Macroeconomic Effects of Unconventional Monetary Policy in Japan: Analysis Using Narrative Sign Restrictions *

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This version: July 2025

Abstract

We evaluate the macroeconomic effects of the unconventional monetary policy (UMP) in Japan. To identify UMP shocks, we impose narrative sign restrictions on structural shocks and historical decompositions by using three significant episodes during Governor Haruhiko Kuroda's tenure related to Quantitative and Qualitative Monetary Easing (QQE). Our results indicate that expansionary UMP shock increases both output and inflation rate. The exchange rates, stock prices, and bank loans also respond to the UMP shock consistently with the predictions of standard macroeconomic theory, implying that the exchange rate channel, the asset price channel, and the credit channel function for the transmission channel of unconventional monetary policy to the real economy. Furthermore, our findings indicate that using the narrative sign restrictions independently or complementarily eliminates the puzzling responses of some variables that occur when using the Cholesky decomposition, and also eliminates the problem of the wide credible intervals that tend to occur when using standard sign restrictions for identification.

Keywords: Unconventional monetary policy, structural vector autoregressive models
JEL Classification: E31, E32, E44, E52

*The authors would like to thank Masahiko Shibamono, Naoko Hara, Naoto Soma, and the seminar and conference participants at the Univerisity of Tokyo, 2024 Japanese Economic Association Autumn Meeting for their helpful comments and discussions. Shintani gratefully acknowledges the financial support of the Grant-in-Aid for Scientific Research (24K00241).

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1 Introduction

Various unconventional monetary policies have been adopted in Japan, including the zero interest rate policy from February 1999 to August 2000, the quantitative easing (QE) policy from March 2001 to March 2006, and the quantitative and qualitative monetary easing (QQE) policy from April 2013 to March 2024. Among these policies, QQE was the largest monetary easing policy in Japan's history, which is a reason why it is also referred to as "unprecedented monetary easing." It is important to note that QQE was characterized by the fact that the then Bank of Japan (BOJ) Governor, Haruhiko Kuroda, tended to place more importance on surprises than on dialogue with the financial market.

What are the quantitative effects of QQE policy introduced during the Kuroda regime? In this study we aim to answer this question using the structural vector autoregressive (VAR) models. In general, however, identifying monetary policy shocks during the period of unconventional monetary policy is considered a difficult task. To address this issue, we employ the identification strategy based on the narrative sign restrictions, which utilize the narrative description of "policy surprise" that influenced financial markets. Specifically, we focus on the following three key events during the Kuroda regime: (i) the introduction of QQE on April 4, 2013; (ii) the expansion of QQE on October 31, 2014; and (iii) the introduction of the negative interest rate policy on January 29, 2016. These three events are often referred to as "Kuroda's bazookas" because of the significant surprises they brought to financial markets. [1]

In the paper, we also argue that identification based on the narrative sign restrictions has several advantages over traditional methods such as Cholesky decomposition and standard sign restrictions. We compare our benchmark results obtained from narrative sign restrictions with those obtained from traditional methods. While the sign restrictions have been used in the analysis of monetary policy in Japan, including Braun

[1] The expression "bazooka" seems to have the following meanings: (1) the scale is large (Mishima, 2015); (2) the policy makes a surprise (Hama, 2016); and (3) all-out measures are being used, rather than an incremental approach (Kawate et al., 2016). See Gunji (2024) for a detailed explanation of the origin of the term "Kuroda Bazooka."

and Shioji (2006), Schenkelberg and Watzka (2013), and Ikeda et al. (2024) to name a few, to the best of our knowledge, this paper is the first work to employ narrative sign restrictions to identify the monetary policy shock of QQE.

The main findings of the paper are as follows. First, an expansionary monetary policy shock significantly increases output and inflation rates. Using the historical decomposition, we find that monetary policy shock has increased the level of GDP by 1.0% and the inflation rate by 0.2% on average over the QQE period. Second, the exchange rate, stock prices, and bank loans respond to monetary policy shocks in a way that is consistent with the predictions of standard macroeconomic theory. This finding implies that the exchange rate channel, the asset price channel, and the credit channel function as channels through which unconventional monetary policy affects the real economy. Third, we confirm that the narrative sign restrictions are effective in identifying monetary policy shocks. The use of the narrative sign restrictions eliminates the puzzling responses observed in the case of Cholesky decomposition, and also provides tighter credible intervals than the case of standard sign restrictions.

Overall, our results confirm some of the previous findings that support the effectiveness of unconventional monetary policy in Japan. There are a number of previous empirical studies on QE and QQE policies using the VAR models. [2] To investigate the macroeconomic effects of the QE policy prior to Governor Kuroda's tenure, Schenkelberg and Watzka (2013) conduct a VAR analysis with sign restrictions and find that monetary easing policy have a positive effect on GDP but only a limited effect on increaseing prices. Similarly, Honda et al. (2013) also find a positive effect on output but a small effect on the price level based on Cholesky decomposition. Both Fujiwara (2006) and Hayashi and Koeda (2019) employ Cholesky decomposition in the regime-switching VAR models. While the former find little effect of QE policy, the latter find that the positive response of output and inflation to a positive excess reserves shock under the effective lower bound regime. [3]

[2]See also Aoki and Ueda (2025) for a comprehensive review of empirical works on the effect of unconventional monetary policy in Japan.

[3]Furthermore, De Michelis and Iacoviello (2016) employ long-run restrictions rather than short-run restrictions to identify the inflation target shock in Japan and find its effect on both GDP and inflation.

Regarding the effectiveness of QQE policy, many VAR studies employ sign restrictions and/or external instruments to identify the monetary policy shocks. For example, Michaelis and Watzka (2017) employ a time-varying parameter VAR model combined with sign restrictions and find that the effects on output and prices differ between the QE and QQE periods. In particular, the responses of the price level tend to be stronger at the onset of the QQE period. On the other hand, Kubota and Shintani (2022) and Kubota and Shintani (2025) use surprises in Euroyen futures rates within a thirty-minute window around each Monetary Policy Meeting (MPM) to identify monetary policy shocks. Using this high-frequency surprise series as external instruments, Kubota and Shintani (2025) claim that both output and price respond to monetary policy shock identified by such an instrument. It should be noted that such a high-frequency identification strategy has been widely used in the literature since the seminal work of Gertler and Karadi (2015) on the US. Accordingly, other studies on Japan, such as Nakamura et al. (2024) and Nakashima et al. (2024), use instruments based on market surprises. [4] Gertler and Karadi (2015)'s approach is further extended by Jarociński and Karadi (2020) who incorporate sign restrictions to distinguish monetary policy shocks from information shocks in the US. Tanahara et al. (2023) and Morita et al. (2025) apply this method of combining the external instruments from high-frequency data and sign restrictions to evaluate the effect of monetary policy in Japan.[5]

Identification of unconventional monetary policy shocks in the nonlinear VAR framework has also been conducted in several studies. For example, Koeda (2019), Miyao and Okimoto (2020), and Ikeda et al. (2024), respectively, employ a regime-switching VAR model, a smooth transition VAR model, and a censored and kinked VAR model. The former two studies use Cholesky decomposition, while the latter uses sign restrictions in identifying the monetary policy shocks. Note that these studies focus more

[4] Nakamura et al. (2024) find that the expansionary monetary policy shock increases output more than prices. Nakashima et al. (2024) separate QQE into its qualitative and quantitative components and assess their respective effects identified by the combination of instruments and the maximum forecast error variance approach. They find that qualitative easing shocks stimulate real economic activity, whereas quantitative easing does not.

[5] Tanahara et al. (2023) find that a contractionary monetary policy shock significantly reduces inflation but not consumption. In contrast, Morita et al. (2025) find tightening monetary policy shock increases output and price levels significantly in the short run but decreases in the medium run.

on the possibility of regime shift in identifying the monetary policy shocks because their sample period includes both QE and QQE periods. In contrast, our sample period starts after the end of QE and we evaluate the effectiveness of QQE policy in a simple linear VAR framework.

The remainder of this paper is structured as follows. Section 2 provides a literature review. Section 3 describes the narrative information about QQE events, the empirical model, data, identification strategy, and estimation algorithm. Section 4 presents the estimation results, and finally, Section 5 concludes the paper.

2 Why narrative restrictions?

In this paper, we identify monetary policy shocks based on narrative sign restrictions. This section provides an overview of the literature underlying this identification strategy and discusses its advantages.

The identification strategy using sign restrictions on impulse response functions, originally proposed by Uhlig (2005), has long been applied in VAR analyses of monetary policy. Another widely used identification strategy involves the use of external instruments, such as high-frequency surprise series. Wolf (2020) uses artificial data generated from a medium-scale New Keynesian model to assess the performance of identification schemes commonly used in macroeconomic analysis. He finds that identification based solely on sign restrictions often fails to recover the true shock, as it tends to mix in other structural shocks, resulting in wide confidence intervals for the impulse responses. In contrast, identification methods using external instruments turn out to perform considerably better.

The narrative approach, which utilizes central bank policy records (episodes) to construct monetary policy shock series, was pioneered by Romer and Romer (1989) and Romer and Romer (2004). [6] Antolín-Díaz and Rubio-Ramírez (2018) develop the narrative sign restriction method, which incorporates narrative information as sign restrictions on structural shocks during specific event periods. They argue that even a

[6] Nakamura and Steinsson (2018) view the narrative approach as a form of "natural experiments."

single narrative sign restriction can dramatically sharpen inference compared to traditional sign restriction approaches. Antolín-Díaz and Rubio-Ramírez (2018) apply this method to identify monetary policy shocks in the US. [7] Furthermore, recent work by Giacomini et al. (2022), Giacomini et al. (2023), Plagborg-Møller and Wolf (2021), and Plagborg-Møller (2022) demonstrates that the narrative sign restriction approach can be interpreted as a form of instrument in proxy VAR models, through a modest refinement of the posterior distribution. Thus, we can expect the narrative sign restriction method to perform well when the data are generated from a theoretical macroeconomic model. Our paper also incorporates refinements based on the narrative proxy approach proposed by Giacomini et al. (2022), integrating the latest advancements in estimation methodologies.

The narrative sign restriction method is also closely related to the Bayesian estimation of structural VAR models. Rubio-Ramírez et al. (2010) propose a method for estimating structural VARs under zero and sign restrictions using QR decomposition with the Haar prior. This approach was further developed and refined by Arias et al. (2018). Giacomini and Kitagawa (2021) demonstrate that Bayesian estimation of VAR models under non-informative priors coincides with maximum likelihood estimates, thereby contributing to the resolution of the long-standing debate between frequentist and Bayesian perspectives. Although Baumeister and Hamilton (2015) raised concerns regarding the use of the Haar prior in sign-restricted Bayesian inference, recent work by Inoue and Kilian (2024) shows that, under stronger narrative restrictions, the influence of the Haar prior becomes negligible. Furthermore, Arias et al. (2023) argue that the use of the Haar prior is not only sufficient but also necessary for the proper identification of impulse responses.

[7] Badinger and Schiman (2023) apply this method to identify monetary policy shocks and central bank information shocks in the Euro area.

3 Empirical Analysis

3.1 Narrative information

In this section, we present direct narrative evidence that the three monetary policy events known as "Kuroda's bazookas" during the QQE period were perceived as surprises by the financial market.

The first of Kuroda's bazookas occurred on April 4, 2013 when the BOJ started QQE under the leadership of then BOJ Governor Kuroda. Aiming for a steady year-on-year increase in the CPI above two percent, the BOJ announced that it would double the monetary base, double its holdings of long-term JGBs, double the average maturity of purchased long-term JGBs, and increase purchases of ETFs and J-REITs over an initial period of about two years. These monetary easing packages exceeded the expectations of financial market participants. On April 4, the Nikkei Stock Average closed at 12,634 yen, up 272 yen from the previous day's close of 12,362 yen. The Japanese yen weakened by 2.2 yen against the US dollar, from 93.4 yen per dollar to 95.6 yen per dollar at 5 p.m. on the Tokyo interbank market. The yield on 10-year JGBs also declined, falling from 0.55 percent to 0.455 percent. In an article entitled "Kuroda takes markets by storm" (April 4, 2013), the *Financial Times* (Soble, 2013) cited an analyst at Credit Suisse, Hiromichi Shirakawa, who stated that "the timing was a surprise and the magnitude was more than expected."

The second of Kuroda's bazookas occurred on October 31, 2014 when the BOJ decided to expand QQE. In addition to raising the target annual increase in the monetary base, the BOJ announced that it would increase its purchases of long-term JGBs, ETFs, and J-REITs, and extend the average remaining maturity of purchased long-term JGBs by up to about three years over the past. Just as when Kuroda's bazooka was first fired, the announcement of the expansion of QQE stimulated trading in financial markets. On October 31, the Nikkei Stock Average closed at 16,413 yen, up 755 yen from the previous day's close of 15,658 yen. The Japanese yen depreciated by 2 yen against the US dollar, weakening from 109.2 yen per dollar to 111.2 yen per dollar. The yield on 10-

year JGBs also declined slightly, from 0.47 percent to 0.45 percent. *Bloomberg News* on October 31, 2014 (Scott and Fujioka, 2014), reported that "Kuroda led a divided board in Tokyo in a surprise decision to expand unprecedented monetary stimulus." The article also cited Masaki Kanno, chief economist at JPMorgan Chase & Co. in Tokyo, who described the event as follows: "We have to admit that this is sort of a second shock after we had the first shock in April last year."

The third of Kuroda's bazookas occurred on January 29, 2016 when the BOJ decided to introduce a negative interest rate policy. The BOJ divided their current account into three tiers: Basic Balance, Macro-Add on Balance, and Policy-Rate Balance, and announced that it would apply a minus 0.1 percent interest rate to the Policy-Rate Balance. According to *The Nikkei* article, this came as a surprise not only to the financial markets but also to the members of the BOJ Policy Board, as then BOJ Governor Kuroda had previously expressed his opposition to the introduction of a negative interest rate policy (Nikkei, 2016). On January 29, the Nikkei Stock Average closed at 17,518 yen, up 477 yen from the previous day's close of 17,041 yen. The Japanese yen depreciated by 1.8 yen against the US dollar, weakening from 118.8 yen per dollar to 120.6 yen per dollar at 5 p.m. on the Tokyo interbank market. The yield on 10-year JGBs also declined, falling from 0.22 percent the previous day to 0.095 percent. The *Financial Times* (Davies, 2016) reported that "some analysts have described the latest surprise announcement as 'a very big regime change'."

Furthermore, Kubota and Shintani (2022) present another piece of evidence that the Kuroda bazookas were the major exogenous shocks of monetary easing during the QQE period. They examined the effect of monetary policy on the financial market during the unconventional monetary policy period in Japan using information from high-frequency data on interest rate futures, which reflects future expectations of financial market participants. They constructed a monetary policy surprise series by measuring the change in euro-yen futures and 10-year JGB futures (long-term JGB futures) by the difference between the futures rate 10 minutes before and the futures rate 20 minutes after the BOJ's statement.

Figure 1 focuses on the monetary policy surprise series based on changes in the 10-year JGB futures. The month in which the biggest shock of monetary easing occurred was February 2016, which was due to the introduction of negative interest rate policy as the third Kuroda's bazooka on January 29. The month in which the second largest monetary easing shock occurred was April 2013, which was due to the introduction of QQE as the first Kuroda's bazooka on April 4. Furthermore, the fifth largest monetary easing shock occurred in November 2014, which was due to the expansion of QQE as the second Kuroda's bazooka on October 31.

Based on this narrative information, we attempt to identify UMP shocks under the structural VAR model, using the fact that three rounds of Kuroda's bazookas are major exogenous monetary easing shocks in the QQE period. In the following, we outline how these three major monetary easing shocks translate into narrative sign restrictions for the identification in order to measure the effects of the QQE.

3.2 Specification of the VAR model

As in Antolín-Díaz and Rubio-Ramírez (2018) and Giacomini et al. (2023), we consider a structural VAR model of order p given by:

$$\mathbf{A_0 y}_t = \mathbf{A}_+ \mathbf{x}_t + \boldsymbol{\varepsilon}_t, \tag{1}$$

for $1 \leq t \leq T$, where $\mathbf{A_0}$ is an invertible $n \times n$ matrix, $\mathbf{y}_t$ is an $n \times 1$ vector, and $\mathbf{x}_t = (\mathbf{y}'_{t-1}, ..., \mathbf{y}'_{t-p}, \mathbf{z}_t)'$ is an $m \times 1$ vector, $\mathbf{z}_t$ is an exogenous variable including a vector of ones, $A_+ = (A_1, ..., A_p, A_z)$ is a $n \times m$ matrix of parameters , and $\boldsymbol{\varepsilon}_t$ is an $n \times 1$ vector of structural shocks which follows $N(0_{n\times1}, I_n)$. By rewriting equation (1), we yield an ordinary reduced form such as

$$\mathbf{y}_t = \mathbf{B}\mathbf{x}_t + \mathbf{u}_t, \tag{2}$$

for $1 \leq t \leq T$, where $\mathbf{B}$=$\mathbf{A}_0^{-1}\mathbf{A}_+$, $\mathbf{u}_t$=$\mathbf{A_0^{-1}}\boldsymbol{\varepsilon}_t$ follows $N(0_{n\times1}, \Sigma)$ and $\Sigma = \mathbf{A_0^{-1}}(\mathbf{A_0^{-1}})'$. Equation (1) is also given as the following orthogonal reduced form allowing identification of a wider range of structural parameters $\mathbf{A_0}$ from estimates $\mathbf{B}$ and $\mathbf{\Sigma}$.

$$\mathbf{y_t} = \mathbf{B}\mathbf{x_t} + \mathbf{P}\mathbf{Q}\varepsilon_t, \tag{3}$$

for $1 \leq t \leq T$, where $\mathbf{P}$ is the Cholesky factor of $\mathbf{\Sigma}$ satisfying $\mathbf{P}\mathbf{P}' = \mathbf{\Sigma}$, and $\mathbf{Q}$ is an $n \times n$ orthonormal matrix ($\mathbf{Q} \in \mathscr{O}(n)$) satisfying $\mathbf{P}\mathbf{Q} = \mathbf{A_0}^{-1}$, or $\mathbf{A_0} = \mathbf{Q}'\mathbf{P}^{-1}$. If all the parameters $(\mathbf{B}, \mathbf{\Sigma})$ and $\mathbf{Q}$ are obtained, the shocks can be identified.

3.3 Data

In the benchmark estimation, we use the following six key macroeconomic variables, mainly referring to Miyao and Okimoto (2020).

$$\mathbf{y}_t = (GDP_t, INF_t, LTR_t, EXR_t, STOCK_t, LENDING_t)'$$

The GDP_t is the monthly real GDP estimated by the Japan Center for Economic Research (JCER), which is a variable of output. The INF_t is the inflation rate, which is year-on-year changes in the consumer price index (CPI), excluding food (less alcohoric beverages) and energy with the consumption tax adjusted.

The LTR_t is the 10-year JGB yield (long-term interest rate), which is used as policy measures of UMPs in our benchmark estimation. [8] This choice is based on the following: (1) long-term interest rates reflect changes in the BOJ's monetary policy stance, according to the narrative analysis in Section 3.1; [9] (2) Since QQE does not necessarily rely on an expansion of quantitative variables, it is debatable whether the quantitative variable could be used as a policy variable; (3) If the shadow rate is used as a policy

[8]The previous empirical literature that examines the macroeconomic effects of UMPs uses various policy measures. Notable examples include the current account of the central bank (Schenkelberg and Watzka, 2013), monetary base (Miyao and Okimoto, 2020), shadow rates (Wu and Xia, 2016), and long-term interest rates (Baumeister and Benati, 2013).

[9]Hirata et al. (2024) pointed out that the "long-term interest rate channel" seems to be the main channel through which UMP affects the economy when short-term interest rates are constrained by the effective lower bound. In addition, they reported that Kendall's rank correlation coefficient between the 10-year JGB yield and the BOJ's policy stance is significant at the 5% level in both the conventional and unconventional policy periods, and that long-term interest rates fluctuate in line with the BOJ's monetary policy stance.

variable, the estimated impact of UMP on the macroeconomy could be affected by the method used to estimate the shadow rate.

In addition, we use three financial variables considering the transmission mechanism of monetary policy. Previous studies, including Mishkin (1995), Kuttner and Mosser (2002), and Boivin et al. (2010), suggest that there are three main channels other than the "interest rate channel" through which monetary policy affects the economy: (1) the exchange rate channel, (2) the asset price channel, and (3) the credit channel. In this study, we use the nominal effective exchange rate (EXR_t) as the "exchange rate channel," the stock price ($STOCK_t$) as the "asset price channel," and the growth rate of bank lending ($LENDING_t$) as the "credit channel."

All variables are monthly series. The GDP is seasonally adjusted by JCER. All variables are expressed in logarithm except for the inflation rate, long-term interest rate, and growth rate of bank lending variables. The lag length in the VAR model is set to two periods based on AIC. The data period spans from January 2007 to December 2024. The starting point is chosen to exclude the quantitative easing policy implemented by the BOJ in the 2000s. [10] The end point is set to include both the outbreak of the COVID-19 and the end of the QQE. The details of the data sources are shown in Table 1.

3.4 Identification Strategy

We use the method called the "narrative sign restrictions" to identify UMP shocks. The method imposes restrictions on the structural shocks by using external information about historically important events.

We consider two types of narrative sign restriction based on Antolín-Díaz and Rubio-Ramírez (2018) and Giacomini et al. (2023). One is called "shock sign restrictions," which imposes restrictions on the sign of structural shocks (structural residuals) at specific periods. When the sign of the structural shock is negative, the restriction can

[10] The starting point also takes into account the fact that the monthly real GDP series published by JCER is available only from 2007.

be written as follows:

$$\varepsilon_{j,t_\nu} = \mathbf{e}'_{j,n}\varepsilon_{t_\nu}(\Theta) \ < \ 0, \tag{4}$$

where $\mathbf{e}'_{j,n}$ represents the jth column of $\mathbf{I}_n$, and $\varepsilon_{t_\nu}(\Theta)$ represents the structural shock (structural residual) of the ith equation of the structural VAR at the specific event (t_ν) based on the set of structural parameters (Θ).

The other restriction is called "historical decomposition restrictions," which imposes restrictions on the magnitude of the contribution of a particular structural shock to the change in a certain variable in a certain period by using historical decompositions. The restriction is further classified into Type A or Type B based on the magnitude of the assumed contribution.

The type A restriction is that the contribution (absolute value) of a particular structural shock is the largest among all the contributions of the other structural shocks. In other words, the structural shock is regarded as the "most important contributor." The following expression of $H(\cdot)$ represents the contribution of the j th shock to the observed unexpected change in the i th variable between periods t and $t+h$ by historical decomposition.

$$\begin{aligned} &\mid H_{i_\nu,j,t_\nu,t_\nu+h_\nu}(\Theta, \varepsilon_{t_\nu}(\Theta), ..., \varepsilon_{t_\nu+h_\nu}(\Theta)) \mid \\ &\qquad - \max_{j \neq j'} \mid H_{i_\nu,j',t_\nu,t_\nu+h_\nu}(\Theta, \varepsilon_{t_\nu}(\Theta), ..., \varepsilon_{t_\nu+h_\nu}(\Theta)) \mid > \ 0 \end{aligned} \tag{5}$$

On the other hand, the type B restriction is that the contribution (absolute value) of a particular structural shock is greater than the sum of the contributions of all other structural shocks. In other words, the structural shock is regarded as the "overwhelming contributor."

$$\begin{aligned} &\mid H_{i_\nu,j,t_\nu,t_\nu+h_\nu}(\Theta, \varepsilon_{t_\nu}(\Theta), ..., \varepsilon_{t_\nu+h_\nu}(\Theta)) \mid \\ &\qquad - \Sigma_{j \neq j'} \mid H_{i_\nu,j',t_\nu,t_\nu+h_\nu}(\Theta, \varepsilon_{t_\nu}(\Theta), ..., \varepsilon_{t_\nu+h_\nu}(\Theta)) \mid > \ 0 \end{aligned} \tag{6}$$

The narrative sign restrictions explained above are also summarized in Table 2. In our benchmark case, we impose the following "shock sign restrictions" and "historical decomposition restrictions" on the structural shocks of one of the structural VAR equations based on the information on the major monetary easing surprises in QQE called Kuroda's bazookas.

$$\varepsilon_{3,2013m04} < 0 \tag{7}$$

$$\varepsilon_{3,2014m11} < 0 \tag{8}$$

$$\varepsilon_{3,2016m02} < 0 \tag{9}$$

$$| \ H_{3,3,2016m02}(\Theta, \varepsilon_{2016m02}(\Theta)) \ | - \Sigma_{j' \neq 3} \ | \ H_{3,j',2016m02}(\Theta, \varepsilon_{2016m02}(\Theta)) \ | > 0 \tag{10}$$

Equation (7) to (9) represent the "shock sign restrictions." In particular, we impose that the structural shock in the third equation of the structural VAR is negative (i.e., an expansionary shock) at the three points in time when the Kuroda bazookas occurred: April 2013, November 2014, and February 2016. On the other hand, equation (10) represents the type B "historical decomposition restrictions" (or "overwhelming contributor"). In particular, we impose that the contribution of the structural shock by historical decomposition in the third equation of the structural VAR to the observed unexpected change in the third variable (long term interest rate) in February 2016 is greater than the sum of the contributions of all other variables.

