetary transmission process, it appears that the impulse responses shown in Figure 2 have dynamics similar to those obtained by Peersman and Smets (PS hereafter) (2003, 39). First, it takes a certain amount of time before monetary policy shocks affect inflation, but the impact is long-lasting: the coefficients continue to be significant for as long as 40 months (our paper) or 15 quarters (PS). Second, after a brief increase in output in response to a monetary policy shock, there occurs a sharp decrease that reaches its peak after 17 months (our paper) or after three to five quarters (PS).[8]

[8] A word of caution is required regarding the comparison between our results and those of PS. First, PS employ aggregate national macroeconomic data for the period 1980–1998, whereas our sample starts after the inception of the euro in 1999 and relies on actual euro area data. Second, PS use the price level rather than the inflation

4.2. Augmented Specification Including Central Bank Communication

In a next step, we examine whether central bank communication plays any role in the transmission of ECB monetary policy. We add the KOF MPC to the benchmark model and, first, explore the joint dynamics of both monetary policy indicators. Figure 3 shows the impulse responses for the MRR and KOF MPC after a 25 bps shock in the MRR and an *equivalent* shock in the KOF MPC.[9]

Figure 3: Augmented Specification—Joint Dynamics of MRR and KOF MPC



Note: The figure shows selected impulse responses to a 25 bps innovation in the MRR and an equivalent innovation in the KOF MPC. Cholesky decomposition is based on the ordering: IP, inflation, M3, MRR, KOF MPC, and inflation expectations. Error bands are one standard error deviations. Full set of impulse responses is available on request.

A 25 bps equivalent shock in the KOF MPC leads to a significant increase in the MRR, with a maximum impact of 15 bps after five months. Changes foreshadowed in communications precede actual changes in the short-term interest rate by about 14 months, which implies that the ECB systematically uses communication to prepare economic agents for its upcoming interest rate policy. In contrast, a shock in the MRR, i.e., an unexpected change in monetary policy, has no significant impact on communication during the first four months. However, after instituting an interest hike for which it provided no preparation, the ECB corrects its communication about future monetary policy significantly downward after five months.

