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# Relationship between inflation, exchange rate and money supply in Indonesia using threshold vector autoregressive (TVAR)

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**Abstract.** Model nonlinear in economic and finance riset are often found. One model that can be used to capture nonlinear relationships in data is Threshold Vector Autoregressive (TVAR) model. TVAR model is generalization of VAR model, it divides the time series into different regimes that are separated by a different threshold. The purpose of this research are is to see the effects between inflation, exchange rate depreciation and money supply in Indonesia and to know the performance of forecasting with VAR and TVAR model. Inflation, exchange rate depreciation and money supply growth produce TVAR on lag 1 with one threshold and two regimes. Each regimes shows different effects. TVAR model has a smaller AIC than the VAR model so forecasting performance of TVAR model is better used in this modeling.

## INTRODUCTION

Economic and financial research has often used time series models such as autoregressive (AR), vector autoregressive (VAR) and etc. But in the results of his research both in the academic promotion and application linear model time series sometimes can not explain all the things that exist in the economic and financial studies. Because in a good economic and financial system in its structure or behavior, it is reasonable to assume that other time series models are non-linear models to be able to explain the differences that exist in the empirical data with different times. Nonlinear behavior in time series data is found, as used in recent economic studies conducted by Horillo (2004), different asymmetric effects in every manufacturing sector in the UK.

The asymmetric effects on monetary shock has become an interesting research topic to study. For example, Cover (1992), Karras and Stokes (1999) and Holmes (2000) provide evidence of asymmetry between positive and negative shock. Weise (1999) and Kakes (1999) found that shock effects on economic conditions in the area concerned.[10] Nonlinear behavior in the economic and financial time series, it is a natural thing that is encountered in various countries in the world or in different regimes. The relationship between variables in the economy shows a non-linear relationship.[7] The presence of nonlinearity on the relationships between variables, when modeled with linear models would result in inappropriate coefficients of parameters.[2] The nonlinearity in the economic variables was also expressed by Enders in 2004, such as fiscal policy, monetary policy, economic growth, and etc.

The nonlinear time series models, the Threshold Autoregressive (TAR) model is a simple identification, prediction, and interpretation model.[9] This AR is a predictor of variables that are only influenced by variables in the previous period. However, this study will discuss Thershold Vector Autoregrsive (TVAR), assuming a threshold (Thershold) that governs all the parameters of different equations. The use of this threshold is useful for determining different economic circumstances for all equations in a unique way and simplifying calculations on every economic condition. Using TVAR because the estimation of a variable is not only influenced by these variables but also influenced by other variables in the previous period.This model will be applied in inflation modeling in Indonesia which fluctuaties relatively quickly (Figure 1). Uncontrolled inflation will be damaging the stability of the national economy. Therefore, this research will examine the effects between inflation, exchange rate depreciation and money supply in Indonesia. Beside that, this study want to know the performance of forecasting with Vector Autoregressive (VAR) and TVAR model.

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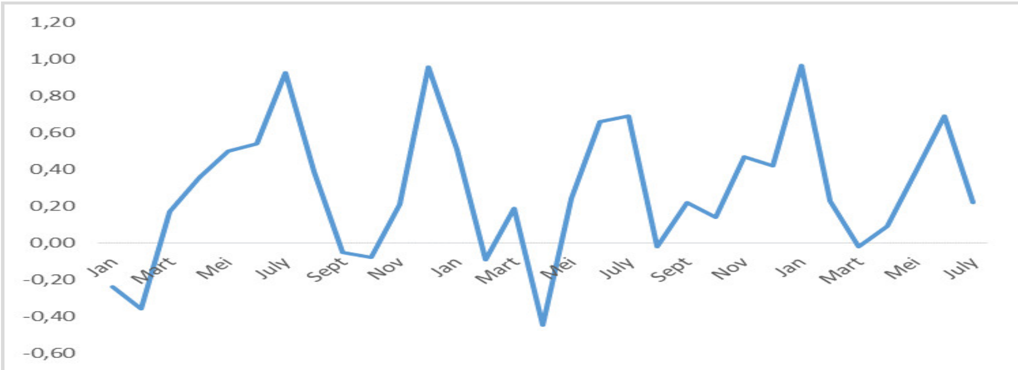



**FIGURE 1.** Inflation In Indonesia January 2015 – July 2017

## METHODS

### Data Sources and Research Variables

The data in this research are inflation *($Y_{t1}$)*, exchange rate depreciation *($Y_{t2}$)* and growth of money supply *($Y_{t3}$)* period of January 2001- June 2017. Inflation data sourced from Statistics Indonesia (BPS). Data of exchange rate depreciation and growth of money supply from Bank Indonesia. The method of analysis used in this research is descriptive analysis and inferencing analysis using VAR and TVAR model.

