非伝統的金融政策がマクロ経済変数に与えた影響*

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概 要

This study examines the macroeconomic effects of monetary policy in Japan. We apply the new identification strategy proposed by Bu et al. (2021) to the Japanese case and estimate monetary policy shocks that bridge periods of conventional and unconventional monetary policymaking. We show the macroeconomic effects of monetary policy; a contractionary monetary policy shock significantly decreases output and inflation rates even under the effective lower bound. However, because the shorter-term and longer-term nominal interest rates are already close to zero, the magnitude of monetary policy shocks on the macroeconomic variables is modest.

JEL Classification: E52; E62; G12

Keywords: monetary policy shock; structural VAR; unconventional monetary policy; variance decomposition

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1 Introduction

This study examines the macroeconomic effects of monetary policy in Japan. Identification of monetary policy shocks under the effective lower bound (ELB) has been a central issue among macroeconomic researchers as well as central bankers. The existing literature on unconventional monetary policies mainly examines the magnitude of monetary policies on financial markets. As Kuttner (2018) and Dell'Ariccia et al. (2018) show, a preponderance of evidence suggests that forward guidance and quantitative easing have succeeded in lowering long-term interest rates. D'Amico et al. (2012), Gagnon et al. (2011), and Hamilton and Wu et al. (2012) estimate the effects of quantitative easing (QE) by the Federal Reserve on lower 10-year term premiums. Swanson (2017) uses the data on intra-daily frequencies to separately identify the forward guidance and asset purchase program components, which are conducted by the Federal Reserve. Arai (2017), Eser and Schwaab (2016), Ghysels et al. (2016), and Krishnamurthy (2018) examine the effects of unconventional monetary policies by the Bank of Japan and European Central Bank on government bond yields. Inoue and Rossi (2019) examine the exchange rates of the U.K., Europe, Canada, and Japan and show that tightening monetary policy in a conventional period generally leads to the appreciation of a country's nominal spot exchange rate. There is a consensus among researchers as to the accommodative effects of unconventional monetary policies on financial markets.

However, the existing studies provide scant evidence on the macroeconomic effects of unconventional monetary policies due to difficulty in identifying monetary policy shocks. The few exceptions are Nakamura and Steinsson (2018), Hanisch (2017), Kimura and Nakajima (2016), and Koeda (2019). Nakamura and Steinsson (2018) examine the effect of QE by the Federal Reserve. Although they investigate the macroeconomic effects of QE, their approach is based on financial market measures. Hanisch (2017), Kimura and Nakajima (2016), and Koeda (2019) investigate the impacts of unconventional monetary policy by the Bank of Japan. They show that unconventional monetary policy shock has a significant effect on the output gap, whereas they report mixed evidence as to whether expansionary unconventional monetary policy shock increases inflation rates.

Based on the new and simple approach proposed by Bu et al. (2021), we identify a unified measure of conventional and unconventional monetary policy shocks from daily changes in the term structure of interest rates. While identification strategies in the literature, such as Hanisch (2017), Kimura and Nakajima (2016), and Koeda (2019), depend on the outstanding balance of current accounts held at the Bank of Japan and (or) monetary aggregates, our strategy to identify shocks utilizes information on the term structure of interest rates. Thus, it focuses on the interest rate channel. The reason why we use information on the yield curve instead of monetary aggregates is because the chief transmission mechanism of monetary policy is the interest rate channel, even under the ELB. For example, forward guidance aims to lower longer-term interest rates by promising to keep the future path of shorter-term interest rates at virtually zero for a considerable period of time. Government bond purchase program can push the bond prices higher and lower the longer-term interest rates. The provision of liquidity, via current accounts held by the Bank of Japan, aims to facilitate the flow of funds to firms that face a severe business environment or difficulty in obtaining funding. Because it increases in the excess reserve in a timely manner, the Bank of Japan seeks to avoid the excess volatility in key policy rates to ensure the interest rate channel is functioning well.[1] Inflation goals are another approach to influencing the interest rates. In December 2009, the Bank of Japan clarified medium- to long-term price stability, which is in a positive rage of two percent or lower. Such an announcement can lower (real) interest rates by increasing inflation expectations via the Fisher equation. Because the policies conducted by the Bank of Japan under the ELB as well as during the "conventional" period aim to lower interest rates and to ensure the interest rate channel functions well, our identification strategy for measuring monetary policy shocks utilizes information on the term structure of interest rates.[2]

Using monetary policy shocks, identified from information on the term structure of interest rates, we examine the macroeconomic effects of monetary policy in Japan from

[1]This view is repeated in speeches by the board members. See, for example, Fukui (2005).

[2]Inoue and Rossi (2019) also adopt a similar approach; they utilize information on changes in the yield curve to identify (un)conventional monetary policies, using a functional vector autoregression (VAR) approach.

1999 to 2011. We show the macroeconomic effects of monetary policy; a contractionary monetary policy shock significantly decreases not only output but also inflation rates even under the ELB. The dynamics of output and inflation rates in response to a monetary policy shock conforms to macroeconomic theory. However, the magnitude of the shocks is small because the policy rates are virtually zero. Thus, the macroeconomic effects of monetary policy shocks are statistically significant, but they are modest.

The structure of this paper is as follows. Section 2 shows the strategy for identifying monetary policy shocks. Section 3 explains the structural VAR model we use and shows impulse responses to a monetary policy shock. Section 4 concludes.

2 Identification of monetary policy shocks

Our identification strategy uses the daily change in the term structure of interest rates rather than the change in the size of the central bank's balance sheet. We do not use the excess reserve, which the Bank of Japan targeted as a main policy indicator before March 2006. While the Bank of Japan adjusted the level of excess reserve and purchased the government bonds from 2003 to 2006, the bank's intention seems to have been to enhance the interest rate channel. For example, the bank provided forward guidance, which it called a commitment policy, to lower the longer-term interest rates.[3] Asset purchases in government bonds also aim to lower longer-term interest rates. As for increases in excess reserve in a timely manner, the bank attempts to avoid excess volatility in key policy rates to ensure a well-functioning interest rate channel. Because the bank consistently tries to lower longer-term interest rates and maintain the interest rate channel under the ELB, our strategy for identifying monetary policy shocks uses information on the term structure of interest rates.

