

# JEMS

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## Causality relationship among interest rate, inflation, exchange rate using vector autoregression

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**Abstract:** This paper aimed to analyze the causal relationship between interest rates, inflation, and exchange rates in Indonesia. This paper used Vector Autoregression (VAR). The Granger causality showed that the interest rate did not affect inflation, but inflation affected the interest rates. The exchange rate affected inflation, but inflation did not affect the exchange rate. As for the interest rate and the exchange rate, they did not affect each other. The Impulse Response Function of the interest rate was due to the shock of a positive change in one of its standard deviations. Inflation response to the change in one standard deviation of the interest rate initially was null in period one, increased in period two, and gradually decreased until period ten. The inflation response was due to the shock of a positive change in one of its standard deviations. In Variance Decomposition, interest rate shifting in period one and period two were still very dominantly influenced by the interest rate itself. Next, it was affected by inflation. Furthermore, changes in inflation in period one and period two were influenced dominantly by inflation itself. In the next period, interest rates and exchange rates affected inflation in a small percentage.

**Keywords:** interest rate, inflation, exchange rate, vector autoregression.

## 1. Introduction

Globalization and various free trade agreements lead to no restrictions between countries on the flow of goods, capital, as well as labor. It will be a challenge for each country to increase its competitiveness, thus unbeatable by others. The flow of capital and goods, both directly and indirectly, can affect the changes in macroeconomic variables, including interest rates, inflation, exchange rate, and economic growth.

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The change of one of the macroeconomic variables could have an impact on other variables. Relationships between macroeconomic variables can also be dynamic, mutually affecting, that have a multiplier impact. Since the monetary crisis in 1997, Indonesia implemented a floating exchange rate system which causes the exchange rate to move more flexibly. The exchange rate will conform to the market mechanism which causes the fluctuating exchange rate. The change occurs since the monetary authority considers that the dynamics of external developments are running so rapidly along with the national economic openness to foreign market penetration, hence the movement of the Rupiah against the US dollar becomes difficult to control permanently (Aji, T.S., Cahyono & Yasin, 2019).

Lately, the exchange rate of Rupiah against the US dollar is very volatile with the trend of declining values. At the end of 2012 the rate was still below 10,000 per US Dollar, but in October 2013 was above 11,000 and in December 2014 reached 12,700. On 09 March 2015 the rupiah exchange rate against the US dollar reached 13,047. Even in the 2nd quarter of 2018 Rupiah exchange rate against the dollar reached 13,800 per dollar.

The exchange rate fluctuation (appreciation or depreciation) in the market shows the magnitude of the volatility in a country's currency. If it is getting bigger, it shows that the movement of the exchange rate is getting bigger and vice versa. When the exchange rate experiences extreme movements, the economy will suffer instability. In an open economy with flexible exchange rate system, the movement of exchange rates can change the relative price to affect the development of exports and imports. The subsequent movements of the exchange rate will affect aggregate demand, economic growth rate and inflation rate. the impact of exchange rate fluctuations on the economy is very large, therefore exchange rate stability needs to be maintained (Aji, T.S., Ismail, Maski, & Santoso, 2016)

On the supply side, the depreciation rate will increase the cost of imported raw materials which can further lead to decreased imports and production output thereby triggering the price increase in general. The net effect of depreciation of exchange rate against the output depends on the relative strength of both the supply and demand. When the value of exports of a country is greater than the value of imports it will implicate the increasing acceptance of foreign exchange.

The global crises in the year of 1998, 2008, and 2012 have made many countries aware of how integrated is the economy among countries. Policy makers are more aware, with the economic open, the flows of information and cross-border goods and services, monetary and fiscal policies in one country will impact other countries. Risk management, as a reaction to another country's policy is required, in particular from the monetary and fiscal side, in the framework of maintaining the stability of the financial system, known as a macro confidential policy. In addition, it is also necessary to understand that between macroeconomic variables has a dynamic relationship that must always be anticipated so that macroeconomic stability can always be maintained. The specific purpose of the study is to analyze causality relationships between interest rates, inflation, exchange rates.

