Estimation of Inflation Threshold of Indonesia and Its Effect on Economic Growth Periode 1981-2019

M S Manurung [1], **A F Yuniasih**[2]

[1] Student, Politeknik Statistika STIS, East Jakarta
[2] Lecturer, Politeknik Statistika STIS, East Jakarta

*Corresponding author's email: 211709841@stis.ac.id

Abstract. Sustainable economic growth with a low and stable inflation rate is one of the goals of macroeconomic policy in improving people's welfare. High inflation can be detrimental to economic growth in the medium and long term while a certain level of inflation is also needed to move the economy. Therefore, the question arises about the level of inflation that does not have a negative impact on economic growth. This study aims to estimate the inflation threshold level and identify its effect on Indonesia's economic growth 1981-2019. The research begins by determining the best model among the models that regress inflation on economic growth with quadratic regression, Hansen's threshold regression (2000), and Mubarik's threshold regression (2005). The best model is the Mubarik threshold regression model (2005) with an inflation threshold of 6.85 percent. Mubarik's (2005) threshold regression analysis was reused in the model involving the FDI variable, the inflation threshold was 7.11 percent, and FDI had a positive effect. Inflation below the inflation threshold encourages economic growth, while inflation above the inflation threshold is detrimental to economic growth. The result of the estimated threshold level is higher than the inflation target by BI, so that inflation targeting can be increased.

1. Introduction

Indonesia is a developing country with the object of macroeconomic policy to achieve sustainable economic growth with a low and stable inflation rate. For this reason, an understanding of the relationship between economic growth and inflation are something that get attention due to its relevance in it. Inflation and economic growth are also key indicators in policy making because both have the ability to reflect the state of an economy [1]. The economic growth to be achieved in the macroeconomic policy objectives is sustainable economic growth. It can be achieved by maintaining macroeconomic stability. One of the efforts to maintain macroeconomic stability can be done through controlling the inflation rate. Low and stable inflation are a prerequisite for sustainable and mutually beneficial to economic growth in improving people's welfare. Each country generally has a main macroeconomic policy, namely high and sustainable economic growth with a low and stable inflation rate [1][2][3]. High inflation rates can harm economic growth in the medium and long term [4][5]. However, inflation also can be maintained at a certain level to encourage economic development [6][7]. This implies that a certain level of inflation is still needed to lubricate and move the wheels of the economy [8].

The next question arises as to what kind of relationship exists between inflation and economic growth or how low is the inflation rate so that it is no longer detrimental to economic growth. To answer this question, identification of the relationship between inflation and economic growth and estimating the inflation threshold has been found. Recent studies related to identifying the relationship between

inflation and economic growth are dominated by a nonlinear approach, but there is still debate about the level of the inflation threshold in the relationship between the two indicators. This is because the conclusion of the relationship between the two indicators and the resulting inflation threshold level will depend on the methods and data used [3][9]. Based on related research, apart from inflation, the process of estimating inflation threshold level and identifying its effect on economic growth will be continued by including Foreign Direct Investment (FDI) as well as an independent variable in the model. FDI is a source of foreign funding that can increase economic growth. FDI plays an important role as one of the factors that contribute to the economic stability of developing countries [18]. In addition, countries with stable economic conditions are one of the factors that attract foreign investors. Countries with stable economic conditions can reduce investment uncertainty or increase investment confidence [19].

In addition, it will also depend on the characteristics of the region in question. So, this study will use several different methods. The analytical methods used are quadratic regression, Hansen threshold regression (2000), and Mubarik threshold regression (2005) [10][11]. Lin & Ye states that the estimation of the inflation threshold level can be obtained accurately if the research is carried out specifically in certain countries [6]. The debate about the appropriateness of the relationship between these two indicators is still open, so there is no consensus regarding the relationship between the two, both empirically and theoretically [2]. Thus, the purpose of this study is to estimate the inflation threshold level and to identify its effect on economic growth in Indonesia with or without including the Foreign Direct Investment (FDI) 1981-2019.

