Structural Shocks and Macroeconomic Conditions in Indonesia

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Abstract:

The objective of this paper is to examine the impacts of structural shocks that lead to macroeconomic weakening in Indonesia during the recovery phase after the global financial crisis. We use real business cycle (RBC) and New Keynesian approach to identify the structural shocks and utilize the Structural Vector Autoregression (SVAR) model to build a macro-econometric model and to analyze the relationships between the shocks and macroeconomic variables. The sample that are used are quarterly data from the Census and Economic Information Center (CEIC) database and Statistik Ekonomi dan Keuangan Indonesia (SEKI) Bank Indonesia from 2007–2019. The results show that production shocks lead to an increase in unemployment and exchange rate shocks lead to depreciation of rupiah against dollar. Aggregate supply shocks, however, only have a relatively small impact on inflation. The effects of aggregate demand shocks on output vary, depending on the source of the shocks. Monetary policy shocks lead to an increase in the central bank interest rate.

Keywords: structural shocks; SVAR; real business cycle (RBC); new Keynesian; unemployment; inflation; exchange rate.

JEL Classification: E12; E31; E32; F31; F62; F68.

Introduction

Major international economic events bring about external disturbances to a small open economy. As a small open economy, Indonesia must meet the disturbances that may results in structural shocks as they are originated from demand and supply. In the aftermath of global financial crisis, the Indonesia's economy showed a promising recovery up to 2012. However, this positive trend started to decline by of 2013. This paper analyses factors that influence the declining of macroeconomic condition in Indonesia following the recovery phase from the global economic crisis. The 2007 global financial crisis sourced from the United States as the epicenter of the crisis and lately compounded by the occurrence of a trade war between the US and China has consequences for macroeconomic fluctuations in various countries, including Indonesia (Blanchard *et al*. 2013, Kim 2019).

The crisis began to impact Indonesia in the fourth quarter of 2008 in which lessened export performance. Economic growth showed a slowdown from the previous figure and inflation rate almost doubled in the same time period. From the external side, the pressure of the crisis, market sentiment, and as a result of the current account deficit and the tight liquidity, rupiah has depreciated. The economic condition in Indonesia after the 2008 global crisis has been slowly restored and has shown improvement until 2012. By 2008, the economy grew at steady rate around 6.2%, with a reasonably low inflation rate of 4.3%. Not only that, the government's initial target of restoring post-crisis macroeconomic stability has shifted to boost sustainable economic growth. In terms of exchange rate fundamentals, even if rupiah was still depreciated against US dollar, the foreign exchange reserves until the end of

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2012 had achieved more than double from the crisis period. Nonetheless, by 2013 the macroeconomic condition experienced a decline which reflected in growth, inflation, and trade volumes.

1. Research Background and Literature Review

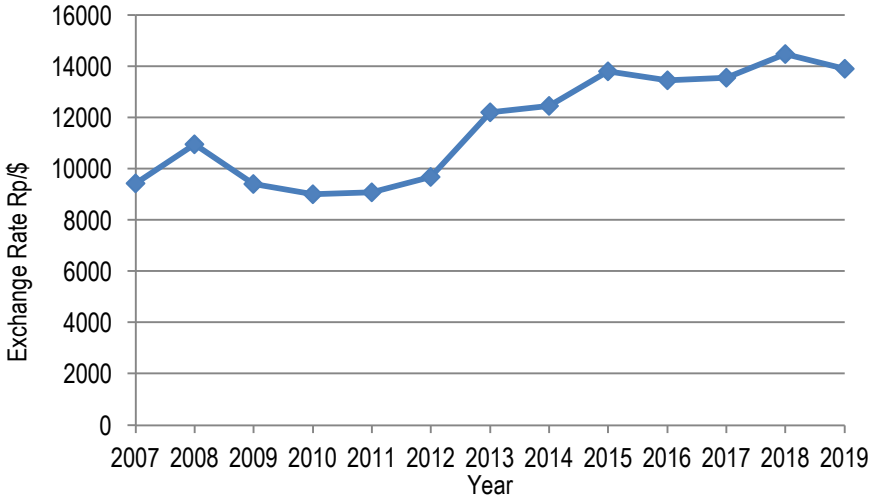
1.1. Research Background

Improvement in economic conditions before 2013 occurred because there are two global trends, namely terms of trade and capital inflow. First, Indonesia experienced terms of trade improvement that was driven by the rising export prices originating from demand for primary commodities in emerging market countries such as India and China. Second, the existence of policies from developed countries that carry out monetary stimulus causes capital inflows to Indonesia. This happens because there is an excess of liquidity at the global level, which then flows to countries that provide attractive returns, including Indonesia (Gruber and Kamin 2007, Liu *et al*. 2019). The ease in capital mobility is not without risk, besides giving benefits to Indonesia by encouraging domestic demand this capital inflow can also be a threat when all of a sudden, the funds that have been invested are withdrawn to their home countries.

In 2013, the fundamental condition of macroeconomic experiences a declined. This can be seen from the value of economic growth which dropped sharply to 5.58% from the previous period which reached 6.23% (year-on-year) in 2012 and 6.5% in 2011, and rising inflation exceeded the target that was expected in 2012 and several other declining macroeconomic variables. The weakening trend that occurs is at least triggered by changes in factors that were previously favorable. The economic slowdown that occurred in India and China also affected the performance of Indonesia's trade and export whose impact can be seen from the decline of trade due to the end of the previous era of high commodity prices. This results in production shocks in the supply side. While from the monetary side, the improvement in the United States' economy has led to a reduction in monetary stimulus where the Fed then raised the Fed's interest rate which ultimately resulted in reduced global liquidity and capital outflow from funds that were originally allocated in developing countries, including Indonesia. This condition then led to the widening of the current account deficit and the depreciation of rupiah against the US dollar which can result in external imbalances (Gruber and Kamin 2007).

Another indicator is that the inflation rate has increased. In the third quarter of 2013, the inflation reached 7.66%. This inflation level was far higher than in 2012, which was only 3.66%. Inflation in 2014 was still high at 8.36% but began to decline in 2015 to 3.35% and 2.72% by 2019. Furthermore, the decline in macroeconomic conditions can be seen from the depreciation of the rupiah exchange rate (Figure 1). This considerable depreciation is a result of the capital outflow due to differences in interest rates with the Fed, which have increased several times in a year. This frequent exchange rate fluctuation is a consequence of the exchange rate system that is used, namely the flexible exchange rate, where the increase and decrease of the exchange rate is determined by the demand and supply of foreign exchange in the financial market (Hubbard *et al.* 2012, Krugman *et al*. 2015, Liu *et al*. 2019). The depreciation of rupiah against dollar has reached a figure of Rp 15,200 per dollar in October 2018, which was the biggest decline in the past few decades.