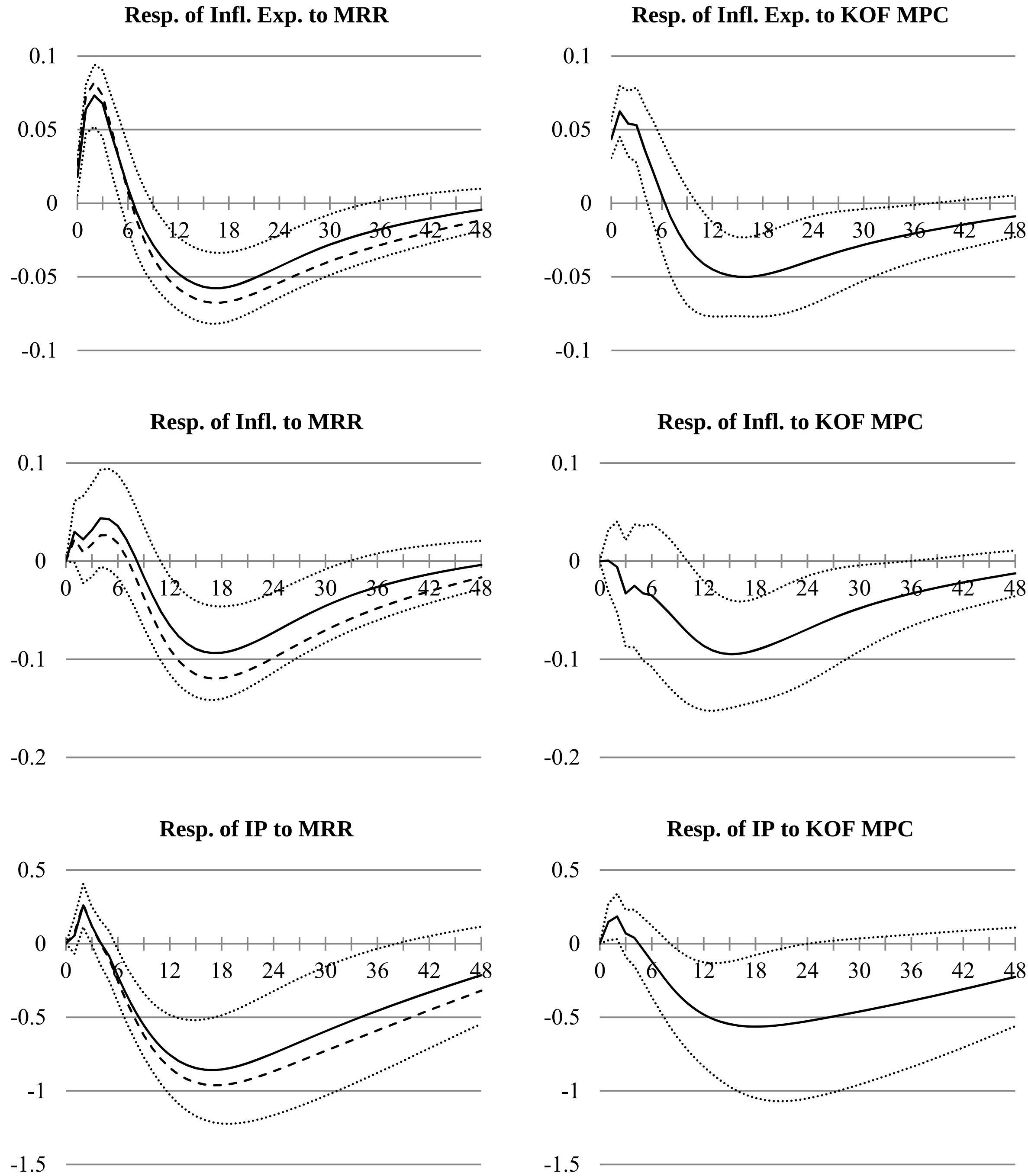
Next, we analyze how inflation expectations, actual inflation, and output react to both monetary policy indicators. The impulse responses are shown in Figure 4. To facilitate a

rate, which leads to longer-lasting impulse responses of prices. Our results are also in line with other studies from the early years of the European Monetary Union (see, e.g., van Els et al., 2003; Mojon and Peersman, 2003; Angeloni et al., 2003).

[9] A one standard deviation shock in the MRR equals 12.9 bps. Accordingly, a one standard deviation shock in the KOF MPC is multiplied by 25/12.9 to create the 25 bps equivalent.

comparison with the results from the *benchmark* specification, we also include the impulse responses to MRR shocks from Figure 2 in the left panel of Figure 4 (dashed lines).

Figure 4: Augmented Specification—Impulse Responses



Note: The figure shows selected impulse responses to a 25 bps innovation in the MRR and an equivalent innovation in the KOF MPC. Cholesky decomposition is based on the ordering: IP, inflation, M3, MRR, KOF MPC, and inflation expectations. Error bands are one standard error deviations. Full set of impulse responses is available on request. The dashed lines show the impulse responses to MRR shocks from the *benchmark* specification (Figure 2).

Communication about future monetary policy influences all three variables. Similar to the way expected inflation reacts to shocks in the MRR in the benchmark model, inflation expectations react positively to a shock in ECB communication for the first five months. As the KOF MPC covers forward-looking information about risks to price stability—i.e., the ECB's inflation expectations—a shock in this variable causes agents to upwardly revise their expectations about future inflation for a short horizon. However, there is a significant drop in inflation thereafter. Communication lowers expected inflation and actual inflation after 11 months. The influence on both variables is enduring, with a maximum impact of 5 bps after 16 months (expected inflation) and 9 bps after 15 months (actual inflation), another indication that inflation expectations are well anchored in the euro area.