2. Literature Review

Economic growth is an indicator that used to measure the development of economic performance in a region over a certain period of time. While inflation is a tendency to increase the price level of general goods and services continuously. Theoretically, the relationship between inflation and economic growth yields various conclusions [9]. Endogenous growth theory explains that the relationship between inflation and economic growth is negative. Meanwhile, there is Keynesian theory through the interaction of the Aggregate Demand-Aggregate Supply (AD-AS) model which explains that the impact of inflation on economic growth is positive in the short term and negative in the long term. The positive relationship between the two indicators in the short term can be explained through the Phillips Curve. However, this theory is not able to explain the occurrence of the phenomenon of stagflation. Then, there is the monetary theory which explains that in the long run inflation does not affect economic growth. In addition to the theories above, there is another theory, namely the neoclassical growth theory which links the relationship between the two indicators with other variables, such as capital, money growth, and consumer behavior. Contrary to previous theories that explain the linear relationship between inflation and economic growth, Fischer in 1993 found that there is a nonlinear relationship between inflation and economic growth or the identification of a threshold for inflation. The relationship between the two will be positive or insignificant before passing a certain threshold (low inflation rate) and negative impact after passing that threshold (high inflation rate). Thus, the theoretical descriptions show that there is no single conclusion in describing the relationship between inflation and economic growth.

Not only from the theoretical side, the empirical side also shows the same thing, namely the various conclusions regarding the relationship between inflation and economic growth. Empirical evidence to identify the relationship between inflation and economic growth has been carried out by many researchers from various countries. The results of the empirical research can be categorized into four possible outcomes in research [12]. First, inflation does not affect economic growth found in Dorrance's 1963 study. Second, there is a positive relationship between inflation and economic growth found in Shi's 1999 study. Third, inflation has a negative effect on economic growth found in Andres & Hernando's 1997 study. The fourth category, the relationship between inflation and economic growth is nonlinear which was found in Fischer's 1993 research. The conclusions of this nonlinear approach will also vary because it depends on the data and methodology used and the characteristics of the region concerned [13]. This makes the relationship between inflation and economic growth even more interesting to study [6].

3. Data and Methodology

3.1. Data

This study uses time-series data for the period 1981-2019. The process of estimating the inflation threshold level and identifying its effect on economic growth begins by comparing and determining the best model among models that regress inflation on economic growth (bivariate model). The analytical method used is quadratic regression, Hansen threshold regression (2000), and Mubarik threshold regression (2005). Furthermore, it includes Foreign Direct Investment (FDI) as an independent variable in the model. The model will use a similar analysis on the best model among the previously formed bivariate models.

Table 1. Data and source of data

Data	Source
Real Gross Domestic Product (GDP)	Badan Pusat Statistik
Consumer Price Index (CPI)	Badan Pusat Statistik
Foreign Direct Investment (FDI)	UNCTAD

3.2. Model

Formation of the Inflation Regression Model on Economic Growth (Bivariate Model) using three different analytical techniques.

(a) Quadratic Model

$$PE_t = \beta_1 + \beta_2 \pi_t + \beta_3 \pi_t^2 + \varepsilon_t \quad (1)$$

PE_t : Economic growth year t
π_t : Inflation first degree year to t
π_t^2 : Inflation second degree year to t
β_1 : Intercept
β_2 : Coefficient of Inflation first degree
β_3 : Coefficient of Inflation second degree
ε_t : Error term
t : t = 1981,1982, …, 2019

β_2 in non-negative number whilw β_3 in negative number so equation (1) has maximum value. The derivation of the quadratic equation (1) is done to obtain the threshold level or the optimum point of inflation. The formula for obtaining the threshold level is as follows:

$$k = \frac{-\beta_2}{2\beta_3} \quad (2)$$

k : Threshold inflation
β_2 : Coefficient of Inflation first degree
β_3 : Coefficient of Inflation second degree

(b) Threshold Model by Hansen (2000)

$$PE_t = \beta_{11} + \beta_{12}\pi_t I(\pi_t \le k) + \beta_{21} + \beta_{22}\pi_t I(\pi_t > k) + \varepsilon_t \quad (3)$$

PE_t : Economic growth year t
β_{11} : Intercept below inflation threshold level
β_{12} : Inflation coefficient below the inflation threshold level
π_t : Threshold inflation year t
β_{21} : Intercept above inflation threshold level
β_{22} : Inflation coefficient above the inflation threshold level

ε_t : Error term
I( ) : Indicator function
k : Threshold inflation
t : t = 1981,1982, …, 2019

In this study, the value of the inflation threshold or k is not yet known, so the estimation of the above model will use conditional least squares. The procedure is to estimate every possible threshold level k using the Ordinary Least Square (OLS) technique. Each model of the estimated k will produce a Residual Sum of Squares (RSS). Then, the selected threshold level k is the threshold level k that minimizes RSS [11].