Our identification strategy follows Bu et al. (2021). The basic method for identifying

[3] In October 2003, the bank enhanced monetary policy transparency to clarify its intentions regarding the future path of monetary policy.

monetary policy shocks is as follows.[4]

$$\Delta R_{5,t} = \alpha_0 + e_t + \eta_t,$$

where $\Delta R_{5,t}$ is the 1-day change in the policy indicator around the monetary policy announcement at time t — the daily change in the 5-year Japanese government bond yield, α_0, is a constant; e_t is the monetary policy shock; and η_t denotes factors orthogonal to the monetary policy shock.[5] We allow η_t to include idiosyncratic noise specific to the 5-year interest rate as well as noise that is common to the entire yield curve.

We extract monetary policy shocks e_t, using a two-step procedure. First, we estimate the sensitivity of each yield to monetary policy shocks through time-series regressions. We assume that the influences of monetary policy shocks are reflected in the developments of zero coupon yields with maturities of 0.5 to 20 years. Each yield is also influenced by noise orthogonal to monetary policy shocks:

$$\Delta R_{i,t} = \alpha_i + \beta_i e_t + \epsilon_{i,t}, \tag{1}$$

where $\Delta R_{i,t}$ is the change in the zero-coupon yield with i-year maturity and $\epsilon_{i,t}$ is the idiosyncratic noise for $\Delta R_{i,t}$. Equation (1) can be written as:

$$\Delta R_{i,t} = \theta_i + \beta_i \Delta R_{5,t} + \xi_{i,t},$$

where $\xi_{i,t} = -\beta_i \eta_t + \epsilon_{i,t}$ and θ_i is a constant. According to Bu et al. (2021), we use

[4] We use the daily data on zero coupon yields, which are estimated by Kikuchi and Shin-tani (2012). As discussed below, the data from 1999 to 2011 is available. That is why our analysis does not cover the years after 2011.

[5] We think that it is reasonable to assume that the monetary policy shock is identified by decomposing a change in 5-year interest rates rather than 2- and 10-year bond yields during the sample period from 1999 to 2011. First, 2-year bond yields are nearly zero during the QEP period from 2001 to 2006. Because there is little variation in 2-year bond yield during the period, monetary policy shocks are not sufficiently well identified to influence macroeconomic variables. Second, 10-year bond yield may not be a policy target. Before the Bank of Japan introduced "Yield Curve Control" in 2016, it officially announced that central banks can control short-term interest rates but not long-term interest rates at https://www.boj.or.jp/en/announcements/education/oshiete/seisaku/b41.htm/. Because "Long-term interest rates" has conventionally been interpreted as 10-year bond yield, we think that the Bank of Japan does not aim to directly influence 10-year bond yield at least until 2016. This is why we believe that 10-year bond yield is not appropriate for identification of monetary policy shocks.

instrumental variables to estimate unbiased β_i;

$$[\Delta R_{i,t}] = \alpha_i + \beta_i[\Delta R_{5,t}] + \mu_{i,t}, \tag{2}$$

where $[\Delta R_{i,t}] = (\Delta R_{i,t}, \Delta R^*_{i,t})$ and $[\Delta R_{5,t}] = (\Delta R_{5,t}, \Delta R^*_{5,t})$. $\Delta R_{5,t}$ and $\Delta R^*_{5,t}$ are, respectively, the 1-day movement in the policy indicator around a policy announcement by the Bank of Japan and the same event window one week before the announcement day. We exploit the fact that β_i can be estimated by an instrumental variable $\Delta R^{IV}_t = (\Delta R_{5,t}, -\Delta R^*_{5,t})$ for the independent variable. The appendix shows that ΔR^{IV}_t are valid instruments for estimating Equation (2) under the assumption that on days of monetary policy meetings, only the variance of monetary policy shocks (e_t) increases while that of the noise remains unchanged, following Rigobon (2003) and Rigobon and Sack (2003).

Second, we obtain monetary policy shocks using β_i which we estimate in Equation (3).

$$\Delta R_{i,t} = \alpha_i + e^{aligned}_t \hat{\beta}_i + \nu_{i,t}, \quad i = 0.5, 1, 1.5, 2, \cdots, 20, \tag{3}$$

where $e^{aligned}_t$ is the measured monetary policy shock.

We estimate the coefficient, β_i, using the data on zero-coupon yields provided by Kikuchi and Shin-tani (2012). Because the data ranges from 1999 to 2011, our analysis is limited to the periods before December 2011. It should be noted that the period from 1999 to 2011 is almost under the ELB. In fact, the Bank of Japan introduced the zero interest rate policy (ZIRP) in February 1999 and the target policy rate was virtually zero until July 2006.[6] Although the policy rate was set to 0.5% after July 2006, the level of the policy remained very low.[7] In response to the Global Financial Crisis in 2008, the Bank of Japan decreased the policy rate to 0.1% and provided massive liquidity to facilitate corporate financing. After 2012, the policy rate fell below zero because of the

[6]While the ZIRP was temporarily terminated in 2000, the policy was changed to a quantitative easing policy and the policy rate was lowered to zero in 2001. Hanisch (2017), which examines the effect of unconventional monetary policy by the Bank of Japan, takes the subsample before 2001 as the 'QE period'.

[7]Hanisch (2017) also takes the subsample from 2006 to the Global Financial Crisis as the 'QE-period' because the target overnight call rate did not noticeably depart from the zero lower bound in this intermediate period.

negative interest rate policy. Figure 1 shows the development of the target overnight call rate after 1985. It shows that both the longer-term and shorter-term nominal interest rates are virtually zero and that the sample period from 1999 to 2011 is almost entirely under the ELB.

