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ANALYSIS OF THE INFLUENCE OF MACROECONOMIC VARIABLES ON INFLATION: THE VECM APPROACH

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Abstract
Inflation is defined as a condition where prices increase. Inflation is a monetary phenomenon in a country where its fluctuations will cause economic turmoil. In the economy, inflation is a combination of aspects of the balance of the goods market, money market, and labor market. This study analyzes the relationship between macroeconomic variables, namely economic growth, interest rates, and the money supply which are expected to affect the movement of the inflation rate in Indonesia in 1989-2019. This study uses the Vector Error Correction Model (VECM) method after showing the existence of cointegration in testing with the VAR model. Forecasting results show that inflation responds positively to interest rates and the money supply and gives a negative response to economic growth. This means that inflation in Indonesia is sensitive to shocks in macroeconomic variables.

Keywords: *Inflation, Macroeconomics Variables, VECM*

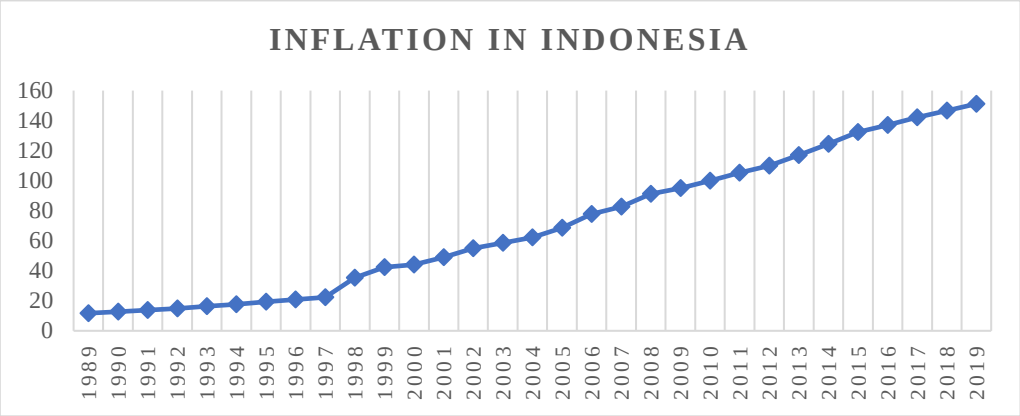
1. INTRODUCTION

Inflation is defined as a condition where prices increase. From an economic perspective, inflation is a monetary phenomenon in a country where fluctuations in inflation will cause economic turmoil (Sutawijaya, 2012). The dynamics in the economy as a whole can be indicated by inflation as a macroeconomic variable. Inflation indicates changes and economic growth, both micro and macro, which in turn will affect the performance of other economies (Septiawan et al., 2016). The phenomenon of rising goods in inflation occurs in all prices of goods and occurs in a relatively long period of time. Inflation also indicates a mismatch in the financial sector, where the transmission mechanism between the financial sector and the real sector is still a lot of obstacles so that the existing funds in the financial sector cannot be absorbed optimally in moving the real sector (Stievany & Jalunggono, 2022). Inflation in the economy is a combination of the balance aspects of the goods market, money market, and labor market. Inflation caused by distortions in the flow of production and distribution of goods from the production sector to the market so that production costs increase is usually called goods market inflation.

The increase in inflation was also triggered by high interest rates (Umam & Isabela, 2018). The high interest rate indicates that the financial sector management mechanism is inefficient, resulting in an increase in the cost of capital. Generally, Inflation has positive and negative impacts. Inflation at a mild level has a positive effect on the economy because it will increase national income. On the other hand, inflation with a high level of uncontrolled inflation (hyperinflation) will cause economic chaos and prices to rise rapidly.

Inflation rate in Indonesia continues to fluctuate. Inflation in this study is measured by the Consumer Price Index (CPI) obtained from the World Bank (Lubis, 2020). From the graph above, it can be seen that the CPI in Indonesia has increased every year. However, there was a very drastic increase in 1998 due to the 1998 Monetary Crisis. The increase from 1997 to 1998 was quite large, amounting to 13%. In the following years, the CPI tended to be stable and did not experience a very significant increase.

Inflation in Indonesia continues to increase every year. However, the most drastic increase in inflation occurred during the monetary crisis in 1998 (Sutawijaya, 2012). The increase that occurred from 1997 to 1998 was quite large, reaching 13%. Then, in the following year, inflation tends to be more stable and does not experience a very significant increase. Higher inflation is common in developing countries and inflation will fluctuate more.



Source: World Bank

Figure 1. Graph of Inflation in Indonesia in 1989-2019

In addition to inflation, the issue of domestic interest rates is a very important macroeconomic indicator in the Indonesian economy (Wismantara & Darmayanti, 2017). Inflation and interest rates have serious negative causes and impacts on the economy if not addressed immediately. The highest inflation rate Indonesia has ever experienced was in the 1960s, when the Old Order experienced hyperinflation of up to 600%. This is because there is too much money in circulation and it is out of control. The occurrence of inflation is caused more by a general increase in the money supply, not due to an increase in the general price of goods and services in the market (Frank Shostak, 2002). Friedman describes inflation as inflation that is always and occurs in every place and inflation is a monetary phenomenon.

Keynes's theory in Ardiansyah (2017) explains the relationship between inflation and economic growth. In Keynes's theory it is explained that in the short run (short run) the aggregate supply curve is positive. However, in a long-term relationship there is a negative relationship. Where when there is an increase in inflation, economic growth will decrease.

2. LITERATURE REVIEW

In research Agusmianata et al., (2018) the money supply has a positive and significant effect on inflation in Indonesia. This positive influence is caused by demand pull inflation, namely inflation that occurs due to increased public demand for various goods and services, thereby increasing prices in general. The increase in demand for goods is caused by an increase in people's income, with increasing income, the money supply is also a lot so that people will easily shop for goods. This is also supported by research Ningsih & Kristiyatnti (2016) which states that the money supply has a positive and significant effect on inflation. Research conducted by Langi et al., (2014) also stated that the money supply had a negative and insignificant effect on inflation in Indonesia.

In research carried by Agusmianata et al., (2018), interest rates have a positive and significant effect on inflation in Indonesia. This positive influence implies that monetary policy will follow the movement of inflation. The policy is reactive and will be lowered if the inflation rate has shown a downward trend. However, high interest rates are not only able to reduce inflation because Indonesia adheres to an open economic system, so inflation can be caused by outside countries. It is the same as the research results Langi et al., (2014) that the interest rate has a positive and significant effect on the inflation rate in Indonesia. However, this contradicts research Ningsih & Kristiyatnti (2016) which states that interest rates have no effect on inflation.

