The Effect of Crude Oil Prices on Inflation, Interest Rates and Economic Growth in Indonesia

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ABSTRACT

This study aims to examine the effect of crude oil prices on inflation, interest rates, and economic growth in Indonesia. The data used are quarterly time series data on crude oil, interest rates, inflation, and Indonesia's economic growth from the first quarter of year 2001 to the second quarter of year 2017. To test the effect, an autoregressive distributed lag (ARDL) equations system or a multivariate ARDL model is used. The results of data analysis reveal that (1) there are no long-run and short-run effects of crude oil prices on inflation, (2) there are long-run and short-run effects of crude oil prices to the interest rate. In the long run, every 1% increase in the price of crude oil, the interest rate drops 0,26%, and (3) there is no effect of crude oil prices on economic growth both in the short and long-run.

Keywords: Crude Oil Prices, Interest Rate, Inflation, Economic Growth, Autoregressive distributed lag model
JEL Classifications: E300, E310, E42, O440.

1. INTRODUCTION

Crude oil is a commodity that has quite high strategic value in the economy of a country. All sectors in the economy both directly and indirectly are closely related to the use of crude oil. Therefore, changes in crude oil prices can affect a nation's macroeconomic conditions. A rise in crude oil prices can directly affect a rise in prices which will ultimately affect inflation, interest rates, and economic growth.

The rise in crude oil prices affects inflation through production cost increase. Meanwhile, the crude oil prices rise can affect the interest rate through a rise in consumption expenditure due to the increased prices in general. The increase in consumption spending will reduce the level of savings which in turn will affect the formation of capital and ultimately affects the economic growth. The increased costs of production cause not only an increase in

prices, but also a decrease in company production and as a result the total output falls. The falling output can push up inflation and push down economic growth at the same time. Besides having a high strategic value in the economy, crude oil is a major commodity in derivative trade, namely as a reference asset (underfying assets). For this reason, changes in crude oil prices can affect all economic activities (Nazarian and Amiri, 2014; Adam, 2016).

Choi et al. (2018) in their study found that there was an asymmetric effect of oil prices on interest rates. The positive effect of oil prices was greater than its negative effect. Another study by Sen (1991) found that increases in fuel prices reduced current accounts and lowered interest rates. The similar effect of oil prices on the rates of interest was found by Lowinger and Wihlborg (1985). Their study revealed that the increase in oil prices had an effect on international interest rates. Meanwhile, Cologni and Manera (2008) found the existence of the effect of oil prices on inflation. They also found

that the inflation shock raises interest rates. Other studies with similar results are Reicher (2010) and Eryigi (2012). The former found that oil prices had a very strong effect on interest rates while the latter found the similar influence not only on interest rates but also on the market of share prices, and exchange rates.

Several studies also have investigated the impact of oil prices on inflation. Ahmed and Wadud (2011) for instance, found that the relationship between oil prices and inflation was negative. In line with this, Iwayemi and Fowowe (2011) and Roeger (2005) found that there was no association between oil prices and inflation. Conversely Adam et al. (2016) found that the dynamics of the effect of world crude oil prices on inflation were positive with multiplier effects of 0.33%.

Not only will lead to higher production costs, the rise in inflation due to the increased oil prices will also lead to higher consumption spending. The increased consumption spending makes the saving level decreased. According to Solow (1956), if more output is directed towards consumption, it will result in a small amount of investment. The more output consumed by community means the smaller the savings and capital formation so that economic growth becomes lower.

So far studies on the effect of oil prices on inflation, interest rates and economic growth have not been done by researchers in developing countries. Therefore, this study is important to carry out to augment the treasury of research results related to the effect of crude oil prices on inflation, interest rates, and economic growth.

The only study looking into the influence of the oil prices on economic growth in Southeast Sulawesi Province, Indonesia was the one conducted by Saidi et al. (2019). However, Southeast Sulawesi Province is a small part of the Indonesian territory, so the variable of economic growth is disaggregated. Meanwhile, in this study, economic growth is aggregate. The current study is intended to look into the effect of crude oil prices on inflation, interest rates and economic growth in Indonesia using quarterly time series data over the period of 2001Q1 to 2017Q2. For the purpose of analysis, the study uses a multivariate autoregressive distributed lag (ARDL) model.

2. LITERATURE REVIEW

Changes in crude oil prices not only affect interest rates, inflation, and economic growth, but also affect poverty rates. Chitiga et al. (2012) for instance, who examined the effect of oil prices on poverty levels in South Africa and they found that oil prices positively affected poverty levels. Another study was carried out by Oluwatayo and Alagbe (2015) to investigate the effect of oil fuel prices on poverty levels in Nigeria. They similarly found that the increase in fuel prices raised the level of poverty. The results of the influence test using the ARDL model revealed that there was a short-term effect of oil fuel prices on poverty levels. Meanwhile, in the long run, there was an influence of unemployment on poverty levels (Muthalib et al., 2018).

A number of studies on the relationships between the price of oil and interest rates have been conducted. Malhotra and Krishna

(2015) found that there was no association between oil prices and interest rates. On the contrary, Khan and Ahmed (2014), Kneeshaw and Bergh (1985) found that there was an association between oil prices and interest rates. They further found that oil prices not only affect inflation but can also affect other macroeconomic variables especially inflation and output. Meanwhile, