The Effects of Japanese Negative Interest Rate Policy on Inflation Rate

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Abstract

This study used recent macroeconomic data in Japan and analyzed how the Bank of Japan's policy " Quantitative-Qualitative Monetary Easing with Negative Interest Rate " affected the domestic financial and foreign exchange markets. We analyzed the impact of monetary policy on CPI (Consumer Price Index) and proved whether the monetary easing policy promotes inflation targeted by the Bank of Japan.

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Contents

1 Introduction

Since 2016, the central bank in Japan (the Bank of Japan) has conducted the Negative Interest Rate Policy, and many scholars have discussed its effect. Monetary easing has been repeated intermittently since the introduction of qualitative-quantitative monetary easing (QQE) by the Bank of Japan on April 4 2013. As a result, the monetary base has expanded rapidly. On the other hand, money stock has expanded slowly, and the 2% price stability target, which is the goal of the policy, has not been achieved yet. Moreover, from September 21 2016, YCC (the Yield Curve Control) was added to the QQE policy. However, due to the influence of the conformable formation of expectation, the expected rate of increase in price has remained at a low level. Therefore, it is suggested that the conformable formation of expectation prevents the Bank from achieving the price stability target.

In this study, we referred to some earlier studies and analyzed the effect of the Negative Interest Rate Policy in Japan from 2013 to 2018. The novelty of this study is that we used the Consumer Price Index (CPI) as a variable of a structured VAR model. We focused on the rate of increase in price; the Bank of Japan set a target of a 2% increase. In addition, we analyzed how the QQE with Negative Interest Rate Policy influenced the CPI.

In this paper, the current situation of Japan is written in chapter 2. In Section 3, we introduce how some earlier studies we referred to analyzed the effect of past monetary policies. We explained the way of analysis used in this paper in chapter 4. We showed the data used in the analysis and the result of the analysis in chapter 5. The consideration of the result of analysis is in the chapter 6.

2 Analysis of Current Situation of Japan

2.1 Overview of the Bank of Japan

In this section, we outline the past and current policies of the Bank of Japan. The Bank is a central bank, which is equivalent to FRB in the U.S.A and ECB in Europe. As a central bank, the Bank issues and controls currency and tries to stabilize commodity prices and the monetary system. The Bank of Japan is a bank of issue, a banker ' s bank, and the government ' s bank.

The basic line of monetary policy is decided at the " Monetary Policy Meeting, " which is held eight times a year and each meeting continues for two days. The Monetary Policy Committee is composed of the President of the Bank of Japan, two Vice Presidents, and six members. " The Outlook for Economic Activity and Prices " (The Basic View) is released to the public as soon as the meeting finishes. This disclosure is heavily influenced by Japanese financial markets and foreign exchange markets. The Basic View of the Monetary Policy Meeting since 2013 is summarized in Table 1.

We would like to explain the Zero Interest Rate Policy and the Negative Interest Rate Policy. These policies are different from " Traditional Monetary Policy, " which stabilizes the macro economy by lowering interest rates. These policies are called " Non-traditional Monetary Policy " because they are accompanied by "Quantitative Monetary Easing, " which is the policy that the central bank strengthens the purchase of government bonds, and " Quantitative-Qualitative Monetary Easing, " which is the policy that enhances quantitative monetary easing.

2.2 Zero Interest Rate Policy

After the breakdown of the bubble economy in Japan, the " Zero interest rate policy " was introduced to improve the economy. After that, the policy was temporarily stopped because of the IT bubble in 2000, but was continued after the IT bubble collapsed. With this policy, quantitative monetary easing was also carried out from 2001 to 2006. The Bank of

Japan attempted to expand the money stock by purchasing government bonds and bills (the Open Market Operation) in the quantitative monetary easing. The effect of the quantitative monetary easing was based on the "Portfolio Rebalancing Effect." Through this measure, money was supplied to financial institutions and surplus money was used for investment and financing because the BOJ Current Account Balance had a 0% interest rate.

The former President of the Bank of Japan, Mr. Shirakawa said that the Zero Interest Rate Policy and the Quantitative Monetary Easing had a significant effect on the preservation of stability of financial systems such as dealing with bad debts. However, he also stated that the effect of boosting the economy was limited.

2.3 Negative Interest Rate Policy

Next, we outline the "Negative Interest Rate Policy" and "Quantitative-Qualitative Monetary Easing" (QQE). The data period after 2013 corresponds to the period of these policies.

On April 4 2013, the Bank of Japan set the policy goal that the bank implements QQE in different dimensions, and the monetary base would be doubled in two years by expanding the amount of long-term government bonds and ETF (Exchange Traded Funds) held and extending the average remaining period of long-term government bonds more than two times in the basic view. Since then, concrete additional monetary easing policies were set at every Monetary Policy Deciding Meeting. In addition to monetary easing, at the meeting on January 29th 2016, the bank announced "Quantitative-Qualitative Monetary Easing with Negative Interest Rate," which applies the negative interest rate (-0.1%) to the excess reserves of the BOJ current account balance. The bank also presented the opinion that the bank aimed to achieve a "2% Price Stability Target" and would continue monetary easing until the target was achieved. This is motivation for continued monetary easing, and the target of 2% price stabilization has not been achieved.

3 Previous Research

3.1 Zero Interest Rate Policy and Policy Duration Effect

To date, various research has been conducted on th effects of the non-traditional monetary policy outlined in section 2. First, some research examines the effects of the Zero Interest Rate Policy focusing on policy duration effect, which is extremely important for stabilization of financial market expectations about future paths of short-term interest rates under the aforementioned policy, and it was assumed that this could produce additional effects of monetary easing. However, Shiratsuka & Fujiki (2001) and Okina & Shiratsuka (2003) demonstrated that monetary easing effects could not influence outside the financial sector under the situation that the ripple mechanism did not operate between the financial sector and the non-financial sector. They concluded that monetary policy alone could not reverse expectations of low growth and deflation in the financial market under the Zero Interest Rate Policy.

Second, Honda et al. (2007) and Harada & Masujima (2010) used the Cholesky Decomposition, which assumes that the reciprocal relationship between variables was a recursive relationship, and demonstrated that an increase in the monetary base had the effect of increasing production, but this was mainly through asset values and bank balance sheets and the path through the policy duration effect was not confirmed. They also showed the effect that the quantitative monetary easing raised interest rates in the long term; the existence of policy duration effect was therefore questioned.

3.2 Monetary Easing and Term Spread

In addition, previous research distinguishes monetary policy shocks using the "Structural VAR Model (Structural Vector Auto Regression Model)" which assumes heteroskedasticity of policy announcement dates and non-announced dates. Features of the Structural VAR Model are that not only the distinguisher of monetary policy shocks as the indicator and direct impacts immediately after the quantitative monetary easing policy is activated, but

also impacts with time lag can be analyzed simultaneously. Wright (2011) revealed that monetary policy shocks reduce long- and short-term interest rates and corporate bond yields. However, these reductions of effects was quite fast, and its half-life was estimated to be about two months. On the other hand, Shibamoto (2012) showed that Japanese quantitative monetary easing shocks reduced the long-short interest rate gap in the short term, while they increased the long-short interest rate gap with rising stock prices.

4 Methods of Analysis

4.1 Structural Vector Auto Regression Models

There are two methods for identifying Structural Auto Regression, which is introduced in Section 3. One uses the Cholesky Decomposition outlined by Harada (2004), the other uses the assumption by Rigobon and Sack (2004) and Wright (2011) that the monetary policy shocks are heteroskedastic. In this paper, we use these two methods for our estimations. We estimated from the period 2013, when Bank of Japan introduced the negative interest rate policy.