3. RESEARCH METHODS

This study uses a quantitative method with the VAR VECM system used as the method of analysis. The use of the VAR-VECM method is expected to be able to capture the relationship between variables and inflation. The type of data used in this study is secondary data for the annual time series from 1989-2019 in Indonesia which was obtained from the World Bank. The main requirement in using time series data is that the basic assumption must be fulfilled, namely stationarity (Gujarati & Porter, 2009).

The data used in this study are inflation with an index unit projected by the Consumer Price Index (CPI), per capita gross domestic product (GDP) in US$ units, interest projected by real interest rates or real interest. rate in percent, and the projected money supply in quasi money or broad money in percent.

The VAR model assumes that all variables are endogenous. VAR can describe economic phenomena by minimizing theory. VAR provides a condition that the data is stationary at the level, while VECM requires that the variables are not stationary at the level and there is cointegration between variables. Using the VECM method can analyze economic phenomena and test whether the empirical model is consistent with economic theory. The stages in applying the VECM method are as follows:

1) Optimal Lag Determination

Regression analysis using time series data, the dependent variable Y is not always explained by other variables X or the independent variable (Gujarati & Porter, 2009). Y often responds to X with a time gap or lag. Lag occurs for several reasons, for example, psychological reasons, technological reasons, and institutional reasons. In order for the estimation method used to determine the relationship between variables in the model optimally, the determination of the lag in the time series data must be precise. According to Green (2003), determining the optimal lag is determined using several criteria, namely: Likelihood Ratio (LR), Akaike Information Criteria (AIC), Schwarz Information

Criterion (SIC), Final Prediction Error (FPE), and Hannan-Quinn Information Criterion (HQ).

2) Stationarity Test

The consequence of using time series data in research is that there are data that have average, variance, and auto variant values at various lag times whose values are not constant at any point in time. If this happens, then the data taken is not stationary. Time series data that has an average that changes over time is often referred to as time varying mean data or time varying variance. Stationarity test in this study using Augmented Dickey-Fuller (ADF).

Dickey Fuller (DF):

$$\Delta Y_t = \delta Y_{t-1} + \varepsilon_t$$

$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + \varepsilon_t$$

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \varepsilon_t$$

Augmented Dickey Fuller (ADF):

$$\Delta Y_t = \delta Y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta Y_{t-i} + \varepsilon_t$$

$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta Y_{t-i} + \varepsilon_t$$

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta Y_{t-i} + \varepsilon_t$$

The best Dickey Fuller (DF) and Augmented Dickey Fuller (ADF) test models are the models with the smallest Akaike Information Criterion (AIC) values. The DF and ADF tests are invalid if the coefficient $\delta > 0$ (positive) caused by the time series data being tested is explosive (Gujarati & Porter, 2009). The hypotheses in testing DF and ADF are:

$H_0: \delta = 0$ means that the data is not stationary.

$H_a: \delta < 0$ means stationary data.

If prob.t > α then accept the null hypothesis.

3) Johansen Cointegration Test

Cointegration occurs between variables that are not stationary. Cointegration occurs when a combination of non-stationary variables eliminates the causes of each variable's non-stationaryness. Meanwhile, economically, two or more variables will be cointegrated if they have a long-term relationship or equilibrium.

$$Y_t = A_1 Y_{t-1} + \cdots + A_p Y_{t-p} + B X_t + e_t$$

When stationary means and cointegrated. Cointegration test is carried out using the test $e_t Y_t X_t$ *Engle-Granger* two steps (*two step residual approach*) and test *Johansen Cointegration*. Test *Johansen Cointegration* can be used to determine cointegration according to the number of variables with the general form as in equation (1).

4) Vector Error Correction Model (VECM)

The specification of VECM is by restricting the long-term behavioral relationship between existing variables so that it converges into a cointegration relationship but still allows dynamic changes in the short term to be able to provide precise and reliable results, making the Vector Error Correction Model (VECM) method known as a reliable model. The cointegration terminology in the VECM method is known as error correction which, if it occurs due to deviations from the long-term balance, will be corrected gradually through gradual short-term partial adjustments (Widarjono (2007) in Afrizal & Farlian (2017)). The VECM model can be written as follows:

$$\Delta Y_{t-1} = \mu_t + \prod Y_{t-1} + \sum_{i=1}^{k=1} \prod i\Delta Y_{t-1} + e_t$$

The VECM model used in this study is as follows:

Model 1

$$CPI_t = C_1 + a_{1i} \sum CPI_{t-k} + a_{1i} \sum GDP_{t-k} + a_{1i} \sum I_{t-k} + a_{1i} \sum M2_{t-k} + e_i$$

Model 2

$$GDP_t = C_2 + a_{1i} \sum GDP_{t-k} + a_{1i} \sum CPI_{t-k} + a_{1i} \sum I_{t-k} + a_{1i} \sum M2_{t-k} + e_i$$

Model 3

$$I_t = C_3 + a_{1i} \sum I_{t-k} + a_{1i} \sum CPI_{t-k} + a_{1i} \sum GDP_{t-k} + a_{1i} \sum M2_{t-k} + e_i$$

Model 4

$$M2_t = C_4 + a_{1i} \sum M2_{t-k} + a_{1i} \sum CPI_{t-k} + a_{1i} \sum GDP_{t-k} + a_{1i} \sum I_{t-k} + e_i$$

The hypothesis test is $H_0: \sum_{j=1}^{m} \delta_i = 0$ with $H_a: \sum_{j=1}^{m} \delta_1 \neq 0$. If t-stat > t-table then accept null hypothesis. For forecasting analysis, the VAR/VECM system provides two analysis, namely Impulse Response Function (IRF) and Variance Decomposition (VD).

5) Impulse Response Function (IRF)

The coefficients in the VAR or VECM models are difficult to interpret, so impulse response analysis is used. Statistics that provide a response to shocks are called IRF and become one of the important analyzes in the VAR/VECM model (Sims, 1980 in (Lütkepohl, 2013)). IRF analysis tracks the reactions of endogenous variables in the VECM system due to shocks or changes in the disturbance variables (e_t)

6) Variance Decomposition (VD)

In addition to the impulse response function, the analytical tool that can be used is the analysis of forecast error decomposition of variance or variance decomposition (VD) which is different from IRF. IRF is used to track the impact of shocks from endogenous variables on other variables in the VECM system. Variance decomposition provides a

value relative to the importance or magnitude of the contribution of each variable in the VECM system that occurs due to shock. VD is also able to predict the contribution of the percentage of variance for each variable due to changes in certain variables in the VECM.