### Vector Autoregression Model (VAR)

The Vector Autoregression Model (VAR) was first popularized in time series econometrics by Sims in 1980. The VAR model is a dynamic equation system in the estimation of a variable depends on the movement of that variable and other variables involved in the system of equations in previous periods.[5] The VAR analysis, each variable is otherwise explained by its own value in the past, also influenced by the past value of other endogenous variables. The general of structural model VAR for l variables with the order p is as follows:

$$Y_{1t} = a_{10} + a_{11,1}Y_{1t-1} + a_{12,1}Y_{2t-1} + \dots + a_{1n,1}Y_{nt-1} + \dots + a_{11,p}Y_{1t-p} + a_{12,p}Y_{2t-p} + \dots + a_{1n,p}Y_{nt-p} + e_{1t} \quad \dots (1)$$

$$Y_{2t} = a_{20} + a_{21,1}Y_{1t-1} + a_{22,1}Y_{2t-1} + \dots + a_{2n,1}Y_{nt-1} + \dots + a_{21,p}Y_{1t-p} + a_{22,p}Y_{2t-p} + \dots + a_{2n,p}Y_{nt-p} + e_{2t} \quad \dots (2)$$

$$\vdots$$

$$Y_{lt} = a_{n0} + a_{n1,1}Y_{1t-1} + a_{n2,1}Y_{nt-1} + \dots + a_{nn,1}Y_{nt-1} + \dots + a_{n1,p}Y_{1t-p} + a_{n2,p}Y_{2t-p} + \dots + a_{nn,p}Y_{nt-p} + e_{nt} \quad \dots (3)$$

$Y_{1t}$ : the first endogeous variable in t periode

$Y_{2t}$ : the second endogeous variable in t periode

$Y_{1t-p}$ : the first endogeous variable in t-p periode

$Y_{2t-p}$ : the second endogeous variable in t-p periode

Model parameter estimation for VAR model with two endogenous variable and lag p is:

$$Y_{1t} = a_{10} + a_{11,1}Y_{1t-1} + a_{12,1}Y_{2t-1} + \dots + a_{11,p}Y_{1t-p} + a_{12,p}Y_{2t-p} + \dots + a_{12,p}Y_{2t-p} + \varepsilon_{1t} \quad \dots (4)$$

$$Y_{2t} = a_{20} + a_{21,1}Y_{1t-1} + a_{22,1}Y_{2t-1} + \dots + a_{21,p}Y_{1t-p} + a_{22,p}Y_{2t-p} + \dots + a_{22,p}Y_{2t-p} + \varepsilon_{2t} \quad \dots (5)$$

If there are as many as M series data and the optimum lag length to be used is up to p lag then the data structure to be used for modeling, is as follows.

**TABLE 1**. Data Structure in VAR Model

| Time (t) | $Y_{1t}$ | $Y_{2t}$ | $Y_{1t-1}$ | $Y_{2t-1}$ | ... | $Y_{2t-p}$ |
|---|---|---|---|---|---|---|
| P+1 | $Y_{1,p+1}$ | $Y_{2,p+1}$ | $Y_{1,p}$ | $Y_{2,p}$ | | $Y_{2,1}$ |
| P+2 | $Y_{1,p+2}$ | $Y_{2,p+2}$ | $Y_{1,p+1}$ | $Y_{2,p+1}$ | | $Y_{2,2}$ |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | | ⋮ |
| M | $Y_{1,M}$ | $Y_{2,M}$ | $Y_{1,M-1}$ | $Y_{2,M-1}$ | | $Y_{2,M-p}$ |

