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DYNAMIC ANALYSIS OF ECONOMIC GROWTH, MONEY SUPPLY, INFLATION AND EXCHANGE RATES: USING OLS AND VAR METHODS

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Abstract

This study aims to analyze the influence of Money Supply, Inflation and Exchange Rate on economic growth in the quarterly period, using Ordinary Least Square and Vector Autoregressive analysis methods. The results of multiple regression tests of the Ordinary Least Square method indicate an invalid model due to the unbreakable assumptions of multicolineritas. Vector Autoregressive Stationary testing shows that all three DLNGDP, DLNCPI and DLNER variables are stationer at the first difference level. Vector Autoregressive estimates show that the impact of CPI and ER in short-term (Lag_1) is significantly positive on changes in economic growth (DLNGDP). But in the longer term (Lag_2) weakened because the influence is significantly negative. The influence of DLNGDP inaction is both negative, both DLNGDP_1, and DLNGDP_2.Gives an indication that economic growth is more determined by economic growth in the past. The Impulse Respond Function shows movement that is increasingly away from the equilibrium point, so the shock leaves a permanent influence on the variable. Variance Decomp [osition] test results show all three variables, DLNGDP, DLNCPI and DLNER are endogenous variables. Forecasting of model obtained is quite accurate because errors are getting closer to zero.

Keywords: GDP; MS; CPI; ER

JEL: 042

1. Introduction

A country's economic progress is measured by its ability to produce goods and services. The indicator used is Gross Domestic Product (GDP), which is the market value of all goods and services produced by the economy in a certain period of time. In the world order, Indonesia's GDP amounted to USD 932.259 billion, ranked 16th, according to the World Bank and the United Nations in 2016. Indonesia is included in the group of 20 countries (G20), which is a group of countries that have GDP ranked 1 to 20 world rankings. The G20 is an informal group of 19 countries and the European Union, as well as representatives of the International Monetary Fund (IMF) and the World Bank (WB). The G20, is the world's premier economic forum with a strategic position as it collectively represents about 65% of the world's population, 79% of global trade, and at least 85% of the world economy.

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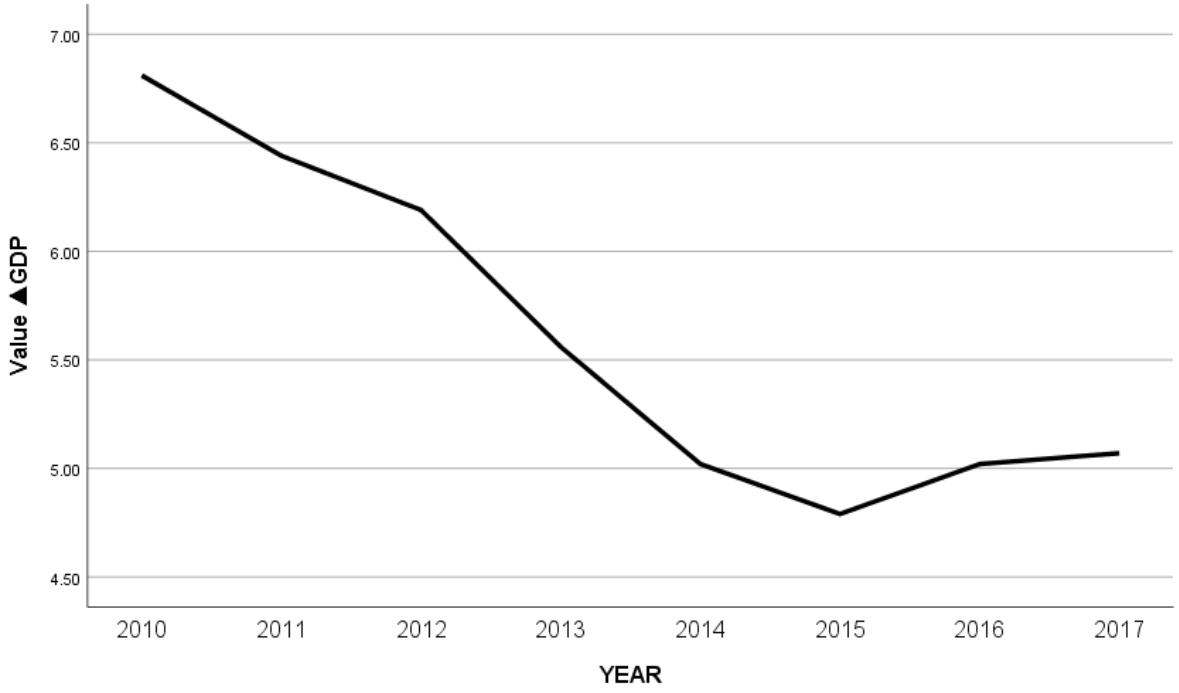
Economic growth is measured by changes in GDP over time, reflecting a country's economic progress. From Figure 1, Indonesia's economic growth shows a decline from 6.81% in 2010 to 5.07% in 2017.