Since normal VAR models cannot the identify structural disturbance term from the result of VAR analysis, it can be difficult to interpret the result in terms of policy when variables have simultaneous relationships. However, it is assumed that financial variables, such as interest rate, react quickly (within a day) to the financial shock. We used the Structural Vector Auto Regression, which can be used in the case of variables having simultaneous relationships. To consider simultaneous relationships, SVAR models have the coefficient matrix A_0. We assumed the model that imposed a short-term constraint as follows.

$$A_0 y_t = \alpha + \sum_{k=1}^{n} B_k y_{t-k} + \epsilon_t \tag{1}$$

Y_t is $m \times 1$ a vector of endogenous variables, n is the lag of endogenous variables, ϵ is $m \times 1$ a vector of structural shock, α is a constant term and A_0, and B_0 to B_k are the Mth order square matrix. Since the SVAR model cannot be identified directly, we multiplied both sides of the equation by the inverse matrix of A_0.

$$y_t = A_0^{-1}\alpha + \sum_{k=1}^{n} C_k y_{t-k} + e_t \tag{2}$$

C_k is $(A_0^{-1}) \times B_k$. e_t is $A_0^{-1}\epsilon_t$.

Harada (2010) imposed the constraint that A_0^{-1} is lower triangular matrix as equation(3). In this condition, endogenous variables in the sth $(0 < s \leq m)$ line of y_t were influenced by

structural shocks up to the sth line, but not influenced by structural shocks after the $s+1$th line. Under the constraint, the result depends on the order of variables. We therefore had to arrange these in an exogenous order. To analyze how monetary policy variables influenced inflation, we arranged the variables in the order of the BOJ Current Account Balance financial variables such as interest rate, stock price, and CPI.

$$A_0^{-1} = \begin{bmatrix} x & 0 & \dots & 0 \\ \vdots & \ddots & \ddots & \vdots \\ \vdots & & \ddots & 0 \\ x & \dots & \dots & x \end{bmatrix} \tag{3}$$

On the other hand, the method suggested in Wright (2011) identified the announcement date and non-announcement date. To impose the constraint, he assumed the monetary policy shock was heteroskedastic. First, decompose A_0^{-1} into columns and let each of which be R_i. R_i is an $m \times 1$ vector. Therefore, the error term is expressed as the following equation(4).

$$e_t = \sum_{i=1}^{n} R_i \epsilon_{it} \tag{4}$$

Equation(2) is rewritten as follows, which is a reduced form VAR.

$$y_t = A_0^{-1} + \sum_{k=1}^{n} C_k y_{t-k} + \sum_{i=1}^{n} R_i \epsilon_{it} \tag{5}$$

e_{it} is the ith structural shock and each of these are independent of each other and over time. The first structural shock e_1 is a monetary policy shock. To identify the effect of this shock, we only had to identify R_1. The monetary policy shock has mean zero and variance σ_1^2 on the announcement date and σ_0^2 on non-announcement date. Other structural shocks have mean zero and variance one. Let Σ_1 and Σ_0 be variance-covariance matrices of reduced form errors of announcement date and non-announcement date, respectively. Equation(6) is clear.

$$\Sigma_1 - \Sigma_0 = R_1 R_1' \sigma_1^2 - R_1 R_1' \sigma_0^2 = R_1 R_1' (\sigma_1^2 - \sigma_0^2) \tag{6}$$

we adapted the normalization that $\sigma_1^2 - \sigma_0^2 = 1$ and estimated R_1 by solving the Minimum Distance Problem.

$$\hat{R_1} = argmin_{R_1}[vech(\hat{\Sigma_1} - \hat{\Sigma_0}) - vech(R_1 R_1')]'[(\hat{V_0} + \hat{V_1}]^{-1}[vech(\hat{\Sigma_1} - \hat{\Sigma_0}) - vech(R_1 R_1')] \tag{7}$$

$\hat{V_0}$ and $\hat{V_1}$ are estimates of the variance-covariance matrices of $vech(\hat{\Sigma_0})$ and $vech(\hat{\Sigma_1})$. After estimating R_1, we derived the impulse response function.

Unlike the method using the Cholesky Decomposition, it is not necessary to consider the exogenous order of variables. Therefore, we could analyze the simultaneous relationships more deeply. However, since this method only estimates R_1, monetary policy shock, we could not analyze the effects of other shocks.