Figure 2 depicts the development of a monetary policy shock which we identify using Equation (3) and Table 1 shows its basic statistics. The figure and table show that the magnitude of the monetary policy shock is very small. The maximum and minimum values of the shock are 0.072% and -0.035%, respectively. The small magnitude reflects the fact that the Bank of Japan had already decreased the policy rate to almost zero percent and the tools to further conduct accommodative monetary policy are limited.[8] Figure 2 shows that the largest shock occurred in September 2002. This might indicate that the announcement was disappointing; that is, the Bank of Japan did not change its policy on September 18, 2002 despite a sharp decline in Japanese stock markets. The figure shows that large negative shocks occurred in March 2011. This may reflect the fact that the Bank of Japan enhanced its monetary easing on the policy meeting on March 14, 2011 in response to the Great East Japan earthquake on March 11, 2011. The figure suggests that identified shock series is reasonable as a measure of a monetary policy shock.

[8] Kubota and Shin-tani (2020) show the absolute value of monetary policy shocks, which they identify is below 10 basis points, while Bu et al. (2021) indicates that it is below 20 basis points. Nakazono and Ikeda (2016) examined the stock market responses under quantitative easing in Japan from 2001 to 2006 and report that the absolute value of monetary policy shocks is below 5 basis points. The evidence that the identified monetary policy shocks in the literature are very small suggests that the extracted series in our study are reasonable as a measure of monetary policy shocks.

3 A VAR analysis

3.1 Structural VAR model

The model we use includes three endogenous variables:

$$\mathbf{x_t} = \begin{pmatrix} \pi_t, \ y_t, \ MPS_t \end{pmatrix}',$$

where x is a vector of the three endogenous variables, and π, y, andMPS are the year-on-year inflation rates, the logarithm of the index of industrial production, and the monetary policy shocks (identified in the previous section), respectively. We also include the constant term and logarithm of Nikkei commodity price index as an exogenous variable to mitigate any potential price puzzle. We assume that the true model can be written as:

$$\mathbf{B}\mathbf{x_t} = \mathbf{A}(L)\mathbf{x_{t-1}} + \varepsilon_\mathbf{t},$$

where $\mathbf{A}$ and $\mathbf{B}$ are coefficient matrices, $\varepsilon_\mathbf{t}$ is a vector of structural shocks, and L is the lag operator. For simplicity, we omit the constant term and exogenous variables. The standard VAR method is described by the following reduced form:

$$\mathbf{x_t} = \mathbf{\Gamma}(L)\mathbf{x_{t-1}} + \mathbf{e_t},$$

where $\mathbf{\Gamma} = \mathbf{B^{-1}A}$ and $\mathbf{e_t}$ is a vector of residuals, which is written as $\mathbf{B^{-1}}\varepsilon_\mathbf{t}$. We impose zero restrictions on $\mathbf{B}$ to identify structural shocks, which are described below:

$$\overbrace{\begin{pmatrix} e_t^{\pi} \\ e_t^{y} \\ e_t^{MPS} \end{pmatrix}}^{\mathbf{e_t}} = \overbrace{\begin{pmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{pmatrix}}^{\mathbf{B^{-1}}} \overbrace{\begin{pmatrix} \varepsilon_t^{\pi} \\ \varepsilon_t^{y} \\ \varepsilon_t^{MPS} \end{pmatrix}}^{\varepsilon_\mathbf{t}}. \tag{4}$$

Equation (4) follows the simple recursive restrictions, as proposed in Bu et al. (2021).

3.2 Impulse responses

Using this estimation strategy, we examine whether an monetary policy shock has significant impacts on macroeconomic variables. Figure 3 shows the impulse responses of monetary policy indicators, inflation rate, and output using data from 1999 to 2011.[9] The responses show that a contractionary monetary policy shock significantly decreases the inflation rate and output when the confidence interval is set to one standard deviation. In response to a one-standard-deviation monetary policy shock, industrial production significantly declines by more than 0.5% four months later. The inflation rate also significantly responds to a contractionary monetary policy shock. The inflation rate gradually decreases; in response to a one-standard-deviation monetary policy shock, it declines by more than 0.02% for approximately one year after a contractionary monetary policy shock occurs. The evidence suggests that monetary policy from 1999 to 2011 has significant impacts on output and inflation rate, but the magnitude is very small.

The estimation results are robust when the lag length is changed to three. Figure 4 shows the impulse responses to a contractionary monetary policy shock when the lag length is changed to three. The figure suggests that a policy shock significantly lowers output and inflation rates. This is the case when we use the index of all industry activity instead of the index of industrial production.[10] Figure 5 shows dynamic reaction of output and inflation rates to a contractionary monetary policy shock and that a policy shock lowers output and inflation rates. The figures also show that the hump-shaped responses of the macroeconomic variables to a contractionary monetary policy shock and the inflation rate decreases more gradually than output does. The robustness check supports our benchmark results: while the impacts of a monetary policy shock on the macroeconomic variables are very weak due to the ELB, they are significant and conform to macroeconomic theory.

[9] The lag length is set to two, as indicated by the Akaike Information Criterion.
[10] The index of all industry activity reflects the output of service industries.

3.2.1 Impulse responses using the full sample from 1999 to 2020

To cover the recent episode in the 2010s, we extend the sample period to December 2020 using the data on interest rates published by the Ministry of Finance, Japan. The Ministry provides data on historical interest rates to date, which are the semiannual compound interest rates on a constant maturity basis, while the detailed method for calculation is not released.

Using the data set, we identify a monetary policy shock and estimate a structural VAR by the same estimation strategy as shown in Section 2. Figure 6 shows the impulse responses of monetary policy indicators, inflation rate, and output using data from January 1999 to December 2020.[11] The responses show that a contractionary monetary policy shock decreases output and the inflation rate. In response to a one-standard-deviation monetary policy shock, industrial production significantly declines more than by 0.5% four months later. The inflation rate also responds to a contractionary monetary policy shock. The inflation rate gradually decreases; in response to a one-standard-deviation monetary policy shock, it declines by 0.02% for approximately one year after a contractionary monetary policy shock occurs. The evidence suggests that monetary policies from 1999 to 2020 also have macroeconomic impacts, but the magnitude is very small.