## 2. Literature review

### The relation between inflation and exchange rate

Inflation is generally defined as a continuous increase in the general price level. There are a few things to underline in the sense of inflation, first, tendency, the propensity of price rising even though price reductions are possible. Secondly, sustained or price increases do not occur once in a while but continuously over a long period of time. Thirdly, the general level of price, meaning the price level in question is the price of goods in general not the price of one kind of goods only. If  $P_{t-1}$  is the price level last year and  $P_t$  is the current price level, then the inflation rate ( $\pi$ ) is

$$\pi = \frac{P_t - P_{t-1}}{P_{t-1}}$$

In accordance with Purchasing Power Parity theory, when domestic goods increase (assuming the price of a fixed foreign goods), domestic goods demand is dropped and the domestic currency tends to weaken. Conversely, if the price of foreign goods increased in such a way that the relative price of domestic goods dropped then demand for domestic goods increased and the domestic currency tends to strengthen.

In the long run, the increase in a country's price level (relative to overseas) resulted in the depreciation of domestic currency, and conversely the decrease in the relative price level causing the currency to be appreciated (Mishkin, 2016).

## The relation between interest rate and exchange rate

All investors expect high returns from the selected investment instruments, including currencies. The interest rate in this case could affect the exchange rate of a currency against other currencies. The interest rate is the cost to be paid by the borrower on the loan earned or in return for the lender on the funds lent.

When capital mobility is flexible, and when assets are perfectly substituted, if the estimate of the return of a domestic asset is greater than the estimated return of foreign asset, the foreigner and the domestic community will only hold the asset in the form of the domestic currency and do not want to hold the foreign assets, and vice versa, until there is no difference in the return rate of both assets. Domestic interest rates are equal to foreign interest rates minus the estimated appreciation of the domestic currency. If the domestic interest rate is higher than the foreign interest rate, then there is an estimate of the positive appreciation of the foreign currency that will compensate for the lower rate of foreign interest

$$i^D = i^F + \frac{E_{t+1}^e - E_t}{E_t}$$

To explain the determination of currency exchange rates parity of the interest rate can be manipulated mathematically into (Mishkin, 2016):

$$E_t = \frac{E_{t+1}^e}{i^F - i^D + 1}$$

## The relation between interest rate and inflation

In classical theory, "interest" is the price of capital, where when the demand for money rises then interest will rise anyway, but people ask for money or borrow money is not solely for investment but also for transactions (consumption) and speculation. Nevertheless the borrower remains subject to interest. That is why in the capitalist economy; more economic transaction activity in the financial sector is compared to the real sector.

Furthermore, it is also known that the interest rate has a relationship with the inflation rate. The nominal interest rate and real interest rate relationship with inflation can be written as follows:

$$i = r + \pi$$

$i$  – nominal interest;

$r$  – real interest;

$\pi$  – inflation.

The equation above is an equation of Irving Fisher (Fisher equation). From the equation it is shown that the nominal interest rate is the sum between the real interest rate and inflation (Mankiw, 2019).

## Empirical study

Many empirical studies examine factors that affect currency exchange rate. Among them Aji, T.S., Ismail, Maski, and Santoso (2016) found that the amount of money supply, interest rate, growth of output, capital flow and inventory dollars affects the exchange rate of rupiah against the dollar.

Triyono (2008) analyzes the exchange rate changes against the US dollar using the error correction model (ECM) with the variable of free inflation, the amount of money supply, the interest rate of SBI, imports. The results of analysis with the T test are known that short-term regression of inflation variables, SBI and imports are not significant to the exchange rate, while the JUB variable affects the exchange rate. In long-term regression of inflation variables, JUB, SBI, and imports affect the exchange rate at  $\alpha = 5\%$ .

Wibowo, T., and Amir, H., (2005) analyzed the factors affecting the rupiah exchange rate. It was found that the difference in revenues, inflation, interest rates and the exchange rate of lag 1 affects the dollar's exchange rate to dollars. Atmadja (2002) found that only the variable amount of money supply has an influence on the movement of the rupiah exchange rate against the American dollar. Variable dependent variables in the study are the rate of inflation, interest rate, amount of money supply, national income, as well as balance of payments.

Meisuri, P.E.A (2013) examined the factors affecting the rupiah currency exchange rate against the dollar. The result of T test shows that inflation has no significant influence on changes in rupiah currency exchange rate against the American dollar, real interest rates have a significant influence on changes in rupiah currency exchange rate against American dollar, and the world crude oil prices have a significant influence on changes in rupiah currency exchange rate against the American dollar. The results of the F test showed that inflation, real interest rates and crude oil prices of the world

had a significant influence on changes in rupiah currency exchange rate against the simultaneous American dollar in the period 2005-20011.