4. RESULTS AND DISCUSSION

4.1. Research Result

4.1.1. Optimal Lag Test

Table 1. Optimal Lag Detection

lag	LogL	LR	FPE	AIC	SC	HQ
0	-510.1836	NA	4.09e+11	38.08768	38.27965	38.14476
1	-365.1598	236.3350*	29389337	28.53036	29.49024*	28,81578
2	-348.9000	21.67983	31500771	28.51111	30.23889	29.02487
3	-327.8886	21.78960	27668973	28.13989	30.63558	28.88199
4	-293.1385	25,74080	11862258*	26.75100*	30.01459	27.72144*

Description: * indicates the order of lags selected by the criteria; LR: sequential modified LR test statistics (5%); FPE: final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.

4.1.2. Stationarity Test

Time series data needs to be tested for stationarity to analyze the behavior of the data so that there is no specific time period and will allow generalization of behavior at the next time. The following are the results of the stationarity test:

Table 2. Stationarity Test Results

Variable	Model	*	Stat	Prob	AIC
			Level		
Consumer price index (CPI)	None	0.0299	2.3517	0.9941	5.0559
	Intercept	0.0254	2.2887	0.9999	4.8862
	Trends & Intercept	-0.1982	-3.2103	0.1015	4.5492
			First Different		
	None	-0.0528	-0.4736	0.5009	5.1490
	Intercept	-0.6554	-3.7568	0.0083	4.8999
	Trends & Intercept	-0.8186	-4.1932	0.0131	4.8671
			Level		
Gross domestic product (GDP)	None	0.0329	1.4281	0.9584	13.8757
	Intercept	0.0018	0.0501	0.9559	13.9035
	Trends & Intercept	-0.1584	-1.8684	0.6447	13.8127
			First Different		
	None	-0.5581	-3.2379	0.0022	13.8795
	Intercept	-0.7040	-3.8160	0.0072	13.8347
	Trends & Intercept	-0.7380	-3.8987	0.0252	13.8745

Real Interest Rate (I)	Level				
	None	-0.4401	-2.1639	0.0315	7.1279
	Intercept	-1.0219	-5.4458	0.0001	6.9524
	Trends & Intercept	-1.0337	-5.3702	0.0007	7.0124
	First Different				
	None	-2.1544	-6.6213	0.0000	7.1821
	Intercept	-2.1572	-6.5065	0.0000	7.2508
	Trends & Intercept	-2.1806	-6.5104	0.0001	7.2945
Amount of Money Supply (M2)	Level				
	None	-0.0060	-0.7220	0.3951	4.3205
	Intercept	-0.0689	-1.1733	0.6720	4.3454
	Trends & Intercept	-0.1825	-2.5562	0.3012	4.2099
	First Different				
	None	-0.6411	-4.6125	0.0000	4.2706
	Intercept	-0.6376	-4.5258	0.0012	4.3281
	Trends & Intercept	-0.6483	-4.2591	0.0112	4.3954

Remarks: *** significant at 1%; ** significant at 5%; * significant 10%;
**** Selected model with minimum AIC requirements, coefficient $\delta < 0$ and significant.

The table above shows the variables of inflation, economic growth, interest rates, and the money supply which are stationary at the first different level. The existence of non-stationary variables causes the possibility of the existence of long-term relationships in the VAR system of equations.

4.1.3. Cointegration Test

Cointegration test in this study uses the Johansen test. The results of the cointegration test can be seen in Table 2. In the results in the table, it can be seen that the Trace Statistics value is greater than the critical value at the 5% significance level. So, it can be concluded that there are 3 cointegration equations formed.

Table 3. Cointegration Test Results

Hypothensized No. of CE(s)	Eigenvalue	Trace Statistics	Critical Value	Prob.**
None *	0.980208	153.6687	47.85613	0.0000
At most 1 *	0.714057	51.68493	29.79707	0.0000
At most 2 *	0.512685	19.13391	15.49471	0.0135
At most 3	0.016931	0.443963	3.841466	0.5052

Description: * indicates rejection of the hypothesis at the level of 5% or 0.05

From the results of the cointegration test in table 2 above, as well as the conclusion of the stationarity test in table 1, the estimation model used in this study is the Vector Error Correction Model (VECM).

The stage prior to the estimation of the VECM model is the stability test. VAR stability test is done by looking at the value of the modulus. If the modulus value is less than 1, then the model is declared stable and can be estimated. Based on the results of the stability test, the modulus value is less than 1 and the VAR model can be said to be stable. The following are the results of the VAR stability test:

Table 4. VAR Stability Test Results

Root	Modulus
0.491488 - 0.442554i	0.661373
0.491488 + 0.442554i	0.661373
0.636129	0.636129
-0.603254	0.603254
-0.348922 - 0.483179i	0.595994
-0.384922 + 0.483179i	0.595994
0.055654 - 0.211426i	0.218628
0.055654 + 0.211426i	0.218628

4.1.4. VECM Estimate

From the four test results above, it can be said that the eligibility requirements for using VECM have been met, namely data on stationary variables at the level level and there is cointegration. The following are the results of the Vector Error Correction Model (VECM) estimation.

Table 5. VECM Estimation Results

Cointegrating Eq:	CointEq1
D(CPI(-1))	1.0000000
D(GDP(-1))	-0.058004
	(0.02417)
	[-2.39977]
D(I(-1))	-8.858309
	(1.49809)
	[-5.91308]
D(M2(-1))	-7.259395
	(191971)
	[-3,78151]
C	-2.269100

Error Correction	D(CPI,2)	D(GDP,2)	D(I,2)	D(M2,2)
CointEq1	-0.007756	6.662317	0.217757	0.007206
	(0.02822)	(1.77582)	(0.07921)	(0.01817)
	[-0.27481]	[3.75169]	[2.74901]	[0.39660]
D(CPI(-1),2)	-0.717353	-43.02998	1.343291	0.065464
	(0.35042)	(22.0477)	(0.98347)	(0.22559)
	[-2,04715]	[-1.95168]	[1.36587]	[0.29020]
D(CPI(-2),2)	-0.333001	1.806358	-0.258020	-0.492544
	(0.33862)	(21.3056)	(0.95037)	(0.21799)
	[0.98340]	[0.08478]	[-0.27150]	[-2.25944]