These "shock sign restrictions" and "historical decomposition restrictions" have been motivated and rationalized by means of narrative analysis in Section 3.1. The choice of the third equation for the identification of the UMP shock is arbitrary and without loss of generality. Furthermore, we would like to emphasize that our restrictions in the benchmark case differ from those of Antolín-Díaz and Rubio-Ramírez (2018) in that they do not use standard sign restrictions, which restricts the signs of the impulse responses. In this sense, our identification strategy can be said to be slightly more agnostic, as much as Badinger and Schiman (2023).

3.5 Estimation

In this study, we estimate the structural VAR in equation (3) using standard Bayesian methods based on Antolín-Díaz and Rubio-Ramírez (2018). However, we use unconditional likelihood for the construction of the posterior, based on the remarks of Giacomini et al. (2023). Thus we abstain from importance sampling as in Badinger and Schiman (2023). [11]

In the algorithm, we first draw a set of parameters $(\mathbf{B}, \mathbf{\Sigma})$ from the normal-inverse-Wishart posterior. At the same time, for each of them, $\mathbf{Q}$ is drawn from the uniform distribution over $\mathscr{O}(n)$ using QR decomposition. In the next step, keep the set of $(\mathbf{B}, \mathbf{\Sigma}, \mathbf{Q})$ that satisfies the narrative sign restrictions; otherwise, discard. [12] Repeat this process until the number of samples that satisfy the narrative sign restriction reaches the required number. [13] After this process, the remaining sets are used for analysis.

4 Result

4.1 Benchmark result

The estimation results for the benchmark case that imposes the three Kuroda's bazookas-based shock sign restrictions and type B historical decomposition restrictions (overwhelming contributor) are reported in Figure 2, where the solid line and the shaded area show the posterior median and 68 percent credible intervals of the impulse responses of the six variables to an expansionary UMP shock over a 10-year period. The UMP shock has been normalized to induce a 10 basis points decline on the long term interest rate (LTR_t).

[11] Specifically, we change the conditional likelihood into the unconditional likelihood by dropping the function $\omega(\cdot)$, which is the importance sampling weight, from the following posterior density formula in Antolín-Díaz and Rubio-Ramírez (2018).

$$\pi(\mathbf{B}, \mathbf{\Sigma}, \mathbf{Q} \mid \mathbf{y}^T, \mathbf{\Phi}(\mathbf{B}, \mathbf{\Sigma}, \mathbf{Q}, \mathbf{y}^\nu, \mathbf{x}^\nu) > 0) \propto \frac{[\mathbf{\Phi}(\mathbf{B}, \mathbf{\Sigma}, \mathbf{Q}, \mathbf{y}^\nu, \mathbf{x}^{\circ}) > \mathbf{0}]\pi(\mathbf{y}^T \mid \mathbf{B}, \mathbf{\Sigma})}{\omega(\mathbf{B}, \mathbf{\Sigma}, \mathbf{Q})}\pi(\mathbf{B}, \mathbf{\Sigma})$$

[12] If it is supposed to impose the standard sign restrictions, first check that the set of parameters satisfies the standard sign restrictions and then check that it satisfies the narrative sign restrictions.

[13] In this study, our sampling is repeated until the number of samples satisfying the narrative sign restriction exceeds 5000.

On the whole, the impulse responses to expansionary UMP shock identified by using narrative sign restrictions are consistent with predictions from standard macroeconomic theory. First, both GDP and the inflation rate respond significantly in a positive direction. GDP increases within a few months of the shock, peaks at 0.4% after three years, and then gradually returns to its original level. The inflation rate also increases to 0.1% for about one year after the shock, and then gradually decreases. The result that the UMP shock has a positive effect on output and prices is consistent with the results of Miyao and Okimoto (2020) and Kubota and Shintani (2025).

Second, the three financial variables also respond significantly. The stock prices and the growth rate of bank lending show a positive response, while the exchange rate shows a negative response, as it shows a response in the direction of a weaker yen. The stock prices increase by 4.9% after four years. The growth in bank lending also increases by 0.2% in one year. The exchange rate also shows a depreciation of the yen of 1.1% after four years. These responses imply that the exchange rate channel, asset price channel, and credit channel are all functioning as a transmission mechanism for unconventional monetary policy.

Furthermore, we compare the actual values of each variable during the QQE period (April 2013 to March 2024) with the estimated values excluding the UMP shock, using the historical decomposition method in Figure 3. [14] Focusing on GDP and the inflation rate, we can see that the estimated values without the UMP shock are lower than the actual values, and that the UMP shock had the effect of pushing up GDP and the inflation rate. The maximum deviation is 10.8 trillion yen for GDP and 0.4 percentage points for the inflation rate. Figure 4 also shows the contribution of the UMP shock to the actual values of each variable. It can be confirmed that the UMP shock pushed up the level of GDP by 1.0% and the inflation rate by 0.2% on average over the period. With regard to financial variables, the UMP shock also affected the exchange rate by −2.6%, stock prices by 10.9%, and the growth rate of bank lending by 0.3% on average over the period. Our results imply that unconventional monetary policy is effective for the

[14] See Kilian and Lütkepohl (2017) for a textbook treatment of counterfactual analysis using historical decomposition.

macroeconomy, and are broadly consistent with the results of Haba et al. (2025), who estimated the effects of UMP from the introduction of QQE in 2013 to the April-June quarter of 2023 using the Bank of Japan's large-scale macroeconomic model, Q-JEM (Quarterly Japanese Economic Model). [15]

4.2 Comparison with the case without narrative sign restrictions

For comparison with the results of the benchmark case, we show the results of using other identification strategies that do not use the narrative information. Specifically, we show the results of using the recursive restrictions (Cholesky decomposition) and the standard sign restrictions.

The recursive restrictions are an identification method traditionally used in VAR models. We assume that the long-term interest rate is the policy variable, and in the conventional manner we place the slow-moving variables (GDP, inflation rate) before it, and the fast-moving variables (exchange rate, stock price, bank lending balance) after it. Figure 5 reports the impulse responses to expansionary UMP shocks using the recursive restrictions for identification. It shows strange results for some variables, unlike the benchmark case that uses narrative sign restrictions. The inflation rate initially responds in the negative direction, causing a price puzzle problem. The exchange rate rises, stock prices and growth rate of bank lending decline, which is also inconsistent with the theory.

On the other hand, the standard sign restrictions developed by Uhlig (2005) are generally weaker assumptions than traditional identification strategies, such as recursive restrictions, and are therefore used by many researchers. For the setting up of standard sign restrictions, we impose sign restrictions in which long-term interest rate responds negatively and inflation rate responds positively for twelve months following the expansionary UMP shocks based on the research by Schenkelberg and Watzka (2013), who examined the effects of Japan's QE using the standard sign restrictions. Figure 6 reports the impulse responses to expansionary UMP shocks using the stan-

[15] They reported that QQE boosted the level of real GDP by an average of 1.3 to 1.8%, and the year-on-year change in CPI (excluding fresh food and energy) by an average of 0.5 to 0.7 percentage points.

dard sign restrictions for identification. These findings indicate that all the variables respond in a direction consistent with the theory. GDP and the inflation rate respond in a positive direction to expansionary UMP shocks. Of the three monetary variables, stock prices and the growth rate of bank lending respond in a positive direction, while the exchange rate responds in a negative direction.

However, we can notice that the credible intervals are wider than in the benchmark case using the narrative sign restriction. When standard sign restrictions are used for identification, there are not a few cases where the credible intervals become wider, and this is widely recognized as a drawback of using standard sign restrictions. To solve this problem, Antolín-Díaz and Rubio-Ramírez (2018) have shown that by additionally imposing narrative sign restrictions on standard sign restrictions, it is possible to sharpen the inference of the structural VAR model more than when only standard sign restrictions are imposed. Figure 7 shows the results of additionally imposing the same narrative sign restrictions as the benchmark case on the standard sign restrictions described above. It can be seen that the credible intervals of the impulse responses of all variables to UMP shocks are as narrow as those of the benchmark case.

One reason why impulse responses are improved by additionally using the narrative sign restrictions is that it becomes possible to identify more accurately structural shocks. Figure 8 shows the posterior distribution of the UMP shocks in February 2016, when the third of Kuroda's bazookas occurred. The light histogram represents the case where the only standard sign restrictions are imposed, while the darker histogram represents the case where both standard sign restrictions and narrative sign restrictions are imposed. In the case where only the standard sign restrictions are imposed, some of the values are estimated as positive (contractionary shocks), but in the case where the narrative sign restrictions are imposed, all the values are estimated as negative (expansionary shocks).

These comparisons demonstrate the benefits of using narrative sign restrictions for identification. The effects of UMPs can be more clearly identified when narrative information is used for identification. We thus expect that this identification strategy reduces the risk of making incorrect inferences in the structural VAR model.

4.3 Robustness Check

4.3.1 Weaker historical decomposition restrictions

In our benchmark case, we impose the “shock sign restrictions” in equations (7) to (9) and the type B “historical decomposition restrictions” in equation (10). In this section, we examine whether the use of weaker historical decomposition restrictions affects the estimation results. Specifically, we examine the case where the type A "historical decomposition restrictions" (most important contributor) following equation (11) are used instead of the type B restrictions in equation (10).

$$\mid H_{3,3,2016m2}(\Theta, \varepsilon_{2016m2}(\Theta)) \mid - \max_{j' \neq 3} \mid H_{3,j',2016m2}(\Theta, \varepsilon_{2016m2}(\Theta)) \mid > 0 \tag{11}$$

Figure 9 shows the impulse responses to the expansionary UMP shocks, where the case using the type A historical decomposition restriction is represented as the dotted line and the lightly shaded area, and the benchmark case using the type B historical decomposition restriction is represented as the solid line and the darker area. Compared to the benchmark case, the credible intervals of using the type A historical decomposition restriction case are slightly wider. However, the median responses of each variable are almost the same in both cases. It suggests that the results derived from benchmark estimation do not change depending on the strength of the historical decomposition restrictions.

4.3.2 Other policy variables

In the benchmark estimation, we used the long-term interest rate as a policy variable of UMPs, but in this section, we use instead the short-term shadow rate (SSR_t). We use the short-term shadow rate estimated by Krippner (2020). To identify the UMP shocks, as in the benchmark estimation, we use the shock sign restrictions at three points based on Kuroda’s bazookas and one type B historical decomposition restriction. For the type

B historical decomposition restriction, we impose the restriction that the contribution of the UMP shock to the change in the short-term shadow rate in February 2016 is greater than the sum of the contributions of the other shocks.

Figure 10 shows the estimated impulse responses to the expansionary UMP shock. The UMP shock has been normalized to induce a 10 basis points decline on the short-term shadow rate. As with the benchmark case, the impulse responses to the UMP shocks identified using narrative sign restrictions are broadly consistent with the predictions from standard macroeconomic theory, even when using short-term shadow rate as the policy variable instead. First, both GDP and the inflation rate respond significantly in a positive direction. GDP increases to 0.2% after a half-year, and then gradually returns to its original level. The inflation rate also increases to 0.08% in the second month, and then gradually decreases. Second, the three financial variables also respond significantly. Stock prices and growth rate of bank lending respond positively, while the exchange rate responds negatively. The stock prices increase by 1.8% after three and a half years. The growth rate of bank lending also increases by 0.1% after one and a half years. The exchange rate also depreciates by 0.7% after 2 months.

Furthermore, we compare the actual values of each variable during the QQE period (April 2013 to March 2024) with the estimated values excluding the UMP shock, using the historical decomposition method in Figure 11. Focusing on GDP and the inflation rate, we can see that the estimated values without the UMP shock are lower than the actual values, and that the UMP shock had the effect of pushing up GDP and the inflation rate, as with the benchmark case. The maximum deviation is 16.0 trillion yen for GDP and 0.7 percentage points for the inflation rate. Figure 12 also shows the contribution of the UMP shock to the actual values of each variable. It can be confirmed that the UMP shock pushed up the level of GDP by 1.4% and the inflation rate by 0.3% on average over the period. With regard to financial variables, the UMP shock also affected the exchange rate by −4.4%, stock prices by 14.6%, and the growth rate of bank lending by 0.4% on average over the period.

In addition, Figure 13 shows the impulse responses to the expansionary UMP shock when the short-term shadow rate is used as a policy variable of UMPs and the Cholesky decomposition is used to identify the shocks. As with the case where the long-term interest rate is used as the policy variable, some of the variables show puzzling responses that are inconsistent with the theoretical predictions, as they respond for expansionary UMP shock in the direction of a stronger yen, lower inflation rate and the growth rate of bank lending.

Based on the above results, it can be confirmed that changing the policy variable has no significant impact on the results obtained from the benchmark estimation.