3.3 Variance decomposition

Figure 7 shows the forecast error variance decompositions over 24-month forecasting horizons. First, both series explain the preponderance of past values at short forecasting horizons. For example, at a six-month-ahead forecasting horizon, the top panel in Figure 7 shows that output explains 94.2% of its forecast error variance, while the bottom panel in Figure 7 shows the inflation rate explains 95.2% of its forecast error variance. As the forecasting horizon expands, the effect of output shocks on the variance of inflation rate remains small. However, after 24 months, output shocks explain 43.3% of the forecast error variance of the inflation rate. Not only is causality unidirectional, but the effect of

[11] The lag length is set to two, as indicated by the Akaike Information Criterion.

output shocks on the inflation rate is also substantial. Second, the impacts of monetary policy shocks on the variances of the macroeconomic variables are very small. For example, at a twelve-month-ahead forecasting horizon, monetary policy shocks explain below 3.0% of the variances of both variables, while the effects of monetary policy shocks on the variances of the two variables remain small, below 3.0%, even at a 24-month-ahead forecasting horizon. The variance decompositions also suggest that the impacts of monetary policy shocks on the dynamics of the macroeconomic variables are very small.

In summary, we find evidence that an monetary policy shock has some impacts on macroeconomic variables such as output and inflation rates in Japan. A contractionary monetary policy shock significantly decreases output and inflation rates; however, the shocks and magnitude are very small.

4 Conclusion

This study examines the macroeconomic effects of monetary policy in Japan. We apply the new identification strategy proposed by Bu et al. (2021) to the Japanese case. We show the macroeconomic effects of monetary policy; a contractionary monetary policy shock significantly decreases output and inflation rates, even under the ELB. The dynamic response of output and inflation rates to a monetary policy shock conforms to macroeconomic theory. However, the magnitude of the shocks is small because the policy rates are virtually zero. Thus, monetary policy significantly influences output and inflation rates even under the ELB, but the impacts are modest.

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Appendix: Strategy for identifying monetary policy shock

According to Bu et al. (2021), we identify monetary policy shocks as follows:

$$\Delta R_{5,t} = a_0 + e_t + \eta_t,$$

where $\Delta R_{5,t}$, a_0, e_t, and η_t are the daily change in zero-coupon yields with 5-year maturities, the constant term, monetary policy shock, and non-monetary policy shock, respectively.

As the first step, we estimate the sensitivity of every yield with maturity i to a monetary policy shock e_t:

$$\Delta R_{i,t} = a_i + \beta_i e_t + \epsilon_{i,t}, \tag{5}$$

where $\epsilon_{i,t}$ denotes the idiosyncratic noise. Rewriting Equation (5), we obtain the following equation:

$$\begin{aligned} \Delta R_{i,t} &= \alpha_i + \beta_i(\Delta R_{5,t} - \alpha_0 - \eta_t) + \epsilon_{i,t} \\ &= \underbrace{\theta_i}_{\alpha_i - \beta_i \alpha_0} + \beta_i \Delta R_{5,t} + \underbrace{\xi_{i,t}}_{-\beta_i \eta_t + \epsilon_{i,t}} . \end{aligned} \tag{6}$$

Here, $\xi_{i,t}$ and $\Delta R_{5,t}$ are correlated.

To estimate an unbiased estimator of β_i, we assume the heteroskedasticity of the variance-covariance matrix in the monetary and non-monetary policy dates:

1. $\sigma_e^M > \sigma_e^{NM}, \sigma_\eta^M = \sigma_\eta^{NM}, \sigma_\xi^M = \sigma_\xi^{NM}$.
2. $E[\eta_t e_t] = E[\xi_t e_t] = 0$.

where M and NM are denoted as monetary and non-monetary policy dates, respectively. The assumption reflects the idea of Rigobon and Sack (2003) that the variance of the monetary policy shock increases in the policy dates, while that of the non-monetary policy shock remains unchanged. It is also assumed that there is no correlation between monetary policy shock and non-monetary policy shock.

As the second step, we construct an instrument variable (IV). In Equation (6), we replace the dependent variable, $\Delta R_{i,t}$ with $(\Delta R_{i,t}, \Delta R^*_{i,t})$, and we replace the independent variable, $\Delta R_{5,t}$ with $(\Delta R_{5,t}, \Delta R^*_{5,t})$. This approach rewrites Equation (6) as:

$$[\Delta R_{i,t}] = \alpha_i + \beta_i[\Delta R_{5,t}] + \mu_{i,t}, \quad i = 0.5, 1, 1.5, 2, \cdots, 20,$$

where $[\Delta R_{i,t}]$ and $[\Delta R_{5,t}]$ are denoted as $(\Delta R_{i,t}, \Delta R^*_{i,t})$ and $(\Delta R_{5,t}, \Delta R^*_{5,t})$, respectively. We can obtain the estimate of the coefficient β_i using an instrumental variable $\Delta R^{IV}_t = (\Delta R_{5,t}, -\Delta R^*_{5,t})$ for the independent variable. Because it is clear that ΔR^{IV}_t is correlated with $[\Delta R_{5,t}]$, $(\Delta R_{5,t}, -\Delta R^*_{5,t})$ can be an instrumental variable. We can show that ΔR^{IV}_t is not correlated with the error term:

$$\begin{aligned}
&Cov[(\Delta R_{5,t}, -\Delta R^*_{5,t})(\xi_{i,t}, \xi^*_{i,t})'] \\
&= Cov[(a_0 + e^M_t + \eta^M_t, -a_0 - e^{NM}_t - \eta^{NM}_t)(-\beta_i\eta^M_t + \epsilon^M_{i,t}, -\beta_i\eta^{NM}_t + \epsilon^{NM}_{i,t})'] \\
&= -\beta_i(\eta^M_t)^2 - \beta_i\eta^M_t\eta^{NM}_t + \beta_i\eta^M_t\eta^{NM}_t + \beta_i(\eta^{NM}_t)^2 \\
&= 0.
\end{aligned}$$

Finally, using $\hat{\beta}_i$, we obtain $e^{aligned}_t$ by estimating the following cross-sectional equations:

$$\Delta R_{i,t} = \alpha_i + e^{aligned}_t\hat{\beta}_i + \nu_{i,t}.$$

表 1: Summary statistics of the data in a SVAR model. The data cover from January 1999 to December 2011.