Pratiwi, T.E. & Santosa (2012) Analyze the behavior of the rupiah exchange rate against the dollar. In this study, it was conducted against 4 (four) macroeconomic variables that allegedly affected the behavior of the Indonesian Rupiah (IDR) against the US Dollar (USD). As the result of interest rate has a positive and significant relation to the exchange rate, CPI has a positive and significant relation to the exchange rate, M2 has a positive and significant relationship to the exchange rate, GDP has a negative and significant relationship to the exchange rate

Le, (2015) analyzed the determinant of the exchange rate in Vietnam and found that the price ratio between Vietnam and America was an important variable that determines the exchange rate. Agustin, G (2009) found that price-level variables, interest rate difference, amount of money supply, foreign exchange reserves, total export value and total import value in the same manner have an influence on changes in rupiah exchange rate against the United States dollar. While partially (t Test), the total variable of the export value has no significant effect on the exchange rate.

### 3. Research methodology and data

This research was conducted in Indonesia using secondary data. The research period is from January 2013 to December 2018. Data was obtained from Bank Indonesia publications. Analysis of the data used in this study uses vector autoregression (VAR). The VAR model considers all economic variables as interdependent (Widarjono, 2016). The variables analyzed in this study are the interest rate ( $i_t$ ), inflation ( $\pi_t$ ), exchange rate ( $E_t$ ). The model used in this study is as follows:

$$\begin{aligned} i_t &= \alpha_3 + \sum_{i=1}^p \beta_{i3} i_{t-i} + \sum_{i=1}^p \lambda_{i3} E_{t-i} + \sum_{i=1}^p \delta_{i3} \pi_{t-i} + e_{3t} \\ \pi_t &= \alpha_4 + \sum_{i=1}^p \beta_{i4} \pi_{t-i} + \sum_{i=1}^p \lambda_{i4} E_{t-i} + \sum_{i=1}^p \beta_{i3} i_{t-i} + e_{4t} \\ E_t &= \alpha_1 + \sum_{i=1}^p \beta_{i1} E_{t-i} + \sum_{i=1}^p \gamma_{i1} i_{t-i} + \sum_{i=1}^p \delta_{i1} \pi_{t-i} + e_{1t} \end{aligned}$$

### 4. Result and discussion

#### Data analysis result

##### 4.1. Stationarity test

To analyze data using the Vector Autoregression (VAR) method, the first test process is to test the data station using the Augmented Dickey Fuller (ADF) test at the same degree until a stationary data is obtained, which is a variable that is not too large and has a tendency to approach the average.

Test results at level indicate that the data is not stationary or the ADF value is greater than  $\alpha = 5\%$ , so the second test is a stationary test in first difference. In the degree test integration, the testing process by changing the degree becomes higher than that done on the data stationarity test. Thus, the entire variable will be performed a test degree integration process.

From the table 1 shows that data has been tested on the test degree of integration in each variable and the whole has been stationary at the first difference degree. This can be known from the probability value of ADF (Augmented Dickey Fuller) smaller than the critical value of 5%.

**Table 1: Data stationarity test**

Variable	Prob. ADF in Level	Prob. ADF in First Diff
Interest Rate ( $i_t$ )	0,64	0.0000
Inflation ( $\pi_t$ )	0,41	0.0000
Exc. Rate ( $E_t$ )	0,48	0.0000

Source: Data Processed, 2019

Probability value of each ADF is for variable Interest Rate of 0.0 where the value is smaller than  $\alpha = 0.05$  or 5% indicates that the data has been stationary. Furthermore the probability value of the inflation ADF is 0.0 where the value is smaller than  $\alpha = 0.05$  Thus indicating the data has been stationary. The ADF probability value for variable exchange rates is 0.0 where the value is smaller than  $\alpha = 0.05$ , indicating that the data has been stationary.



## 4.2. Lag length optimum test

Lag Length test is one of the problems that will be experienced when using the Vector Autoregression (VAR) method because it must determine the optimal lag that if the lag used in the station test is too little, then the residual of the regression will not display the white noise process so that the model cannot estimate actual errors appropriately. Consequently,  $\gamma$  and standard mistakes are not properly estimated.