(c) Threhold Model by Mubarik (2005)

$$PE_t = \beta_1 + \beta_2(\pi_t) + \beta_3 * D_t(\pi_t - k) + \varepsilon_t \quad (4)$$

PE_t : Economic growth year t
π_t : Inflation year t
β_2 : Inflation coefficient below the inflation threshold level
$\beta_2 + \beta_3$: Inflation coefficient above the inflation threshold level
ε_t : Error term
D_t : Dummy variable
k : Threshold inflation
t : t = 1981,1982, …, 2019

Similar to the estimation technique in the threshold method also uses the conditional least squares technique. The principle is to determine the threshold level of inflation k is k which minimizes RSS [10].

4. Empirical Result

4.1. Inflation

Figure 1 shows that the movement of inflation in Indonesia is quite volatile. In that period, the highest inflation ever occurred in Indonesia was 77.63 percent in 1998. Meanwhile, the lowest inflation was 2.01 percent in 1999. In 1998, the year Indonesia experienced the monetary crisis, there was a spike in the inflation rate from 11. 05 percent to 77.63 percent. Then, Inflation declined sharply in 1999 to 2.01 percent. In 2008 there was an increase in the inflation rate to 11.06 percent due to the world financial crisis.

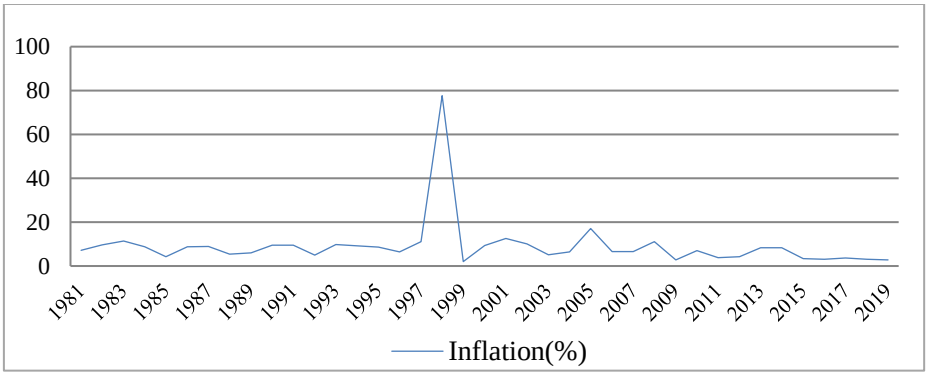

Figure 1. Inflation developments (2012 CPI=100) Indonesia 1981-2019.

4.2. Economic growth

Figure 2 shows that the movement of Indonesia's economic growth tends to fluctuate with an average growth of 5.04 percent. During that period, the highest economic growth was 8.23 percent in 1995, while

the lowest economic growth fell by -13.13 percent in 1998 as a result of the Asian financial crisis which brought Indonesia to a slump in economic growth.

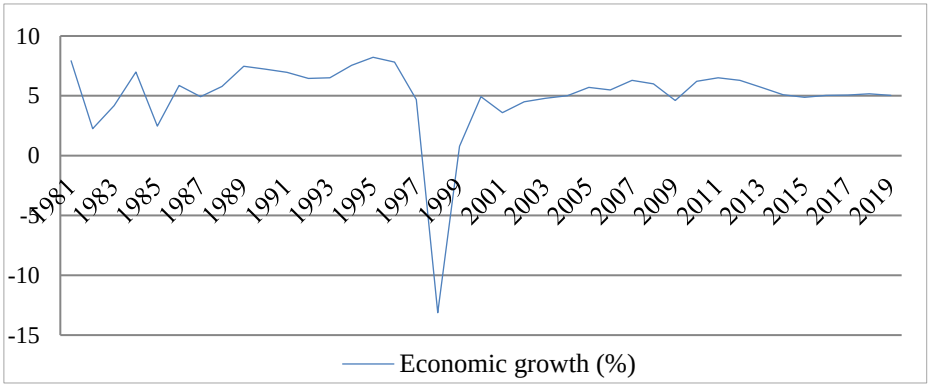

Figure 2. The development of Indonesia's economic growth 1981-2019.