	MP shock (%)	IIP	$\pi(\%)$	Commodity Price
Mean	−0.001	104.54	−0.30	110.28
Median	−0.001	104.35	−0.31	107.65
Maximum	0.072	119.40	2.24	183.89
Minimum	−0.035	78.00	−2.55	70.45
Std. Dev.	0.015	8.08	0.77	30.90
Skewness	0.980	−0.55	0.40	0.33
Kurtosis	6.969	3.80	4.97	1.93
Observations	156	156	156	156

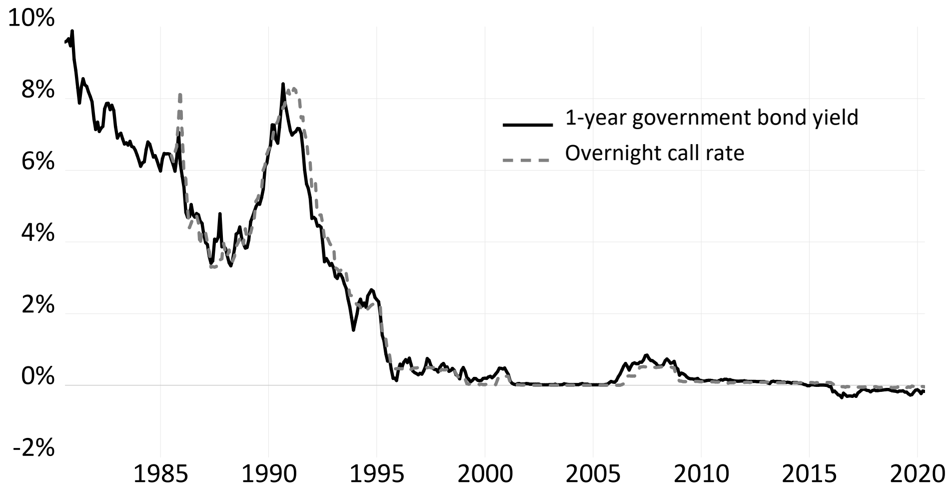

図 1: Development of the target overnight call rate (Source: Bank of Japan)