So the VAR model obtained from the data structure in table 1 can be made in matrix form

$$\begin{bmatrix} Y_{1,p+1} & Y_{2,p+1} \\ Y_{1,p+2} & Y_{2,p+2} \\ \vdots & \vdots \\ Y_{1,M} & Y_{2,M} \end{bmatrix} = \begin{bmatrix} 1 & Y_{1,p} & Y_{2,p} & \cdots & Y_{2,1} \\ 1 & Y_{1,p+1} & Y_{2,p+1} & \cdots & Y_{2,2} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1 & Y_{1,M-1} & Y_{2,M-1} & \cdots & Y_{2,M-p} \end{bmatrix} \begin{bmatrix} a_{10} & a_{20} \\ a_{11,1} & a_{21,1} \\ a_{12,1} & a_{22,1} \\ \vdots & \vdots \\ a_{12,p} & a_{22,p} \end{bmatrix} + \begin{bmatrix} e_{1,p+1} & e_{2,p+1} \\ e_{1,p+2} & e_{2,p+2} \\ \vdots & \vdots \\ e_{1,M} & e_{2,M} \end{bmatrix} \quad \ldots (6)$$

$$\boldsymbol{Y}_{(M-p)x2} = \boldsymbol{X}_{(M-p)x(1+2p)}\boldsymbol{A}_{(1+2p)x2} + \boldsymbol{\epsilon}_{(M-p)x2} \quad \ldots (7)$$

$$\boldsymbol{\epsilon} = \boldsymbol{Y} - \boldsymbol{XA} \quad \ldots (8)$$

$$\boldsymbol{\epsilon}^2 = (\boldsymbol{Y} - \boldsymbol{XA})^T(\boldsymbol{Y} - \boldsymbol{XA}) \quad \ldots (9)$$

$$\boldsymbol{\varepsilon}^2 = \boldsymbol{Y}^T\boldsymbol{Y} - \boldsymbol{Y}^T\boldsymbol{XA} - \boldsymbol{A}^T\boldsymbol{X}^T\boldsymbol{Y} + \boldsymbol{A}^T\boldsymbol{X}^T\boldsymbol{XA} \quad \ldots (10)$$

$$\boldsymbol{\varepsilon}^2 = \boldsymbol{Y}^T\boldsymbol{Y} - 2\boldsymbol{A}^T\boldsymbol{X}^T\boldsymbol{Y} + \boldsymbol{A}^T\boldsymbol{X}^T\boldsymbol{XA} \quad \ldots (11)$$

The coefficient estimate of the matrix A then equation (11) is derived against A then equated to zero to obtain the following result.

$$\frac{d\varepsilon^2}{dA} = 0$$

$$= 0 - 2\boldsymbol{X}^T\boldsymbol{Y} + 2\boldsymbol{X}^T\boldsymbol{X}\hat{\boldsymbol{A}}$$

$$\boldsymbol{X}^T\boldsymbol{Y} = \boldsymbol{X}^T\boldsymbol{X}\hat{\boldsymbol{A}} \quad \ldots (12)$$

$$(\boldsymbol{X}^T\boldsymbol{X})^{-1}\boldsymbol{X}^T\boldsymbol{X}\hat{\boldsymbol{A}} = (\boldsymbol{X}^T\boldsymbol{X})^{-1}\boldsymbol{X}^T\boldsymbol{Y} \quad \ldots (13)$$

$$\hat{\boldsymbol{A}}_{OLS} = (\boldsymbol{X}^T\boldsymbol{X})^{-1}\boldsymbol{X}^T\boldsymbol{Y} \quad \ldots (14)$$

TVAR method is a model of VAR which generally aims to capture the existence of nonlinearity in the system due to asymmetric periodic changes, regime changes, and others. TVAR there is the division of endogenous time series into different regimes. The time series each regime will be explained by different linear VAR models. The TVAR model (p) of two variables and two regimes is as follows:

$$Y_{1t} = \begin{cases} a_{110} + a_{111,1}Y_{1,t-1} + \cdots + a_{111,p}Y_{1,t-p} + \cdots + a_{112,p}Y_{2,t-p} + e_{11t}\ ; Y_{1t-d1} \le \gamma_1 \\ a_{120} + a_{121,1}Y_{1,t-1} + \cdots + a_{121,p}Y_{1,t-p} + \cdots + a_{122,p}Y_{2,t-p} + e_{12t}; Y_{1t-d1} > \gamma_1 \end{cases} \quad \ldots (15)$$

$$Y_{2t} = \begin{cases} a_{210} + a_{211,1}Y_{1,t-1} + \cdots + a_{211,p}Y_{1,t-p} + \cdots + a_{222,p}Y_{2,t-p} + e_{111t}; Y_{2t-d2} \leq \gamma_2 \\ a_{220} + a_{221,1}Y_{1,t-1} + \cdots + a_{221,p}Y_{1,t-p} + \cdots + a_{222,p}Y_{2,t-p} + e_{211t}; Y_{2t-d2} > \gamma_2 \end{cases} \quad \ldots (16)$$