Figure 1. Exchange rate fluctuation 2007-2019



Source: Bank Indonesia, 2019

The government's foreign exchange reserves also began to decline from around 130 billion US dollars at the beginning of 2018 to 120.65 billion US dollars in a few months. This is due to the stabilization of the exchange rate policy. Other indicators such as the unemployment rate in February 2013 of 5.88% had risen to 6.18% in 2015, and then fell again to around 5.34% in 2018.

Furthermore, the high level of uncertainty in the global economy has affected the condition of Indonesia's external balance. In terms of the ratio of the current account deficit to GDP, it increased compared to the previous period due to a decrease in the performance of the trade balance. Foreign debt towards GDP is seen to have increased from 34.8% in 2017 to 35.8% in 2018. While the ratio of the accumulation of exports and imports of goods and services to GDP (the degree of openness of the Indonesian economy) has seen a decline. However, several other indicators of external sustainability show improvement so that it supports the resilience of the external sector. The ratio of foreign debt to foreign exchange reserves has decreased in line with the increase in foreign exchange reserves at the end of 2018.

Table 1 External sustainability indicators 2015-2018

Indicator (%)	2015	2016	2017	2018
Ratio of current account to GDP	-2.03	-1.82	-1.60	-2.98
Ratio of foreign debt to GDP	36.1	34.3	34.8	35.8
Ratio of export and import of goods and services to GDP	0.60	0.90	1.1	-0.7
Ratio of total foreign debt to reserve assets	293.3	275.0	271.2	309.0

Source: Bank Indonesia, 2018.

1.2. Literature Review

This study uses the approach of the Real Business Cycle (RBC) and the New Keynesian. They are currently the leading theories on business cycle. The RBC theory explains that economic conditions that experience periodic expansion or recession are natural events. Weakening economic conditions resulted in fluctuations output and employment is the result of the various shocks that have hit the real economy and markets make adjustments quickly to maintain the balance (Vašková and Vašková 2010, Shirota 2019). From policymakers' as well as academic's point of view, examining structural shocks is one of the important areas as it helps to formulate decisions regarding the variable of interest. The Real Business Cycle approach emphasizes the importance of including shock from the supply side. RBC theory explains that supply shocks cause the macroeconomic fluctuations (Chugh 2015). To complete the analysis, we considered the shocks from the demand side by using the New Keynesian approach. It states that the demand shocks, such as changes in government policy that lead to fluctuation in macroeconomic conditions, trigger business cycles (Chugh 2015). Another important factor is market failure, it causes inefficient business cycle fluctuations by lowering output produced than the potential GDP. The market failure arises because of price and wage rigidity in the labor market while the company maintained its profit maximizing mark-up. In this case, the government plays a role in overcoming economic problems (Chugh 2015, Scarth 2014, Romer 2012).

Economists define shocks differently. Shock can be defined as the gap of actual and potentials of a variable and the gap is called the disequilibrium (Hubbard *et al.* 2012, Insukindro 1998). In general, the magnitude of a business cycle is measured using this definition. When an economic policy is implemented to address the disequilibrium, it creates additional source of shocks (Conway 1987). Chugh (2015) defines a shock as a change that cannot be explained. In the supply and demand perspective, the change is represented by the shift of the demand and supply. Shocks originating from the demand and supply sides are known as structural shocks (Jiang *et al.* 2020). Therefore, an unexpected occurrence that have a wide structural impact on large scale economy can be called a macroeconomic shock, for instance economic crisis (Hubbard *et al*. 2012).

A strand of literature has been focusing on the impact of shocks to macroeconomic variables. Ireland (2004) uses the New Keynesian Model to look at the impacts of the cost-push, monetary policy shocks, and RBC model's technology shocks on the output aggregate and employment. Heidarpour, *et al.* (2015) examines the effect of government investment shocks on consumption, employment, output, and inflation. Goodhart (2007) states that shocks towards money stock will affect the economy through the credit supply system, which will affect the interest rate and real economy through the IS curve. In five European Union member countries, a positive shock in interest rate affects output negatively (Ďurčová 2012). Leeper *et al*. (2003) states that short-term interest rates cannot be used to identify the quantitative monetary policy because the interest rates can fluctuate due to unobservable shocks towards money demand. In the case of Indonesia, economic fluctuations and exchange rate shock or the twin shocks are found to positively influence deposit interest rates (Insukindro 2020).

In addition to the macroeconomic variables described above, the government also concerns on the efforts to anticipate the weakening of the rupiah exchange rate. Fluctuations in foreign exchange rates are determined by demand and supply aggregate dynamics. In particular, the exchange rate is determined by three markets *i.e*. output market, money market, and foreign exchange market. The three equilibrium in this market determines the level of output and foreign exchange balance (Cover and Mallick 2012, Krugman *et al*. 2015). A study on exchange rate fluctuations were conducted by Peersman (2011) found that exchange rates were the source of the independent shocks for the British Economy. Whereas Cover and Mallick (2012) found that shocks to the exchange rate had little influence on the unemployment and output levels in the UK, indicating that flexible exchange rates for most of the British economy had been isolated from shocks. Batini *et al*. (2005) found that real import prices and the aggregate supply shocks caused inflation in the UK. The economic shocks due to the presence of news also lead to exchange rate volatility (Tah 2013). Garratt *et al*. (2003) analyzed the structural innovation in the Nominal Effective Exchange Rate (NEER) in a small open economy. They found that monetary contraction causes an appreciation of exchange rates, however when uncovered interest parity (UIRP) condition is considered it leads to depreciation.

2. Data and Methodology

2.1. Data

The data in this study consist of quarterly data from 2007-2019 and are drawn from the Census and Economic Information Center (CEIC) database and Statistik Ekonomi dan Keuangan Indonesia (SEKI) Bank Indonesia. The 2007 period was chosen as the year of study, as the slowdown in economic performance was seen after the global economic crisis. This period is used as a critical point. The variables that are included are unemployment, output gap, output, inflation, domestic interest rates, exchange rate, expected exchange rate depreciation, interest rate differentials, and BIRate. Unemployment is measured by open unemployment rate. Output gap is calculated by taking the difference between real output and potential output, while output is represented by GDP constant price 2010. Inflation is calculated from consumer price indices. Domestic interest rate (INDIR) is 3-months deposits interest rate (rupiah). Interest Rate Differential (DIR) is the difference between domestic dan foreign interest rate. BIRate is the central bank interest rate. Exchange rate is the exchange rate of rupiah against US dollar or Rp/US Dollar, and expected change of exchange rate is expected change of Rp/US Dollar.

2.2. Methodology

The paper uses the RBC and New Keynesian approach, that has covered shock both in terms of demand and supply to analyze the link between variables used in this research model. The model consists of three main components:

- investment and saving (IS) curve that reflects the balance in the goods and services market;
- monetary policy (MP) curve that illustrates the monetary policy of the Central Bank;
- Phillips Curve (PC) that represents the Phillip Curve.