4.2 Problems of These Methods

It is widely known that the order of variables is very important in the SVAR using the Cholesky Decomposition and that if the order of variables changes, the result also changes. This is because, the earlier the variable order, the greater the impact of the shock of the variable on the other variables . Therefore, the exogenous of variables must be well examined. On the other hand, since the SVAR using the assumption that monetary policy shocks are heteroskedastic can analyze only the influence of monetary policy shock, this method cannot identify the ripple paths of the effect of monetary policy. Furthermore, it was necessary to ensure whether the normalization that $\sigma_1^2 - \sigma_0^2 = 1$ was appropriate.

To deal with these problems, we analyzed both methods to determine the robustness of the relationships between monetary policy and inflation, and attempted to identify ripple paths.

5 Data

Because the Bank of Japan started the QQE Policy on April 4 2013, the sample period was from April 1 2013 to March 31 2018. We used the BOJ Current Account Balances, which is well influenced by the BOJ ' s purchasing ETF and J-REIT, as an index of QQE. In addition, we used the 3-month London Interbank Offered Rate (LIBOR) based on yen as an index of short-term interest rate, the 10-year Japanese government bond yield as an index of long-term interest rate, the Nikkei Stock Average (Nikkei255) as an index of Japanese stock market, and the US Dollar/Yen Spot Rate as an index of international exchange markets. These indexes are variables well used in previous research that uses VAR models to estimate the effect of monetary easing. All variables used closing prices.

As an index of inflation, which was used to estimate the effect of monetary policy, we used the Consumer Price Index without fresh food and energy (CoreCore CPI). Since the price of fresh food fluctuates significantly and the price of crude oil dropped significantly in the period, CPI including these could not capture the keynote of inflation. Details and sources of these data are reported in Table 2. We converted the monthly data of CPI to the daily data by cubic interpolation. The BOJ Current Account Balance, NIkkei225, and CPI are logarithmic.

Announcement dates, which were used in the method using the assumption of heteroskedasticity, were the dates of the BOJ Policy Decision Meeting and non-announcement dates were previous dates of the meeting. During the sample period, the BOJ Policy Decision Meeting was held 57 times. Therefore, the sample size used to identify R_1 was 114. The lag of the VAR was 2, which was selected using the Akaike ' s Information Criterion.

6 Results

6.1 Cholesky Decomposition

First, we used SVAR using the Cholesky Decomposition for our estimations. We used six variables and arranged the exogenous order such that $BALANCE$, $LIBOR$, $BOND$, $USDJPY$, $STOCK$, $CPIFE$. Since it is widely known that even if reduced form VAR has transient variables, the estimators of SVAR are consistent, we used level data of all variables. The impulse response is shown in Figure 1. The result indicated that these four relationships were statistically significant.

1. The increase of the BOJ Current Account Balance reduces short-term and long-term interest rates.
2. The increase of the BOJ Current Account Balance increases CPI.
3. The expansion of yen depreciation increases CPI.
4. The increase of stock prices reduces CPI.

The first result, the monetary easing reduced short- and long-term interest rates, is the effect of the monetary policy, which coincides with previous research. The second result revealed that the monetary easing increased CPI. This indicates one of targets of this paper confirming the effect of the monetary easing on inflation was achieved. The third result, the expansion of yen depreciation increased CPI, is a well-known effect. On the other hand, the fourth result, the increase in stock price reduced CPI has not been reported in previous research. We did not analyze this problem in more detail because this deviated from our research purpose. However, there is room for future analysis of this problem. To check the robustness, we estimated using monthly data of same variables. As a result, only the second result was found to be statistically significant. The impulse response of monthly data is shown in Figure 2.

6.2 Method Using Assumption of Heteroskedastic

Next, we used SVAR using the assumption of heteroskedasticity. We used four variables, $BALANCE$, $BOND$, $STOCK$, $CPIFE$. The result is shown in Figure 3. In this analysis, the result that the increase of the BOJ Current Account Balance also increased CPI was ensured. However, it was not statistically significant that the increase of BOJ Current Account Balance had an effect on long-term interest rates and stock prices.

7 Conclusion

Various research has been conducted for both theoretical and actual proof as to whether the non-traditional monetary policy implemented by central banks such as the Bank of Japan really bring about economic recovery, but no definitive conclusions have been obtained. We conducted an empirical analysis of the monetary easing policy implemented by the Bank of Japan, focusing specifically on price increases.