D(GDP(-1),2)	-0.003846	-0.004641	0.007659	0.000604
	(0.00292)	(0.18349)	(0.00818)	(0.00188)
	[-1.31871]	[-0.02530]	[0.93579]	[0.32197]
D(GDP9-2),2)	-0.002720	-0.494152	0.007559	0.002461
	(0.00288)	(0.18097)	(0.00807)	(0.00185)
	[-0.94560]	[-2.73059]	[0.93640]	[1.32886]
D(I(-1),2)	-0.101971	31.46892	0.488024	0.137640
	(0.19819)	(12.4696)	(0.55622)	(0.12759)
	[-0.51452]	[2,52366]	[0.87739]	[1.07880]
D(I(-2),2)	-0.048992	9.812554	0.184241	0.066664
	(0.09262)	(5.82747)	(0.25994)	(0.05963)
	[-0.52897]	[1.68384]	[0.70877]	[1.11805]
D(M2(-1),2)	0.168128	76.00972	1.013688	-0.171080
	(0.399997)	(25,1657)	(1.12255)	(0.25749)
	[0.42035]	[3.02037]	[0.90302]	[-66441]
D(M2(-2),2)	0.091175	-24.65130	0.595220	0.337658
	(0.28461)	(17.9074)	(0.79879)	(0.18322)
	[0.32035]	[-1.37660]	[0.74515]	[1.84286]
C	0.309075	18.73269	0.234617	0.101333
	(0.63291)	(39,8216)	(1.77630)	(0.40745)
	[0.48834]	[0.47042]	[0.13208]	[0.24870]
R-squared	0.440728	0.711566	0.872720	0.481548
adj. R-squared	0.144642	0.558866	0.805337	0.207073
Sum sq. resids	169.0978	669416.7	1331,965	70.08067
SE equation	3.153876	198.4375	8.851603	2.030367
F-statistics	1.488515	4.659892	12.95154	1.754433
Likelihood logs	-63.07899	-174.9087	-90.94208	-51.18778
Akaike AIC	5.413258	13.69694	7.477191	4.532428
Schwarz SC	5.893198	14.17688	7.957131	5.012367
Mean dependent	0.126118	7.080979	0.072807	-0.078770
SD dependent	3.410128	298.7711	20.06225	2.280121
Determinant resid covariance (dof adj.)		28000890		
Determinant resid covariance		4400606		
Likelihood logs		-359.7583		
Akaike information criterion		29.90802		
Schwarz criterion		32.01975		
Number of coefficients		44		

Description: Standard errors in ( ) & t-statistics in [ ]

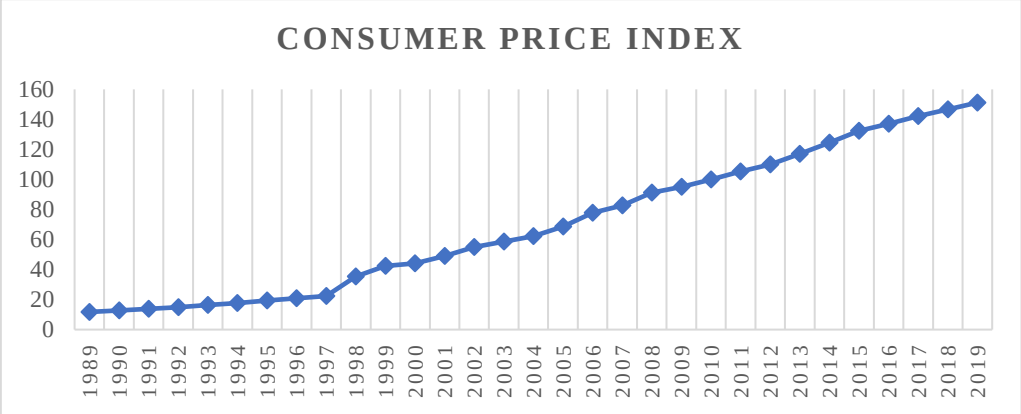
In table 5, the first part shows long-term estimates on the relationship between inflation, economic growth, interest rates, and the money supply. The second section of the table provides statistical information for each equation and the bottom section provides information for the VAR system as a whole. The information in brackets is the standard errors value and the t-statistics value is indicated by the brackets below it.

In the VECM estimation results above, it can be seen that the t-statistic value of economic growth [-2.39977], interest rate [-5.91308], and money supply [-3.78151]. The

t-statistic value of the three variables is more than the t-table value. This means that economic growth, interest rates, and the money supply have a significant effect on inflation. Meanwhile, in the second part of the table above, the short-term relationship with the highest R-squared value is owned by the interest rate, namely 87%, followed by economic growth with an R-squared value of 71%, and the money supply 48%.

4.2. Discussion

4.2.1. Inflation Development in Indonesia

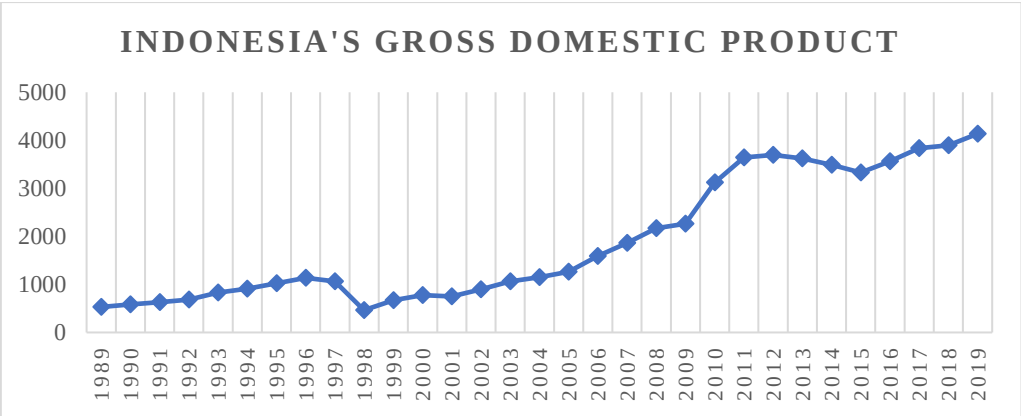


Source: World Bank

Figure 2. Graph of Indonesian Consumer Price Index

Inflation in this study is measured by the Consumer Price Index (CPI) or Consumer Price Index (CPI) obtained from the World Bank. From the graph above, it can be seen that the CPI in Indonesia has increased every year. However, there was a very drastic increase in 1998 due to the 1998 Monetary Crisis. The increase from 1997 to 1998 was quite large, amounting to 13%. In the following years, the CPI tended to be stable and did not experience a very significant increase.

4.2.2. The Development of Economic Growth in Indonesia



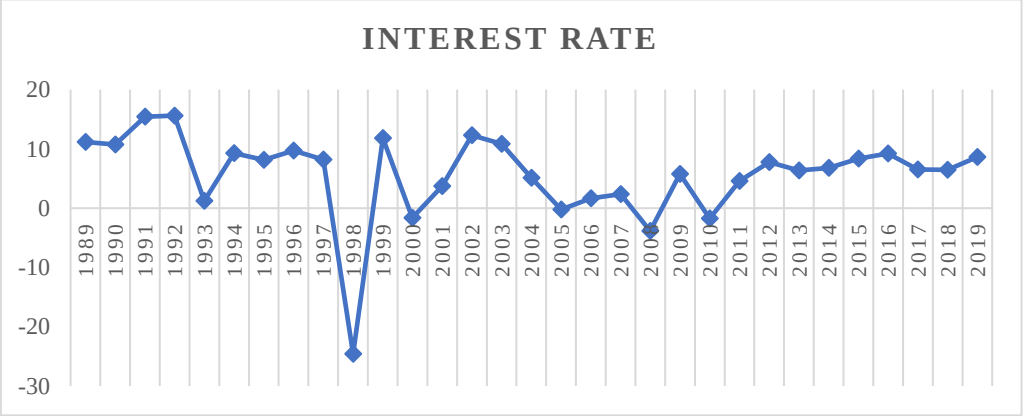
Source: World Bank

Figure 3. Graph of Indonesia's Gross Domestic Product

Economic growth in this study is measured by Indonesia's Gross Domestic Product (GDP). Indonesia's GDP from 1989 to 2019 continued to fluctuate. From 1989 to 1996,