5 Conclusion

This study estimates the macroeconomic effects of Japan's unconventional monetary policy using a structural VAR model with a latest identification method, called narrative sign restrictions. Specifically, we attempt to identify UMP shocks by imposing restrictions on the sign of structural shocks and the contribution of UMP shocks to specific variables by using historical decompositions at the QQE period in which three major monetary easing shocks called Kuroda's bazookas occurred.

The main findings are as follows. First, an expansionary UMP shock pushes up output and inflation rates. This result is consistent with the results of Miyao and Okimoto (2020) and Kubota and Shintani (2025). Using the historical decomposition, it can be confirmed that the UMP shock pushed up the level of GDP by 1.0% and the inflation rate by 0.2% on average over the QQE period. Second, the exchange rate, stock prices, and bank loans respond to UMP shocks in a way that is consistent with the predictions of standard macroeconomic theory. This outcome implies that the exchange rate channel, the asset price channel, and the credit channel function as channels through which unconventional monetary policy affects the real economy. Third, we confirm that the narrative sign restriction is an effective tool for identifying UMP shocks. Using the narrative sign restriction independently or complementarily eliminates the puzzling responses of some variables that occur when using the Cholesky decomposition, and also eliminates the problem of the wide credible intervals that tend to occur when using standard sign restrictions. Being able to more clearly identify the effects of UMPs reduces the risk of making inadequate inferences from structural VARs.

There are some directions in which this study could be extended. In this study, we examine the macroeconomic effects of QQE. However, QQE is a combination of two major policy packages: quantitative easing and qualitative easing. As Koeda (2019) and Nakashima et al. (2024) have pointed out, the impact of each policy on macroeconomic variables could be different. With the use of narrative information, it seems to be possible to examine the macroeconomic effects of each policy that makes up QQE individually. The extension remains for future work.

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Variable	Definition	Source
GDP_t	Real GDP	Japan Center for Economic Research
INF_t	Year-on-year change in CPI (excluding food (less alcoholic beverages) and energy) with consumption tax adjusted	Ministry of Internal Affairs and Communications
LTR_t	Newly issued government bonds yield (10 years)	Cabinet Office
EXR_t	Nominal effective exchange rate	Bank of Japan
$STOCK_t$	Nikkei Stock Average index（Nikkei 225）	Nikkei Inc.
$LENDING_t$	Year-on-year change in domestic bank loans (Monthly average)	Bank of Japan

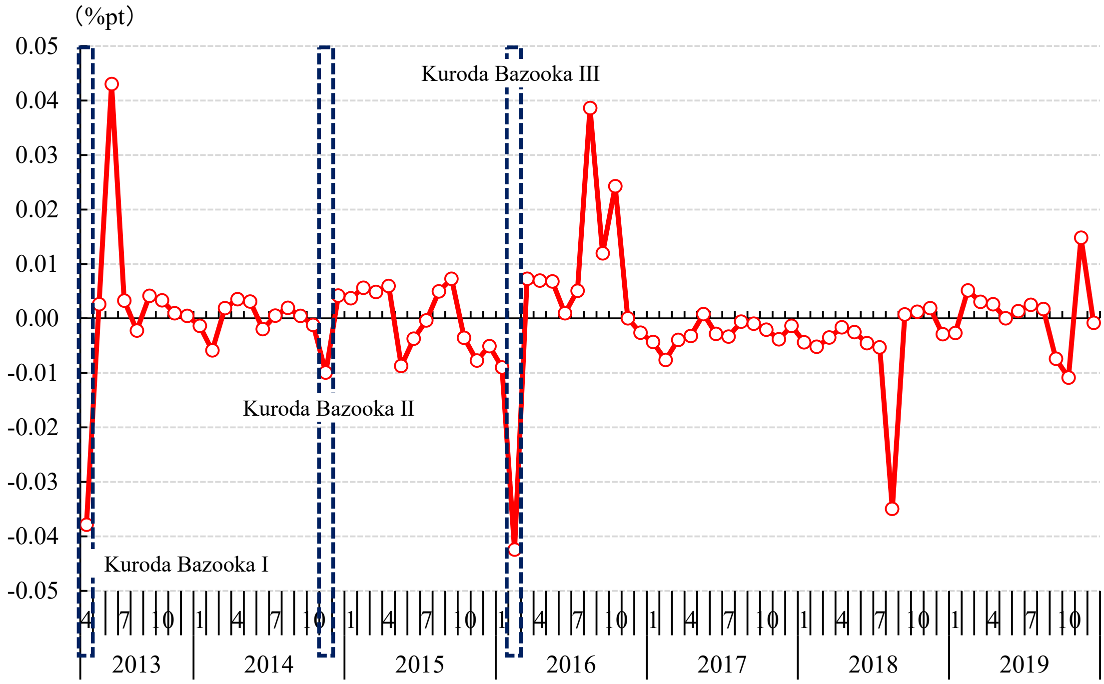
Notes: All variables are monthly series between January 2007 to December 2024. The GDP, exchange rate and stock price are in logarithmic form. The data series code for the domestic bank loan is BS02'FAABK_FAAB2DBHA37.

Table 1. Data source

(1)Shock sign restrictions
$\varepsilon_{j,t_\nu} = \mathbf{e}'_{j,n}\varepsilon_{t_\nu}(\Theta) < 0$
(2)Historical decomposition restrictions
(I)Type A restrictions (most important contributor)
$\mid H_{i_\nu,j,t_\nu,t_\nu+h_\nu}(\Theta,\varepsilon_{t_\nu}(\Theta),...,\varepsilon_{t_\nu+h_\nu}(\Theta)) \mid - \max_{j\neq j'} \mid H_{i_\nu,j',t_\nu,t_\nu+h_\nu}(\Theta,\varepsilon_{t_\nu}(\Theta),...,\varepsilon_{t_\nu+h_\nu}(\Theta)) \mid > 0$
(II)Type B restrictions (overwhelming contributor)
$\mid H_{i_\nu,j,t_\nu,t_\nu+h_\nu}(\Theta,\varepsilon_{t_\nu}(\Theta),...,\varepsilon_{t_\nu+h_\nu}(\Theta)) \mid - \Sigma_{j\neq j'} \mid H_{i_\nu,j',t_\nu,t_\nu+h_\nu}(\Theta,\varepsilon_{t_\nu}(\Theta),...,\varepsilon_{t_\nu+h_\nu}(\Theta)) \mid > 0$

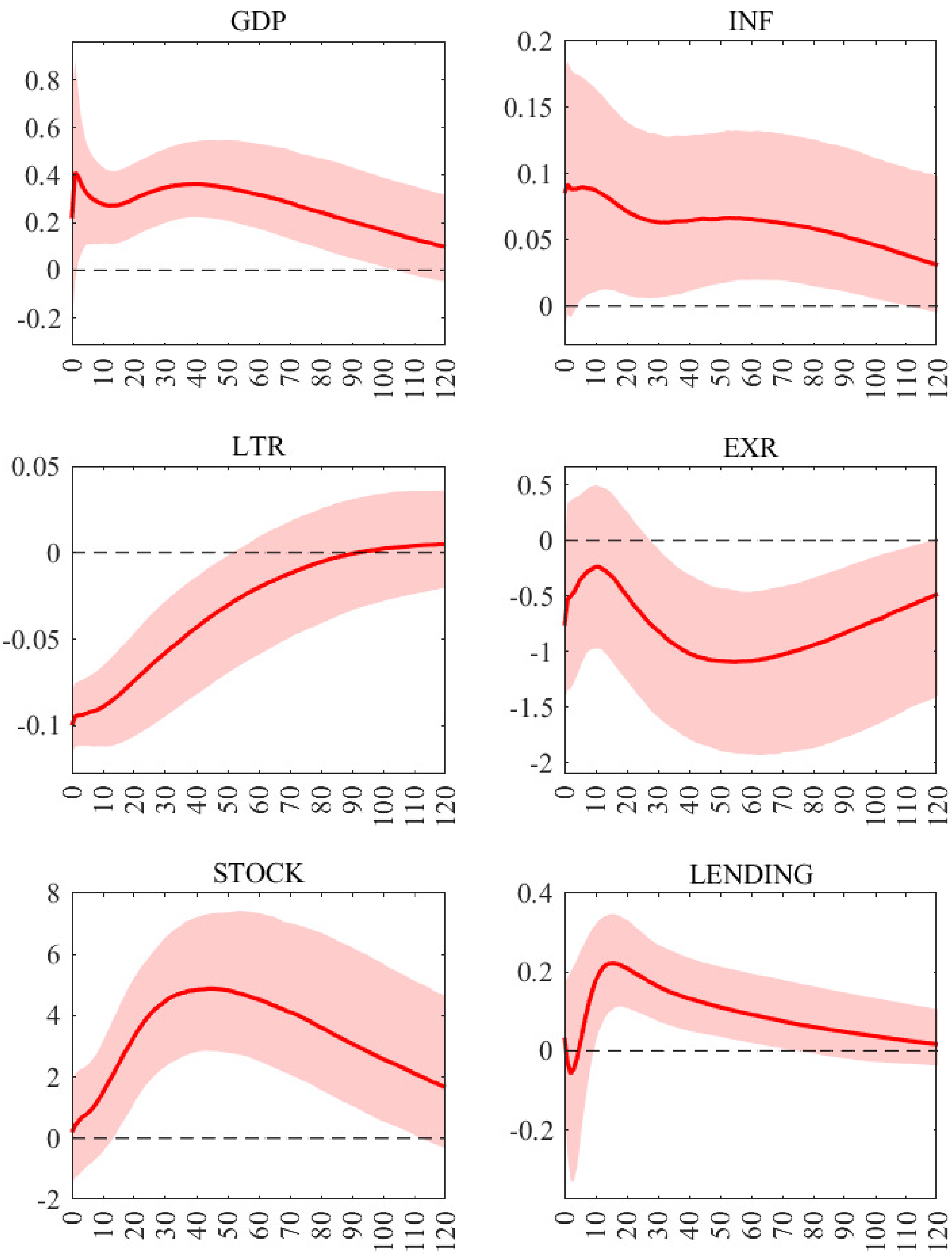
Notes: $H(\cdot)$ represents the historical decompositions, and it calculates the contribution of the jth shock to the unexpected change in the ith variable between periods t_ν to $t_\nu + h_\nu$. Θ represents a set of parameters.

Table 2. Two types of narrative sign restrictions



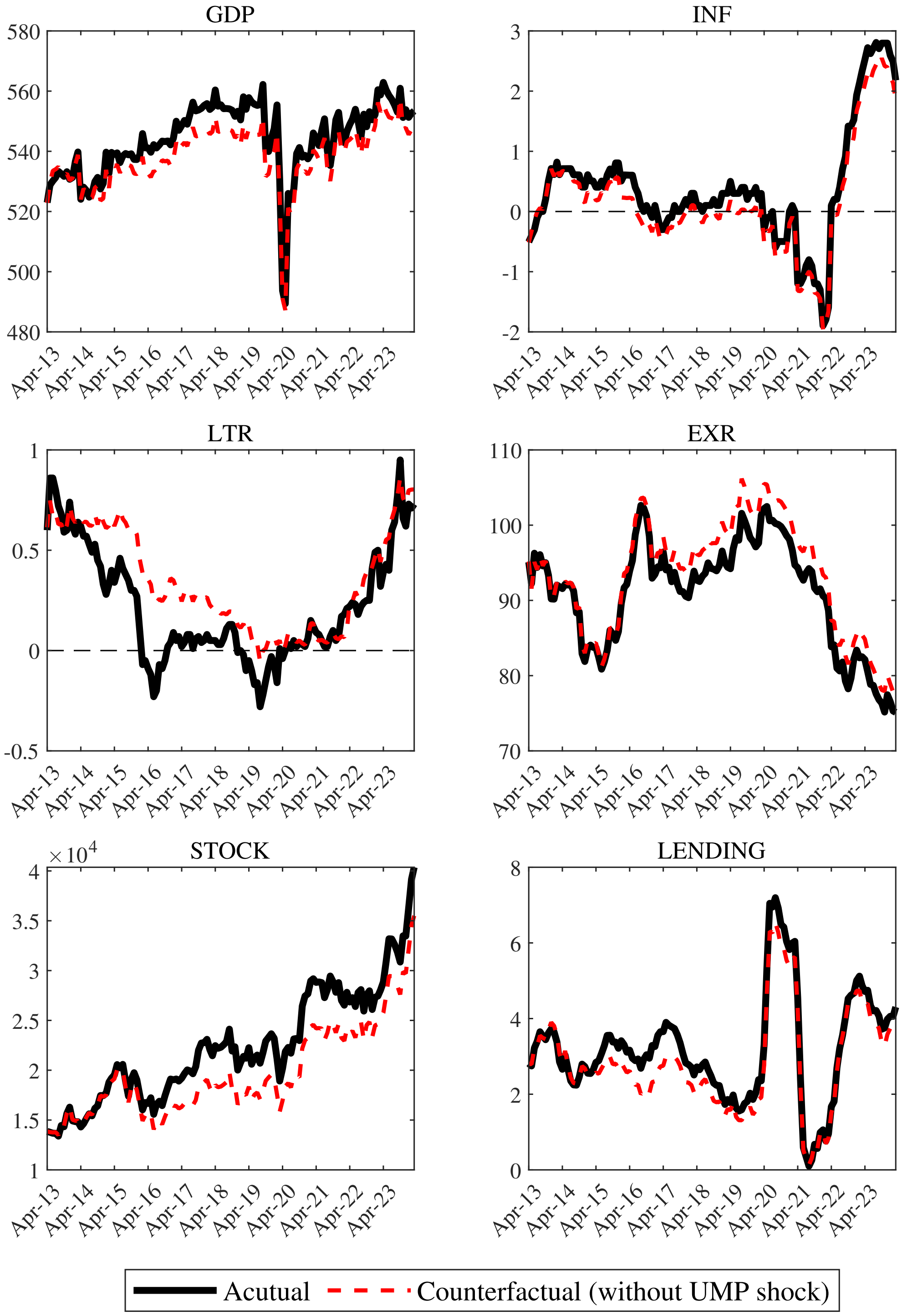
Notes: It is from Kubota and Shintani (2022), which measures the changes in 10-year JGB futures by the difference between 10 minutes before and 20 minutes after the BOJ statement.