Figure 1. Economic Growth 2010 – 2017



Various estimates have been made by several researchers on the factors that affect a country's economic growth. Concerned, Arintoko and Suharno (2019) examined the influence of monetary variables on economic growth in Indonesia. Using ordinary least square estimation techniques, the results showed that SBI interest rate variables and the amount of money supply had a negative and significant effect on economic growth. Investment variables have a positive and significant effect on economic growth, while variable exchange rates and inflation have no significant effect on economic growth in Indonesia in the period 2010-2017. Okoroafor, Adeniji and Olasehinde(2018) examined the causal relationship between inflation and economic growth and estimated the threshold and inflation forecast in Nigeria from 1961 to 2016. It uses Granger causality tests, Autoregressive Distributed Lag (ARDL), Autoregressive Integrated Moving Average (ARIMA) and Vector Autoregressive Multivariate Time Series (VAR). Granger's causality test results showed that inflation did not cause economic growth and economic growth did not cause inflation during the study period.

Zakiah, and Umaruddin Usman(2019) examined the impact of Total Money Supply, Inflation and Exchange Rate on National Income in Indonesia during the period 1996 – 2017. Using OLS estimation and Vector Autoregression Model (VAR) with Impulse Response Function (IRF). Ols estimates show that The Amount of Money Supply (JUB) shows a significant positive influence

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and inflation has a significant negative influence on economic growth. The exchange rate does not have a significant influence on economic growth. Var test results show that there is a direct relationship between variable money supply to national income and a direct relationship between national income and exchange rates. The results of the study with the analysis of money supply response took one year, variable inflation took four years, and variable exchange rate took three years to stabilize aftershocks caused by other variables in the study.

Forhad&Homaifar (2017) examined the effectiveness of Bangladesh's monetary policy transmission using the Structural Vector Autoregressive Model (SVAR) during the period 1972-2014. The results show that monetary policy shocks do have a short-term effect on real output (GDP), price levels, and exchange rates. Monetary policy shocks resulted in inflation, the pressure that led to the devaluation of Taka Bangladesh.

From some of the above studies obtained the conclusion that the Amount of Money Supply there is a significant and insignificant effect on economic growth, Inflation has a significant effect and does not affect economic growth and monetary shocks affect inflation. The exchange rate has no significant influence on economic growth and monetary transmission affects the exchange rate. The analysis period used is annual. Based on some of the facts above, the purpose of this study is to analyze the influence of Money Supply, Inflation and Exchange Rate on economic growth in the quarterly period, using OLS and VAR analysis methods.

2. Library Overview

2.1 Quantity Theory of Money

Most of the initial studies investigated the relationship between various variables, especially money growth, inflation rate and economic growth. A popular theory that explains relationships is the Money Quantity Theory, suggesting that money supply (M) affects price (P) and output (Y) levels. Money theory QAuantity Theory of Money (QTM) is supported and calculated using fisher equation (1897) as follows:

$$\mathbf{M.V = P.Y} \qquad (2.1)$$

Where, M = The amount of money in circulation

V =Velocity of maney

P = Price

Y = Output (GDP)

The Money Quantity Theory assumes only a constant V in the short term. Therefore the equation (2,1) can be rewritten as $\%\Delta M = \%\ \Delta P + \%\ \Delta Y$. That means that changes in the amount of money in circulation will affect changes in nominal GDP ($\%\Delta Y$) and price changes ($\%P$). As a consequence, from the monetary side, controlling money supply is the main variable in stabilizing the economy.

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Likewise if the equation is changed to % ΔY =% ΔM - % ΔP . This means that economic growth (% ΔY) is determined positively by the growth of money supply (% ΔM) and weakened by the rate of price change or inflation (-% ΔP). There are two types of theoretical expectations regarding the effect of changes in the inflation rate and money on output growth (Chari et al., 1996). Based on the exogenous growth model, it is that the inflation rate will not affect the growth rate and also the inflation rate against the output level. In contrast to the endogenous growth model that emphasizes that money and inflation affect the rate of output growth. There are two channels for such effects. One argument is known as the Mundell-Tobin effect in which inflationary policies increase growth more because inflation reduces human wealth, and to accumulate wealth, people save more and will reduce real interest rates and increase capital accumulation, which then increases output in the economy (Haslag, 1997).

2.2 Purchasing Power Parity (PPP)

One theory that explains the relationship between price levels or inflation and exchange rate movements is purchasing power parity theory. Purchasing Power Purity concept was introduced by classical economist David Ricardo and popularized by Swedish economist Gustave Cassel in 1920, when European countries such as Germany, Soviet and Hungary experienced high inflation. As an exchange rate theory, the determination of purchasing power parity (PPP) is applied in the direction of equilibrium exchange rates and domestic and foreign prices. Basically PPP is known as the "one price law". The one-price law states that the price of a traded commodity must be the same in different countries after calculating the exchange rate between currencies. The explanation of ppp theory is closely related to the One Price Act, which states that in a competitive market free of transportation costs and official trade barriers (e.g. tariffs), identical goods (of the same type) must be sold in different countries at the same price (if the price is expressed in the same currency unit).