Indonesia's GDP continued to increase, then in 1997 it decreased by 73,698USD. Then in 1998 there was a significant decline, namely 599,764USD. For the following years, Indonesia's GDP continues to increase. Then, in 2010 there was a significant increase in GDP, amounting to 861,115USD and continued to increase until 2014. Then in 2015 it decreased by 159,942USD and then Indonesia's GDP experienced a fairly good development.

4.2.3. Interest Rate Developments in Indonesia

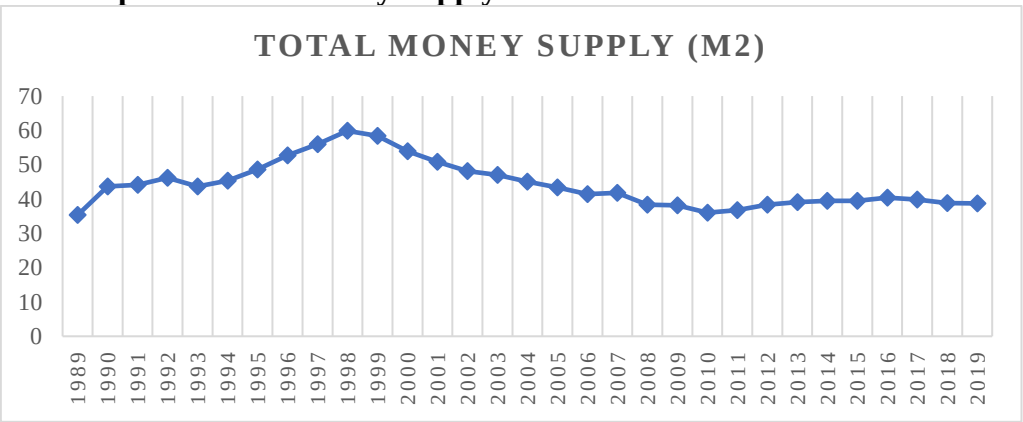


Source: World Bank

Figure 4. Indonesia's Interest Rate

The development of interest rates in this study is measured by the real interest rate or Real Interest Rate. Real interest rates in Indonesia fluctuate from year to year. In 1993, it experienced a sharp decline but was still positive, namely from 15.6% in 1992 to 1.2% in 1993. A very drastic decline in interest rates occurred in 1998 with a decline of 32% in 1997. the interest rate was 8.2% to -24.6% in 1998. Then in 1999 it immediately experienced a very drastic increase, namely by 36% with 1998 the interest rate of -24.6% to 11.8% in 1998. 1999. Then, in 2000 it decreased again to -1.6% and then in 2001 it increased to 3, 7% and continued to increase in 2002, namely 12%. Furthermore, interest rates in Indonesia are still fluctuating but the value is stable and there is no significant increase or decrease.

4.2.4. Development of the Money Supply in Indonesia



Source: World Bank

Figure 5. The Money Supply in Indonesia

The money supply in this study is measured by the amount of quasi money or broad money supply (M2) or broad money. The development of the money supply in Indonesia is considered to be fluctuating but its value is still stable. The highest amount of money in circulation occurred in 1998, which was 59,86% and the lowest was in 1989, which was 35,31%.

4.2.5. Impulse Response Function

Impulse response function estimation is needed to examine the response to shock from the standard deviation of the variable to the variable itself and other variables. IRF analysis predicts how the conditions of the four variables will be in the next 10 years. If the image from the impulse response shows a movement that is getting closer to the point of balance or convergence or also returns to the previous balance, it means that the response of the variable due to a shock or shock will gradually disappear. So that the shock does not leave a permanent effect on these variables. Below are the results of the impulse response for the research variables:

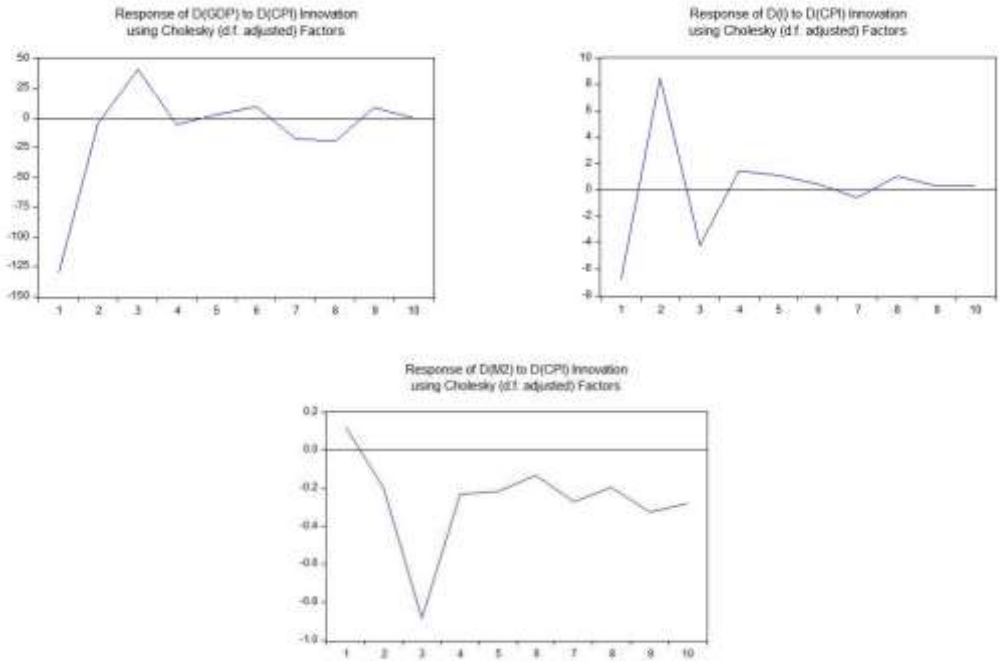


Figure 6. Impulse Response GDP, I, and M2 to CPI

The response of economic growth (GDP) after a shock from inflation (CPI) of one deviation has a direct effect in the first year of -129.6824. The response of economic growth to shocks from inflation was very volatile until the 10th year. However, the shock that caused a positive effect was in the 3rd year of 40.39335.