$\gamma_1$ : the threshold value that divides the VAR of the $Y_{1t}$ equation into 2 regimes

$\gamma_2$ : the threshold value that divides the VAR of the $Y_{2t}$ equation into 2 regimes

$Y_{2t}$ : the second endogenous vriable of t periode

$Y_{1t-d1}$ : the endogenous variable 1 in the period t-$d_1$ which becomes the reference of the regime distribution based on the predetermined threshold value

$Y_{2t-d2}$ : the endogenous variable 2 in the period t-$d_2$ which becomes the reference of the regime distribution based on the predetermined threshold value

Delay and Threshold Value Selection Procedure for TVAR model

1) Regression modeling for each endogenous variable of period t with variable endogen variable of period t-p. The optimum lag selection results with AIC, SIC, HQ, and FPE criteria.

$$Y_{1t} = b_{10,1} + b_{11,1}Y_{1,t-1} + e_{11t}$$
$$Y_{1t} = b_{10,2} + b_{11,2}Y_{1,t-2} + e_{12t}$$
$$\vdots$$
$$Y_{1t} = b_{10,p} + b_{11,p}Y_{1,t-p} + e_{1pt} \quad \ldots (17)$$

$$Y_{2t} = b_{20,1} + b_{21,1}Y_{1,t-1} + e_{21t}$$
$$Y_{2t} = b_{20,2} + b_{21,2}Y_{1,t-2} + e_{22t}$$
$$\vdots$$
$$Y_{2t} = b_{20,p} + b_{21,p}Y_{1,t-p} + e_{2pt} \quad \ldots (18)$$

Regression equation model is then searched for Mean Square Error (MSE). Regression model that produces the smallest MSE value, its endogenous lag variable will be the delay value in TVAR modeling.

$(\gamma_{11}, \gamma_{12}, \ldots, \gamma_{1n})$ dan $(\gamma_{21}, \gamma_{22}, \ldots, \gamma_{2n})$

2) Perform VAR modeling by trying 70 percent of the data from endogenous variables with the selected delay as the threshold value. Data that can result in a minimum MSE will then be the value of the threshold.
3) Perform VAR modeling by trying 70 percent of the data from endogenous variables with the selected delay as the threshold value. Data that can result in a minimum MSE will then be the value of the threshold.

## Stages on The Method

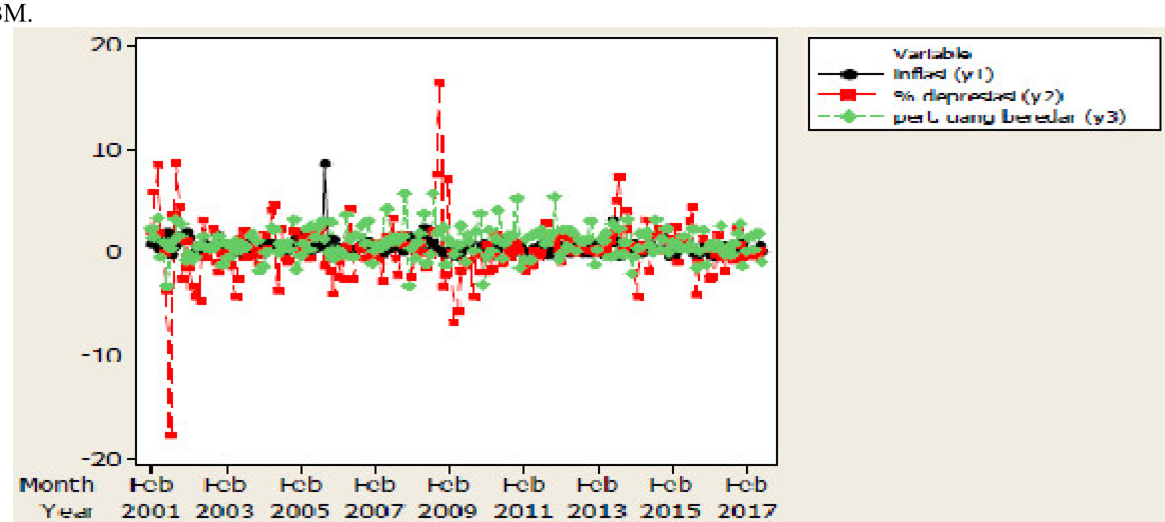
TVAR is a linear model approach with the division of time into several regions (regimes) passed by the threshold. The threshold used is the turning point where it occurs per the model linear phase. TVAR model with one time series threshold into two regimes. Both regimes are two linear models of the VAR model. The stages in the TVAR method:

1) Checking stationeritas data; The data stationeral examination was performed by using Augmented Dickey Fuller (ADF) and Philips Perron (PP) test.
2) Selects the optimum lag to be used on the model; The criteria to be used in choosing the optimum lag are Akaike's Information Criterion (AIC), Schwarz Information Criterion (SIC), Hannan-Quinn Criterion (HQ), and Final Prediction Error (FPE).
3) Testing the significance of the existence of threshold with Lagrange Multiplier Test (LM test)
4) Estimating the parameters of the TVAR model
5) Testing assumption of residual model of multivariate normal distribution and white noise.
6) Compare TVAR and VAR with AIC and FPE goodness criteria.

## RESULT

### Relationship Between Inflation, Exchange Rate Depreciation, and Money Supply Growth in Indonesia

The three variables in this study tend to have the same pattern and show fluctuations (Figure 2). Inflation shows fluctuations due to fuel price hikes (December 2014) and economic crises in Novemver 2008. The money supply is an equilibrium value between demand and supply of money occurring in Indonesia. In addition, the money supply also determines the number of transactions, the amount of goods and services produced and the price level. The global crisis did not show a serious impact on the growth of the money supply which was lower than the 2005 crisis BBM.




Source: Bank Indonesia

**FIGURE 2**. Time Series Plot Of Inflation, Exchange Rate,Growth Of Money Supply

### Test Stationarity of Data, Data Stability and Optimum Lag Determination

The first stage in the analysis carried out a variable stationary test already statistically on a level using the Phillips-Perron (PP) method (p-value < 0.05/ Appendix 1). With all points the Inverse Roots of AR Characteritic Polynomial is inside circle (Appendix 2). Thus it can be said that the VAR model used in the determination of the lag is stable (11 lag). Based on the five criteria used, four of them (FPE,AIC, SC, and HQC) in table 2, it can be concluded that the optimum lag length is selected the lag 1 delay 1. The determination of this optimum lag was in line with the results of Venus Khim and Liew studies that the HQC criteria were able to identify optimum lag lengths better than other criteria in either large samples or small samples (T <120).[13]

**TABLE 2**. Lag Optimum

| Lag | FPE | AIC | SC | HQ |
|---|---|---|---|---|
| 0 | 9.000515 | 10.71091 | 10.76538 | 10.73301 |
| 1 | 7.618903* | 10.54424* | 10.76211* | 10.63262* |
| 2 | 7.772882 | 10.56414 | 10.94541 | 10.71881 |
| 3 | 7.818522 | 10.56975 | 11.11441 | 10.79070 |
| 4 | 8.374882 | 10.63803 | 11.34610 | 10.92527 |
| 5 | 8.697179 | 10.67507 | 11.54653 | 11.02859 |
| 6 | 8.706093 | 10.67503 | 11.70989 | 11.09484 |
| 7 | 8.818514 | 10.68640 | 11.88467 | 11.17249 |
| 8 | 8.682994 | 10.66899 | 12.03065 | 11.22136 |
| 9 | 8.854535 | 10.68609 | 12.21116 | 11.30475 |
| 10 | 9.609437 | 10.76485 | 12.45331 | 11.44979 |
| 11 | 9.042650 | 10.70031 | 12.55217 | 11.45154 |

## Significance Test of Threshold Existence

Testing the significance of the existence of the threshold is done by LR test where p-value is obtained from the simulation by resampling bootstrap with 1000 replication. P-value is the percentage of LR of resampling data greater than statistics test. Table 3 is the result of testing the significance of the existence of threshold.

**TABLE 3**. Significance of Threshold

| **Regimes** | **Significant Level** | **Critical Value** | **P-value** | **Decision** |
|---|---|---|---|---|
| **1 Vs 2** | 1% | 30.98230 | 0,000 | Tolak $H_0$ |
| | 5% | 29.29884 | | Tolak $H_0$ |
| | 10% | 2719451 | | Tolak $H_0$ |
| **1 Vs 3** | 1% | 6253824 | 0,000 | Tolak $H_0$ |
| | 5% | 56.37625 | | Tolak $H_0$ |
| | 10% | 62.53824 | | Tolak $H_0$ |

The test results on the threshold obtained a p-value value of 0.000 either on VAR testing with TVAR regime 1 or on VAR with TVAR regime 2 (Table 3). The results of this show that the threshold on the TVAR programmer is appropriate to do.