4.3. Foreign Direct Investment

Figure 3 shows that the movement of FDI in Indonesia for the 1981-2019 period fluctuated by an average of 13.11 percent. The highest FDI occurred in the 1998 Indonesian monetary crisis, which was 28.12 percent, which was a sharp increase from 1997. This was due to the impact of the depreciation of the rupiah against foreign currencies.

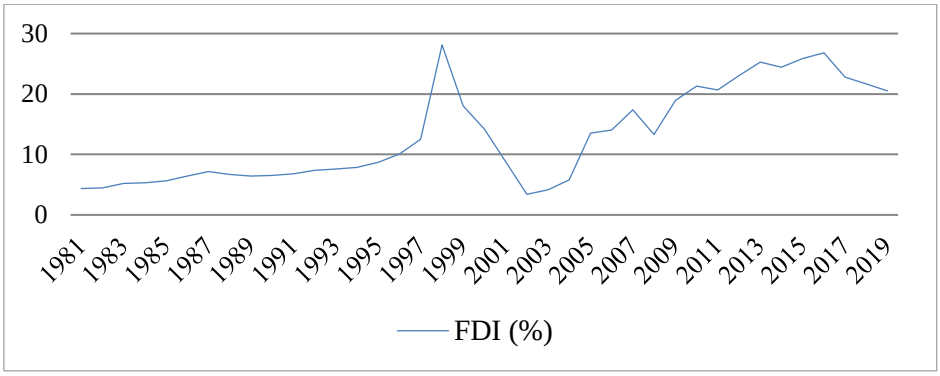

Figure 3. Percentage of FDI to Indonesia's GDP 1981-2019.

The initial stage is to sort the value of the independent variable, namely inflation starting from the smallest value to the largest value. The sorted data is divided into several groups. This grouping will depend on the researcher. The next step is to calculate the average of the inflation and economic growth variables in each formed group. The results of these stages can be shown in Table 2.

Table 2. Inflation and Economic Growth

Number	Range	Observation	Average of inflation	Average of economic growth
1.	$0 \leq \pi < 3$	3	2.50	3.48
2.	$3 \leq \pi < 5$	8	3.81	5.16
3.	$5 \leq \pi < 7$	8	6.19	6.12
4.	$7 \leq \pi < 9$	7	8.43	6.36
5.	$9 \leq \pi < 11$	7	9.59	5.70
6.	$11 \leq \pi < 13$	4	11.53	4.64
7.	$\pi \geq 13$	2	47.37	-3.72

π : Inflation

Based on the grouping of Indonesia's historical data between inflation and economic growth variables in Table 2, as an early indication, identifying the nature or pattern of the relationship between inflation and economic growth can be done by plotting the values of these two (Mubarik, 2005). The result of Table 2 can be shown that there is no conclusion that a low inflation rate will be associated with a high growth rate or vice versa. This is an indication of a nonlinear relationship between economic growth and inflation, namely the relationship between the two indicators in the figure can be positively and negatively related. However, this requires further empirical evidence. If it is proven to have a nonlinear relationship empirically, then the research is continued by identifying the inflation threshold.

Stationarity test

Model analysis using time series data can be done if it fulfills the assumption of stationarity. Testing the stationarity assumption in this study using Augmented Dicky-Fuller (ADF).

Table 3. Results of stationarity test.

Variable	level I(0)		Diff pertama I(1)	
	P-value	Kesimpulan	*P-value*	Kesimpulan
LOG(PDB)	0.4586	Not stationer	0.0031	Stationer
LOG(IHK)	0.9442	Not stationer	0.0000	Stationer
FDI	0.1944	Not stationer	0.0000	Stationer

Bivariate Model Comparison

Based on the measure of the goodness of the model as shown in Table 4, among the three bivariate models, this study will use the Mubarik (2005) threshold regression model. This is because the model generated by Mubarik's (2005) threshold regression has Adj. The largest R-squared is also RSS, AIC, SIC, and HQ with the smallest value among the three models.

Table 4. Rresult of bivariate model comparison.

Goodness of fit	Quadratic	*Threshold* Hansen (2000)	*Threshold* Mubarik (2005)
R-squared	0,83085	0,859357*	0,858907
Adjusted R-squared	0,821453	0,847302	0,851069*
Residual Sum of squares	76,11013	63,28327*	63,48558
Akaike Info Criterion	3,660343	3,530228	3,478974*
Schwarz Criterion	3,788309	3,700850	3,606941*
Hannan-Quin Criterion	3,706256	3,591446	3,524888*

*) Best indicator

The best bivariate model chosen is the model with the Mubarik Threshold Regression analysis (2005). Table 5 summary of Mubarik's (2005) threshold regression results can show that the estimated inflation threshold level generated by the model is 6.85 percent.