In the interest rate variable (I), the effect caused by inflation from the first to the second year experienced a significant increase, from -6.73 to 8.47 in the second year. Then, it decreased in the third year to -4.20 and continued to fluctuate until the 10th year.

The inflation variable causes a fluctuating shock effect on the money supply variable (M2). In the first year, the money supply had a value of 0.115 then in the second year it decreased to -0.20 and experienced a very significant decrease in the third year to -0.88.

Then, in the fourth year there was a very significant increase to -0.23. For the following years, the money supply continued to fluctuate.

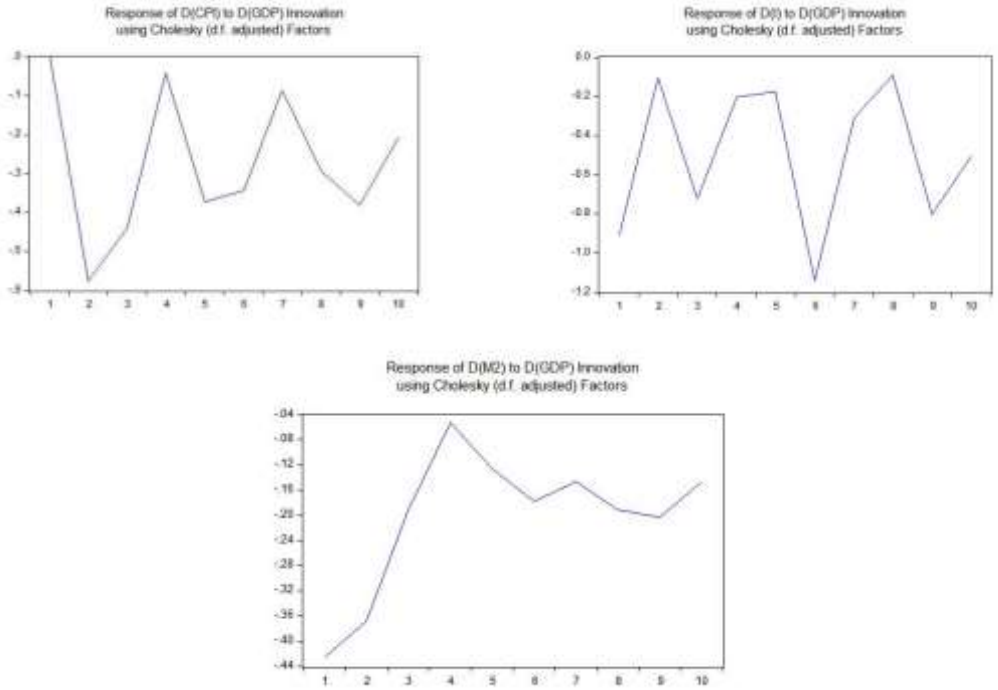


Figure 7. Impulse Response CPI, I, and M2 to GDP

The response of inflation after the shock of the economic growth variable of one deviation in the first year has not been seen. However, in the second year, inflation decreased significantly to -5.7. Then in the fourth year there was a significant increase to -0.04 from the previous -4.3 in the third year. Then in the following years inflation experienced a shock that was quite volatile and tended to be unstable.

In the interest rate variable (I), the effect caused by the economic growth variable from the first to the second year experienced a significant increase, the interest rate value in the first year was -0.90 to -0.10 in the second year. Then further decreased in the third year to -0.72 and the fourth year to -0.20. In the fourth and fifth years, the interest rate value tends to be stable until in the sixth year it experiences a very sharp decline, from the previous -0.17 to -1.14 and subsequently experienced a sharp decline.

The variable of economic growth causes a fluctuating shock effect on the variable of the money supply. In the first year the value of the money supply was -42 then in the second year it increased to -36. Furthermore, in the third year, the money supply experienced a significant increase, namely to -19 and the highest value of the money supply occurred in the fourth year of -5 which furthermore the value of the money supply continued to fluctuate until the tenth year.

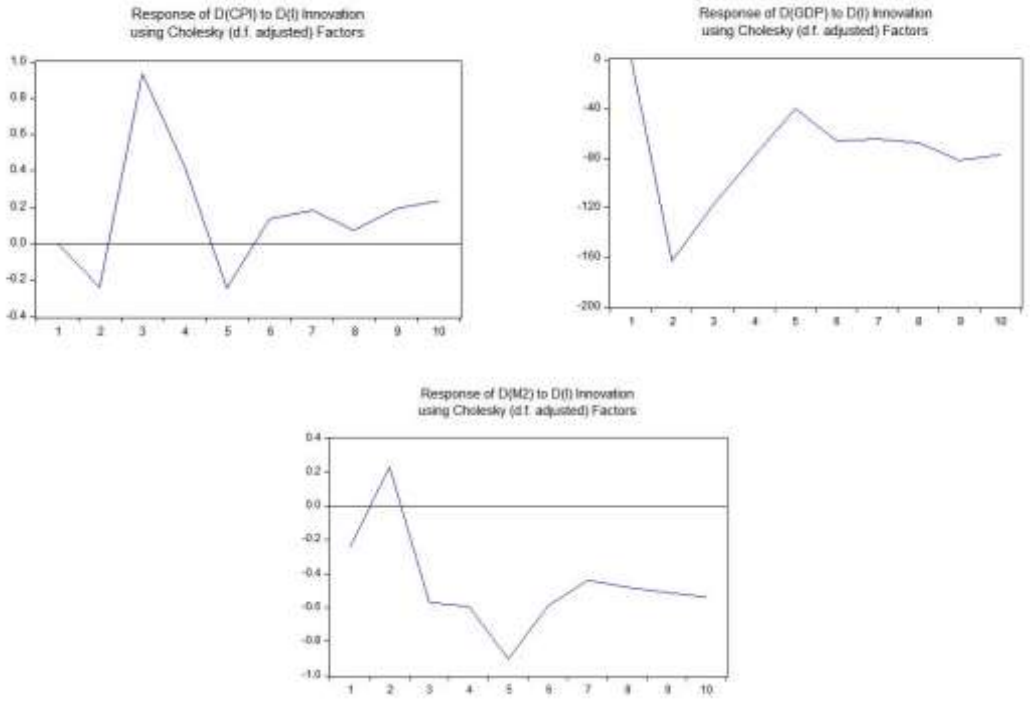


Figure 8. Impulse Response CPI, GDP, and M2 to I

The response of inflation to shocks from interest rates is highly volatile. In the first year, interest rates have not had a significant effect on inflation. However, in the second year, inflation decreased by -0.24 then in the third year it experienced a very significant increase, namely to 0.93 and continued to decline until it reached its lowest point in the fifth year with inflation of -0.24. In the sixth year it increased to 0.13 and inflation continued to fluctuate until the tenth year.