## Modeling TVAR

Research modeling TVAR for 2 regime and 3 regime (Tabel 4). The trimming value used as a limit on the search for threshold estimation is 0.15.

The threshold value ($\gamma$) that divides regimes 1 and 2 on TVAR with 2 regimes is 0.44. This value illustrates that is a pattern of inflationary relationships, exchange rate depreciation, and money supply growth that differ between conditions when inflation is less than equal to 0.44 and when inflation is more than 0.44. TVAR with 2 regime shows that no significant variables affect inflation 1 month ahead if inflation is less than equal to 0.44 (condition of regime 1). Whereas when the current inflation is more than 0.44 (regime condition 2), the money supply growth significantly affects inflation 1 month ahead.

**TABLE 4.** Estimation of Parameter Coefisien TVAR 2 and 3 Regimes

| Threshold/ Regimes | Variable | Constanta | $Y_{1(t-1)}$ | $Y_{2(t-1)}$ | $Y_{3(t-1)}$ |
|---|---|---|---|---|---|
| 1/1 | $Y_1$ | 0.2143 | 0.2609 | -0.0132 | 0.0846 |
| | $Y_2$ | -0.1393 | 1.4046 | -0.0183 | -0.0385 |
| | $Y_3$ | 1.3159*** | 1.6019* | 0.0342 | -0.2261 |
| 1/2 | $Y_1$ | 0.5736*** | 0.0822 | 0.0195 | 0.1556** |
| | $Y_2$ | -0.1355 | -0.2227 | 0.6811*** | 0.2752` |
| | $Y_3$ | 1.1092*** | -0.1970 | 0.1419* | -0.1855* |
| 2/1 | $Y_1$ | 0.2143` | 0.2609 | -0.0132 | 0.0846 |
| | $Y_2$ | -0.1393 | 1.4046 | -0.0183 | -0.0385 |
| | $Y_3$ | 1.3159*** | 1.6019* | 0.0342 | -0.2261 |
| 2/2 | $Y_1$ | 0.2449 | 0.4324 | 0.0202 | 0.2529** |
| | $Y_2$ | 1.2975 | -1.5586 | 0.6017*** | -0.2415 |
| | $Y_3$ | 1.5919 | -0.6733 | -0.0116 | -0.0504 |
| 2/3 | $Y_1$ | 0.6541*** | 0.0692 | -0.0157 | 0.1116` |
| | $Y_2$ | -0.5502 | -0.1656 | 1.0324*** | 0.5129** |
| | $Y_3$ | 0.62009` | -0.0216 | 0.3539** | -0.2442* |

## Comparison of VAR Model, TVAR 2 Regime, and TVAR 3 Regime

The γ values that divide the 1, 2, and 3 regimes on the TVAR 3 regime are 0.44 and 0.86. This value illustrates that there is a pattern of inflationary relationships, exchange rate depreciation, and money supply growth that differ between conditions when inflation is less than 0.44, more than 0.44 and less than equal to 0.86, and more than 0.86. If inflation is less than equal to 0.44 (regime condition 1), nothing significantly affects inflation 1 month ahead. If there is inflation with a value greater than 0.44 and less than equal to 0.86 (regime condition 2), only the growth of money supply alone significantly affects inflation in the next 1 month. If there is inflation of more than 0.86 (regime condition 3), the inflation will significantly boost inflation in the next 1 month.