Thus Purchasing Power Parity is expressed in the following formula:

$$\mathbf{PPP} = \mathbf{ER}\frac{\mathbf{P}*}{\mathbf{P}} \qquad (2.2)$$

Referring to the law of one price, then

$$\mathbf{PPP}.\mathbf{P} = \mathbf{ER}\,\mathbf{P}* \qquad (2.3)$$

Where, PPP is a Purchasing Power Parity or One Price Law;

ER is the domestic currency exchange rate against foreign currencies;

P* are foreign prices; and

P is domestic price

As is known the theory of money quantias and purchasing power parity are as follows:

$$M\,V = PY \qquad (2.1)$$

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$$P = ER\ P^* \quad (2.3)$$

substitute P from equation (2.3) to equation (2.1)

$$M\ V = ER\ P^*\ Y \quad (2.4)$$

From equation (2.4) we issue Exchange Rate

$$ER = M.V/P^*Y \quad (2.5)$$

From the equation (2,5) it can be interpreted when the exchange rate changes % ΔER = % ΔM + % ΔV -% ΔP * -% ΔY), caused by changes in money supply (ΔM), changes in money circulation (ΔV) are reduced by changes in foreign prices (ΔP *) and changes in output (ΔY).

Or output issued from the equation (2.4), become

$$Y = M.V/ERP^* \quad (2.6)$$

Interpreted, if output changes,(% Δ Y = =% ΔM +% ΔV -% ΔP * -% ΔER), caused by changes in money supply(M) and changes in Money Circulation(V) are reduced or weakened by changes in foreign prices(P*) and changes in Exchange Rate(ER).

According to Mankiw (2015), there is a positive relationship between exchange rates and economic growth, where the higher the exchange rate, the higher the net export (the difference between exports and imports) the higher, because exports increase imports decrease. This increase will have an impact on the growing amount of output and will cause GDP (Economic growth) to increase.

2.3 Previous Research

Korkmaz (2016) using Panel Data Analysis 2002 – 2011, examined the relationship between foreign exchange rates and economic growth variables against 9 randomly selected European countries (France, Germany, Greece, Hungary, Italy, Spain, Turkey, Poland, United Kingdom). It found that there is a long-term balance of relationship between foreign exchange rates and economic growth for 9 European countries. Granger's causality test was applied and it was concluded that there was a causality of the exchange rate towards economic growth.

Riassunto's 2017 research examined the effectiveness of bangladesh's monetary policy transmission using the Structural Vector Autoregressive Model (SVAR) for the period 1972-2014. The SVAR model investigates how monetary policy shocks are defined as unexpected rate hikes against real and nominal macro variables; i.e. real output, prices, real effective exchange rates, and money supply. The results show that monetary policy shocks do have short-term effects on real output, price levels, and exchange rates. Monetary policy shocks resulted in inflationary pressures leading to the devaluation of Bangladesh's Taka. This paper shows that to consider the trade-off between Bangladeshi output and interest rates.

Hendajany and Wati research (2020) aims to predict macroeconomic indicators such as inflation, interest rates, exchange rates, and economic growth. The methods used are Vector

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Autoregressive (VAR) with stages in the form of stationary test, determination of inaction length, co-integration test, VAR model estimation, causality test, and forecasting of each variable in the next five years (2019-2023). The results in this study showed inflation and exchange rate data stationary at the level while the data on interest rates and stasion economic growth in the first differencing (lag 1). The results of the causality test show an interrelationship in which inflation affects the exchange rate (exchange rate) and vice versa, and there is a one-way relationship in which inflation affects economic growth, interest rates affect the exchange rate (exchange rate) and economic growth affects the exchange rate (exchange rate) and interest rates. The predicted results of Indonesia's economic indicators for the next five years for the value of inflation and interest rates tend to increase every year although not very large. Meanwhile, the exchange rate has increased considerably with the highest value occurring in 2023. However, these conditions do not affect the predicted value of economic growth, which the predicted results for 2019-2023 tend to be constant.

Gatawa, Abdulgafar and Olarinde (2017) examined the impact of money supply, inflation and interest rates on economic growth in Nigeria, using time series data from 1973-2013. VAR models and Granger Causality tests and Error Correction Vectors (VEC) are used. The results of the VEC model provide evidence supporting the positive impact of money supply, while inflation and interest rates show a negative impact on economic growth especially in the long run. Short-term results reveal that with the exception of inflation, broad money supply and negative interest rates are associated with economic growth. For Granger's causality test, it was revealed that there are no explanatory variables that cause economic growth. Implies that money supply, inflation, and interest rates do not affect growth.

3.Research Method

3.1 Multiple Regression Analysis

Regression analysis is a statistical analysis used to determine the relationship between dependent variables and independent variables. When there is only one dependent variable and one independent variable is called a simple regression analysis, whereas when there are several independent variables it is called a double regression analysis (Mutiple Regression).

The Ordinary Ordinary Least Square (OLS) method is a method used to guess the classic regression coefficient by minimizing the sum of squares of errors.