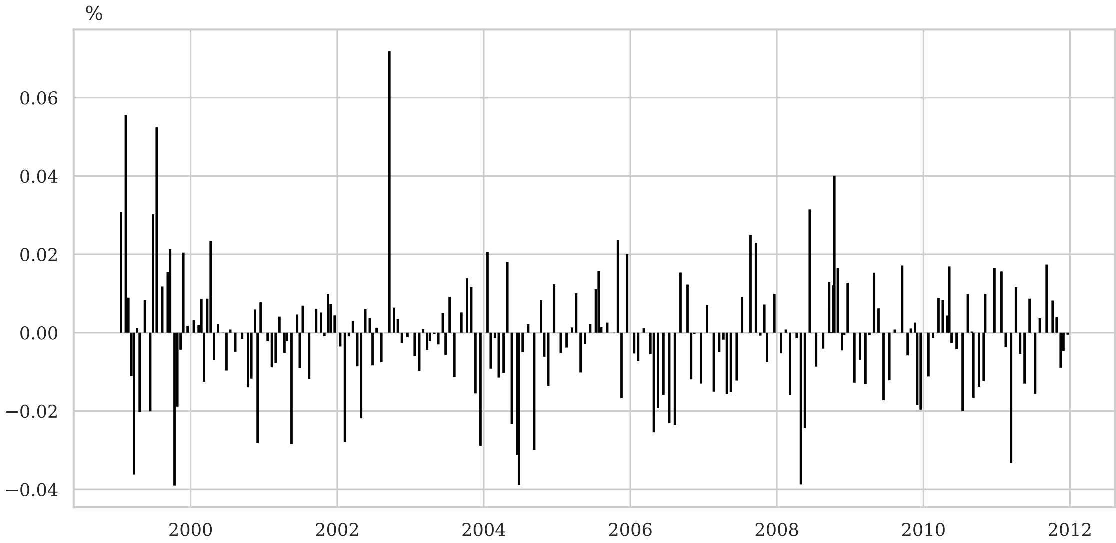

図 2: Development of identified monetary policy shock

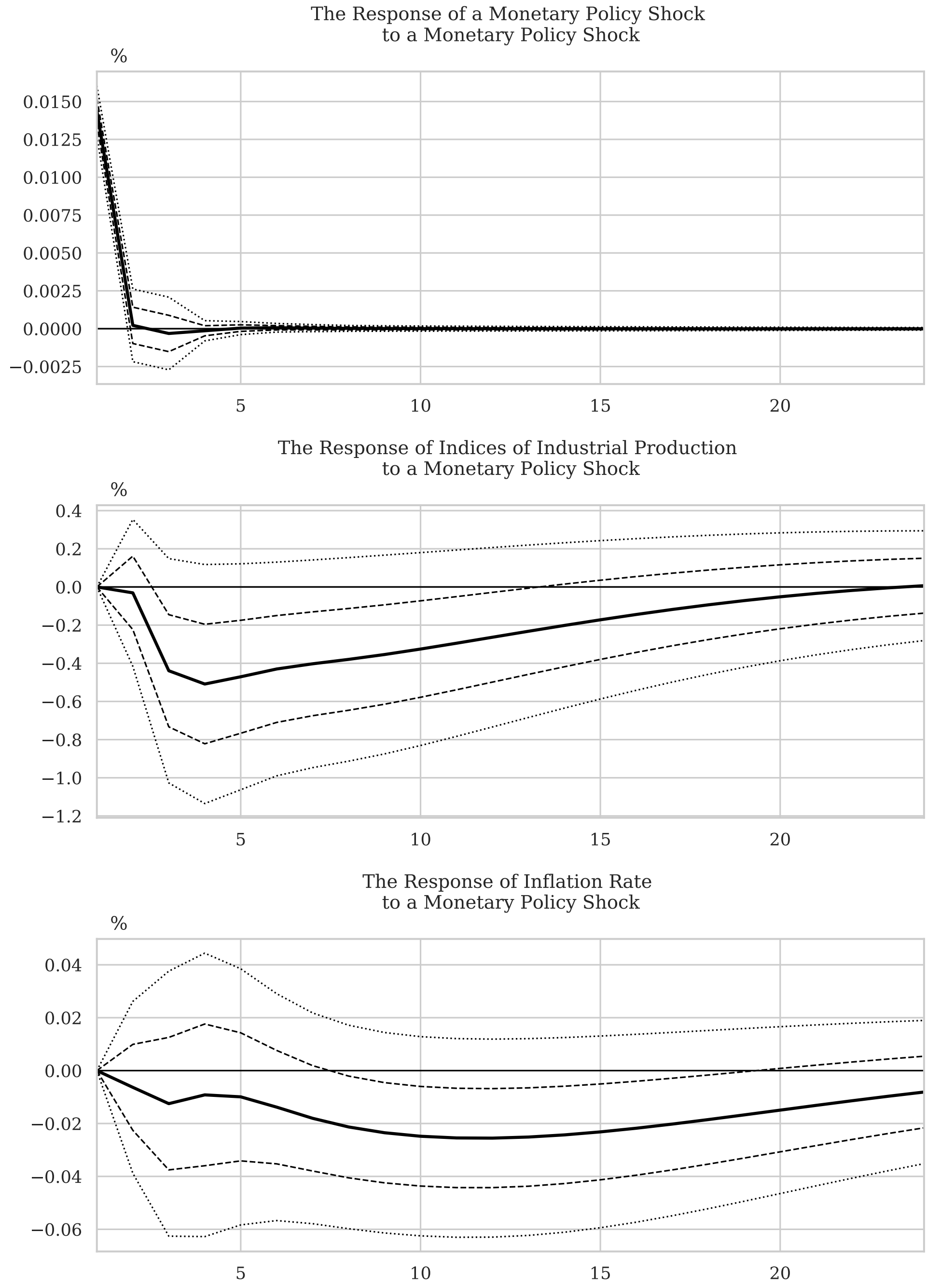

図 3: Impulse responses to a contractional monetary policy shock. The lag length is set to two. Solid lines represent the means. Dashed lines represent the 16th and 84th percentiles. Dotted lines represent the 5th and 95th percentiles. The data cover from January 1999 to December 2011.

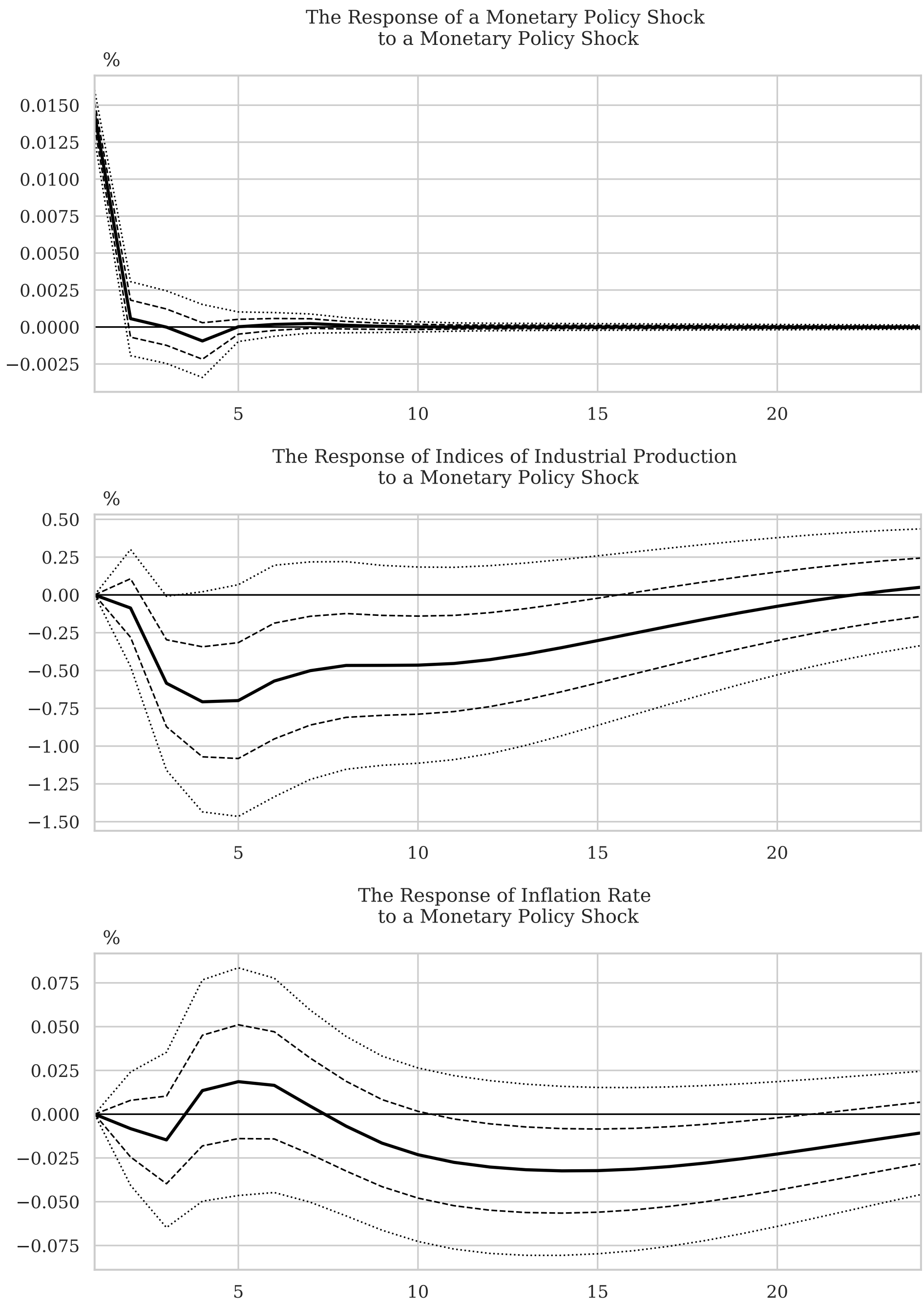

図 4: Robustness check (1): Impulse responses to a contractional monetary policy shock. The lag length is set to three. Solid lines represent the means. Dashed lines represent the 16th and 84th percentiles. Dotted lines represent the 5th and 95th percentiles. The data cover from January 1999 to December 2011.