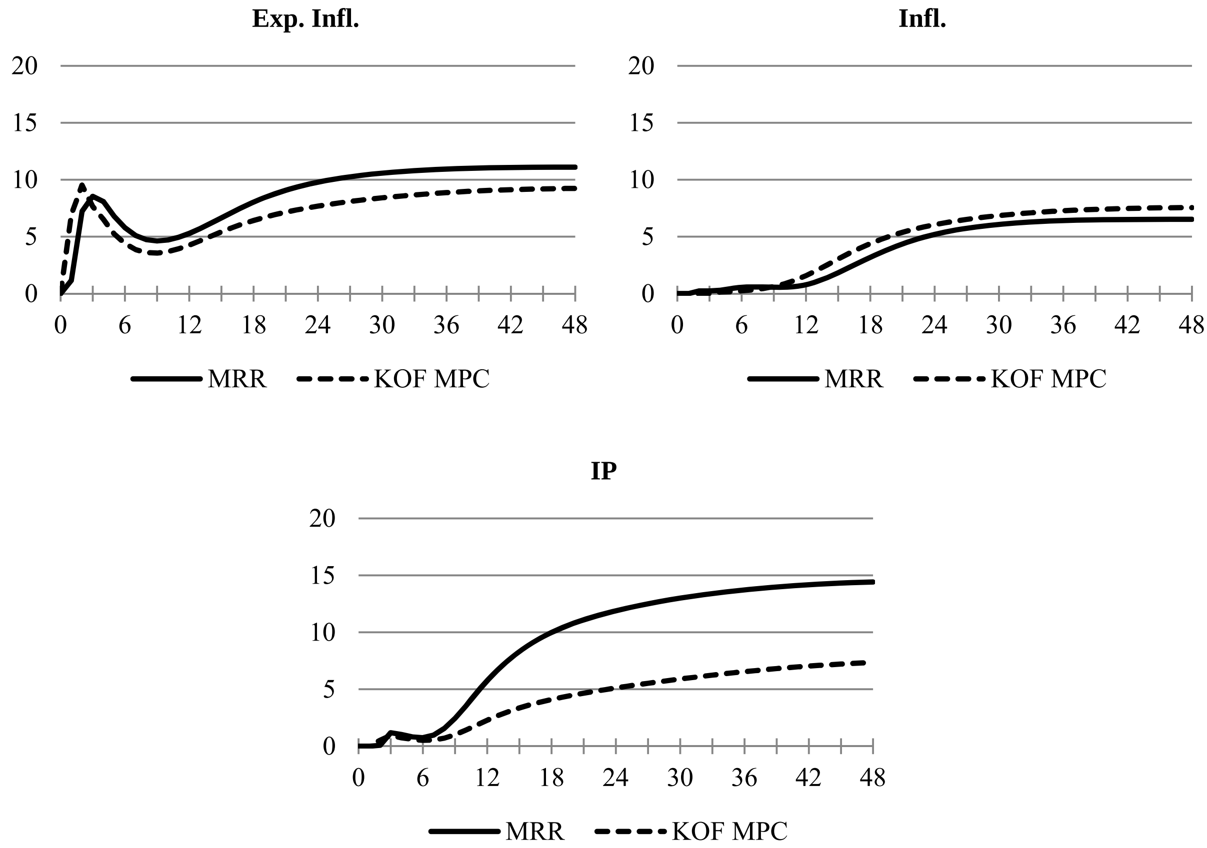
As indicated by the dashed lines in the left panel of Figure 4, communication mildly crowds out the effects of actual monetary policy shocks on inflation in the augmented setup: the influence of the MRR on (expected) inflation becomes significantly negative after (9) 11 months, which is a small increase in the outside lag compared to the baseline specification. Furthermore, the maximum impact of a 25 bps hike in the MRR on inflation expectations (6 bps) and inflation (9 bps) is marginally lower than in a model without central bank communication (7 bps and 12 bps, respectively).

Industrial production takes longer to react to communication than to the MRR (9 months vs. 6 months). The maximum contraction of output is found after 18 (17) months for the KOF MPC (the MRR): its peak is 56 bps for a 25 bps equivalent hike in the case of communication and 86 bps after an actual interest rate surprise hike of 25 bps. Thus, when the analysis of the monetary transmission process takes communication into consideration, output contracts less in response to interest rate shocks compared to the baseline specification (96 bps).