In this paper we use modified New Keynesian Phillips curve that describes the short-term relationship between the output gap, the difference between actual GDP and potential GDP, and inflation (Cover and Mallick 2012, Giese and Wagner 2007). If the output gap is positive, it means that there is an expansion in the economy, the unemployment rate will decline, and the inflation will likely rise.

According to the Purchasing Power Parity (PPP) approach, the increase in inflation in a country more than the foreign inflation will result in domestic currency exchange rates depreciation. The difference in the rate of return of assets between countries can also lead to appreciation or depreciation of currencies. In this condition, Uncovered Interest Parity (UIRP) does not hold. UIRP condition is a condition in which the foreign exchange market is in equilibrium condition where the foreign interest rate is the same as the domestic interest rate with the assumption that there are no transaction costs and obstacles in trading. Therefore, in this condition, the differential interest rate is zero so that the arbitrage does not occur. If there is an appreciation in one of the currency exchange rates, it will immediately be offset by the depreciation of other currency, or pair currency, so that it will return to equilibrium (Krugman *et al*. 2015).

Based on the approach, therefore, to analyze the effect of structural shocks on Indonesia's macroeconomic conditions, a model consisting of productivity equations, IS equations, Phillips Curve equations, monetary policy rule equations and exchange rate equations is used (Cover and Mallick 2012, Krugman *et al*. 2015). The approach states that output and employment fluctuations are caused by various structural shocks that hit the economy, which

include productivity shock, IS shock, AS shock, monetary policy shock, and exchange rate shock. The shocks are represented in the errors in each equation.

$$\mu_t = \mu_{t-1} - \alpha_1(y_{t-1} - y^n_{t-1}) + \varepsilon^p_t \quad \text{Productivity (1)}$$

$$y_t = \beta_1\mu_t + \beta_2 p_{t-1} + \beta_3 i_{t-1} + \varepsilon^{IS}_t \quad \text{IS (2)}$$

$$p_t = \mu_1\mu_{t-1} + \mu_2(y_{t-1} - y^n_{t-1}) + \mu_3 q_{t-1} + \varepsilon^{AS}_t \quad \text{Phillips curve (3)}$$

$$BIRate_t = \lambda BIRate_{t-1} + (1-\lambda)[\gamma_1 p_t + \gamma_1(y_{t-1} - y^n_{t-1})] + \varepsilon^{MP}_t \quad \text{Monetary Policy Rule (4)}$$

$$q_t = \kappa_1 q^e_t + \kappa_2(i_t - i^f_t) + \varepsilon^q_t \quad \text{UIRP Exchange Rate Equation (5)}$$

Equation 1 states that the unemployment rate depends on the value of the output gap and production shocks. The basic idea is that unemployment (μ_t) responds to lag in unemployment rate (μ_{t-1}), output gap $(y_{t-1} - y^n_{t-1})$, and productivity shock (ε^p_t). Equation 2 shows the IS equation, the output level is influenced by the unemployment rate, lag of inflation (p_{t-1}), nominal interest rate (i_{t-1}), and IS shock (ε^{IS}_t). Equation 3 is the Phillips curve equation which shows the relationship between inflation and unemployment and its shock (ε^{AS}_t). Equation 4 shows the effect of monetary policy (BI Rate) and its shock (ε^{MP}_t). It is assumed that the bank rate gradually adjusts to the desired level, the bank rate depends on inflation (p_t), the output gap $(y_{t-1} - y^n_{t-1})$, and MP shocks (ε^{MP}_t). Equation 5 shows the exchange rate (q_t) equation that is influenced by the expected of exchange rate (q^e_t), interest rate differential $(i_t - i^f_t)$, and exchange rate shocks (ε^q_t).

The model used in this study is the Structural Vector Autoregression (SVAR) model, which is a development of the VAR model. Sims (1980) proposed the new model that does not specify exogenous and endogenous variables. The SVAR model was developed to test theories and predict policies. Since the model is over-parameterized, the t-test is not reliable. Therefore, this model does not estimate the parameters but examines the interrelationship between variables. The SVAR model is used when (1) there is a suspected reverse causality between variables and (2) the error term is assumed to be a composite error that is an error containing shocks from an X variable and shocks from a Y variable (Equation 6) (Sims 1980, Enders 2015).

$$A(L)y_t = A_0\left(I_n - A_1L - A_2L^2 \dots \dots A_pL^p\right)y_t = A_0e_t = B\varepsilon_t \quad (6)$$

where: A_0 = *n* x *n* matrix of contemporaneous effects between variables; A(L) = matrix of polynomials lag of variables of interest; y_t = n x 1 vector containing each of n variables included in the VAR; B = matrix of restrictions; ε_t = *n* x *n* column vector of structural shocks; e_t = n-column vector of reduced form shocks.

Structural VAR emphasizes on restrictions on responses from variables and predicts the impact of interventions. Several assumptions are applied to build a complete SVAR model as well as to develop the restrictions, they are based on economic theory and literature review (Cover and Mallick 2012, Krugman *et al*. 2015, Hubbard *et al.* 2012, Arestis and Sawyer 2008, Saliu *et al.* 2020). In this paper, the restrictions that are imposed in the system are as follows.

- The unemployment rate (Unemp) is affected by output gap shocks and is not directly affected by inflation and exchange rate shocks. This is known as Okun's Law, which shows the relationship between cyclical unemployment and the output gap. Based on RBC theory, cyclical unemployment occurs due to the business cycle recession. If the current unemployment is greater than the natural unemployment, then the output gap has decreased;
- Output is affected by unemployment, inflation, and domestic interest rates (INDIR) shock. Negative demand shocks have a negative effect on output;
- The inflation rate is influenced by unemployment, exchange rate (ER), and output gap shocks. If Okun's Law relationship is substituted into the Phillips curve, we will obtain inflation equation that is influenced by aggregate supply and demand shocks;
- The BI Rate is influenced by inflation and output gap shocks. Unanticipated shocks can lead to high inflation and the negative output gap. This leads the central bank issues its monetary policy through the interest rate channel;
- The exchange rate (ER) is affected by interest rate differential (DIR) and expected exchange rate depreciation (Exper) shocks. If there is a difference between domestic and foreign interest rate, it will result in capital flows that affect the fluctuation of exchange rate and at the same time UIRP does not hold;

- The domestic interest (INDIR) rate is affected by expected exchange rate depreciation (Exper) shocks. As domestic interest rate may reflect the returns on investment in the domestic country, the returns will be affected by the expected rate depreciation shocks, which can be a negative signal of the domestic economy;
- Interest differential is determined by expected exchange rate depreciation (Exper) shocks. Consistent with the previous point, shocks in expected rate depreciation affect domestic interest rates. Therefore, they also affect interest rate differential, as interest differential is defined as the difference between domestic and foreign interest rates.

Based on the restrictions, the SVAR matrix can be written as follows. Some elements in the second matrix or the B matrix are null, for example $a_{13} = 0$, it means that the long-term response of the unemployment variable towards the inflation variable shocks is zero.