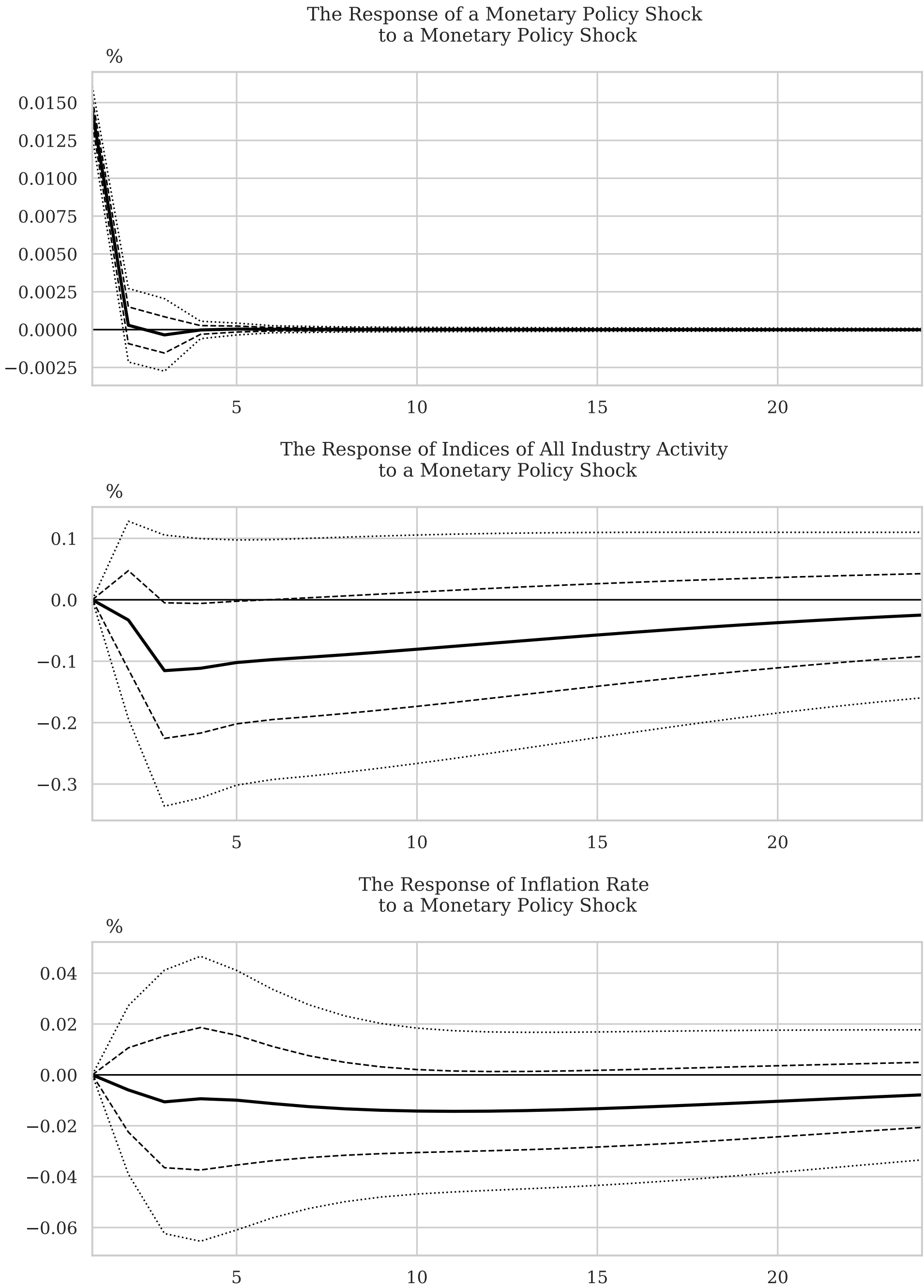

図 5: Robustness check (2): Impulse responses to a contractional monetary policy shock using the indices of all industry activity instead of IIP. The lag length is set to two. Solid lines represent the means. Dashed lines represent the 16th and 84th percentiles. Dotted lines represent the 5th and 95th percentiles. The data cover from January 1999 to December 2011.