The models to be tested in this study are as follows:

$$LnGDP_t = \beta_0 + \beta_1 LnMS_t + \beta_2 Ln\ CPI_t + \beta_3 Ln\ ER_t + \varepsilon_t \quad (3.1)$$

Where , LnGDPt is Ln PDB in period t

$LnMS_t$ is Ln Money Supply in periode t

$LnCPI_t$ is Ln Consumer Price Index in periode t

$LnER_t$ is Ln Exchange Rate in periode t

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β_0 is Constant

$\beta_1, \beta_2, \beta_3$ is the regression coefficient or parameter of each variable

ε_t is a random error and is normally distributed

To test the validity of the above models need to be tested classic assumptions. Classic Assumption Test according to Gujarati and Porter (2011) aims to ensure that the results of the study is valid with the data used in theory is unbiased, consistent and assessment of the coefficient of regression efficiently. The Classic assumptions that must be tested include:

1. Normality Test

Normality tests were used to ensure that the data in this study were distributed normally.

2. Linearity test

Linearity tests are conducted to determine the relationship between bound variables and linear free variables.

3. Multicolinearity Test

Aims to test whether the regression model found any correlation between independent variables.

4. Heteroskedastisity Test

Aiming to test whether in the regression model there is variance inequality from residual or error one observation to another. If variance from residual one observation to another remains, then it is called homokedastisitass and if different is called heteroskedastisitas.

5. Autocorrelation

Aiming to test whether in the linear regression model there is a correlation between the fault of the disruptor in a certain period and the fault of the disruptor in the previous period.

3.2 VAR Analysis

Vector Autoregressive or VAR is usually used to analyze the system relationships of time variables and to analyze the dynamic impact of the disruption factors contained in the variable system. The VAR model in economics was popularized by Sims (1980). The vector auto regression (VAR) model is one of the most successful, flexible, and easy-to-use models for multivariate time series analysis. Multivariate analysis method is a statistical method whose purpose is to analyze data consisting of many variables and allegedly between variables are interconnected with each other. The VAR model has proven to be very useful for describing the dynamic behavior of economic and financial time series and for forecasting. This often provides superior estimates for those derived from univariate time series models and complex theoretical-based simultaneous equations. Forecasts from the VAR model are quite flexible as they can be conditional on the potential future path of the variables specified in the Model.

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Figure 3.2, showing the test steps in VAR modeling as follows:

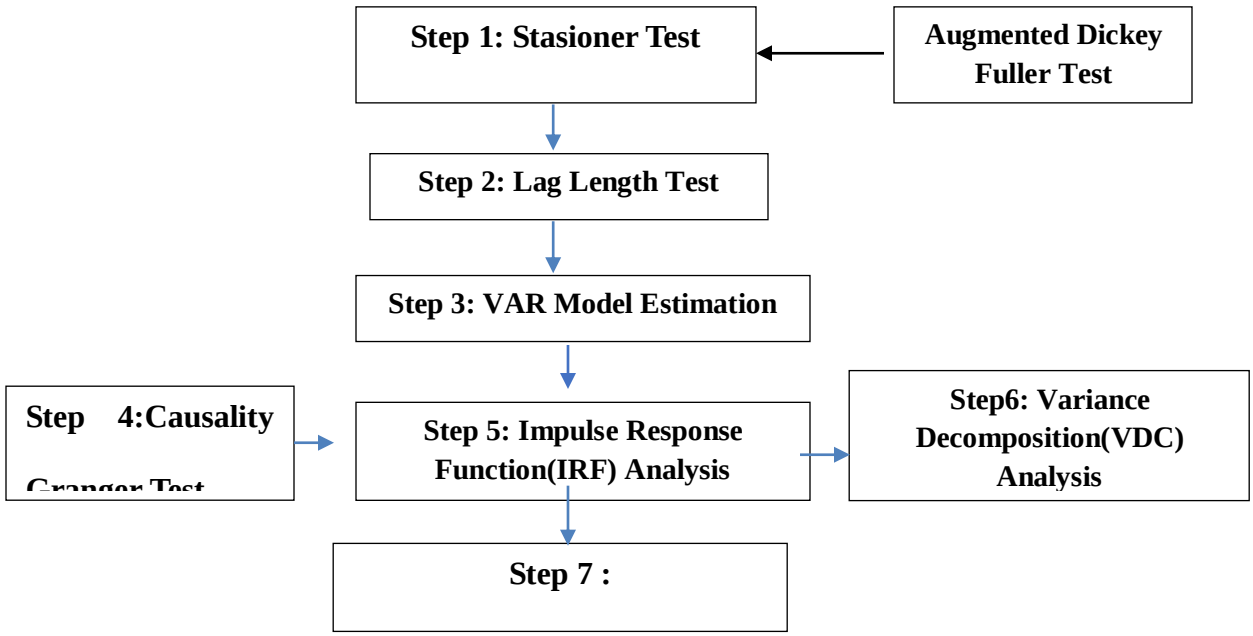

Figure 3.2. Engineering Flow Chart and Econometric Testing

3.2.1 Stationer Test

Stationaryity is one of the important prerequisites in the econometrics model for time series data. Stationary data is data that shows mean, variance and autovarians (at lag variations) remain the same at any time the data is formed or used, meaning that with stationary data time series models can be said to be more stable. If the data used in the model is not stationary, then the data is reconsidered its validity and stability, because the regression results derived from the data that is not stationary will cause spurious regression. Spurious regression is a regression that has a high R2, but there is no meaningful relationship between the two.