Table 2. SVAR restriction matrix

$$\begin{bmatrix} Unemp \\ Output \\ Inflation \\ BIRate \\ ER \\ INDIR \\ DIR \\ OutputGap \\ Exper \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & a_{18} & 0 \\ b_{21} & 1 & b_{23} & 0 & 0 & b_{26} & 0 & 0 & 0 \\ c_{31} & 0 & 1 & 0 & c_{35} & 0 & 0 & c_{38} & 0 \\ 0 & 0 & d_{43} & 1 & 0 & 0 & 0 & d_{48} & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & e_{57} & 0 & e_{59} \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & f_{69} \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & g_{79} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{Unemp} \\ \varepsilon_{Output} \\ \varepsilon_{Inflation} \\ \varepsilon_{BIRate} \\ \varepsilon_{ER} \\ \varepsilon_{INDIR} \\ \varepsilon_{DIR} \\ \varepsilon_{outputGap} \\ \varepsilon_{Exper} \end{bmatrix}$$

Source: Authors' formulation.

3. Results and Discussion

This section describes the results of the study. Before proceeding into estimating the SVAR model, all variables should be stationary. ADF test is used to test whether the variables are stationary at the level. The results of the unit root test are presented in Table 3. All variables are stationary at the level as indicated by the significant ADF test statistics.

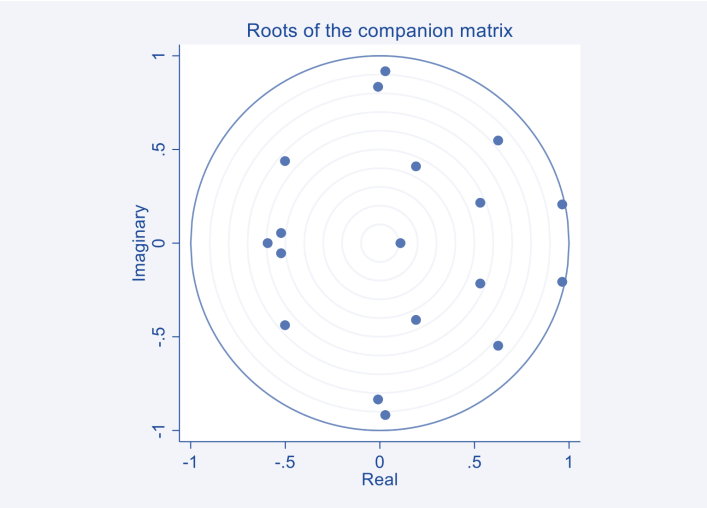
Table 3. Unit Root Test Results

No	Variables	ADF Test
1	Output	-17.963***
2	Inflation	-4.050***
3	BIRate	-4.036***
4	Unemployment	-7.064***
5	ER	-5.627***
6	INDIR	-4.736***
7	DIR	-3.425**
8	OutputGap	-17.152***
9	Exper	-6.570***

Note: ***) indicates that the variable is stationary at a critical value of 1%; **) indicates that the variable is stationary at a critical value of 5%;
Source: Unit root test results.

The next step is to determine the number lag for VAR estimation. Akaike's Information Criterion (AIC), Schwarz's Bayesian Information Criterion (SBIC), and the Hannan and Quinn Information Criterion (HQIC) are used to determine the lag variable used in the VAR model. Based on the test, the results suggest that lag of three should be used. The model also passed several diagnostic tests *i.e.*, the stability test, normality test, and autocorrelation. The stability test indicates that the system is stable with eigenvalue <1 and the roots are within the unit circle.

Figure 2. Stability Test-Unit Circle



Source: Test results.

3.1. Impulse Response Function

Impulse Response Function (IRF) analysis is used to examine the composite shock effect in the equation system towards the variables of interest (Insukindro and Pritadrajati 2019). The SVAR approach applies restrictions on the contemporaneous structural parameters, which are expected to be able to explain the dynamic changes in the Indonesian economy caused by structural shocks.

The Impulse Response Function is derived from the equation system as follows. From Equation 7, we can analyze the effect of one unit of change in the e_{Xt} shocks on Y_t in which others are assumed to be constant.

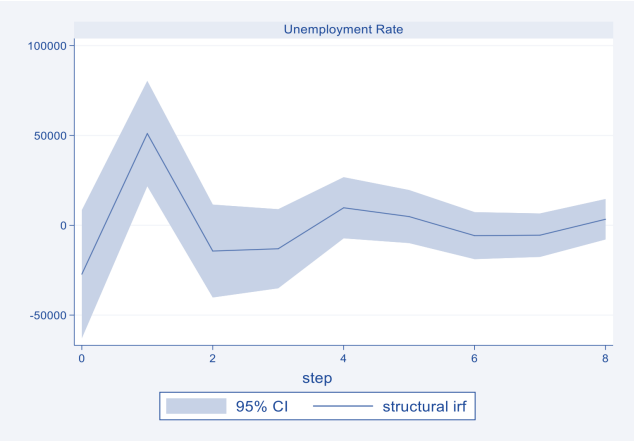
$$\begin{bmatrix} Y_t \\ X_t \end{bmatrix} = \begin{bmatrix} \bar{Y} \\ \bar{X} \end{bmatrix} + \sum_{i=0}^{\infty} \begin{bmatrix} \emptyset_{11}(i) & \emptyset_{12}(i) \\ \emptyset_{21}(i) & \emptyset_{22}(i) \end{bmatrix}^{i} \begin{bmatrix} e_{Yt-i} \\ e_{Xt-i} \end{bmatrix} \quad (7)$$

The four Φ_{jk} elements in Equation 7 are impact multipliers or impulse response functions. For example, Φ_{12} (0) is the effect of one unit of change in the e_{Xt} shocks on Y_t in which others are assumed to be constant. The model requires a stable equation system (or eigenvalue <1), which is located in a unit circle or is stationary. Sims (1980), however do not require differencing to be stationary because it will remove a lot of information.

Figure 3 shows unemployment response to the production shocks. In the first period, the production shocks originating from the output gap leads to an increase of 51,066 unemployed people. The effect levels out in the fifth period onward. This is consistent with empirical research which states that the business cycle that results in the production shocks affecting the unemployment rate (Constant and Zimmermann 2014). The increase in the output gap shows that the potential output is more significant than the real output resulting in a decrease in economic conditions, which can lead to increased cyclical unemployment (Okun's law). The high production cost results in demands for wage increases. If the company cannot fulfil the demand, the cyclical unemployment increases, and the subsequent impact exacerbates the output gap. Therefore, the model captures production shocks from the supply side in the economy (Chugh 2015, Cover and Mallick 2012, Romer 2012, Hubbard *et al.* 2012).