To arrive at a more complete picture of the role communication plays in the monetary transmission process, we decompose the variance of inflation expectations, actual inflations, and IP (see Figure 5).

This exercise adds support to the impression given by Figure 4. Communication explains a slightly higher share of variation in inflation (8 percent) than does the MRR (7 percent). In case of expected inflation, the MRR (11 percent) marginally outperforms the KOF MPC (9 percent) in terms of explanatory power. Finally, the share of explained variation in output is also larger for the MRR (14 percent) compared to the KOF MPC (7 percent). Thus, when it comes to the transmission of monetary policy to inflation, communication is just as important as actual interest rate decisions. Furthermore, it also plays a noticeable role in the transmission of monetary policy to output.

Figure 5: Augmented Specification—Variance Decomposition



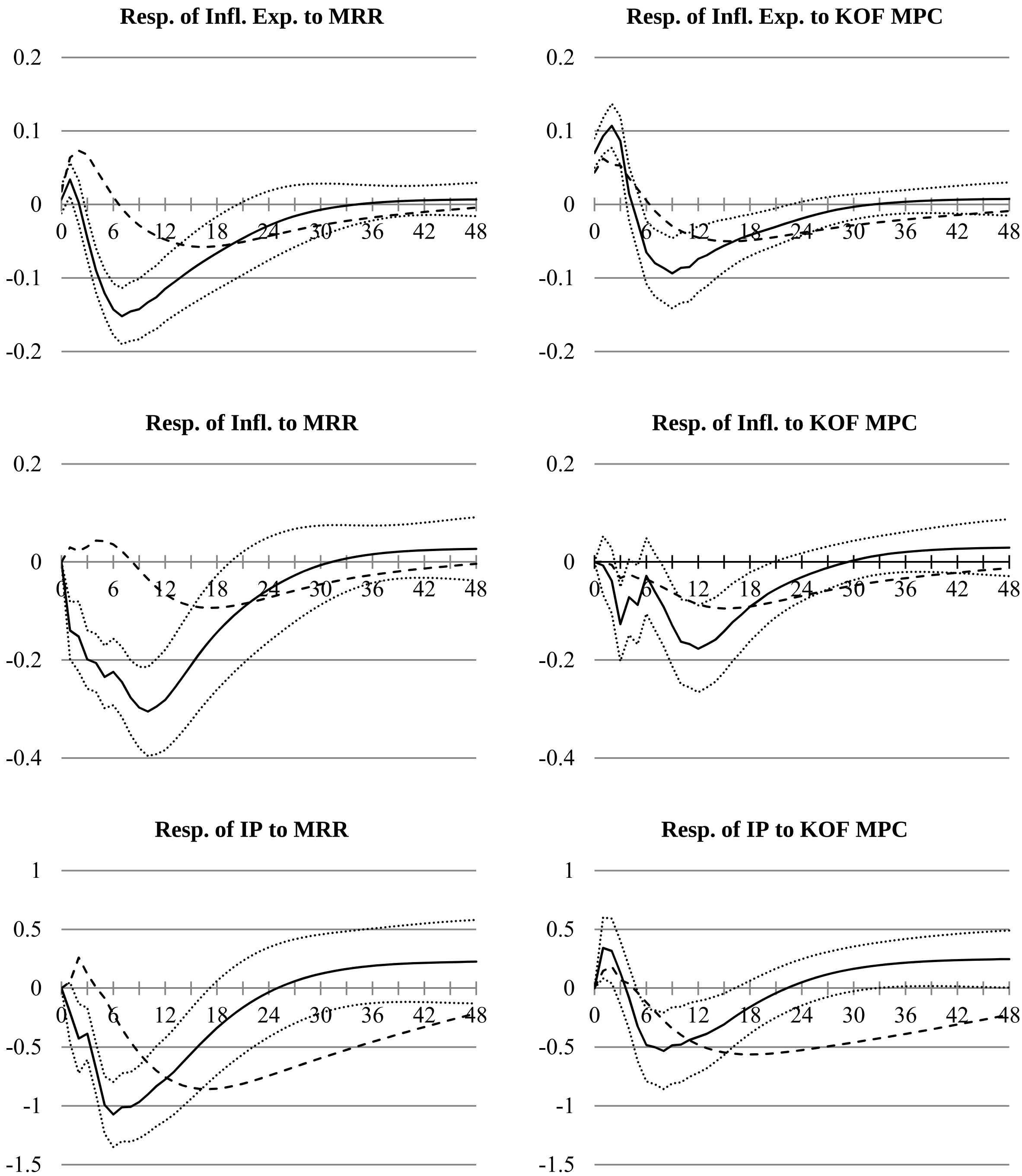
Note: The figure shows the share of variation in inflation expectations, inflation, and IP explained by the MRR and the KOF MPC. Cholesky decomposition is based on the ordering: IP, inflation, M3, MRR, KOF MPC, and inflation expectations.