However, if you enter too much lag, it will be able to reduce the ability to reject  $H_0$  due to the addition of too much parameters will reduce the free degree. Here are the Lag Length test results

**Table 2: Lag length result**

Lag	AIC	SIC	HQ
0	5.075271	5.171635	5.113548
1	-2.226648	-1.841191*	-2.073540*
2	-2.271639*	-1.597091	-2.003700

Source: Data Processed, 2019

From the lag length test results show the number of star symbols on the numbers in each result column. In column lag 0, there is no star symbol at all. However, in column lag 1 there are two asterisks. And there is one asterisk in lag 2. Then it can be directly determined the optimal lag recommended by E-Views at Lag 1.

In addition to the star symbol which is a recommendation to determine the optimal lag, it can also be seen from the addition of the AIC (Akaike Information Criterion) column, SIC (Schwarz Information Criterion), and HQ (Hanna-Quinn Information Criterion) where the smaller summation results become the optimal lag recommendation by E-Views.

At lag 0, it can be seen that the AIC summation is 5.075271, the sum of SIC is 5.171635, and for a total of 5.113548. Then, at the lag of 1 of the AIC summation is -2.226648, the total SIC is -1.841191, and the HQ of -2.073540. Meanwhile, at the lag of 2 of AIC summation are -2.271639, the sum of SIC are -1.597091, and summation at the HQ of -2.003700.

## 4.3. Cointegration test

To know the long-term relationship between variables in the vector autoregression model is the cointegration test. Test cointegration on this study using Johansen test. Based on the Table below are all the statistical trace values below the critical value, so that it can be concluded there is no cointegration or no long-term relationship.

**Table 3: Cointegration test result**

Hypothesized	Trace	0.05	
No. of CE(s)	Statistic	Critical Value	Prob.**
None	24.30738	29.79707	0.1878
At most 1	7.140111	15.49471	0.5614
At most 2	1.881517	3.841466	0.1702

Source: Data Processed, 2019

## 4.4. VAR estimation

Stationary test results were concluded that stationary data at first difference level. Based on Johansen's cointegration test it turns out that the data was not cointegrated so that the estimated VAR was VAR at first difference level.

## 4.5. VAR stability test

Further VAR models need stability tests. If the model has stability then the estimate will not change with a large deviation even though the period is extended so that the estimated results can be justified (Gujarati, 2004). The Model is said to be stable when the modulent value is less than one. In the Table below look the characteristic root values or modulus all indicate a value of less than one, so it can be concluded that the VAR model used has stability.

**Table 4: Model stability test**

Root	Modulus
0.655438	0.655438
0.087224 - 0.562583i	0.569305
0.087224 + 0.562583i	0.569305
-0.134557 - 0.294991i	0.324230
-0.134557 + 0.294991i	0.324230
-0.259635	0.259635

Source: Data Processed, 2019

#### 4.6. Granger causality test

At a later stage, the Granger or Granger causality is a test that explains the causal relationship between interest rate, inflation and exchange rate. Empirically, the test of causality of Granger can be done using the VAR model, the Granger equation can be interpreted as follows:

- Unidirectional Causality of dependent variables to an Independent variable. This happens when the dependent coefficient of variable lag is statistic significantly different from zero, while the overall coefficient of lag of the independent variable is equal to zero.
- Feedback/Bilateral Causality if the coefficient of lag is all variable, both dependent and independent variables statistical significance differ from zero.
- Independence if the coefficient of lag of all variables, both dependent and independent variables statistic no different from zero.

**Table 5: Granger causality**

Null Hypothesis:	Prob.
Interest rate does not Granger Cause Inflation	0.1570
Inflation does not Granger Cause Interest Rate	0.0284
Exchange Rate does not Granger Cause Inflation	0.0248
Inflation does not Granger Cause Exchange Rate	0.7219
Exchange rate does not Granger Cause Interest Rate	0.2422
Interest Rate does not Granger Cause Exchange Rate	0.1001

Source: Data Processed, 2019

From the results of the aforementioned Granger test can be noted that If the probability of the F-Statistics  $< \alpha$  then the  $H_0$  is rejected. Table above indicates that the probability value F-statistic = 0.1570  $> \alpha$  which is 0.05 or 5%, then the  $H_0$  accepted means that the Interest Rate does not affect inflation.

If the probability of the F-Statistics  $< \alpha$  then  $H_0$  is rejected. Table above indicates that the probability value F-statistic = 0.0284  $< \alpha$  which is 0.05 or 5%, then  $H_0$  is rejected means inflation affects the Interest Rate. Table above indicates that the probability value F-statistic = 0.7219  $> \alpha$  which is 0.05 or 5%, then the acceptable  $H_0$  means inflation does not affect the exchange rate.