One of the formal concepts used to know the stationaryity of data is through unit root test. This test is a popular test, developed by David Dickey and Wayne Fuller as Augmented Dickey-Fuller (ADF) Test. If a time series data is not stationary on order zero, I(0), then the stationaryity of the data can be searched through the next order or first difference so that the stationary level obtained on the nth order (first difference or I(1), or second difference or I(2), and so on. First Difference is a variable change of a certain period of time against the previous period.

According to Nachrowi and Usman (2006) there are several models to choose from to perform the ADF Test:

$$\Delta Yt = \delta Y_{t-1} + ut \text{ (no interception)} \quad (3.1)$$

$$\Delta Yt = \beta + \delta Y_{t-1} + ut \text{ (with intercessors)} \quad (3.2)$$

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$$\Delta Yt = \beta 1 + \beta 2t + \delta Y_{t-1} + ut \text{ (intercept with time trend)} \quad (3.3)$$

Δ= first difference of the variables used, t = trend variable

The hypotheses for this test are:

H0: $\delta = 0$ (there is a root unit, not stationary) and

H1: $\delta \neq 0$ (there is no a unit root, stationary)

3.2.2 Lag Length Test

VAR model estimation starts by determining how long the exact lag is in the VAR model. Determining the length of optimal lag is important in VAR modelling. If the optimal lag entered is too short then it is feared that it cannot explain the dynamism of the model thoroughly. However, too long optimal lag will result in inefficient estimation due to reduced degree of freedom (especially models with small samples). Therefore it is necessary to know the optimal lag before performing VAR estimation.

3.2.3 VAR Model Estimation

The VAR model is an econometrics model built on relationships between variables that refers to the model and is used to look at causality relationships between variables. General model, VAR with lag 1:

$$Y_t = \alpha 1i + \sum \beta 1i\, Yt - 1 + \sum Y 1i Xt - 1 + \varepsilon t \quad (3.2.3)$$

3.2.4 Granger's Causality Test

Causality tests are conducted to find out if an endogenous variable can be treated as an exogenous variable. This stems from ignorance of the inter-variable knowledge. If there are two variables y and z, then whether y causes z or z causes y or applies both or there is no relationship between the two. The variable y causes variable z to mean how much the z value in the current period can be explained by the z value in the previous period and the y value in the previous period. In this study, granger's causality method was used to test the causality relationship between two variables. Predictive power from previous information may indicate a causality relationship between y and z over a long period of time.

3.2.5 Impulse Response Function Analysis

Estimation of impulse response function is done to check the shock response of innovation variables to other variables. Estimates using the assumption of each innovation variable are not correlated with each other so that the direct distribution of the influence of a surprise can be direct. The impulse response image will show the response of a variable due to another variable shock up to several periods after the shock occurs. If the impulse response image shows movement that is getting closer to the convergence point or returning to the previous balance means that the response of a variable due to a surprise will disappear for longer so that the shock does not leave a permanent influence on the variable.

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3.2.6 Variance decomposition

Variance decomposition decomposes the variation of one endogenous variable into the shock component of other endogenous variables in the VAR system. The decomposition of this variant explains the proportion of movement of a series due to the surprise of the variable itself compared to the surprise of other variables. If surprise εzt is unable to explain the forecast error variance variable yt then it can be said that the variable yt is exogenous (Enders, 2004). This condition variable yt will be independent of surprise εzt and variable zt. Conversely, if surprise εzt is able to explain the forecast error variance variable yt means that variable yt is an endogenous variable.

4. Empirical Results

4.1 Multiple Reggression Test

The test results of the regressi model of economic growth (Ln GDP) with free variables Of Money Supply (LnMS), Inflation (LnCPI) and Exchange Rate (LnER) with OLS method are as follows:

Ln GDP = 3.824 + 0,394 LnMS + 0.016 LnCPI + 0.114 LnER (4.1)
Prob. (0.00) (0.00) (0.819) (0.073)
Adjusted R-Square = 0.975; Prob (F-statistic) : 0.000

The equation(4.1) suggests that only the variable Amount of Money Supply (MS) is significant at the probability of < 0.05 and the variable Exchange Rate (ER) is significant at the probability of <0.10, while the CPI variable is insignificant. The 1% increase in MS resulted in a 0.394% increase in GDP and a 1% increase in the exchange rate (ER) resulting in a 0.114% increase in economic growth (GDP).

The effect of the three free variables in explaining economic growth (GDP) is quite strong, namely 97.5%, the remaining 2.5% is explained by other variables. The three free variables are simultaneously able to describe the bound variable (GDP), indicated by Prob(F-statistic) worth 0.000.