Figure 1. Monetary policy surprises measured as changes in 10-year JGB futures



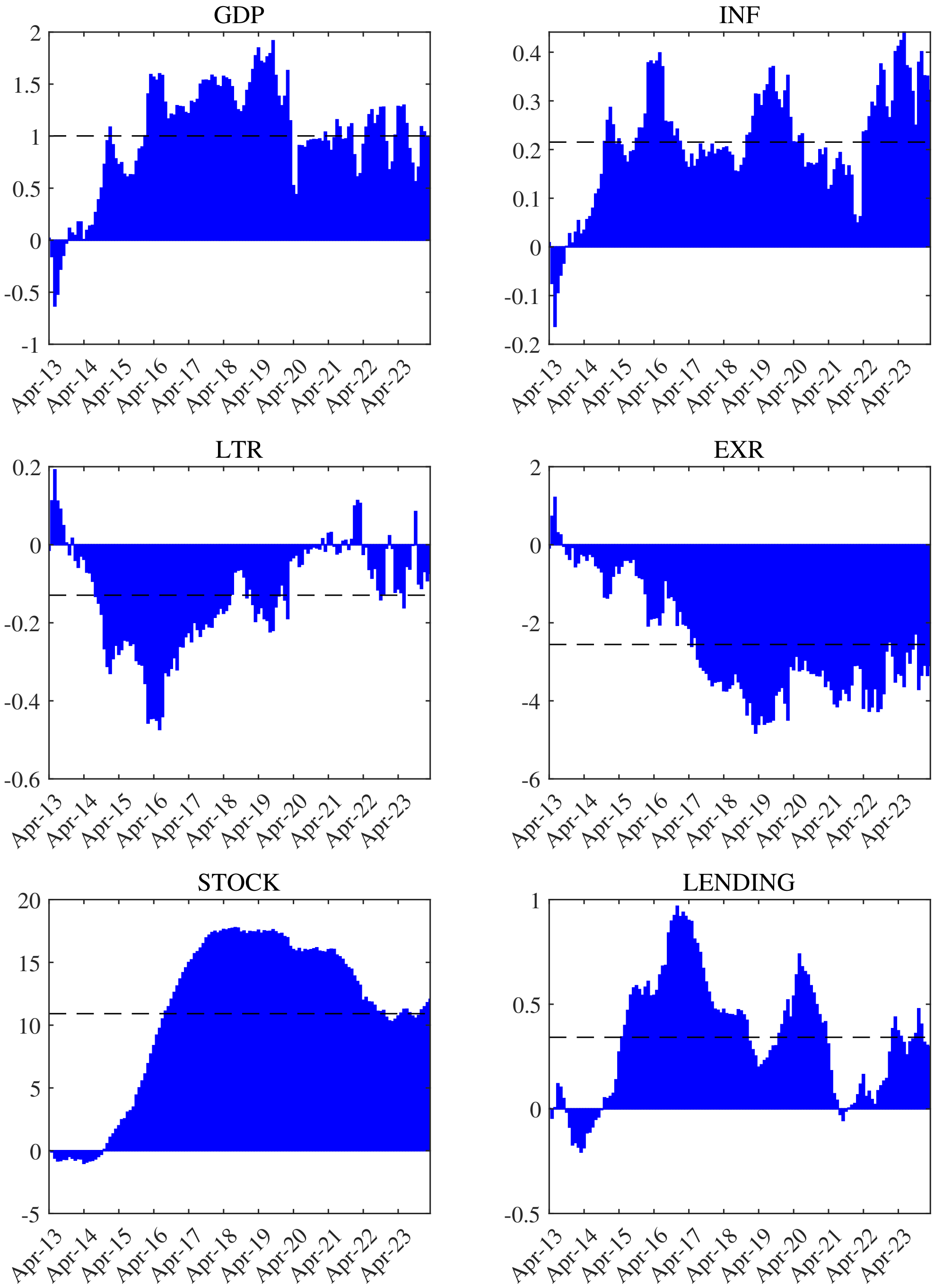
Notes: The impulse responses are obtained from our structural VAR model with shock sign restrictions and type B historical decomposition restrictions (overwhelming contributor) based on narrative information about Kuroda's bazookas. It uses 5000 sets that satisfy the restrictions. Solid line are median estimates; shaded area correspond to 68 percent credible intervals. The UMP shock has been normalized to have an impact of minus 10 basis points on LTR.

Figure 2. Impulse responses to expansionary UMP shock (Benchmark case)



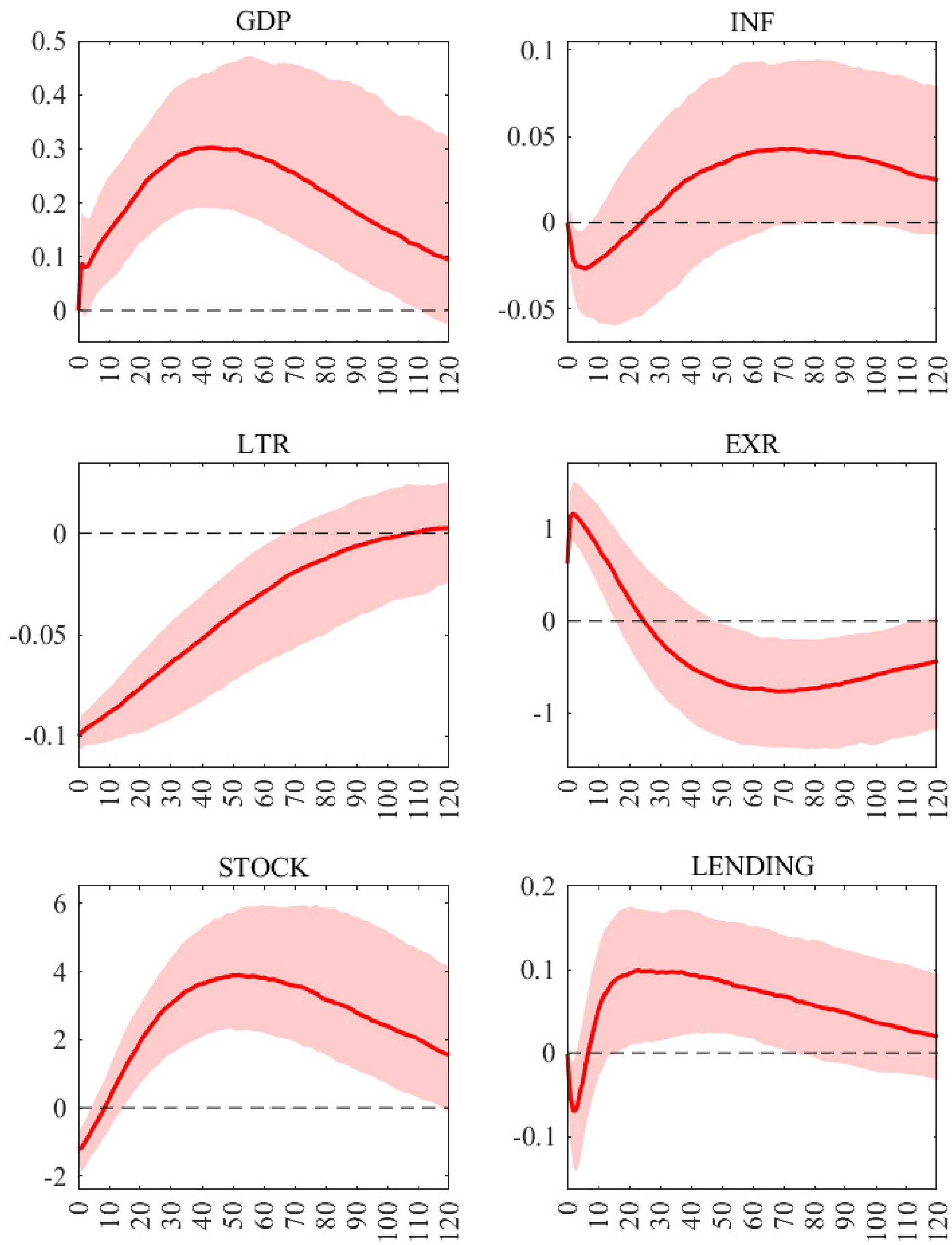
Notes: The bold line plots the actual values. The dashed line is the counterfactual estimates without UMP shock using historical decomposition.

Figure 3. Historical counterfactuals during QQE period



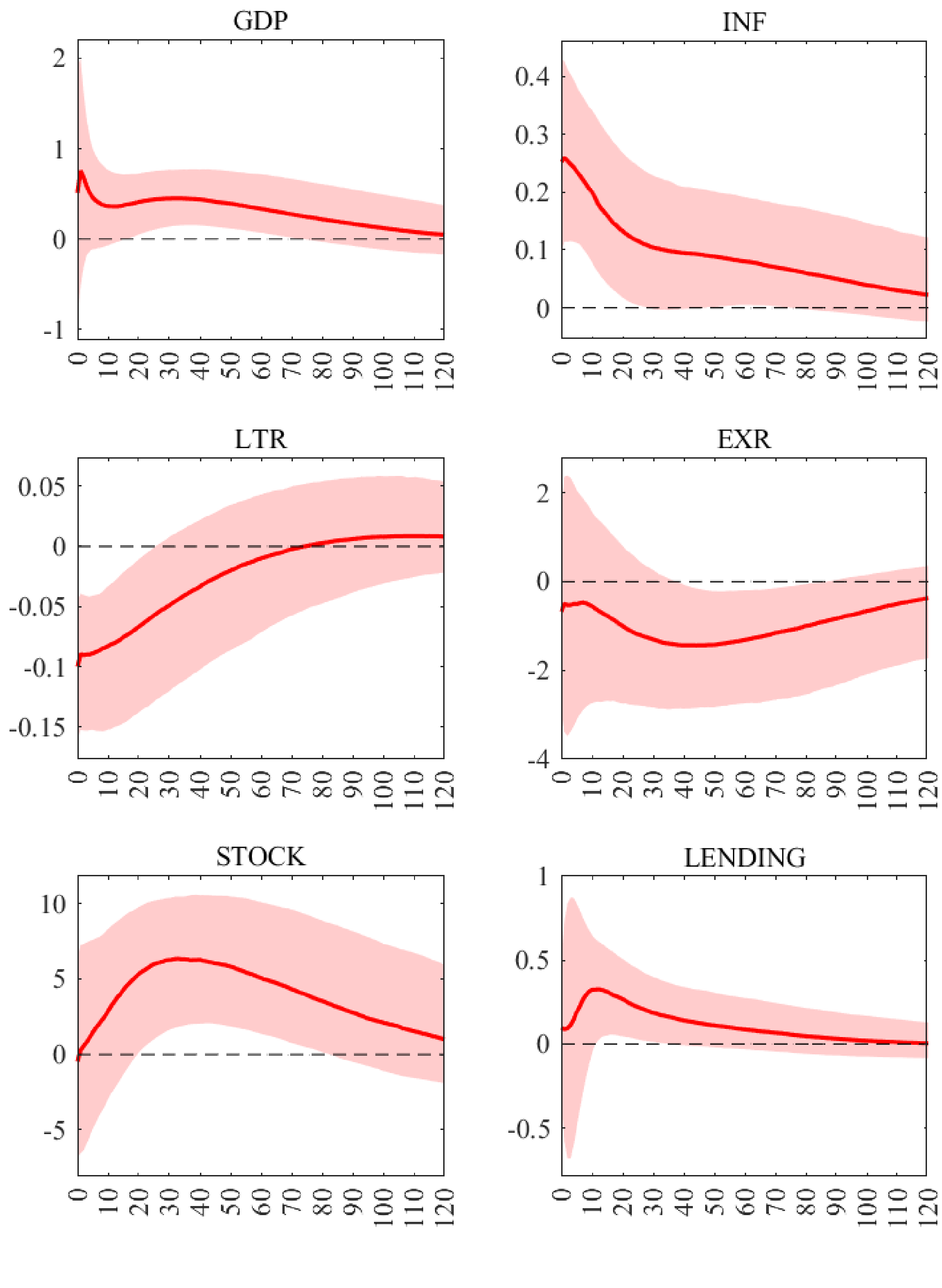
Notes: The bar graph shows the contribution of the UMP shock to the actual value. The dashed line shows the average value during the period.