The table above shows that the probability value of F-statistic = 0.0248  $< \alpha$  is 0.05 or 5%, then  $H_0$  is rejected meaning that the rate affects inflation. Table above indicates that the probability value of F-Statistic = 0.2422  $> \alpha$  i.e. 0.05 or 5%, hence the acceptable  $H_0$  means that the exchange rate does not affect the Interest Rate. The Table above shows that the probability value of F-Statistic = 0.1001  $> \alpha$  is 0.05 or 5%, the  $H_0$  is acceptable meaning that the Interest Rate does not affect the exchange rate.

### 5. Discussion

#### 5.1. Inflation and BI rate

Inflation is a continuous increase in the price of goods and services. The main impact of inflation is the deterioration of money value so that currency buying power is decreasing. The decline in purchasing power will impact the condition of the individual economy, business world and state budget. High inflation will negatively impact the overall economy (Suseno & Astiyah, 2009)

Seeing the negative impact of inflation, each country strives to control the inflation rate at a stable and low level. The low inflation size is very relative and differs between countries. Low inflation rates in developed countries range from 2-3 percent, while in developing countries the inflation rate below 10 percent is considered reasonable.

The influence between inflation on the Interest Rate (BI rate or the BI 7-day Repo Rate) is a reflection that Bank Indonesia will respond to inflation fluctuations in Indonesia by adjusting the

interest rate of BI Rate or BI 7-days Repo Rate. Bank Indonesia uses a benchmark rate of BI Rate until August 19, 2016, thereafter after 19 August 2016 using a reformulation of the benchmark interest rate to BI 7-day Repo Rate. In the tenor structure monetary operations shifted from 360 days to 7 days. This change in reference rate of Bank Indonesia is expected to increase Indonesia's economy more rapidly to the level targeted by Bank Indonesia.

The monetary operating framework is constantly refined to strengthen policy effectiveness in achieving the established inflation target. The 7-day BI (Reverse) Repo Rate instrument is used as a new policy interest rate as it can rapidly affect the money market, banking and the real sector. The BI 7-Day Repo Rate instrument as a new reference has a stronger relationship to the money market interest rate, is transactional or traded on the market, and encourages the deepening of the financial markets, particularly the use of Repo instruments. Using the 7-day BI (Reverse) Repo Rate instrument as a new policy interest rate, there are three main impacts expected. Firstly, the strengthening of the monetary policy signals with the interest rate (Reverse) Repo Rate 7 days as the main reference in the financial market. Secondly, the increase in effectiveness of monetary policy transmission through its influence on the interest rate movements of money market and bank interest rates. Third, the formation of a deeper financial market, especially transactions and the establishment of a interest rate structure in the interbank money Market for the tenor of 3-12 months (<https://www.bi.go.id/id/moneter/bi-7day-RR/penjelasan/Contents/Default.aspx>).

The main determinant of Bank Indonesia's BI 7-day Repo Rate is inflation in Indonesia. Inflation is influenced by the number of currency circulation in the country and the amount of production and demand of the community resulting in the volatility of price of goods and services. If inflation rises then the benchmark rate also rises, and conversely if inflation falls then Bank Indonesia will decrease the magnitude of the BI 7-day Repo Rate. The change in the value of BI 7-day Repo Rate is not only on the rise of the price alone, but rather to the economic growth of people and countries globally.

As the inflation rate increases, the interest rates and deposits will also increase and reduce the rate of currency circulation in the community. When the economy is weak, then Bank Indonesia will reduce the BI 7-day Repo Rate to stimulate the development of small industries and other economic sectors. Thus, the Government is expected to control the inflation rate so that the country's economy remains stable.

In conjunction with the community economy, the determination of the value of the BI 7-day Repo Rate also greatly affects the daily economic conditions. For example, when price of the underlying materials jumped sharply due to the difficulty of harvesting or scarcity of certain staples, the BI 7-day Repo Rate will drop to spur the credit turnover in the community. With the good economy and increased money circulation, it is expected that the staple price becomes down and then stabilizes again. While in preventing inflation, the BI 7-day Repo Rate is also very important to control the money circulating in the community. When the increase in inflation, bank institutions prefer to save money to Bank Indonesia, so slowly the money circulating will be reduced.