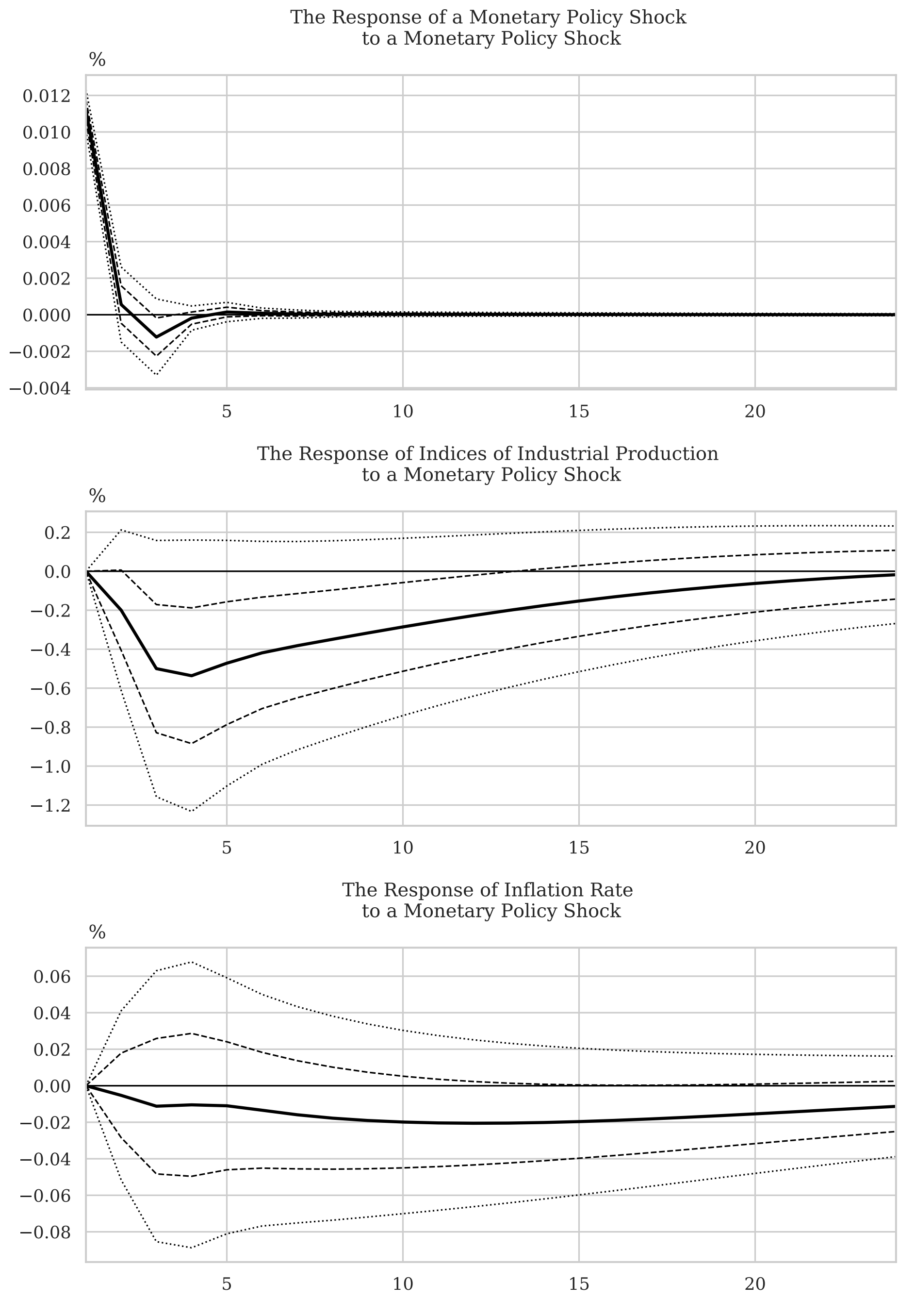

図 6: Extending the sample period to date. Impulse responses to a contractional monetary policy shock. The lag length is set to two. Solid lines represent the means. Dashed lines represent the 16th and 84th percentiles. Dotted lines represent the 5th and 95th percentiles. The sample period covers from January 1999 to December 2020.

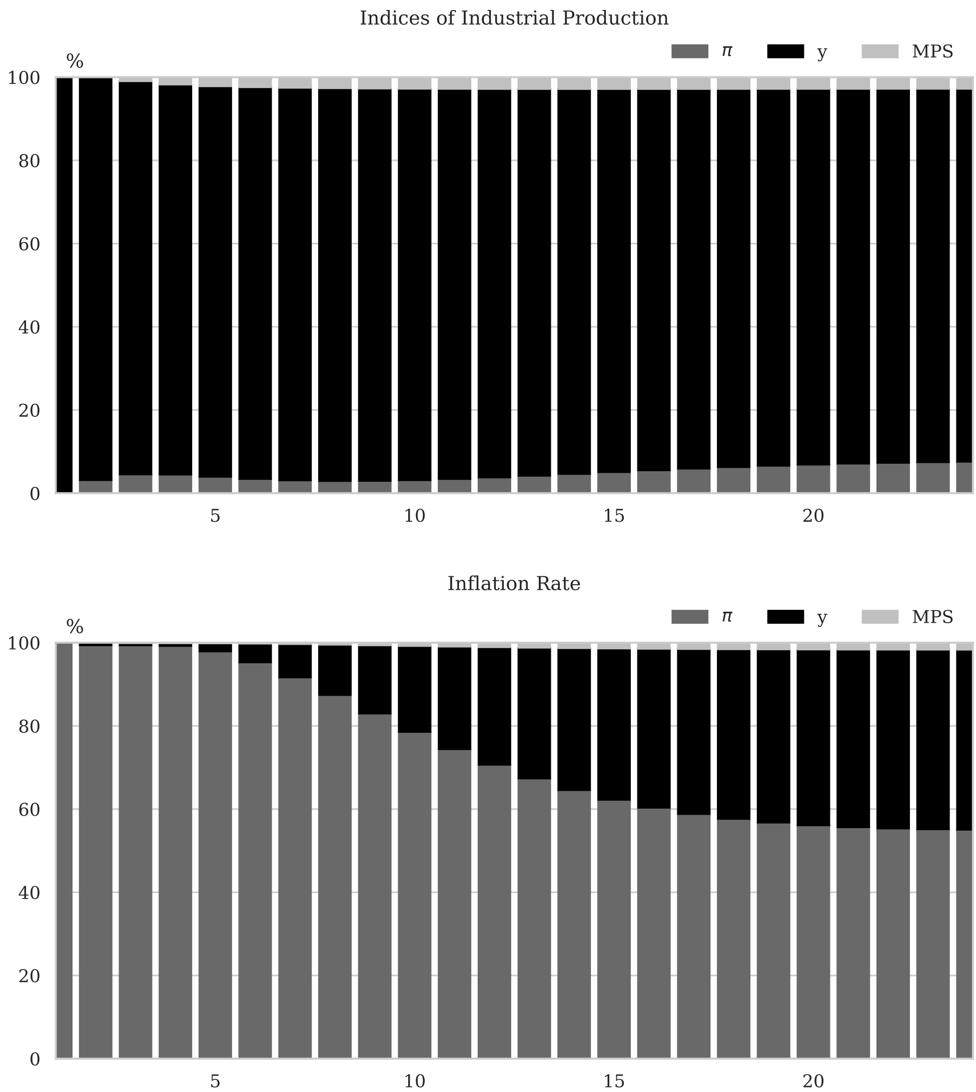

図 7: Forecast error variance decomposition