Figure 4. Contribution of UMP shock to the actual value during QQE period



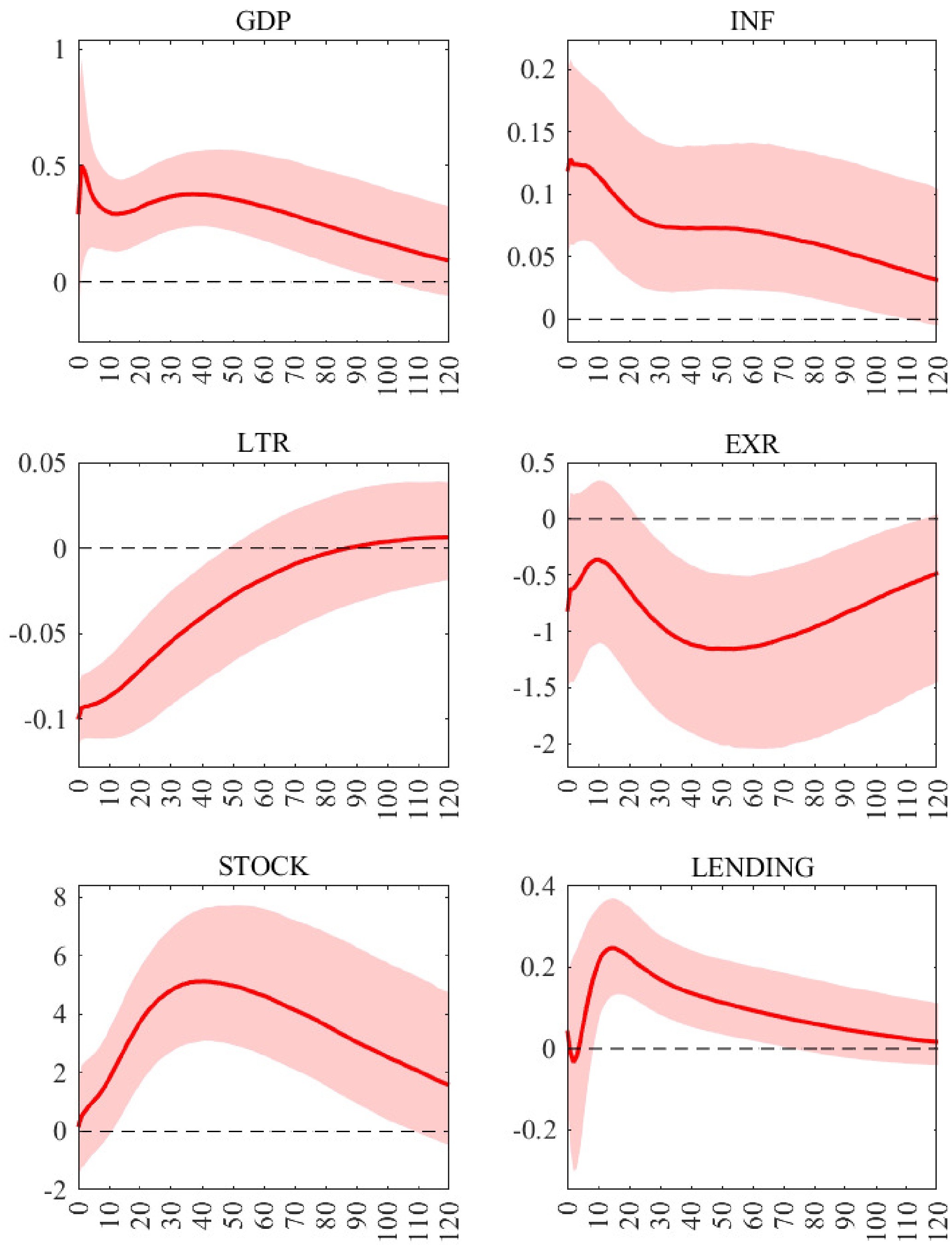
Notes: The impulse responses are obtained from our structural VAR model with Cholesky decomposition. The variables are ordered as the slow variables (GDP_t, INF_t), policy variable (LTR_t), fast variable (EXR_t, $STOCK_t$, $LENDING_t$). It uses 5000 data sets. Solid line are median estimates; shaded area correspond to 68 percent credible intervals. The UMP shock has been normalized to have an impact of minus 10 basis points on LTR.

Figure 5. Impulse responses to expansionary UMP shock (Using Cholesky decomposition)



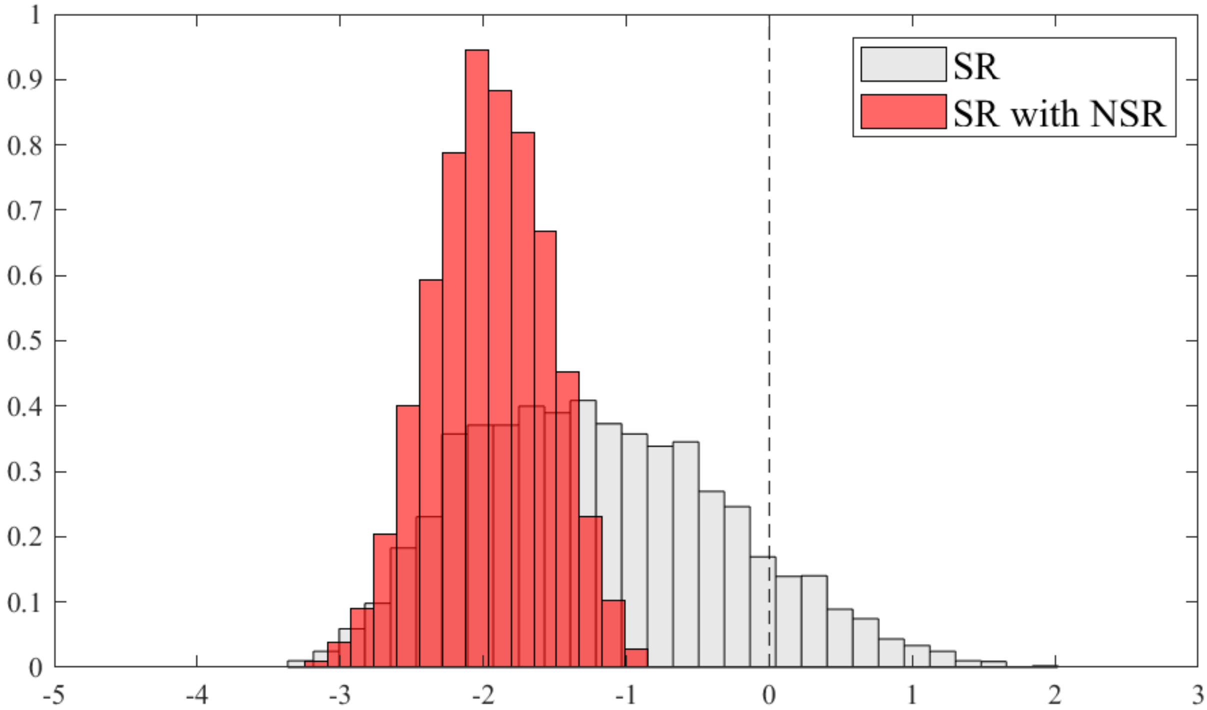
Notes: The impulse responses are obtained from our structural VAR model with standard sign restrictions. It is assumed that long term interest rate responds negatively, inflation rate respond positively for twelve months following the UMP shocks. It uses 5000 sets that satisfy the restrictions. Solid line are median estimates; shaded area correspond to 68 percent credible intervals. The UMP shock has been normalized to have an impact of minus 10 basis points on LTR.

Figure 6. Impulse responses to expansionary UMP shock (Using standard sign restrictions)



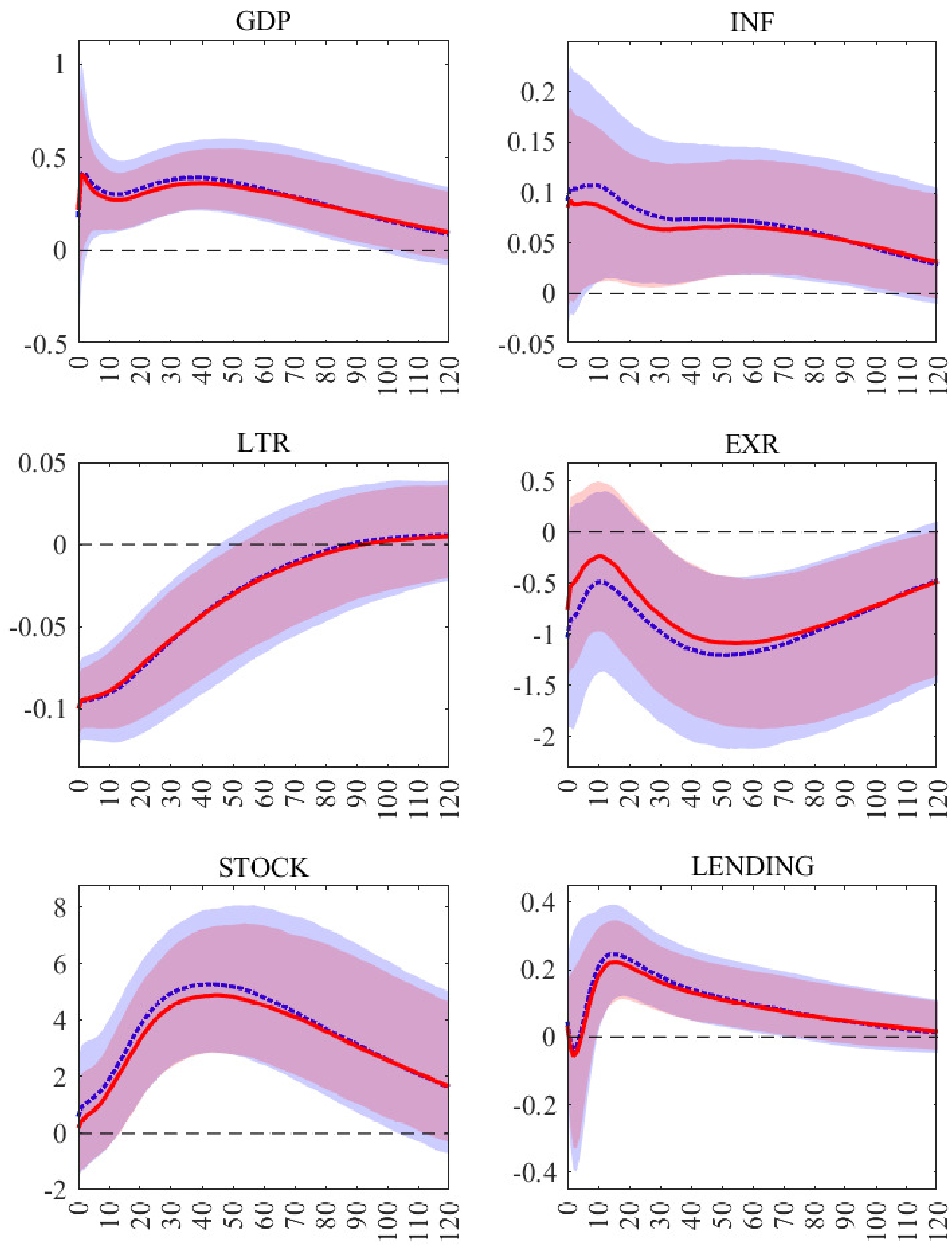
Notes: The impulse responses are obtained from our structural VAR model using both standard sign restrictions and narrative sign restrictions. For the standard sign restrictions, it is assumed that long term interest rate responds negatively, inflation rate respond positively for twelve months following the UMP shocks. For the narrative sign restrictions, the same restrictions as the benchmark case are imposed. It uses 5000 sets that satisfy the restrictions. Solid line are median estimates; shaded area correspond to 68 percent credible intervals. The UMP shock has been normalized to have an impact of minus 10 basis points on LTR.