We conclude that communication improves the management of expectations about future interest rates. Given its importance in the transmission process and its impact on inflation and inflation expectations, we reason that communication improves the efficacy of monetary policy. However, a VAR model using communication as the sole indicator of monetary policy performs much worse than our benchmark model (results not shown). The reaction of (expected) inflation and output has the correct sign, but is not statistically significant. Thus, communication is a complement to, but not a substitute for, the main refinancing rate in the ECB's monetary policy transmission.

4.3. Augmented Specification—Financial Crisis Subsample

Since our sample also covers the recent financial crisis we are able to test whether the monetary policy transmission mechanism changed during that time span compared to the overall sample period. Figure 6 shows impulse responses of a VAR model for the period October 2008–December 2012 and compares them with the ones from Figure 4, which are indicated by a dashed line.

Figure 6: Augmented Specification—Impulse Responses for the Financial Crisis Subsample



Note: The figure shows selected impulse responses to a 25 bps innovation in the MRR and an equivalent innovation in the KOF MPC. Cholesky decomposition is based on the ordering: IP, inflation, M3, MRR, KOF MPC, and inflation expectations. Error bands are one standard error deviations. Full set of impulse responses is available on request. The dashed lines show the impulse responses to MRR and KOF MPC shocks from the *augmented* specification (Figure 4)

Shocks in the MRR and the KOF MPC affect (expected) inflation and output with a shorter outside lag than in the case for the overall sample period. Furthermore, the peak effect of (expected) inflation is stronger than the one shown in Figure 4. More interestingly, the shocks die out faster compared to the overall sample period. For instance, shocks to industrial production become insignificant after 17 months in case of the MRR (compared to 38 months) and 16 months in case of the KOF MPC (compared to 24 months).

This rapid "recovery" indicates than the transmission mechanism is different during the financial crisis. The effect of monetary policy on (expected) inflation and output is less enduring than during normal times.[10] Despite a stronger peak effect during the financial crisis period, the overall effect of monetary policy on (expected) inflation and output is weaker. This is particularly relevant for output, where the cumulative impact after 36 months is almost twice as large during the overall sample period than it is for the financial crisis subsample. In general, this is bad news for the ECB since stimulating the real economy seems to be considerably more difficult during the financial crisis period and, worse, there is not much scope for further stimulus using conventional interest rate policy. However, the results for the financial crisis subsample should be interpreted with some caution since we rely on only 51 observations and the period considered does not include a single interest rate hike.