Classic Assumption test results can be found in Table 1 below:

Table 4.1 Classic Assumption Test

Indicator	Normality	Autocorrelation	Heteroscedasticity	Mulitcollinerity
Jarque – Bera Probabillity	0.3387			
Breusch- Godfrey Prob.Chy- Square		0.4169		
White Heteroscedastisity Probality Chy- Square			0.5684	
Variance Inflation Factor				MS =10.55 ER = 9.585

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The Jarque-Bera Probability Test shows 0.3387> 0.05, meaning that the data in the study meet normal rules. Likewise, Chy-Square Probability, 0.4169> 0.05, means there is no heteroscedasticity. The Chy-Square Breusch-Godfrey Probability Test of 0.4169> 0.05 shows that there is no autocorrelation in the model. However, seen from the Variance Inflation Factor, 10.55> 10.00 indicates multicollinearity in the multiple regression model. There is a high correlation between the Money Supply (MS) and Exchange Rate (ER) variables in the multiple linear regression model.

Thus the multiple regression model above does not meet the criteria for Best Linear Un] Estimates (BLUE). Deviation from the Classical assumptions will result in invalid estimates. As a result of the multicolinearity, it will be difficult to see the effect of explanatory variables on the variables described (Maddala, 1992).

4.2 VAR

4.2.1 Stationer Test

The results of the Stationary Test can be seen in Table 4.2.1 showing that the three variables, GDP, CPI and ER meet the criteria for the Stationary Test on the First Difference. Only the MS variable is not Stationary. This means the DLNMS variable must be excluded from the model.

Tabel 4.2.1 Stationer Test

Null Hypothesis: D(LNGDP) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-19.70583	0.0001
Test critical values:	1% level	-3.626784	
	5% level	-2.945842	
	10% level	-2.611531	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LNMS) has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.713525	0.4159
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LNCPI) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.154943	0.0000
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

Null Hypothesis: D(LNER) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.563666	0.0000
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

4.2.2 Lag Length

From Table 4.2.2. With the endogenous variables AND GDP, DL CPI and DLNER, it can be seen that all asterisks are at lag 4. This indicates that the recommended optimal lag is lag 4.

Table 4.2.2. Lag Length

VAR Lag Order Selection Criteria
Endogenous variables: DLNGDP DLNCPI DLNER
Exogenous variables: C
Date: 02/27/21 Time: 09:46
Sample: 2010Q1 2019Q4
Included observations: 34

Lag	LogL	LR	FPE	AIC	SC	HQ
0	197.0620	NA	2.21e-09	-11.41541	-11.28073	-11.36948
1	203.1077	10.66877	2.64e-09	-11.24163	-10.70291	-11.05791
2	246.9641	69.65441	3.45e-10	-13.29201	-12.34926	-12.97050
3	254.3414	10.41502	3.93e-10	-13.19656	-11.84977	-12.73726
4	295.5302	50.88019*	6.34e-11*	-15.09001*	-13.33918*	-14.49293*
5	298.6652	3.319440	1.01e-10	-14.74501	-12.59015	-14.01014

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

4.2.3 VAR Model Estimation

From the VAR estimation results in Table 4.2.3, it shows that the model of changes in economic growth is as follows:

DLNGDP = 0.005DLNCPI_1 - 0.004DLNCPI_2 + 0.006DLNER_1 - 0.036DLNER_2
Probability (0.04) (0.04) (0.05) (0.05)
- 0.08DLNGDP_1 -0.925DLNGDP_2 + 0.0266 (4.2.3)
Probability (0.07) (0.07) (0.002)

Adj. R-squared = 0.857

Equation (4.2.3) shows the effect of CPI and ER in the short term (Lag_1) is a significant positive effect on changes in economic growth (DLNGDP). However, in the longer term (Lag_2) it is weakened because the effect is significantly negative. The effect of DLNGDP inaction on Probability of 10% or 0.1 is both negative, both DLNGDP_1 is -0.077749%, and DLNGDP_2 is -0.925014%. Give an indication that economic growth is more determined by growth economy in the past.The effect of changes in DLNCPI_1, DLNCPI_2, DLNER_1, DLNER_2, DLNGDP_1 and DLNGDP_2 on Economic Growth (GDP) is quite strong, indicated by Adj. R-square is 85.7%, 14.3% is influenced by variables outside the model.

Table 4.2.3 VAR Estimation

Vector Autoregression Estimates
Date: 02/27/21 Time: 10:12
Sample (adjusted): 2010Q4 2019Q4
Included observations: 37 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	DLNCPI	DLNER	DLNGDP
DLNCPI(-1)	-0.111041	-0.113606	0.004947
	(0.16093)	(0.15515)	(0.03655)
	[-0.68999]	[-0.73225]	[0.13535]
DLNCPI(-2)	0.112488	0.062030	-0.004092
	(0.15637)	(0.15075)	(0.03552)
	[0.71938]	[0.41148]	[-0.11520]
DLNER(-1)	-0.101160	0.174391	0.005565
	(0.19982)	(0.19263)	(0.04538)
	[-0.50626]	[0.90530]	[0.12261]