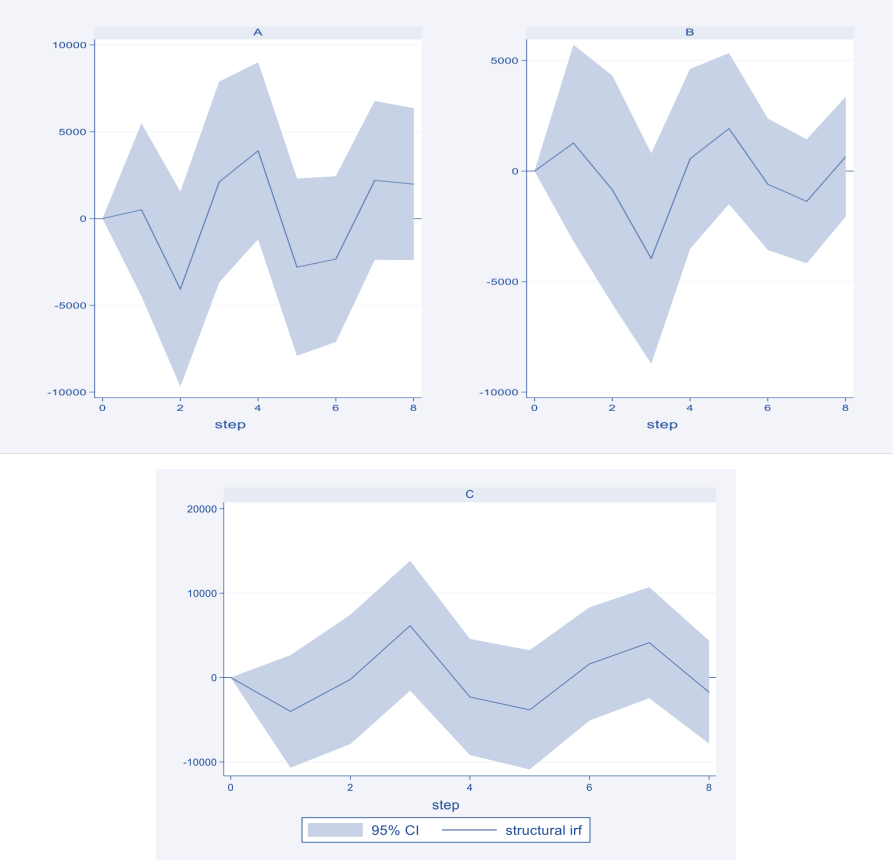
Figure 4a, 4b, and 4c show that IS shocks affect the level of output in Indonesia. The figures indicate that output oscillates around zero as a response to IS shocks originating from the unemployment, inflation, and domestic interest rates. The unemployment shocks resulted in an increase in output of 506.158 billion rupiah in the first period, but it decreases output in the second period (Figure 4a). Similar to the output response to unemployment shocks, the inflation shocks resulted in a temporary increase in output at the beginning of the period and then declined again in the third period. In the first period, the inflation shocks will cause real money demand to fall, domestic interest rates to rise, investment to fall, which leads to the fall of the output (Figure 4b). The domestic interest rate shocks affect output in the same pattern, but initial effect is negative (Figure 4c). This result is in line with the study of (Ďurčová 2012).

Figure 3. Unemployment Response to Production Shocks



Source: Impulse response results

Figure 4. Output response to IS shocks

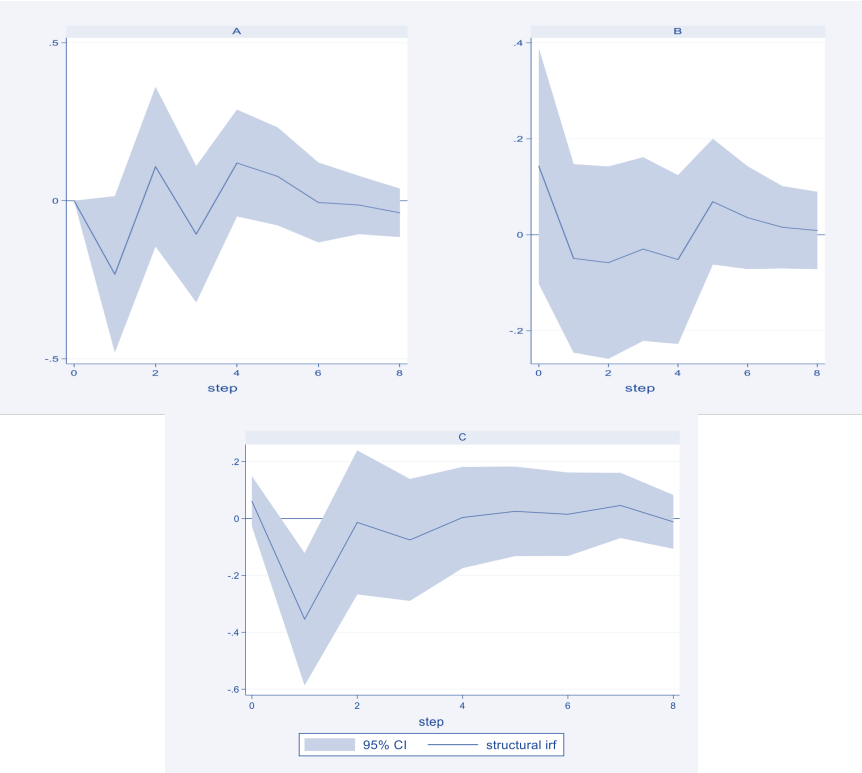


Source: Impulse response results.

Figure 5 shows the effect of AS shocks on the inflation rate in Indonesia. The figures indicate that inflation response differently to the three shocks, the AS shock originating from unemployment, output gap, and exchange rate. Overall the response of inflation to these shocks is relatively small. The unemployment shocks result in a decrease in inflation by 0.232% in the first period. This result is in line with the theory stating that if the unemployment shocks exist, then the demand aggregate will fall and further, resulting in the fall of the output because there is unemployment at the beginning of the period (Figure 5a). On the other hand, the output gap shocks increase in inflation by 0.143% at the beginning of the period. The increase in the output gap shows that the potential output is larger than the real output that lead to the rise of inflation (Figure 5b). Furthermore, the exchange rate shocks increase inflation instantly. The exchange rate shocks result in depreciation, an increase in exports, an increase in foreign exchange from the export results, increase in income, an increase in purchasing

power, an increase in consumption, which then leads to inflation that comes from the demand-pull inflation by 0.06% (Figure 5c). However, in the subsequent period inflation drops to -0.35%. This result is in line with the study of Batini *et al.* (2005) and Osabuohien *et al.* (2018).