In classical theory, that "interest" is the price of capital, where when the demand for capital (money) rises then interest will rise anyway, but people ask for money or borrow money is not solely for investment but also for transactions (consumption) and speculation. Nevertheless the borrower remains subject to interest. That is why in the capitalist economy, more economic transaction activity in the financial sector is compared to the real sector. It is also known that the interest rate has a relationship with the inflation rate. The nominal interest rate and real interest rate relationship with inflation can be written as follows:

$$i = r + \pi$$

The equation above is an equation of Irving Fisher (Fisher equation). From the equation it is shown that the nominal interest rate is the sum between the real interest rate and inflation (Mankiw, 2019). From the equation, it can be concluded that the inflation rise will have an impact on the nominal interest rate.

## 5.2. Exchange rate and inflation

In this study it was found that the exchange rate affects inflation. These results indicate that the prices of goods and services in Indonesia are strongly influenced by the ups and downs of the exchange rate. It means that there is Indonesia's dependence on foreign goods, which can be in the form of raw materials, capital goods or finished goods that are ready for consumption. Inflation caused by changes in the rupiah exchange rate can be categorized as imported inflation.

The Assistant Governor of the Head of the BI Economic and Monetary Policy Department Dody Budi Waluyo did not deny the decrease in the rupiah would have an effect, especially on the price of imported raw materials for industry. The weakening of the rupiah will indeed increase the production costs of some importers. In fact, some companies that have foreign debt can be depressed



(<https://www.cnbcindonesia.com/market/20180304131321-17-6130/dampak-pelemahan-rupiah-sudah-masuk-hitungan-Inflation-bi>).

The case in the study was irrelevant if it was described using the Purchasing Power Parity (PPP) theory. PPP reveals that the exchange rate equals the ratio of domestic prices and overseas prices. This theory describes the exchange rate between the two countries will change according to the change in the price level in both countries. This purchasing power parity theory is a one-price legal application at the overall price level and not a price of one kind of goods (Mishkin, 2016).

The currency exchange rate is heavily influenced by the foreign exchange market's demand and supply conditions. In increasingly integrated international market conditions, the factors that determine foreign currency demand and supply are increasingly complex and difficult to control. Factors influencing include: Export and import activities, capital flows, and speculation.

### 5.3. Impulse response function

The Impulse Response Function can be utilized to analyze the shock effect of a variable to other variables. The Shock of endogenous variables could affect the variables themselves and could have an impact on other endogenous variables, so it could be known to the magnitude of the endogenous variable's influence.

The IRF picture below explains when there is a shock to variable endogenous variables such as Interest Rate, inflation and, exchange rate against the change of each of those variables. In this study will be focused on the influence of various shock to Interest Rate and inflation

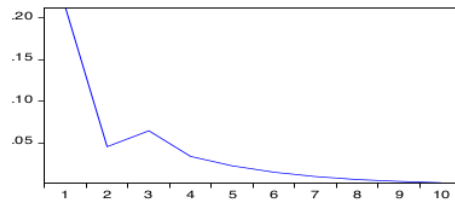
### 5.4. Impulse response interest rate

The picture below shows the response of the Interest Rate (BI Rate) against the shock of itself and the variable inflation and exchange rate. The response given by the Interest Rate variable because of the shock of change one standard of the variable deviation itself as a whole is positive. In the period 1 included quite high (amounting to 0.2), but decreased drastically by the 2nd period (by 0.045), slightly up in the 3rd period and decreased gradually to a period of 10 to 0.0028.

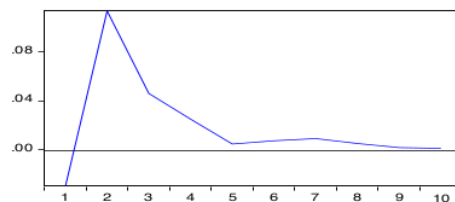
**Figure 1: Impulse response interest rate**

Response to Cholesky One S.D. (d.f. adjusted) Innovations

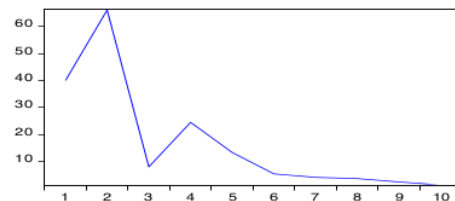
Response of D(BI\_RATE) to D(BI\_RATE)