4.4. Augmented Specification—Alternative Identification Scheme

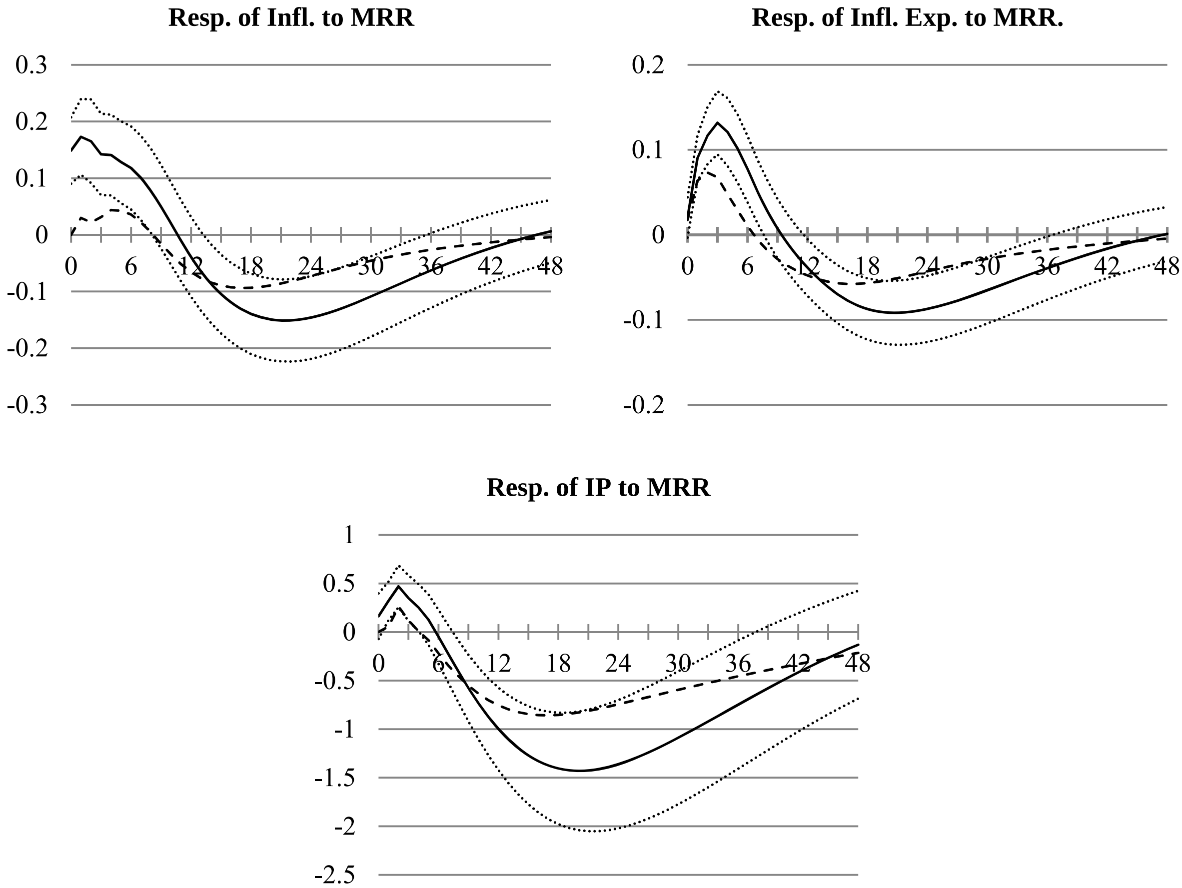
As part of our robustness tests, we use a different identification scheme for the transmission of interest rate shocks to (expected) inflation and output. We use the median MRR surprise based on the Reuters poll one week before each Governing Council meeting, which gives us the reaction to interest rate surprises as perceived by financial experts. The impulse responses are shown in Figure 7. To facilitate a comparison with the results using Cholesky decomposition, we also include the impulse responses to MRR shocks from Figure 4 (dashed lines).

There are two noticeable differences between Figure 7 and Figure 4. First, the peak impact on (expected) inflation and, even more striking, on output is more pronounced than in the case of the Cholesky identification. For instance, a surprise 25 bps hike depresses output by 143 bps after 20 months (in comparison to 86 bps after 17 months). This effect could be interpreted as an "upper bound" on the possible effect of "true" interest rate surprises. Second, a surprise 25 bps hike initially leads to a greater increase in inflation expectations than that

[10] Note that we compare the financial crisis period with the overall sample period, which also contains the financial crisis. Impulse responses for the pre-crisis period support our conclusions since these are even more enduring than for the overall sample period.

shown in Figure 4 and also causes an increase in actual inflation. A truly surprising interest rate hike is an even stronger indication that the ECB is attempting to address an unforeseen threat to price stability compared to the case when the shocks were obtained using Cholesky decomposition. Finally, despite this stronger peak effect, all three shocks die out similarly to the die out shown in Figure 4.