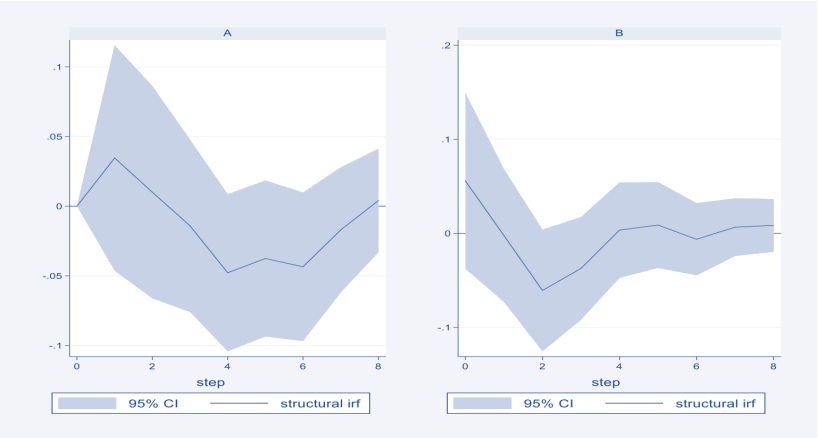
Figure 5. Inflation Response to Aggregate Supply (AS) Shocks



Source: Impulse response results.

Figure 6 shows the increase in the BI Rate due to monetary policy shocks originating from inflation and the output gap of one standard deviation. The inflation shocks resulted in an increase in the BI Rate by 0.03%. In this case, the central bank has to raise the BI Rate interest rates to control the inflation rates (Figure 6a). The output gap shocks resulted in an increase in the BI Rate by 0.06% immediately but it decreases BI Rate after ward (Figure 6b). The decline in economic conditions has prompted the central bank to raise the BI Rate. The change in the BI Rate gives an upward pressure to the domestic interest rate and in turns attract capital inflows that can drive the economy. The results of this study show that Bank Indonesia responded quickly to the structural shocks. According to the Keynesian, in disequilibrium condition, interest rates have a direct relationship with prices or inflation (Insukindro 2020). The results of this study show that Bank Indonesia responded quickly to structural shocks.

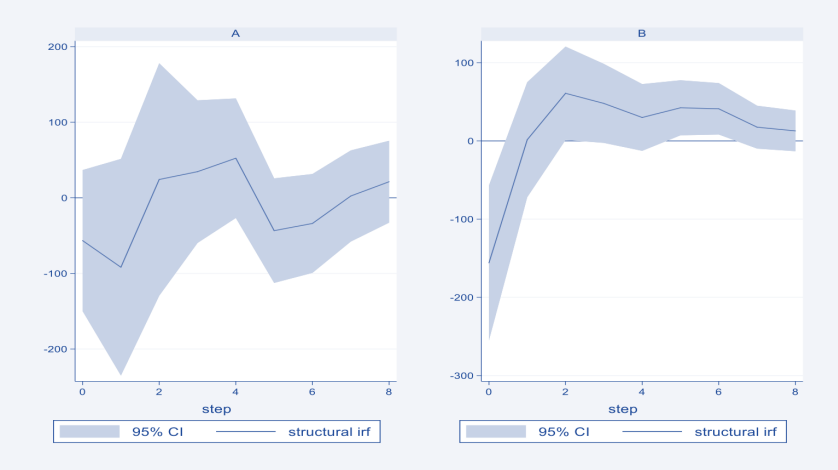
Figure 6. BI Rate response to monetary policy shocks



Source: Impulse response results.

Figure 7 show the response of exchange rate due to exchange rate shocks. The shocks are originating from interest rate differential and expected exchange rate depreciation. Both shocks lead to depreciation of rupiah. The exchange rate differential shocks result in an exchange rate depreciation of Rp56.67 per Dollar (Figure 7a). The difference in interest rate encourages arbitrage between countries, which leads to the capital flight and then the exchange rate depreciation. The expected exchange rate depreciation shocks result in the exchange rate depreciation of Rp155.91 per dollar (Figure 7b).

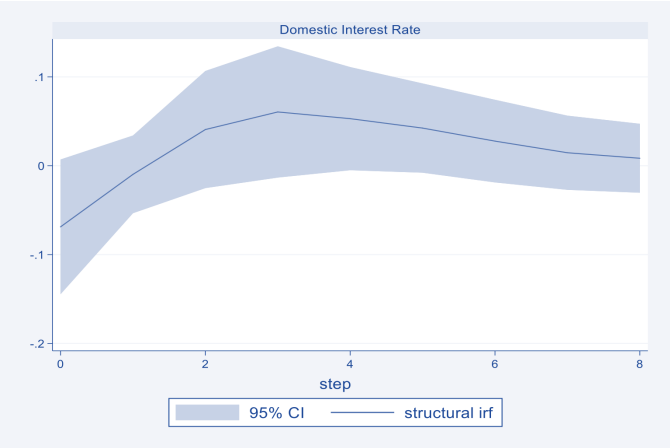
Figure 7. Exchange rate response to exchange rate shocks



Source: Impulse response results.

Figure 8 presents the effect of expected exchange rate depreciation shocks (Exper) to the domestic interest rates (INDIR) in Indonesia. The shocks resulted in a decrease in the domestic interest rate of 0.07%. If there is an expected exchange rate depreciation shocks, the rate of return of the domestic interest rate will be less attractive to the market players. Based on the monetary economic theory, in which the market is efficient, changes in interest rates can predict changes in exchange rates. In the short term, the change in exchange rate can be predicted using random walk method while in the long term it can be predicted using the fundamental factors. The results of the study showed that the UIRP condition was not reached. Therefore, structural shocks affect the weakening of economic conditions, in which the unemployment rate increases, the output falls, the inflation is high, and the depreciation of the exchange rate. This is following the theory of Real Business Cycle (RBC) and New Keynesian, which state that a decrease in aggregate demand results in a recession caused by various shocks that hit the economy (Chugh 2015, Scarth 2014).

Figure 8. Domestic interest rate response to expected exchange rate depreciation



Source: Impulse response results.

To check the robustness of the findings from the Impulse Response Functions, Granger Causality test is used to find the short-run dynamic and causality relationship between variables. The test can be used to identify whether structural shocks granger caused macroeconomic variables. The results of the analysis using the test show that at 5% significance level, all structural shocks affect macroeconomic variables, except only one variable

that is the unemployment. The results conform with the previous IRF analysis in which structural shocks affect macroeconomic indicators.

Conclusion

The global financial crisis and unexpected events generate structural shocks to the Indonesia's economy. While the Indonesian economy are improving up to 2012, by 2013 it began to decline. This study identified the shocks that lead to the weakening of macroeconomic conditions in Indonesia by using a Real Business Cycle (RBC) and New Keynesian approach. The approaches are used as they incorporate both shocks from the demand and the supply side and thus are better in representing the reality. The sample that are used are quarterly data from the Census and Economic Information Center (CEIC) database and Statistik Ekonomi dan Keuangan Indonesia (SEKI) Bank Indonesia from 2007-2019. This study uses the Structural Vector Autoregression (SVAR) model to build a macro-econometric model to analyze the relationship among the macroeconomic variables. The effects of structural shocks towards Indonesia's economy are analyzed using the impulse response function.