Response of D(INFLASI) to D(BI\_RATE)



Response of D(KURS) to D(BI\_RATE)



The Interest Rate response to shock changes one standard deviation of the inflation variable initially negative at the Stage 1 of -0.02, but soaring in period 2 to 0.1 further decreases to 0.001268 in period 10. The Interest Rate response to Shock rates is very volatile, it is seen from the form of the chart being up and down. In the period of 1 40.03, up to 66.11 in the period 2, fell drastically in the period of 3 to 7.9, rose again to 24.45 in the period 4 then gradually decreased to reach 1.26 in the period of 10. The overall response value is marked positively.

### 5.5. Impulse response inflation

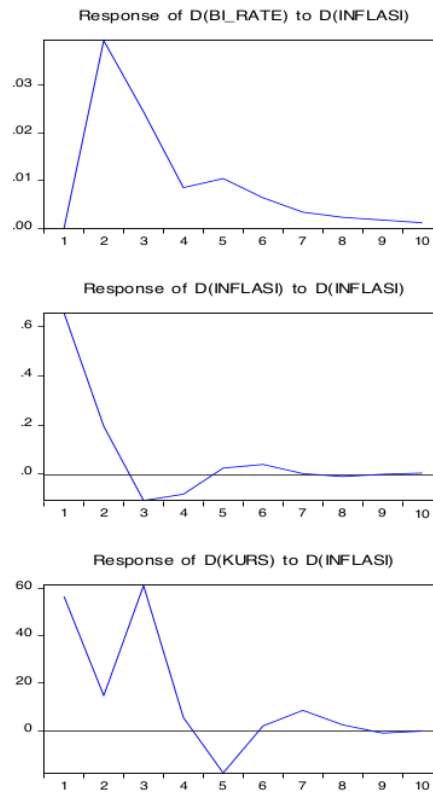
The following picture shows the response of inflation against the shock of itself and the variable Interest Rate and exchange rate. The inflation response to shock changes to a standard deviation of the Interest Rate variable initially in the period of 1 by 0, up from period 2 to 0.0399 and decreasing to a period of 10 to 0.0011.

The response given by the inflation variable due to the shock change of one standard variable deviation itself in its entirety is positive. In the 1st period is zero, up in the period of 2 to 0.0399 and the increase of the decline until the period of 10 to 0.0011.

The Inflation Response to Exchange Rate Shock is very volatile, it can be seen from the graph that fluctuates. In period 1 it was 56.64, dropped drastically in period 2 to 14.7, then rose again to 61.24. Then it gradually decreases until it reaches -17.958 in period 5. Then it goes up then falls again as shown in the figure and table below.

**Figure 2: The inflation response**

Response to Cholesky One S.D. (d.f. adjusted) Innovations



### 5.6. Variance decomposition result

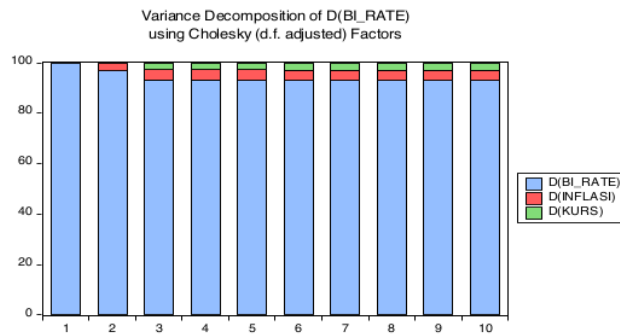
Forecast decomposition of variance can be used to determine the relative role of each variable, namely to predict the contribution percentage of the variant of each variable due to the presence of certain variables in the vector auto regression system.

## 5.7. Interest rate

The Table and the picture below reflect the predicted contribution percentage of the interest rate variable (BI Rate & BI 7-day Repo Rate) to change the Inflation variable and the interest rate. The change in interest rate variable (BI Rate & BI 7-day Repo Rate) in period 1 and period 2 is still very dominant influenced by the variable itself (interest rate) about 100 percent in the period of 1 and 96.79 percent in the period 2, even until the 10th period is still stable in the range of 93 percent.