This was observed in the Cholesky Decomposition and in identifying monetary policy shocks. However, its ripple path could not be clarified in this analysis and is left for future research. It is hard to say that there is the definite effect that stock prices which was obtained by using the Cholesky Decomposition and the weak yen influenced the CPI because we could not obtain the robustness with the monthly data.

In addition, we used the BOJ Current Account Balance as the monetary policy variable in our analysis because this seemed to have expanded with purchases of ETF and J-REIT and we could obtain daily data. However, we thought that it was possible to use the monetary base as monetary policy variables because it was specified as the monetary easing adjustment method. Therefore, we analyzed the monetary base as the monetary policy variable. The result is presented in Figure 4. As a result of this analysis, the following significant relationship was found to exist.

1. The increase of the Monetary Base increases CPI.
2. The increase of the Monetary Base reduces long-term interest rates.
3. The decrease of long-term interest rates increases increases CPI.

From the above, the monetary easing by the Bank of Japan may have raised the CPI by using the decline in long-term interest rates as the ripple path. However, we could not obtain the robustness by analysis with the monthly data on the similar set of variables. We did not conduct further analysis this time, but we will identify ripple paths of monetary easing by reviewing combinations of variables and data period used this time in the next time.

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Table 1: The Bank of Japan's monetary policy

Announcement Date		Policy Details
2013	4-Apr	The Bank of Japan will increase Japnese monetary base to the target in two years 138 trillion (2012/12) → 270 trillion (the end of 2014) . The monetary base and the balance of long-term government bonds and ETF will be doubled in two years. The average remaining period of purchases of long-term government bonds will be doubled. The bank conduct "Quantitative-Qualitative monetary easing". The bank will adjust the financial market so that the monetary base will be increased at the rate equivalent to about 60 to 70 trillion yen per year, and increase the balance of long-term government bonds at the rate equivalent to about 50 trillion yen per year for declining interest rates on the entire yield curve.
2014	18-Feb	The loan support fund will be doubled and the redemption period will be exteded from 3 years to 4 years.
	31-Oct	The monetary base will be increased at the rate equivalent to about 80 trillion yen (about 10-20 trillion yen added) per year. The balance of long-term bond, ETF and J-REIT will be increased at the rate equivalent to about 80 trillion yen (about 30 trillion yen added), 3 trillion yen and 90 billion yen per year.
2015	21-Jan	Many kind of Providing funds's deadline will be exteded for one year. The upper limit of "support for strengthening growth base" will be raised from 1 trillion yen to 2 trillion yen, and the total limit will be raised from 7 trillion yen to 10 trillion yen.
	18-Dec	The balance of long-term bond, ETF and J-REIT will be increased at the rate equivalent to about 80 trillion yen (unchanged). The average remaining purchase period will be extended 7 to 10 years in this year, and 7 to 12 years from next year or later.
2016	29-Jan	The negative interest rate (▲0.1%) will be applied to the current accounts of the Bank of Japan. The current accounts are divided into three levels, and the positive interest rate, zero interest rate, and negative interest rate will be applied to each level. The Bank of Japan aims to achieve 2% inflation called "price stability target", and continue "Quantitative and Qualitative monetary easing with negative interest rates" until necessary.
	15-Mar	The balance of ETF will be increased at the rate equivalent to about 3 trillion yen per year until the end of March and about 3.3 trillion yen per year after April.
	29-Jul	The balance of ETF will be increased at the rate equivalent to about 6 trillion yen (almost doubled) per year. The total amount of special US dollars funds for growth support will be increased to 24 billion dollars (almost doubled).
	21-Sep	Short-term interest rate: The negative interest rate (▲0.1%) will be applied to the Policy-Rate Balances of the current account balance of the Bank of Japan. Long-term interest rate: the balance of long-term bonds will be increased so that the interest rate on 10-year bonds stay at the current level (about 0%). For long and short interest rate operations, new operation methods will be introduced. (i) JGB (Japan Government Bond) will be purchased at the rate specified by the Bank of Japan (Limit Order Operation). (ii) The period of fixed-rate funding operations will be extended from 1year to 10 years.
2018	23-Jan	The acceptance periods of "Funds to support increased lending", "Funds to support strengthening growth base" and "Fund operations to support financial institutions in the disaster areas" will be extended more 1 years.