The results showed that in general the relationship of various shocks and the macroeconomic variables are consistent with the economic theory. The production shocks affect the unemployment rate by increasing it. Exchange rate depreciates as a response of exchange rate shocks from either interest differentials or expectation of depreciation. Thus, the shocks contribute to the declining of Indonesia's economy. The responses of inflation and output vary depending on the types of shocks. Demand shocks particularly from inflation and domestic interest rates leads a decrease in output. Inflation responses due to aggregate supply are found to be relatively small. In term of monetary policy, the monetary policy shocks originating from inflation and output gap immediately increase BI Rate. The central bank reaction is driven by the motivation to stabilize the economy.

Based on the results of the study, three suggestions are proposed for policy makers and further research agenda. First, since a particular shock have impacts on several macroeconomic variables, the government is expected to create a stable economic condition to minimize the macroeconomic volatility. Second, this study includes only inflation and output gap as the determinants of BI Rate. There are, however, other factors that influence the central bank interest rate, for instance exchange rate shocks. Therefore, we recommend imposing a restriction in the SVAR model on the exchange rate shocks so that it has a direct effect towards the BI Rate. Third, effectiveness of an economic policy on stabilizing the economy can be evaluated using counterfactual simulation. Thus, to shed light on the topic, research in this area is encouraged.

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APPENDIX

Table 4. Definition of variables and source

Notation	Variable	Definition	Unit	Source
u_t	Unemp	Open unemployment rate	People	CEIC Database
$y_t - y_t^n$	OutputGap	Difference between real output and potential output	Percentage	CEIC Database
y_t	Output	The amount of GDP measured from the expenditure side with at constant price 2010	Billion Rupiah	CEIC Database
p_t	Inflation	Price increases in general and continuously	Percentage	SEKI, BI
i_t	INDIR (*domestic interest rate*)	3 months deposits interest rate (Rupiah)	Percentage	SEKI, BI
i_t^f	US-IR *(foreign interest rate*)	3 months deposits interest rate (Dollar)	Percentage	SEKI, BI
q_t	*ER*	Exchange Rate Rp/US Dollar	Rp/US	CEIC Database
q_t^e	*Exper*	*Expected Exchange Rate* D*epreciation* Rp/ US Dollar	Rp/US	CEIC Database
DIR	*DIR (Interest Rate Differential)*	Difference between *domestic* dan *foreign interest rate*	Percentage	SEKI, BI
BI Rate	BI Rate	Central Bank Interest Rate that reflect monetary policy *stance*	Percentage	SEKI, BI

Table 5. Impulse response function

Step	(1)	(1)	(1)
	sirf	Lower	Upper
0	-27,197.50	-62,806.80	8,411.75
1	51,066.70	21,778.30	80,355.00
2	-14,346.00	-40,186.30	11,494.40
3	-13,072.40	-35,065.30	8,920.59
4	9,747.19	-7,251.97	26,746.30
5	4,842.56	-9,903.11	19,588.20
6	-5,776.74	-18,852.70	7,299.19
7	-5,515.11	-17,593.30	6,563.09
8	3,354.52	-7,887.77	14,596.80

Note: 95% lower and upper bounds reported; (1) Impulse = D_OutputGap and Response = D_Unemp
Source: impulse response results

(1) Impulse = D_Unemp and Response = D_Output
(2) Impulse = D_Inflation and Response = D_Output
(3) Impulse = D_INDIR and Response = D_Output

Step	(1)	(1)	(1)	(2)	(2)	(2)	(3)	(3)	(3)
	Sirf	Lower	Upper	sirf	Lower	Upper	sirf	Lower	Upper
0	0	0	0	0	0	0	0	0	0
1	506.158	-4,462.26	5,474.57	1,270.34	-3,165.91	5,706.59	-4,013.23	-10,672.80	2,646.38
2	-4,065.99	-9,662.14	1,530.16	-845.952	-6,003.56	4,311.66	-220.457	-7,873.45	7,432.53
3	2,109.22	-3,665.89	7,884.32	-3,956.28	-8,704.32	791.753	6,147.24	-1,539.14	13,833.60
4	3,902.79	-1,184.65	8,990.22	553.991	-3,506.04	4,614.02	-2,300.42	-9,167.99	4,567.15
5	-2,799.4	-7,898.60	2,299.81	1,923.14	-1,483.81	5,330.09	-3,828.89	-10,884.20	3,226.40
6	-2,334.71	-7,099.88	2,430.46	-596.341	-3,563.75	2,371.07	1,613.46	-5,088.92	8,315.84
7	2,202.35	-2,363.02	6,767.72	-1,368.54	-4,165.75	1,428.67	4,134.05	-2,436.82	10,704.90
8	1,980.06	-2,391.79	6,351.91	646.163	-2,061.16	3,353.48	-1,738.62	-7,828.22	4,350.97

Note: 95% lower and upper bounds reported
Source: Impulse response results

(1) Impulse = D_Unemp and Response = D_Inflation
(2) Impulse = D_OutputGap and Response = D_Inflation
(3) Impulse = D_ER and Response = D_Inflation

Step	(1)	(1)	(1)	(2)	(2)	(2)	(3)	(3)	(3)
	sirf	Lower	Upper	sirf	Lower	Upper	sirf	Lower	Upper
0	0	0	0	0.1431	-0.1019	0.3881	0.0605	-0.0272	0.1482
1	-0.2325	-0.4794	0.0144	-0.0493	-0.2456	0.1470	-0.3540	-0.5862	-0.1218
2	0.1077	-0.1445	0.3599	-0.0583	-0.2585	0.1420	-0.0137	-0.2666	0.2391
3	-0.1057	-0.3209	0.1094	-0.0299	-0.2210	0.1613	-0.0754	-0.2895	0.1386
4	0.1195	-0.0492	0.2882	-0.0518	-0.2275	0.1240	0.0034	-0.1742	0.1811
5	0.0773	-0.0776	0.2319	0.0689	-0.0619	0.1997	0.0251	-0.1321	0.1822
6	-0.0053	-0.1314	0.1209	0.0355	-0.0714	0.1425	0.0148	-0.1317	0.1613
7	-0.0135	-0.1054	0.0783	0.0155	-0.0701	0.1011	0.0459	-0.0685	0.1603
8	-0.0380	-0.1145	0.0385	0.0089	-0.0716	0.0894	-0.0118	-0.1063	0.0827

Note: 95% lower and upper bounds reported
Source: Impulse response results

(1) Impulse = D_Inflation and Response = D_BIRate; (2) Impulse = D_OutputGap and Response = D_BIRate

Step	(1)	(1)	(1)	(2)	(2)	(2)
	sirf	Lower	Upper	sirf	Lower	Upper
0	0	0	0	0.0558	-0.0377	0.1493
1	0.0346	-0.0463	0.1155	-0.0023	-0.0729	0.0683
2	0.0100	-0.0662	0.0863	-0.0608	-0.1254	0.0039
3	-0.0141	-0.0759	0.0477	-0.0373	-0.0919	0.0172
4	-0.0478	-0.1041	0.0086	0.0034	-0.0473	0.0542
5	-0.0376	-0.0936	0.0184	0.0088	-0.0368	0.0544
6	-0.0435	-0.0968	0.0098	-0.0063	-0.0446	0.0320
7	-0.0171	-0.0619	0.0278	0.0066	-0.0241	0.0372
8	0.0040	-0.0331	0.0412	0.0084	-0.0197	0.0365