The next that affects the interest rate is Inflation, in the 1st period of 0 percent, then rises to 3 percent in the period 2 and stable to a period of 4. The period 5 rises to 4 percent and is stable up to a period of 10. The rate affects the interest rate of the BI Rate by 0 percent in the period 1. It rises slightly to 0.02 percent in the period 2, then rises to 2.7 percent in the period of 3 and stable to a period of 10.

**Figure 3: Variance decomposition BI rate**

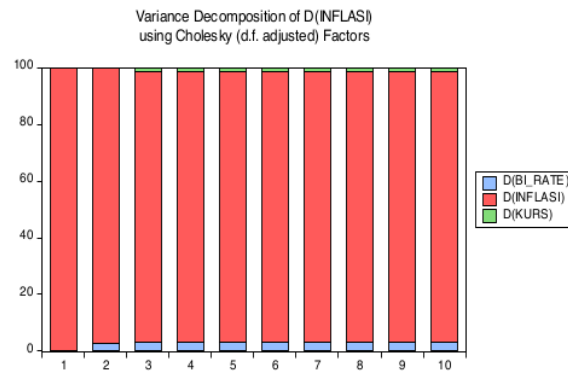


## 5.8. Inflation

Changes in the Inflation variable in period 1 and period 2 are still very dominant influenced by the variable itself (Inflation) around 99, 79 percent, down to 97 percent in period 2. In period 3 It fell back to 95.49 and stabilized until period 10.

The Interest Rate in the 1st period contributed 0.2 percent to the Inflation change, and then rose to 2.86 in the 2nd period. In the period of 3 rose to 3.24 percent and stabilized until period 10. The rate in the 1st of the contribution was 0 percent against the Inflation change. Period 2 rises to 1.1 percent and is stable up to a period of 10.

**Figure 4: Variance decomposition inflation**



## 6. Conclusions and recommendations

### Conclusion

1. Granger causality result between Interest Rate, Inflation and exchange rate is as follows: The Interest Rate does not affect Inflation, but the reverse Inflation affects the Interest Rate; Exchange Rate affects Inflation, but Inflation does not affect the exchange rate; and for Interest Rate and exchange rates both do not influence each other.
2. Impulse Response Function
  - a. The response given by the Interest Rate variable because of the shock of change one standard of the variable deviation itself as a whole is positive. The Interest rate response to shock changes one standard deviation variable Inflation was initially negative at stage 1 of -0.02, but jumped in period 2 to 0.1 further downhill. The Interest Rate response to Shock rates is very volatile; it is seen from the form of the chart being up and down. Overall response value marked positively.
  - b. The Inflation response to shock changes to a standard deviation of the Interest Rate variable initially in the period of 1 by 0, up in a period of 2 and decreasing to a period of 10. The response given by the Inflation variable due to the shock change of one standard variable deviation itself in its entirety is positive. In the 1st period of zero, up in the period of 2 and the increase of the decline until the period of 10. Inflation response to Shock rates is very volatile; it is seen from the form of a chart that rises down.
3. Variance Decomposition
  - a. The change in interest rate variable (BI Rate & BI 7-day Repo Rate) in period 1 and period 2 is still very dominant influenced by the variable itself (interest rate) about 100 percent in the period of 1 and 96.79 percent in the period 2, even until the 10th period is still stable in the range of 93 percent. The next that affects the interest rate is Inflation, in the 1st period of 0 percent, then rises to 3 percent in the period 2 and stable to a period of 4. The period 5 rises to 4 percent and is stable up to a period of 10. The rate affects the interest rate of the BI Rate by 0 percent in the period 1. Increase slightly to 0.02 percent in the period 2, then increase to 2.7 percent in the period of 3 and stable to a period of 10.
  - b. Predicted contribution percentage of variant Inflation variables against changes in exchange rate and interest rate variables. Changes in the Inflation variable in period 1 and period 2 are still very dominant influenced by the variable itself (Inflation) around 99, 79 percent, down to 97 percent in period 2. The Interest Rate in the 1st period contributed 0.2 percent to the Inflation change, then rose to 2.86 in the 2nd period. The Exchange rate in the 1st of the contribution was 0 percent against the Inflation change. Period 2 rises to 1.1 percent and is stable up to a period of 10.

### Recommendations

1. For further research to use different periods such as the period before the BI-Rate change to BI 7 days Repo Rate.
2. The other limitation is that the research period needs to be extended, where the research period is January 2013 – December 2018. This is because it finds a possible long-term relationship.

### Conflicts of Interest

The author declares no conflict of interest.

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