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DLNER(-2)	-0.766323	-0.079351	-0.036122
	(0.20374)	(0.19641)	(0.04627)
	[-3.76137]	[-0.40401]	[-0.78063]
DLNGDP(-1)	0.251636	0.464931	-0.077749
	(0.30841)	(0.29732)	(0.07005)
	[0.81593]	[1.56376]	[-1.10997]
DLNGDP(-2)	0.211526	-0.446892	-0.925014
	(0.30588)	(0.29488)	(0.06947)
	[0.69154]	[-1.51551]	[-13.3149]
C	0.007586	0.011071	0.026603
	(0.00911)	(0.00878)	(0.00207)
	[0.83262]	[1.26035]	[12.8554]
R-squared	0.404991	0.200372	0.880661
Adj. R-squared	0.285990	0.040447	0.856793
Sum sq. resids	0.050958	0.047360	0.002629
S.E. equation	0.041214	0.039732	0.009361
F-statistic	3.403241	1.252909	36.89753
Log likelihood	69.37103	70.72600	124.2148
Akaike AIC	-3.371407	-3.444649	-6.335937
Schwarz SC	-3.066639	-3.139880	-6.031168
Mean dependent	0.003514	0.012162	0.012162
S.D. dependent	0.048775	0.040561	0.024736

Determinant resid covariance (dof adj.)	1.84E-10
Determinant resid covariance	9.79E-11
Log likelihood	268.8688
Akaike information criterion	-13.39831
Schwarz criterion	-12.48401
Number of coefficients	21

4.2.4 Granger Causality Test

The results of the Granger Causality test can be seen in Table 4.2.4. The effect is seen only on one side, not simultaneous. DLNER affects DLNCPI, DLNCPI does not affect DLNER. DLNGDP affects DLNER, but DLNER does not affect DLNGDP.

Table 4.2.4 Granger Causality Test

Pairwise Granger Causality Tests

Date: 02/27/21 Time: 10:08

Sample: 2010Q1 2019Q4

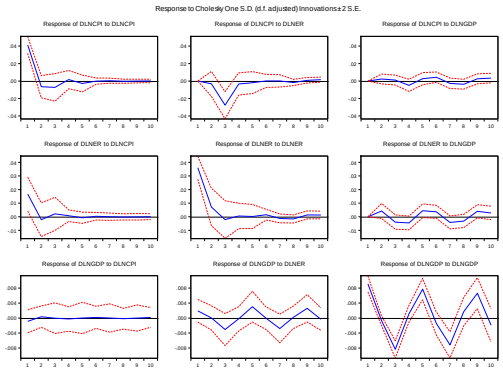
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
DLNER does not Granger Cause DLNCPI	37	9.32258	0.0006
DLNCPI does not Granger Cause DLNER		0.67047	0.5185
DLNGDP does not Granger Cause DLNCPI	37	1.11230	0.3412
DLNCPI does not Granger Cause DLNGDP		0.16096	0.8520
DLNGDP does not Granger Cause DLNER	37	2.85121	0.0725
DLNER does not Granger Cause DLNGDP		0.47528	0.6260

4.2.5 Impulse Response Function

The impulse response function will show the response of a variable due to the shock of other variables up to several periods after the shock occurs. Figure 4.2.5 shows the movement further away from the equilibrium point, meaning that the response of a variable due to a surprise will be stronger over time so that the shock leaves a permanent effect on the variable.

Gambar 4.2.5 Impulse Response Function



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4.2.6 Variance Decomposition

Table 4.2.6 first describes the Variance decomposition of the DLNCPI variable. In the first period, the DLNCPI variable was influenced by the variable itself by 100%. However, the second to tenth period (SE <0.10) is influenced by DLNER and DLNGDP variables. The influence of the DLNER variable initially increased to 29,685% in period six and then decreased to 29,421% in period ten. The DLNGDP variable shows an increase up to period ten, which is 3,532%. Thus it can be said that the DLNCPI variable is an endogenous variable.

Table 4.2.6 Variance Decomposition

Variance Decomposition of DLNCPI:

Period	S.E.	DLNCPI	DLNER	DLNGDP
1	0.041214	100.0000	0.000000	0.000000
2	0.041904	99.13036	0.569780	0.299860
3	0.050710	69.76278	29.98821	0.249011
4	0.051087	68.83489	29.97639	1.188724
5	0.051267	68.64906	29.90152	1.449427
6	0.051454	68.15170	29.68516	2.163144
7	0.051523	67.97275	29.60607	2.421180
8	0.051683	67.55716	29.53601	2.906835
9	0.051750	67.38029	29.48252	3.137191
10	0.051879	67.04665	29.42103	3.532319

Variance Decomposition of DLNER:

Period	S.E.	DLNCPI	DLNER	DLNGDP
1	0.039732	17.63090	82.36910	0.000000
2	0.040657	17.12500	81.78761	1.087390
3	0.040956	17.15118	80.85828	1.990531
4	0.041220	16.96864	79.84096	3.190403
5	0.041462	16.80572	78.91567	4.278613
6	0.041647	16.66372	78.34620	4.990075
7	0.041873	16.48394	77.59191	5.924151
8	0.042022	16.36895	77.19247	6.438576
9	0.042235	16.20397	76.51783	7.278193

10	0.042344	16.12066	76.21416	7.665178

Variance Decomposition of DLNGDP:

Period	S.E.	DLNCPI	DLNER	DLNGDP
1	0.009361	0.865896	4.235409	94.89869
2	0.009395	1.010137	4.207723	94.78214
3	0.012934	0.533806	7.832482	91.63371
4	0.012987	0.567458	7.793307	91.63924
5	0.015408	0.403315	9.391371	90.20531
6	0.015474	0.413292	9.312622	90.27409
7	0.017275	0.331624	10.06943	89.59895
8	0.017359	0.338801	9.987051	89.67415
9	0.018757	0.290204	10.45651	89.25329
10	0.018857	0.295179	10.37437	89.33045

The second table 4.2.6 describes the Variance Decomposition variable DLNER. In the first period, the DLNER variable was influenced by the variable itself amounting to 82,369%. The DLNCPI variable (SE <0.05) shows a decreasing effect from 17.63090% in the first period to 16.12066% in the tenth period. The LNGDP variable shows an increase from 0.0000% in period one to 7.665178% in period ten. So, it can be concluded that the LNER variable is an endogenous variable.

The third table 4.2.6 describes the Variance Decomposition variable DLNGDP. In the first period, DLNGDP was influenced by the variable itself amounting to 94.89869%. The influence of DLNGDP on the variable itself is relatively bigger than the DLNCPI variable and the DLNER variable, which is> 85,000%. The DLNCPI variable shows a decreasing effect from 1.010137% in the second period to 0.295179% in the tenth period. The DLNER variable shows an increase from 4.207723% in the second period to 10.37437% in period ten. Thus, it can be concluded that DLNGDP is an endogenous variable.

4.2.7 Forecasting

Based on Equation 4.2.3 in the design of forecasting changes in economic growth. Forecasting changes in economic growth (EDLNGDP) appears to follow the pattern of changes in actual economic growth (DLNGDP). Figure 4. shows that most of the forecast patterns of changes in economic growth for EDLNGDP coincide with the actual (DLNGDP). Meanwhile, Error, which is the difference between DLNGDP and EDLNGDP, shows that it is getting closer to zero. The forecast of changes in economic growth for the 41st period, namely the First Quarter of 2020, is

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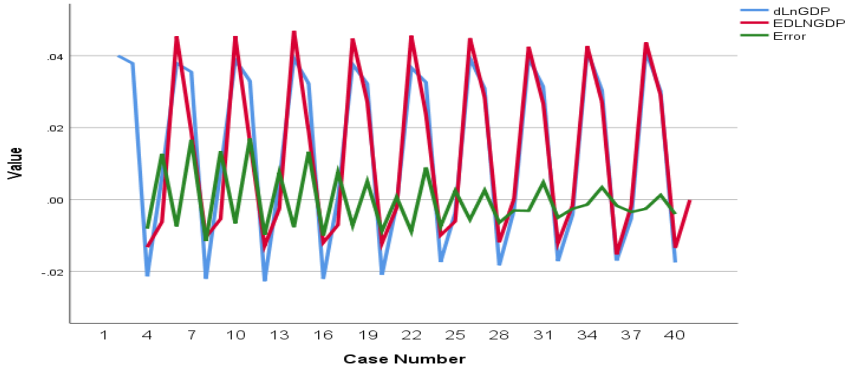
0.00%. From the above results, it can be concluded that the VAR model obtained is quite accurate.

Figure 4.2.7 Forecasting



5. Conclusion and Suggestions

5.1 Conclusion

1. The results of the Multiple Linear Regression test using the OLS method show that the model is invalid because it violates the assumption of multicollinearity, so it is difficult to estimate the effect of independent variables on the dependent variable.
2. Stationary test for the four variables, only three variables are stationary at the first difference level, namely DLNGDP, DLNCPI and DLNER, while DLNMS is not stationary.
3. The estimation results of the VAR Model show that the effect of CPI and ER in the short term (Lag_1) is a significant positive effect on changes in economic growth (DLNGDP). However, in the longer term (Lag_2) it is weakened because it has a significant negative effect. The effect of DLNGDP inaction is both negative, both DLNGDP_1 and DLNGDP_2 ... giving an indication that economic growth is more determined by past economic growth.
4. Impulse Respond Function shows a movement further away from the equilibrium point, meaning that the response of a variable due to a surprise will get stronger over time so that the shock leaves a permanent effect on the variable.
5. The Variance Decomposition test results show that the three variables, DLNGDP, DLNCPI and DLNER are endogenous variables.
6. The VAR model prediction obtained is quite accurate because the forecasting of changes in economic growth (EDLNGDP) appears to follow the pattern of changes in actual economic growth (DLNGDP) and mostly coincides with the actual and the error is getting closer to zero.

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5.2 Suggestions

1. Researchers who wish to explore the dynamic analysis of economic growth should carry out the Johansen co integration test, to explore the possibility of applying Vector Error Correction Model (VECM) analysis.

2. In connection with the short-term positive impact of the Exchange Rate (ER) variable and the longer term having a negative impact, Bank Indonesia intervention should be carried out on a quarterly basis. Buying foreign currency when the rupiah strengthens or appreciates and then selling foreign currency in the following quarter.

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