In the variable of economic growth (GDP), the effect of interest rates in the first year has not been seen. Then it experienced a significant decrease in the second year to -163.06 but continued to increase until the fifth year, the value of economic growth was -39.92. However, after the fifth year, economic growth continued to decline and finally in the tenth year it increased to -77.21.

The interest rate has a very fluctuating effect on the money supply variable (M2). In the first year the value of the money supply was -0.24 then in the second year it increased to 0.23. The money supply continued to decline until the fifth year it reached its lowest point for ten forecast periods with a value of -0.90 and continued to increase until in the tenth year it fell to -0.54.

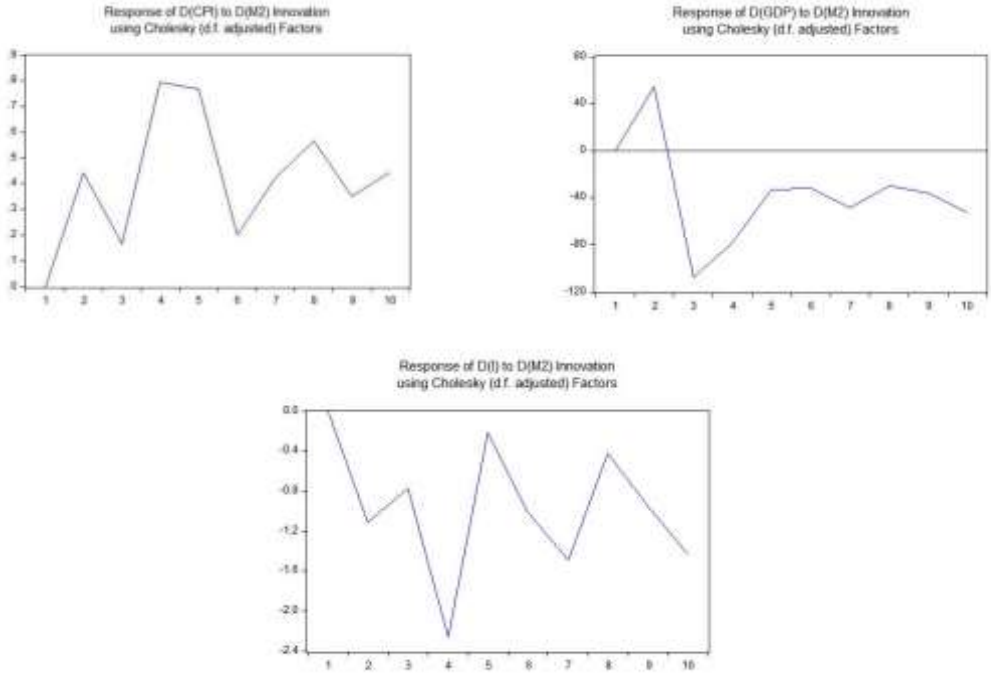


Figure 9. Impulse Response CPI, GDP, and I to M2

Inflation's response to shocks in the money supply fluctuates greatly each year. However, in the first year, the inflation rate against shocks was still 0. Then it experienced a very sharp increase in the second year to 4.4 and decreased in the third year to 1.6. Inflation continued to increase until in the fourth year it became the highest point of 7.9 and then continued to decline until the sixth year it reached 2. Furthermore, the inflation rate continued to fluctuate due to shocks in the money supply.

In the variable of economic growth, the effect of the money supply in the first year has not been seen. Until the second year, economic growth increased to 54.4. Then it continued to experience a drastic decline until the third year it reached a value of -108. However, after that, economic growth continued to increase until in the tenth year the value fell to -52.5 from the previous value of -35.8.

The money supply variable has a very fluctuating effect on the interest rate variable. In the first year, the money supply variable has not had a significant effect on interest rates. Until the second year, the interest rate decreased by -1.1 and had increased in the third year to -0.77 but again experienced a sharp decline in the fourth year to -2.26. The interest rate increased again in the fifth year worth -0.22 and subsequently the interest rate fluctuated quite extreme.

Table 6. Impulse Response Function Results

Response to Inflation	
GDP	Negative
Interest Rate	Positive
M2	Negative
Response to GDP	
Inflation	Negative

Interest Rate	Negative
M2	Negative
Response to Interest Rates	
Inflation	Positive
GDP	Negative
M2	Negative
Response to M2	
Inflation	Positive
GDP	Negative
Interest Rate	Negative

Simultaneously, the shocks given by inflation to economic growth give a negative response, and vice versa. Meanwhile, interest rates provide a positive response to inflationary shocks and vice versa. The money supply responds negatively to shocks from inflation but inflation responds positively to shocks from the money supply.

Economic growth and interest rates both gave a negative response to the shocks they received from each variable. This also happened to economic growth and the money supply, which both gave a negative response. Interest rates and money supply also gave a negative response to the shocks they received.

4.2.6. Variance Decomposition

If the Impulse Response Function (IRF) graph shows the shock forecast and the length of time needed to achieve stability, then Variance Decomposition explains the proportion of movement of a variable due to a shock or shock from the variable itself compared to the shock caused by other variables. In other words, VD shows how big the contribution of variance in each variable is due to changes in certain variables in the VAR system.

Table 6. Variance Decomposition (VD) Estimation Results

Variance Decomposition of D(CPI)

Period	S.E.	D(CPI)	D(GDP)	IN)	D(M2)
1	3.153876	100,0000	0.000000	0.000000	0.000000
2	3.599497	95.48343	2.557203	0.454850	1.504515
3	3.837392	88.56613	3.558498	6.366080	1.509290
4	4.197505	85.85172	2.984226	6.316601	4.847451
5	4.532065	84.02410	3.237685	5.706992	7.031227
6	4.708481	84.40011	3.534211	5.370811	6.694870
7	4.949038	84.99457	3.228685	4.995500	6.781242
8	5.208333	84.94038	3.233800	4.529218	7.296600
9	5.418335	85.04203	3.486579	4.308946	7.162444
10	5.604157	85.08000	3.394549	4.202351	7.323101

In the first year, the inflation variable is explained by the inflation variable itself by 100 percent. However, the percentage continues to fluctuate every year. In the second year the inflation variable was able to explain the inflation variable itself as much as 95%, the remaining 2.55% was explained by the economic growth variable, 0.45% was explained by the interest rate variable, and the money supply was able to explain the

inflation variable as much as 1.5%. It continues to decline until the tenth year, the inflation variable can only be explained by the inflation variable itself as much as 85%. 3.4% of the inflation variable can be explained by the variable of economic growth, 4.2% is explained by the interest rate, and 7.3% is explained by the money supply.