Figure 7. Impulse responses to expansionary UMP shock (Using both standard sign restrictions and narrative sign restrictions)



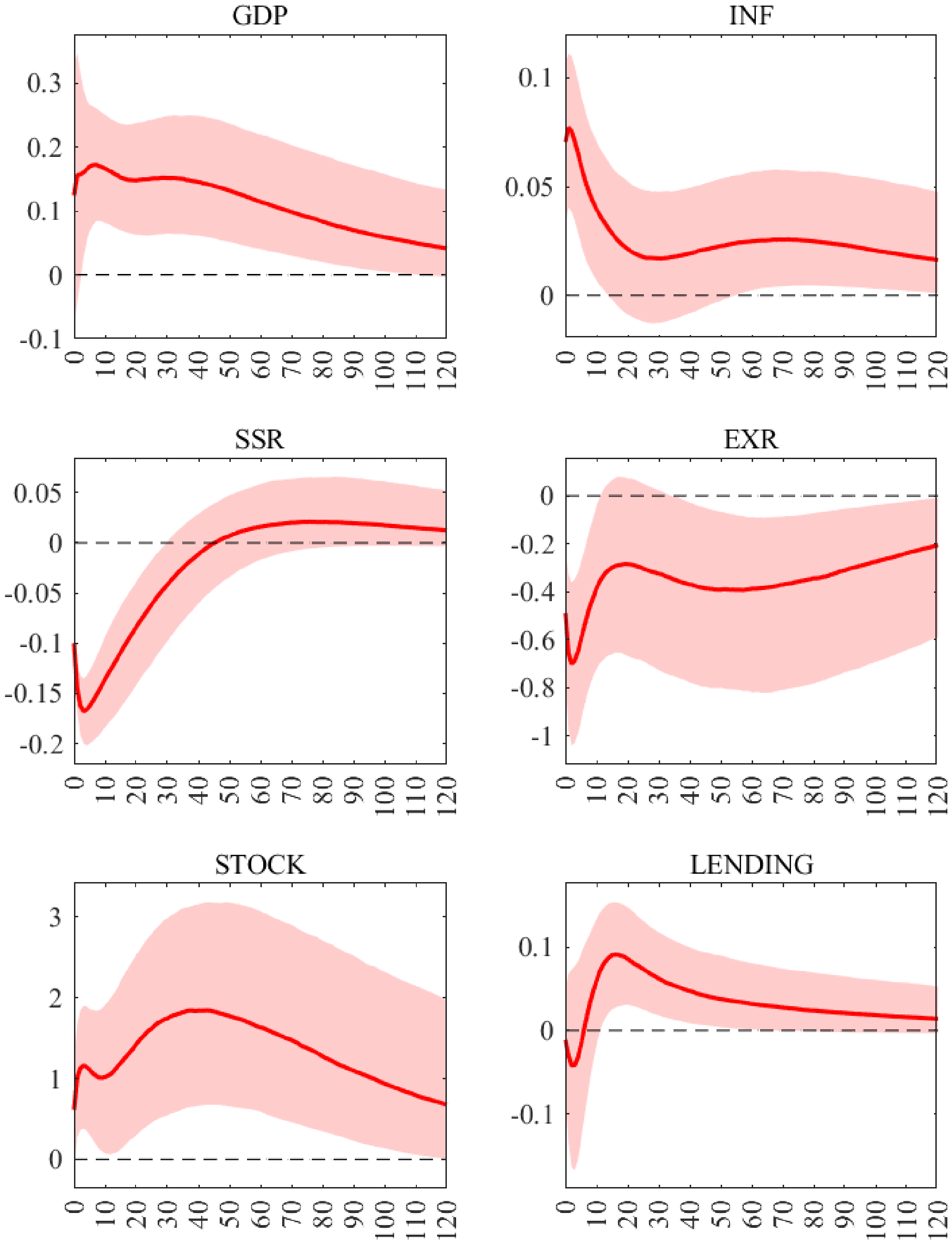
Notes: The light histogram plots the posterior distribution of the UMP shock at February 2016 with the case where the only standard sign restrictions are imposed. The darker histogram plots the posterior distribution of the UMP shock at February 2016 with the case where both standard sign restrictions and narrative sign restrictions of the benchmark case are imposed. It uses 5000 sets that satisfy the restrictions respectively.

Figure 8. UMP shock at February 2016 with and without narrative sign restrictions



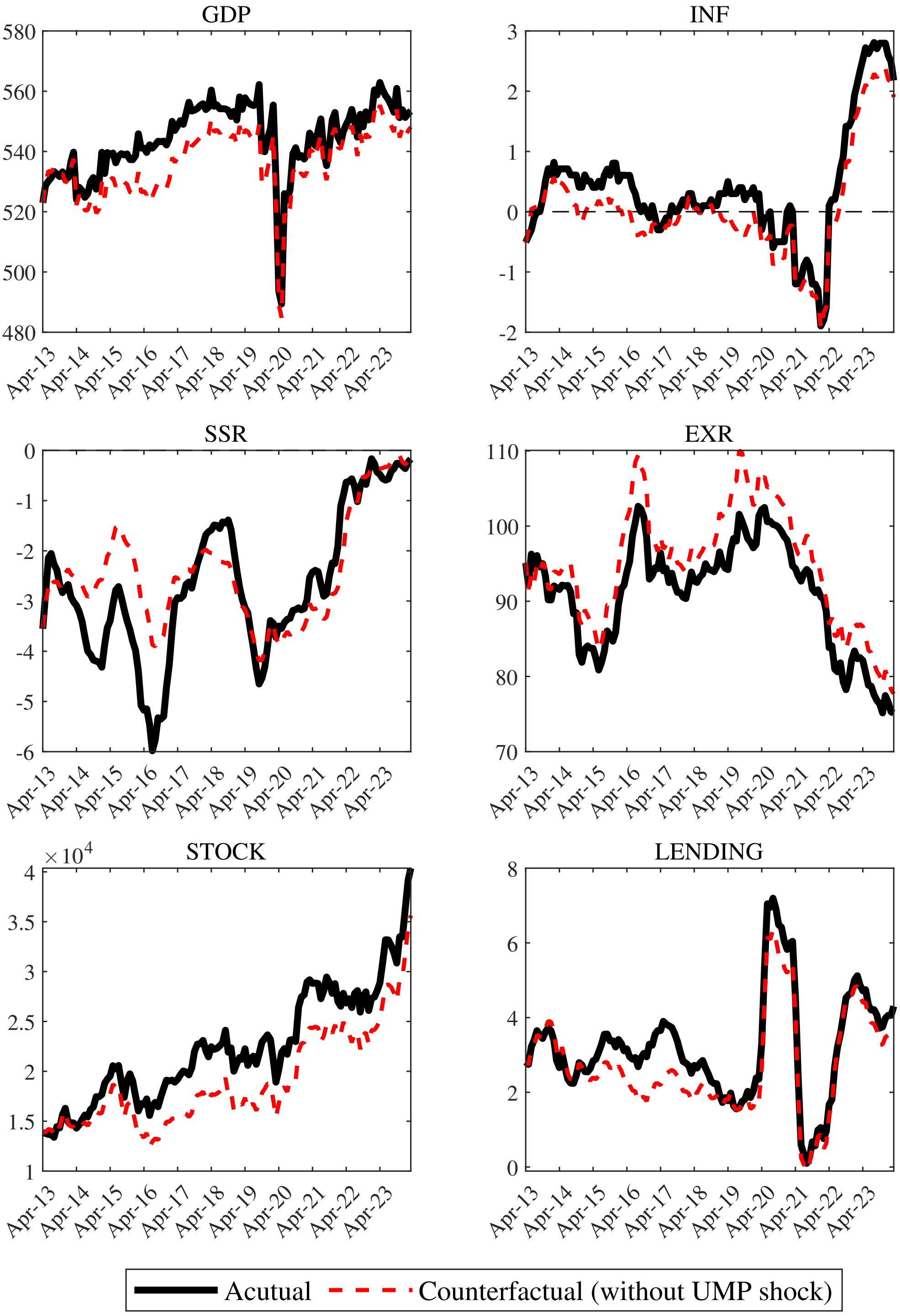
Notes: The light shaded area and dotted line represent the IRFs of the case where type A (most important contributor) historical decomposition restrictions are imposed. The darker shaded area and solid line represent the IRFs of the case where type B (overwhelming contributor) historical decomposition restrictions are imposed.

Figure 9. Impulse responses to expansionary UMP shock with alternative restrictions (type A or type B historical decomposition restrictions)



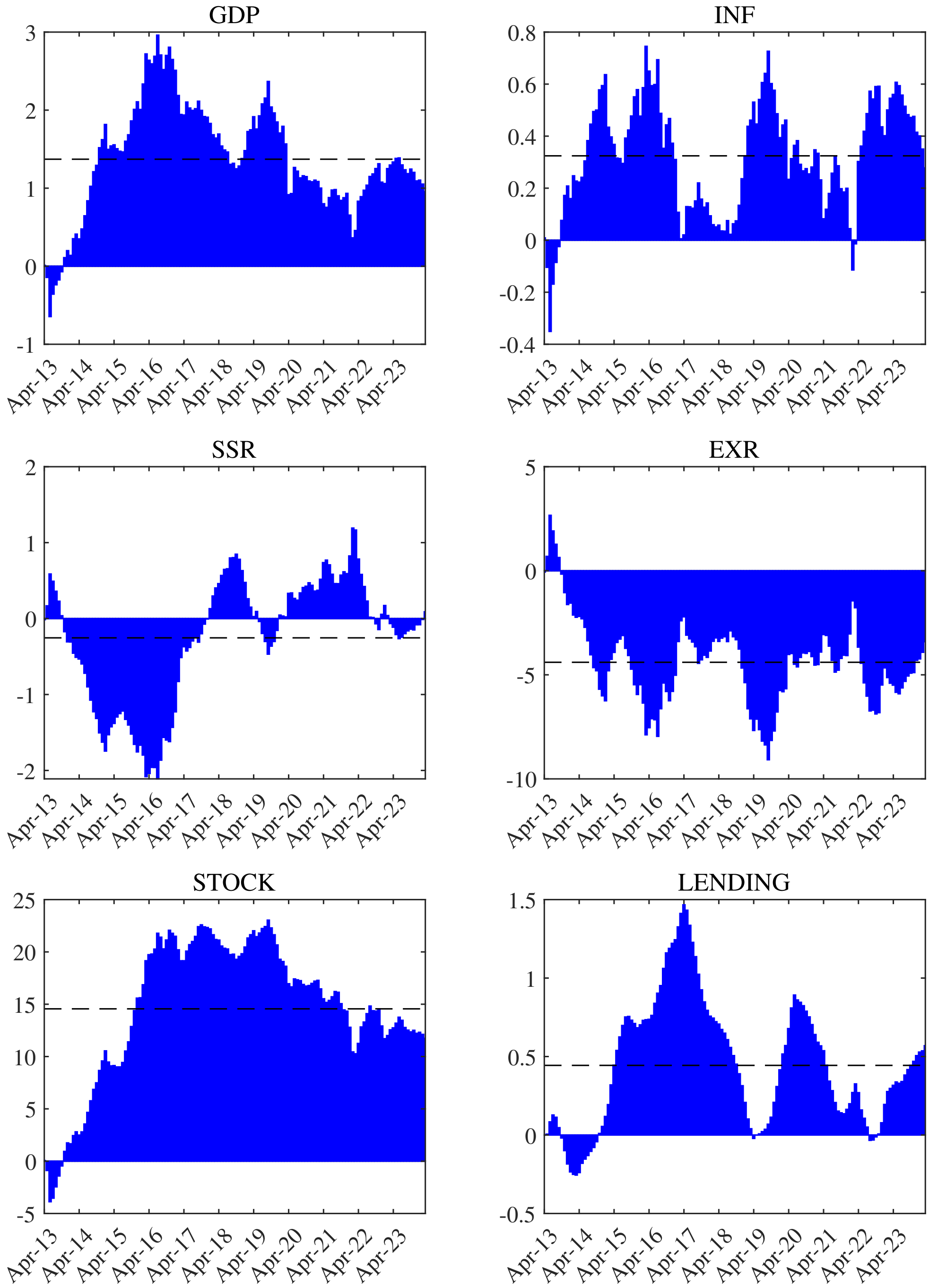
Notes: The impulse responses are obtained from our structural VAR model with shock sign restrictions and type B historical decomposition restrictions (overwhelming contributor) based on narrative information about Kuroda's bazookas. It uses 5000 sets that satisfy the restrictions. Solid line are median estimates; shaded area correspond to 68 percent credible intervals. The UMP shock has been normalized to have an impact of minus 10 basis points on SSR.