Table 5. Result of threshold Mubarik (2005).

Variable	Coefficient	t-statistic	*p-value*
D(LOG(IHK))**	0,610898	4,360203	0,0001
D(6.85)*(D(LOG(IHK))-6.85)**	-1,015001	-6,813047	0,0000
C**	2,412024	2,96591	0,0053
R-squared		0,858907	
Adjusted R-squared		0,851069	
Residual Sum of squares		63,48558	
Prob(F-statistic)		0,00000	

The model formed has fulfilled the assumptions of normality, heteroscedasticity, and autocorrelation. In this model, it can be shown that with a significance level of 5 percent, inflation below the threshold level has a positive effect on economic growth. This means that inflation with a level below 6.85 percent is conducive to economic growth. On the other hand, with a significance level of 5 percent, it can be stated that inflation above the inflation threshold level has a negative effect on economic growth. This means that inflation with a level above 6.85 percent will be detrimental to economic growth.

Table 6. Results of threshold Mubarik (2005) include FDI.

Variable	Coefficient	t-statistic	*p-value*
D(LOG(IHK))**	0,536264	4,291173	0,0001
D7.11*(D(LOG(IHK))-7.11)**	-0, 992701	-7,395571	0,0000
D(FDI)*	0,001627	2,404056	0,0216
C**	2,783621	3,736273	0,0007
R-squared		0,877467	
Adjusted R-squared		0,866964	
Residual Sum of squares		55,13449	
Prob(F-statistic)		0,000000	

The estimated threshold level increased compared to the bivariate model after involving the FDI variable. This indicates that the additional foreign capital into Indonesia will increase the inflation threshold. The changes in variables result in changes to the inflation threshold level [3]. Stable economic conditions can increase FDI into Indonesia. In which the inflation threshold level still has a positive impact on economic growth. The inflation threshold level of 7.11 percent can be categorized into a moderate inflation rate [14]. Meanwhile, low inflation with an annual inflation rate consisting of only single digit numbers [15]. After obtaining the estimated inflation threshold level, the next step is to identify the relationship of inflation above and below the estimated inflation threshold level to economic growth. Based on Table 6, with a significance level of 5 percent there is sufficient evidence to state that inflation with a level below the threshold level of 7.11 percent will encourage economic growth. Every one percent increase in the inflation rate below 7.11 percent will have a positive impact on economic growth of 0.54 percent. On the other hand, inflation with a level above the inflation threshold of 7.11 percent will have a negative impact on economic growth. For every one percent increase in the inflation rate above 7.11 percent, it will hurt economic growth by 0.45 percent.

Then, in addition to obtaining an estimate of the inflation threshold level and identifying its effect on economic growth both below and above the inflation threshold, the model can also identify the influence of another independent variable involved on economic growth, namely the Foreign Direct Investment (FDI) variable. FDI as a variable approach to investment has a positive effect on economic growth. This positive impact can be obtained because of the transfer of assets, introduction of production technology and managerial expertise to promote economic growth [19]. This is consistent with Solow's growth theory which states that capital accumulation and economic growth will be positively proportional [9][16].

5. Conclusion and Recommendation

The estimation of the threshold level in the best bivariate model, namely the Mubarik threshold regression model (2005) is 6.85 percent with inflation below the threshold level encouraging economic growth, while inflation above the threshold level is detrimental to economic growth After involving Foreign Direct Investment (FDI)) as part of the independent variable, the estimated threshold level of inflation is 7.11 percent with inflation below the threshold level beneficial to economic growth. On the other hand, inflation above the inflation threshold is detrimental to economic growth. In addition, FDI has a positive effect on economic growth. The estimation of the inflation threshold level increased after involving the FDI variable. Inflation above a certain level can be detrimental to economic growth, so Bank Indonesia plays a role in preventing Indonesia from experiencing such an adverse inflation rate through interest rate control. However, it is hoped that BI will not put too much pressure on the inflation

rate. In other words, keep giving room for inflation to move so as to obtain optimum economic growth. For further research, it is possible to identify the threshold level that gives results in more than two groups.