**TABLE 5.** Estimation Coeficient VAR

| Equation | *Coefficient* | | *p-value* |
|---|---|---|---|
| $Y_{1t}$ (Inflation) | $Y_{1.11}$ | 0.219 | 0.0020 |
| | $Y_{2.11}$ | 0.006 | 0.7738 |
| | $Y_{3.11}$ | 0.140 | 0.0008 |
| | C | 0322 | 0.0001 |
| $Y_{2t}$ (exchange rate depreciation) | $Y_{1.11}$ | -0.184 | 0.4677 |
| | $Y_{2.11}$ | 0.202 | 0.0072 |
| | $Y_{3.11}$ | 0.316 | 0.0349 |
| | C | -0.062 | 0.8344 |
| $Y_{3t}$ (growth of money supply) | $Y_{1.11}$ | -0.268 | 0.0419 |
| | $Y_{2.11}$ | 0.068 | 0.0807 |
| | $Y_{3.11}$ | -0.162 | 0.0368 |
| | C | 1.318 | $4.13 \times 10^{-15}$ |

After the estimation of VAR coefficient parameters, followed by multivariate normality test and white noiseIf the result of d-d plot shows that more than 50 percent of the value $d_i^2 \leq \chi^2_{n;0,05}$ , in residual model has multivariate normal distribution. The white noise assumption is to create a Vector Autoregressive Moving Average (VARMA) model of the residual to be tested. If the smallest AIC value is generated from the VARMA model with the order (0,0) then it can be said that the residual has fulfilled the white noise assumption. Normal multivariate test results and white noise for residuals for the VAR model, TVAR 2 Regime, TVAR 3 Regime, and VAR concluded were met.

After forming the three models and testing the residual assumptions for the three models, the next step is to compare the model to determine the model to analyze the relationship between inflation, exchange rate depreciation, and money supply growth. Table 6 is the comparison of the goodness of the model.

**TABLE 6.** Criteria The Model

| Model | AIC | MSE |
|---|---|---|
| VAR | 439.396 | 4.0111 |
| TVAR 1 | 412.2343 | 3.8322 |
| TVAR 2 | 415.4421 | 4.240 |

Based on the best model selection results with AIC and MSE methods, the best model for reporting TVAR with 2 Regimes. TVAR model with 2 Regimes.

$$\widehat{Y_{1t}} = \begin{cases} 0{,}2143. + 0{,}2609\, Y_{1,t-1} - 0{,}0132 Y_{2,t-1} + 0{,}0846 Y_{3,t-1} & ; Y_{1t-1} \leq 0{,}44 \\ 0{,}5736^{***} + 0{,}0822\, Y_{1,t-1} + 0{,}0195 Y_{2,t-1} + 0{,}1556^{**} Y_{3,t-1} & ; Y_{1t-1} > 0{,}44 \end{cases} \quad \text{...(19)}$$

$$\widehat{Y_{2t}} = \begin{cases} -0{,}1393 + 1{,}4046\, Y_{1,t-1} - 0{,}0183 Y_{2,t-1} - 0{,}0385 Y_{3,t-1} & ; Y_{1t-1} \leq 0{,}44 \\ -0{,}1355 - 0{,}2227\, Y_{1,t-1} + 0{,}6811^{***} Y_{2,t-1} + 0{,}2752. Y_{3,t-1} & ; Y_{1t-1} > 0{,}44 \end{cases} \quad \text{...(20)}$$

$$\widehat{Y_{3t}} = \begin{cases} 1{,}3159^{***} + 1{,}6019^{*} Y_{1,t-1} + 0{,}0342 Y_{2,t-1} - 0{,}2261 Y_{3,t-1} & ; Y_{1t-1} \leq 0{,}44 \\ 1{,}1092^{***} - 0{,}1970\, Y_{1,t-1} + 0.1419^{*}\, Y_{2,t-1} - 0{,}1855 Y_{3,t-1} & ; Y_{1t-1} > 0{,}44 \end{cases} \quad \text{...(21)}$$

. significant at α =0,1
** significant at α =0,01
* significant at α =0,05
*** significant at α=0,001

The regime 2 this is also a significant percentage of depreciation affect the growth of money in circulation with a positive direction. When an increase in the percentage of the exchange rate resulted in weak economic growth to spur the economy one of them is by increasing the money supply.

## CONCLUSION

The results of this study show that the relationship between inflation, the percentage of depreciation, and the growth of money supply are different for each regime. Model TVAR 2 Regime is better than VAR and TVAR 3 Regime in modeling inflation with predictor variable of exchange rate depreciation and growth of money supply.

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## APPENDIX

### Appendix 1. Stationery Test Using Phillips-Perron Methode

| Variabel | *p-value* | Kesimpulan |
|---|---|---|
| Inflasi (%) | 0,000 | Stasioner |
| Depresiasi Nilai Tukar (%) | 0,000 | Stasioner |
| Pertumbuhan Uang Beredar | 0,000 | Stasioner |

### Appendix 2. Stability Test