Note: 95% lower and upper bounds reported
Source: Impulse response results

(1) Impulse = D_DIR and Response = D_ER; (2) Impulse = D_Exper and Response = D_ER

Step	(1)	(1)	(1)	(2)	(2)	(2)
	sirf	Lower	Upper	sirf	Lower	Upper
0	-56.5702	-149.889	36.7482	-155.905	-254.831	-56.9776
1	-91.8284	-235.108	51.4516	1.55043	-71.9350	75.0358
2	24.2636	-129.467	177.994	60.9139	1.28323	120.545
3	34.6163	-59.7011	128.934	47.9559	-2.53152	98.4433
4	52.3996	-26.6763	131.475	29.9822	-12.6932	72.6575
5	-43.4362	-112.571	25.6982	42.3600	7.16848	77.5514
6	-33.8932	-99.2702	31.4837	41.0404	8.18643	73.8944
7	2.38779	-57.9005	62.6761	17.5745	-9.84612	44.9952
8	21.2889	-32.8486	75.4264	12.8069	-13.1824	38.7961

Note: 95% lower and upper bounds reported
Source: Impulse response results

(1) Impulse = D_Exper and Response = D_INDIR

Step	(1)	(1)	(1)
	Sirf	Lower	Upper
0	-0.0688	-0.1445	0.0070
1	-0.0097	-0.0534	0.0340
2	0.0408	-0.0251	0.1066
3	0.0605	-0.0133	0.1344
4	0.0530	-0.0050	0.1110
5	0.0424	-0.0078	0.0926
6	0.0277	-0.0188	0.0742
7	0.0147	-0.0271	0.0564
8	0.0084	-0.0304	0.0472

Note: 95% lower and upper bounds reported
Source: Impulse response results

Table 6. Granger Causality Wald Tests

Equation	Excluded	chi2	Df	Prob > chi2
D_Output	D_Inflation	1.8431	2	0.398
D_Output	D_BIRate	1.8947	2	0.388
D_Output	D_Unemp	6.1954	2	0.045
D_Output	D_ER	4.7063	2	0.095
D_Output	D_INDIR	1.2462	2	0.536
D_Output	D_DIR	1.3201	2	0.517
D_Output	D_OutputGap	18.789	2	0.000
D_Output	D_Exper	1.2793	2	0.527
D_Output	ALL	47.002	16	0.000
D_inflation	D_Output	1.2493	2	0.535
D_inflation	D_BIRate	4.4346	2	0.109
D_inflation	D_Unemp	3.598	2	0.165
D_inflation	D_ER	12.095	2	0.002
D_inflation	D_INDIR	2.8111	2	0.245
D_inflation	D_DIR	2.6511	2	0.266
D_inflation	D_OutputGap	1.7734	2	0.412
D_inflation	D_Exper	5.8338	2	0.054
D_inflation	ALL	65.987	16	0.000
D_BIRate	D_Output	2.8707	2	0.238
D_BIRate	D_Inflation	0.9173	2	0.632
D_BIRate	D_Unemp	0.0795	2	0.961
D_BIRate	D_ER	0.2457	2	0.884
D_BIRate	D_INDIR	6.6586	2	0.036
D_BIRate	D_DIR	1.6198	2	0.445
D_BIRate	D_OutputGap	3.0943	2	0.213
D_BIRate	D_Exper	6.7012	2	0.035
D_BIRate	ALL	31.808	16	0.011
D_Unemp	D_Output	10.331	2	0.006
D_Unemp	D_Inflation	0.7630	2	0.683
D_Unemp	D_BIRate	0.2698	2	0.874
D_Unemp	D_ER	0.4055	2	0.816
D_Unemp	D_INDIR	2.8387	2	0.242
D_Unemp	D_DIR	4.9312	2	0.085
D_Unemp	D_OutputGap	13.953	2	0.001
D_Unemp	D_Exper	0.1375	2	0.934
D_Unemp	ALL	22.425	16	0.130
D_ER	D_Output	3.0929	2	0.213
D_ER	D_Inflation	3.9729	2	0.137
D_ER	D_BIRate	3.4627	2	0.177
D_ER	D_Unemp	0.5464	2	0.761
D_ER	D_INDIR	8.3171	2	0.016
D_ER	D_DIR	2.0807	2	0.353
D_ER	D_OutputGap	2.2218	2	0.329
D_ER	D_Exper	7.5629	2	0.023
D_ER	ALL	46.311	16	0.000
D_INDIR	D_Output	2.8278	2	0.243
D_INDIR	D_Inflation	14.478	2	0.001
D_INDIR	D_BIRate	13.746	2	0.001
D_INDIR	D_Unemp	3.1056	2	0.212
D_INDIR	D_ER	2.1868	2	0.335
D_INDIR	D_DIR	1.2017	2	0.548
D_INDIR	D_OutputGap	4.0325	2	0.133
D_INDIR	D_Exper	5.0128	2	0.082
D_INDIR	ALL	96.921	16	0.000
D_DIR	D_Output	0.1124	2	0.945

Equation	Excluded	chi2	Df	Prob > chi2
D_DIR	D_Inflation	20.079	2	0.000
D_DIR	D_BIRate	5.1238	2	0.077
D_DIR	D_Unemp	0.0808	2	0.960
D_DIR	D_ER	0.1485	2	0.928
D_DIR	D_INDIR	5.3830	2	0.068
D_DIR	D_OutputGap	0.2366	2	0.888
D_DIR	D_Exper	4.1242	2	0.127
D_DIR	ALL	68.481	16	0.000
D_OutputGap	D_Output	14.467	2	0.001
D_OutputGap	D_Inflation	1.2286	2	0.541
D_OutputGap	D_BIRate	0.7922	2	0.673
D_OutputGap	D_Unemp	6.6396	2	0.036
D_OutputGap	D_ER	1.8865	2	0.389
D_OutputGap	D_INDIR	3.9383	2	0.140
D_OutputGap	D_DIR	2.8092	2	0.245
D_OutputGap	D_Exper	1.2722	2	0.529
D_OutputGap	ALL	38.596	16	0.001
D_Exper	D_Output	2.4007	2	0.301
D_Exper	D_Inflation	0.6499	2	0.723
D_Exper	D_BIRate	1.9375	2	0.380
D_Exper	D_Unemp	0.3306	2	0.848
D_Exper	D_ER	30.390	2	0.000
D_Exper	D_INDIR	4.9641	2	0.084
D_Exper	D_DIR	1.3630	2	0.506
D_Exper	D_OutputGap	2.7134	2	0.258
D_Exper	ALL	88.678	16	0.000

Source: Granger causality test results.