Figure 10. Impulse responses to expansionary UMP shock estimated with short term shadow rate (using narrative sign restrictions)



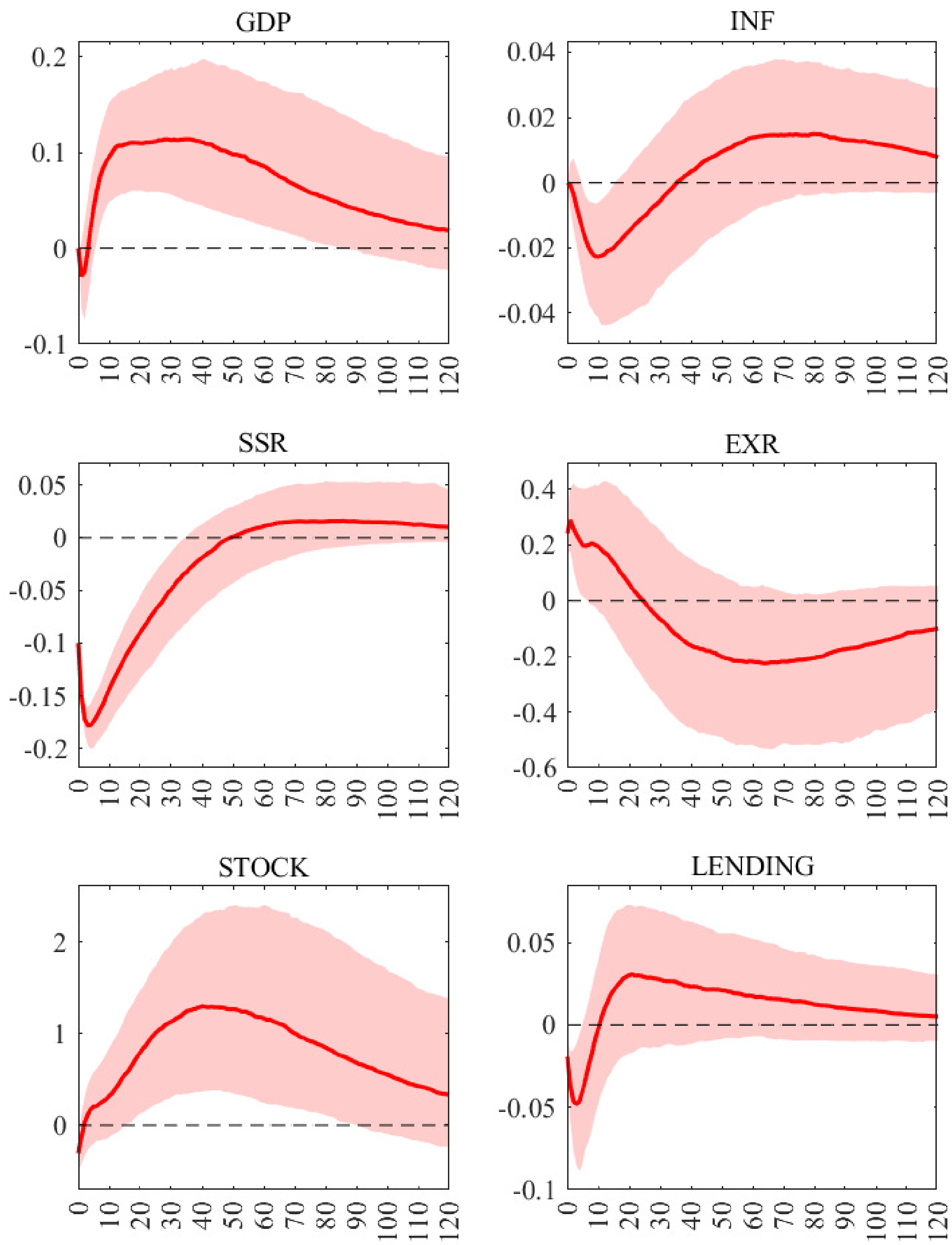
Notes: The bold line plots the actual values. The dashed line is the counterfactual estimates without UMP shock using historical decomposition.

Figure 11. Historical counterfactuals during QQE period estimated with short term shadow rate



Notes: The bar graph shows the contribution of the UMP shock to the actual value. The dashed line shows the average value during the period.

Figure 12. Contribution of UMP shock to the actual value during QQE period estimated with short term shadow rate



Notes: The impulse responses are obtained from our structural VAR model with Cholesky decomposition. The variables are ordered as the slow variables (GDP_t, INF_t), policy variable (SSR_t), fast variable $(EXR_t, STOCK_t, LENDING_t)$. It uses 5000 data sets. Solid line are median estimates; shaded area correspond to 68 percent credible intervals. The UMP shock has been normalized to have an impact of 10 basis points on SSR.

Figure 13. Impulse responses to expansionary UMP shock estimated with short term shadow rate (using Cholesky decomposition)

Appendix

In this appendix, we provide detailed summaries and background on three major monetary easing surprises called Kuroda's bazookas in the QQE periods.

Kuroda's bazooka I (April 4, 2013)

In December 2012, the second Shinzo Abe Cabinet was formed. Prime Minister Abe has proposed Abenomics, which consists of three arrows: (1) an aggressive monetary easing, (2) a flexible fiscal policy, and (3) a growth strategy that stimulates private investment, with the aim of overcoming deflation. In February 2013, the government and the BOJ released a joint statement with the aim of overcoming deflation early and achieving sustainable economic growth with price stability. In this context, on March 20, 2013, Mr. Haruhiko Kuroda, a former official of the Ministry of Finance and former President of the Asian Development Bank, was appointed as the new Governor of the BOJ, with a mandate to pursue aggressive monetary easing.

The Monetary Policy Meeting held on April 3 and 4, 2013 was the first meeting for Governor Kuroda since he took office. Since the launch of the Abe Cabinet at the end of the previous year, the financial markets have been anticipating the introduction of strong monetary easing measures, and the yen has weakened, stocks prices and bond prices have risen. With the financial markets paying close attention to what kind of easing measures Governor Kuroda would introduce, the *Financial Times* (Mackenzie (2013)) reported the following: "Markets don't like being disappointed, and it's show time for the Bank of Japan. Three central banks meet on Thursday but the focus is on the BOJ under the new leadership of Haruhiko Kuroda". On the other hand, there were also cautious views, such as the view that it would be difficult to meet all of the expectations of the financial markets because only two weeks had passed since his appointment as governor (the Nikkei (2013)), and the view that the specifics of monetary easing would be postponed to the next meeting (the Asahi-Shimbun (2013)).

Amidst this mixture of expectations and anxieties, the actual policies that were implemented greatly exceeded market expectations. Under the leadership of Governor

Kuroda, the BOJ decided to introduce QQE by unanimous vote of the members of the Monetary Policy Meeting. Aiming for a steady year-on-year increase in the CPI above two percent, the BOJ announced that it would double the monetary base, double its holdings of long-term JGBs, double the average maturity of purchased long-term JGBs and increase purchases of ETFs and J-REITs over an initial period of about two years. At a press conference on April 4, 2013, Governor Kuroda emphasized that (1) all necessary policies had been implemented at that point, (2) the framework of the policies had been revised to make them easier to understand, and (3) the new monetary easing was different from previous measures in both quantity and quality.

The new monetary policy announced by Governor Kuroda was clearly different from the monetary policy of the previous Governor Shirakawa, who was criticized for his incremental approach (the Nikkei (2023)). For the introduction of the QQE, the *Financial Times* (Soble (2013)) cited an analyst at Credit Suisse, Hiromichi Shirakawa, who described as "The timing was a surprise and the magnitude was more than expected." The *Bloomberg News* (Fujioka and Hidaka (2013)) also reported that the BOJ set a two-year horizon for the price target under the new monetary easing policy, quoting Takuji Okubo, chief economist at Japan Macro Advisors in Tokyo and formerly at Goldman Sachs Group Inc. as saying that "it's fast and furious" and that "the specific mention of a two-year time horizon was a positive surprise."

Kuroda's bazooka II (October 31, 2014)

In April 2014, Japan raised its consumption tax rate from five percent to eight percent. After that, the Japanese economy was sluggish due to a reactionary decrease in the rush demand that occurred before the consumption tax rate was raised. In addition, against the backdrop of concerns about a slowdown in the global economy, crude oil prices have been falling since the summer, and downward pressure on consumer prices has been increasing. In overseas financial markets, there were also voices of disappointment about Governor Kuroda not taking additional easing measures (Otsuka (2014)). Even among economists in Japan, there were few who thought that the BOJ would move to implement additional monetary easing immediately. According to the

ESP Forecast survey, which collects forecasts from economists conducted by JCER, as of early October 2014, 10 out of 38 respondents predicted that the BOJ would adopt additional monetary easing at its Monetary Policy Meeting to be held at the end of the month.

On October 31, 2014, the Monetary Policy Meeting was held, and the BOJ decided to expand QQE by a narrow margin of five to four. In addition to raising the target annual increase in the monetary base, the BOJ announced that it would increase its purchases of long-term JGBs, ETFs, and J-REITs, and extend the average remaining maturity of purchased long-term JGBs by up to about three years compared to the past. At the press conference following the Monetary Policy Meeting, Governor Kuroda explained that the Japanese economy had been weak after the consumption tax rate was increased and that there were short-term factors pushing down prices, such as the fall in crude oil prices. He then stated that the reason for the additional monetary easing was to prevent the risk of a delay in the steady progress of the change in deflationary sentiment from becoming a reality and to maintain the momentum of the improvement in inflation expectations. However, the Policy Board members who opposed the expansion of QQE shared the view that the risk of a downward swing in the outlook for prices was increasing, but they also stated that the effects of additional monetary easing did not outweigh the costs and side effects associated with it.

In the morning of October 31, the majority view in the Tokyo stock market was that there would be no additional monetary easing this time, so the BOJ's decision, which was announced in the afternoon, was received with great surprise (Sakai (2014)). The *Financial Times* (Cook (2014)) reported that "Bank of Japan surprised global financial markets on Friday by expanding its massive stimulus spending in a stark admission that economic growth and inflation have not picked up as much as expected after a sales tax hike in April". The *Bloomberg News* (Scott and Fujioka (2014)) also reported "Kuroda led a divided board in Tokyo in a surprise decision to expand unprecedented monetary stimulus" and cited a chief economist at JPMorgan Chase & Co. in Tokyo, Masaki Kanno, who described as "We have to admit that this is sort of a second shock after we had the first shock in April last year."

Kuroda's bazooka III (January 29, 2016)

The financial markets were turbulent at the start of 2016. The global economic outlook became increasingly uncertain due to the continued fall in crude oil prices and the economic slowdown in China and other emerging and resource-producing countries, and stock markets worldwide, including Japan, had been weak since the end of the previous year.

However, surprisingly few economists in Japan thought that the BOJ would embark on additional monetary easing. According to the ESP Forecast survey conducted by JCER, as of early January 2016, only 6 out of 35 economists predicted that the BOJ's Monetary Policy Meeting at the end of the month would adopt additional monetary easing. In addition, when Governor Kuroda was asked in the Diet on January 21, 2016 about the possibility of introducing a negative interest rate policy, he replied, "We are not considering it at this time," which also led to expectations that the Bank of Japan would not move quickly to implement additional monetary easing (Nikkei (2016)).

In this situation, at the Monetary Policy Meeting held on January 28 and 29, 2016, the BOJ decided to introduce a negative interest rate policy by a narrow margin of five to four. The BOJ divided their current account into three tires: Basic Balance, Macro-Add on Balance, and Policy-Rate Balance, and announced that it would apply a minus 0.1 percent interest rate to the Policy-Rate Balance. At a press conference following the Monetary Policy Meeting, Governor Kuroda cited the need to prevent the risk of a negative impact on the reversal of deflationary sentiment due to the instability of financial markets and the slowdown of the global economy since the beginning of the year as the reason for additional monetary easing. However, the Policy Board members who opposed the introduction of the negative interest rate policy gave the following reasons: (1) the introduction of the negative interest rate policy could be seen as the limit of conventional asset purchases; (2) the complex mechanism of the negative interest rate policy could cause confusion; and (3) the negative interest rate policy would have significant side effects on financial market functions and the financial system.

On January 29, 2016 the financial markets were in a state of turmoil as a result of the Bank of Japan's surprise introduction of a negative interest rate policy and the subsequent evaluation of this policy. Even for some investors who were bracing themselves for the possibility of a surprise from the Bank of Japan, they never expected the Bank of Japan to adopt a negative interest rate policy (Komoriya (2016)). The negative interest rate policy has different flavor from the conventional QQE, and the *Financial Times* (Davies (2016)) reported "some analyst have described the latest surprise announcement as 'a very big regime change'."