Table 7. Variance Decomposition of D (GDP) Estimation Results

Variance Decomposition of D(GDP)

Period	S.E.	D(CPI)	D(GDP)	IN)	D(M2)
1	3.153876	42.70849	57.29151	0.000000	0.000000
2	3.599497	21.08231	41.93435	33.28141	3.701926
3	3.837392	16.58180	34.01559	36.28047	13.12215
4	4.197505	13.69782	36.38669	34.48339	15.43210
5	4.532065	12.56121	39.84265	32.69419	14.90196
6	4.708481	11.82981	40.14567	33,39424	14,63028
7	4.949038	11.03590	41.05305	33.09617	14.81488
8	5.208333	10.29010	43.02492	32.67455	14.01043
9	5.418335	9.536728	43.41189	33.48114	13.57024
10	5.604157	8.856210	43,45718	33,82099	13.86562

In the first year, the variable of economic growth can only be explained by the variable of inflation and the variable of economic growth with values of 42.7% and 57.3%, respectively. The variable of economic growth continues to fluctuate until the second year is only able to explain the variable of economic growth itself by 42%. With 21% explained by the inflation variable, 33.3% explained by the interest rate, and 3.7% explained by the money supply. Until the tenth year, economic growth was able to explain itself by 43.5% and the others were explained by inflation variables, interest rates, and the money supply with respectively 8.9%, 34%, and 14%.

Table 8. Variance Decomposition of D (I) Estimation Results

Variance Decomposition of D(I)

Period	S.E.	D(CPI)	D(GDP)	IN)	D(M2)
1	3.153876	57.80142	1.045505	41.15308	0.000000
2	3.599497	74.56341	0.529053	24.11460	0.792930
3	3.837392	76.60853	0.770266	21.56852	1.052685
4	4.197505	72.00953	0.735309	23.58290	3.672269
5	4.532065	72.05744	0.745562	23,53019	3.666811
6	4.708481	71.15477	1.410954	23.28505	4.149229
7	4.949038	69.13284	1.415822	24.32642	5.124921
8	5.208333	69.10234	1.408729	24,31711	5.171823
9	5.418335	68.47446	1.710785	24.25123	5.563525
10	5.604157	67.33153	1.803807	24.40428	6.460382

In the first year, the interest rate variable was able to explain its own variable by 41%, with 57% explained by inflation and 1.04% explained by economic growth. This value continued to fluctuate and in the second year it decreased by 17% so that in the second year the interest rate was only able to explain itself by 24% with 74% explained

by inflation, 0.52% explained by economic growth, and 0.79% explained by the money supply. In the tenth year, the interest rate variable is explained by the interest rate of 24.4%, inflation of 67%, economic growth of 1.8%, and the money supply of 6.4%.

Table 9. Variance Decomposition of D (M2) Estimation Results

Variance Decomposition of D(M2)					
Period	S.E.	D(CPI)	D(GDP)	IN)	D(M2)
1	3.153876	0.320655	4.406402	1.398061	93.87488
2	3.599497	0.810080	4.760416	1.671033	92.75847
3	3.837392	6.722114	2.853300	3.485578	86.93901
4	4.197505	5.712574	2.297644	5.047686	86.94210
5	4.532065	4.890715	1.947241	8.330231	84,83181
6	4.708481	4.436260	1.880016	9.041865	84,64186
7	4.949038	4.243414	1.756744	8.817604	85.18224
8	5.208333	3.909372	1.694597	8.682350	85.71368
9	5.418335	3.858108	1.656451	8.661349	85.82409
10	5.604157	3.746372	1.570412	8.745986	85.93723

In the first year, the money supply variable can be explained by 93.87% by the variable itself and 0.32% by inflation, 4.4% by economic growth, and by the interest rate of 1.39%. The VD value of the money supply decreases every year, until in the second year the money supply is able to explain the variable itself by 92.75%, 0.81% is explained by inflation, 4.76% is explained by economic growth, and 1.67% is explained by interest rates. The money supply variable continues to fluctuate in explaining the variable itself. Therefore, the value of variance decomposition in the tenth year has increased from the previous 85.82% to 85.93% in explaining the variable itself. The value of 85.93% was followed by the inflation variable which was able to explain the money supply variable of 3.7%, 1.5% were influenced by economic growth, and 8.7% were influenced by interest rate variables.

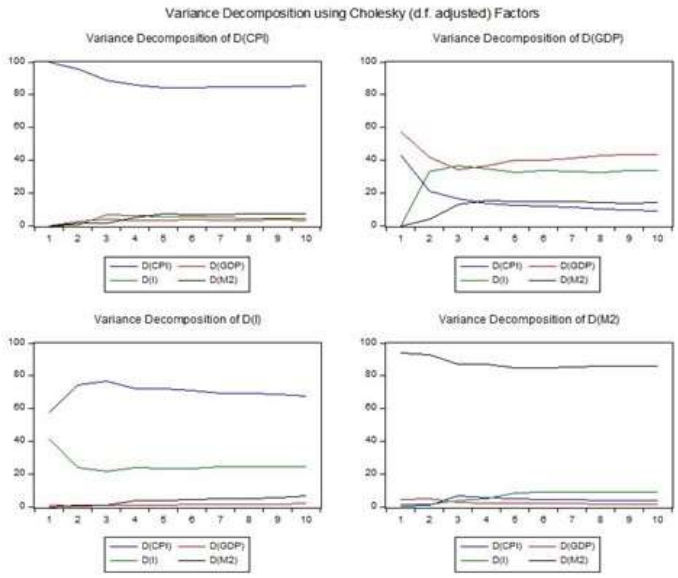


Figure 10. Estimated Results of Variance Decomposition

From the variance decomposition graph of inflation above, it can be concluded that from the first year to the tenth year, the inflation variable still dominates. Then, on the graph of economic growth, it can be seen that the contribution of the interest rate variable is almost the same as the contribution of the economic growth variable itself, also the contribution of the inflation variable and the money supply are almost the same. Meanwhile, on the interest rate chart, the inflation variable dominates even from the first year to the tenth year. The contribution of the inflation variable to changes in interest rates is greater than the contribution of the interest rate itself. Furthermore, in the variance decomposition graph, the money supply, from the first year to the tenth year, is dominated by the money supply variable itself.

5. CONCLUSION

This study seeks to investigate the relationship between macroeconomic variables and inflation in Indonesia. This study uses VECM in an effort to increase the likelihood of obtaining a suitable relationship model. In addition, the VECM technique allows mutual interactions and does not demand the theory's primacy. In this study, the variables evaluated were the response of economic growth (GDP), interest rates (I), and the money supply (M2) to inflation (CPI).

The economic growth and money supply responses to inflation are negative. In the meanwhile, the response of interest rates to inflation is positive. Inflation, meanwhile, responded positively to shocks to interest rates and money supply and negatively to shocks resulting from economic growth. This indicates that the Indonesian inflation rate is vulnerable to shocks in macroeconomic variables.

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