Table 2: Parameters of Structural VAR Models

$BALANCE$	The BOJ Current Account Balance (hundred million yen) (The Bank of Japan)
MB	Monetary Base (hundred million yen) (The Bank of Japan)
$STOCK$	Nikkei Stock Average (Nikkei225) (Macrotrends)
$LIBOR$	London Interbank Offered Rate (LIBOR) (Based on Yen) (%) (FRED)
$BOND$	10-year Japanese Government Bond Yield (%) (Ministry of Finance)
$USDJPY$	US Dollar/Yen Spot Rate (¥/$) (World Bank)
$CPIFE$	CoreCore CPI (Consumer Price Index) (Ministry of Internal Affairs and Communications)

[1] All variables used closing prices.
[2] $BALANCE, STOCK, CPI$ are base 10 logarithms of original data.

Figure 1: Estimated Impulse Response in Cholesky Decomposition VAR (6 parameters, Daily)

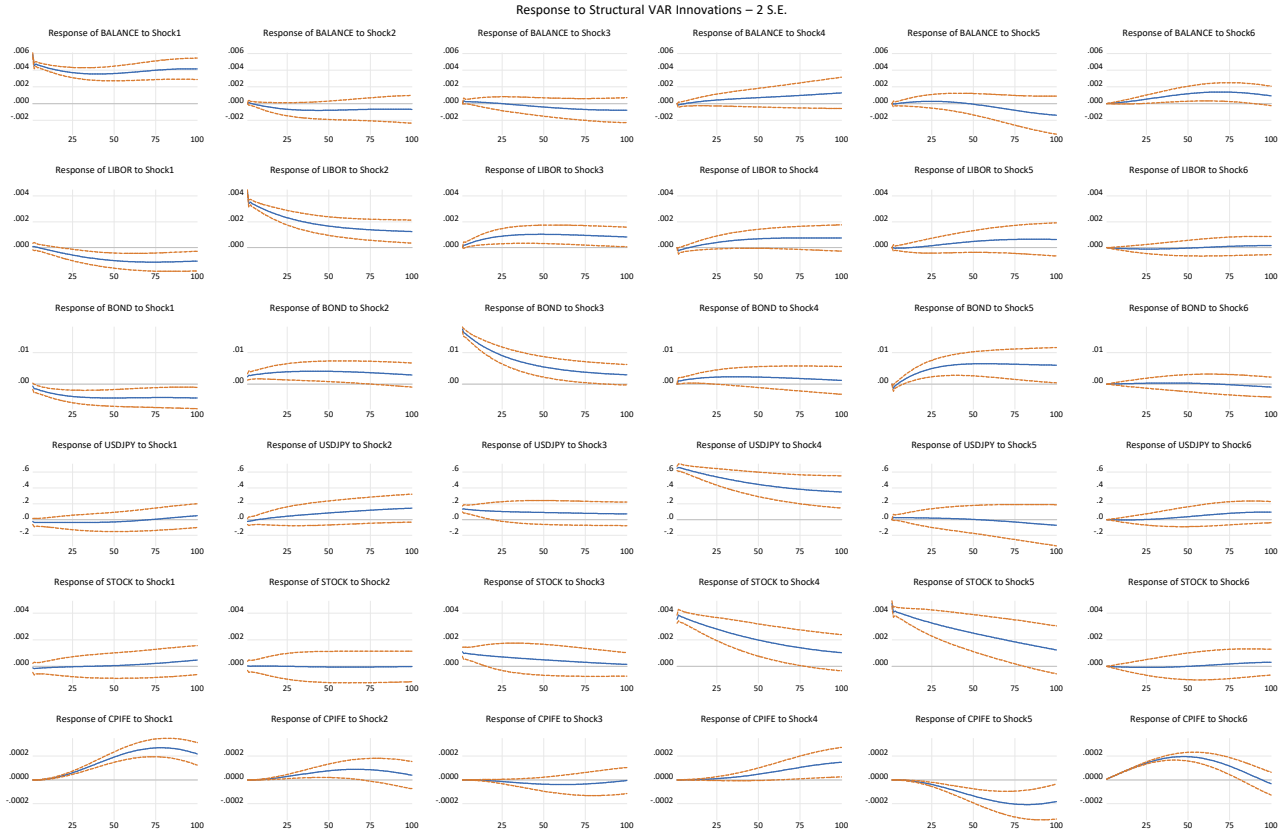

Figure 2: Estimated Impulse Response in Cholesky Decomposition VAR (6 parameters, Monthly)