Figure 7: Augmented Specification—Impulse Responses Using Reuters Surprises



Note: The figure shows selected impulse responses to a 25 bps interest rate surprise (obtained using the Reuters poll) in the MRR. Error bands are one standard error deviations. Full set of impulse responses is available on request. The dashed lines show the impulse responses to MRR shocks from the *augmented* specification using Cholesky decomposition (Figure 4).

In general, these stronger reactions compared to the impulse responses in Section 4.2. should not be surprising. Here, we use an identification scheme that relies on events that were actually surprising to financial experts rather than using shocks obtained by means of the empirical model. "True" surprises are rare—only 7 percent of the ECB's interest rate decisions were unexpected—and the shocks identified using Cholesky identification are not necessarily a (complete) surprise to financial markets.

5. Conclusions

In this paper, we use a VAR model to study the influence of central bank communication on monetary policy transmission. We employ the Swiss Economic Institute's Monetary Policy Communicator as a variable (along with the main refinancing rate) to measure the European Central Bank's future monetary policy stance. Our sample covers the period January 1999–December 2012. Our main findings are as follows.

First, communication about future monetary policy influences expected inflation and actual inflation similarly as the actual MRR. Industrial production, however, is more strongly affected by actual interest rate shocks. Communication mildly crowds out the effects of monetary policy shocks; the influence of the MRR is marginally lower and the outside lag slightly longer (in case of actual inflation) in a model that contains central bank communication compared to a benchmark model without it. However, a VAR model using communication as the sole indicator of monetary policy performs much worse than the benchmark model. Thus, communication complements the short-term interest rate in the monetary policy transmission process.

Our results indicate that both inflation expectations and actual inflation react as strongly to shocks in communication about future monetary policy as they do to actual shocks in the target rate. Systematic central bank communication—as engaged in by the ECB—successfully improves the management of expectations about future interest rates. Changes in communication precede changes in the short-term interest rate by about 14 months. Thus, given its importance in the transmission process and its impact on inflation and inflation expectations, we conclude that communication improves the efficacy of monetary policy.

We show that studying monetary policy transmission mechanisms needs to involve more than just analyzing rare shocks in the short-term interest rate. Future work on monetary policy transmission should take note of our findings and employ an indicator for central bank communication. An assessment of Federal Reserve communication in this context would be a fruitful avenue for future research. Facing the zero lower bound of interest rates, the Federal Reserve uses communication to keep expectations of the future target rates low.[11] Employing the traditional short-term interest rate as the single indicator would fail to reveal this "easing" bias.

Second, since our sample covers the recent financial crisis we are able to test whether monetary policy transmission changed during that time span compared to the overall sample period. Despite a stronger peak effect during the financial crisis period, the overall effect of

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[11] *"The Committee … currently anticipates that exceptionally low levels for the federal funds rate are likely to be warranted at least through mid-2015"* (Federal Open Market Committee, 2012).

monetary policy on (expected) inflation and output is weaker during the crisis since it is less enduring than during normal times. In general, this is bad news for the ECB since stimulating the real economy seems to be considerably more difficult during the financial crisis period and, worse, there is not much scope for further stimulus using conventional interest rate policy.[12]

Third, we explore the maximum potential influence of interest rate shocks on (expected) inflation and output using the median MRR surprise based on the Reuters poll conducted one week before each Governing Council. Not surprisingly, the peak impact on (expected) inflation and, in particular, on output is more pronounced than in case of shocks identified by means of the empirical model. However, despite this stronger peak effect, all three shocks die out in a way similar to that observed with the Cholesky identification.

Finally, as mentioned in the introduction, one caveat to the VAR methodology is that it analyzes the reaction of macroeconomic variables to *shocks* and ignores the role of *expected* interest rate changes, which, in reality, account for the overwhelming majority of interest rate decisions. Thus, our findings should be interpreted cautiously as we provide evidence only for the role of unexpected shocks as identified in communication and the interest rate.

[12] Note that the results for the financial crisis subsample should be interpreted with some caution since we rely on only 51 observations and the period considered does not include a single interest rate hike.

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