References

[1] C. J. Fei, S. S. Kun, and M. T. Ismail, "Threshold Effects of Inflation on Economic Growth: Evidence from Dynamic Panel Threshold Regression Analysis for 18 Developed Economies," *J. Manag. Econ. Ind. Organ.*, no. January, pp. 51–62, 2019, doi: 10.31039/jomeino.2019.3.1.4.

[2] H. Fakhri, "Relationship between inflation and economic growth in Azerbaijani economy: is there any threshold effect?," *Asian J. Bus. Manag. Sci.*, vol. 1, no. 1, pp. 1–11, 2011, [Online]. Available: https://mpra.ub.uni-muenchen.de/id/eprint/33494.

[3] M. Seleteng, M. Bittencourt, and R. Van Eyden, "Non-linearities in in fl ation – growth nexus in the SADC region : A panel smooth transition regression approach," *Econ. Model.*, vol. 30, pp. 149–156, 2013, doi: 10.1016/j.econmod.2012.09.028.

[4] A. Chowdhury and R. Ham, "Inflation targeting in indonesia: searching for a threshold ¤," vol. 54, no. 4, pp. 645–655, 2009.

[5] M. B. Celil Aydın, Omer Esen, "Inflation and Economic Growth A Dynamic Panel Threshold Analysis for Turkish Republics in Transition Process.pdf." .

[6] M. J. Rutayisire, "Threshold Effects in the Relationship between Inflation and Economic Growth : Evidence from Rwanda By," no. February, 2015.

[7] A. Phiri, "Nonlinear impact of inflation on economic growth in South Africa : a smooth transition regression analysis," vol. 10, no. 1, pp. 1–17, 2018.

[8] J. Temple, "Inflation and growth: Stories short and tall," *J. Econ. Surv.*, vol. 14, no. 4, pp. 395–426, 2000, doi: 10.1111/1467-6419.00116.

[9] A. López-villavicencio and V. Mignon, "On the impact of inflation on output growth : Does the level of inflation matter ?," vol. 33, pp. 455–464, 2011, doi: 10.1016/j.jmacro.2011.02.003.

[10] Y. Ali, "Inflation and Growth : An Estimate of the Threshold Level of Inflation in Pakistan By Yasir Ali Mubarik The Working Paper is Available at State Bank of Pakistan Website : www.sbp.org.pk State Bank of Pakistan Working Paper No . 8 , June 2005 Inflation and," *SBP Work. Pap. Ser. no.*, no. 8, 2005.

[11] B. E. Hansen, "Sample splitting and threshold estimation," *Econometrica*, vol. 68, no. 3, pp. 575–603, 2000, doi: 10.1111/1468-0262.00124.

[12] T. Vinayagathasan, "Journal of Asian Economics Inflation and economic growth : A dynamic panel threshold analysis for Asian economies," *J. Asian Econ.*, vol. 26, pp. 31–41, 2013, doi: 10.1016/j.asieco.2013.04.001.

[13] "Volume XIV Editorial Board Editor in Chief Executive Manager : Redactors," vol. XIV, no. 1, 2019, p.242.

[14] Sukirno, S. (2016). Makroekonomi Teori Pengantar Edisi Ketiga. Jakarta: Rajawali Pers.

[15] Samuelson, P. A., & Nordhaus, W. D. (2004). Ilmu Makro Economi Edisi Tujuh Belas. Jakarta: PT. Media Global Edukasi.

[16] S. D. Thanh, "Threshold Effects of Inflation on Growth in the ASEAN-5 Countries: A Panel Smooth Transition Regression Approach," *SSRN Electron. J.*, no. March 2014, 2014, doi: 10.2139/ssrn.2411931.

[17] A. Abdulrahman, A, Fawaz M, and, A. Riyad M. (2018). Foreign Direct Investment and Economic Stability: The Case of Arab Peninsula Advances in Social Science Research Journal - Vol. 5, No. 8

[18] A. M. Ruth and S. Syofyan. (2014). Faktor Penentu Foreign Direct Investment di ASEAN-7 Analisis Data Panel 2000-2012 Media Ekonomi, Vol. 22, No. 1, April

[19] M. Kholis. (2012). Dampak Foreign Direct Investment terhadap Pertumbuhan Ekonomi Indonesia (Studi Makroekonomi dengan Penerapan Data Panel). Jurnal Organisasi dan Manajemen. Vol. 8, No. 12, p.111-120.