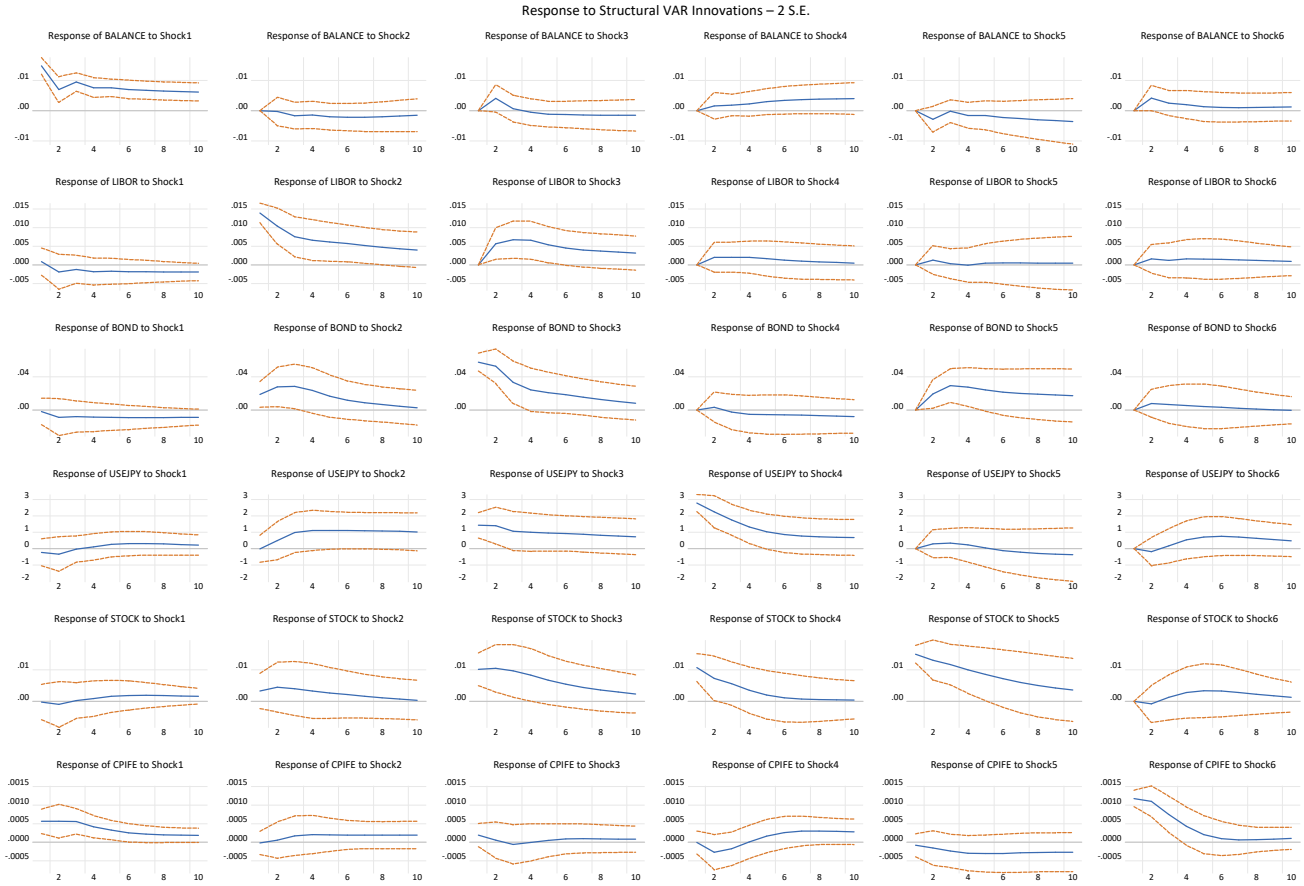

Figure 3: Estimated Impulse Response Using Announcement Days (4 parameters, Daily)

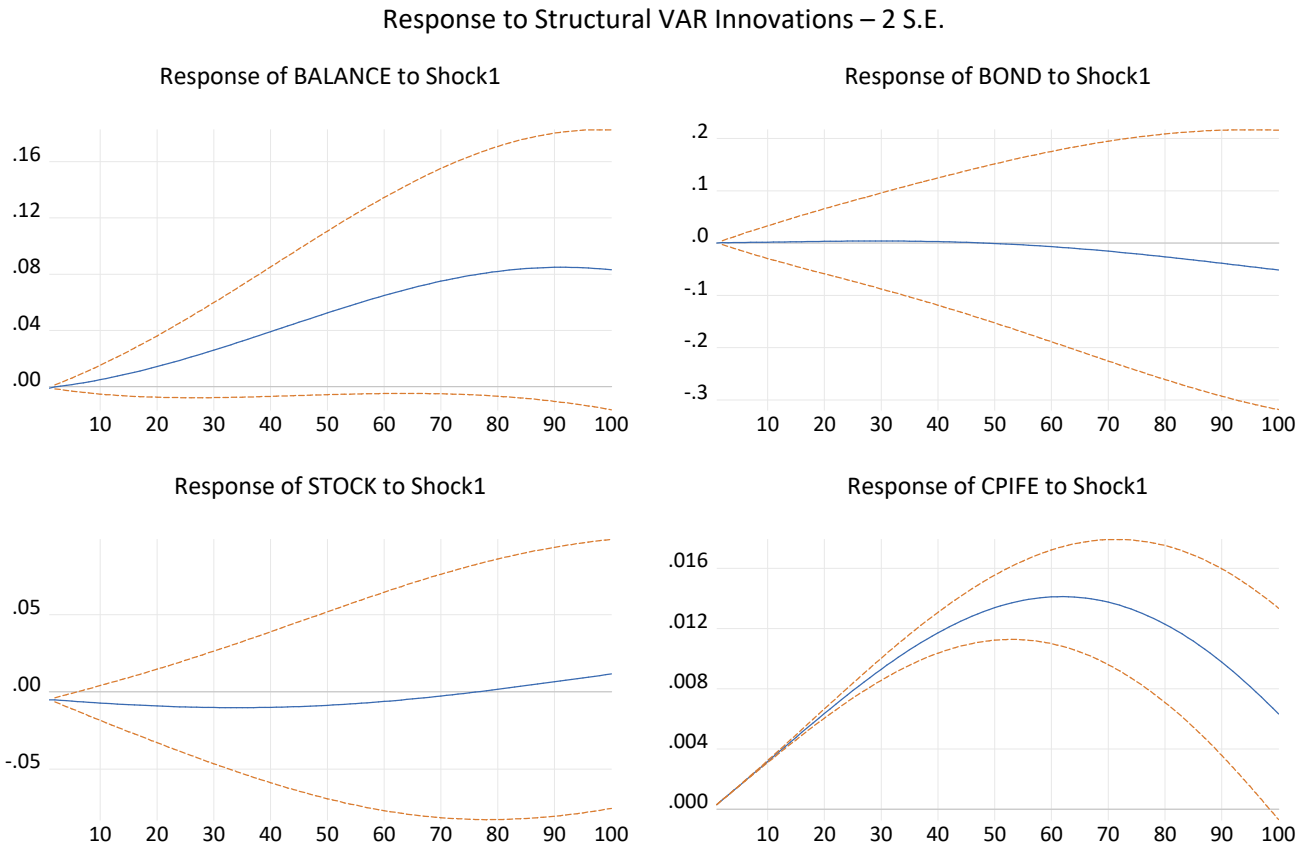

Figure 4: Estimated Impulse Response in Cholesky Decomposition VAR Using Monetary Base (6 parameters, Daily)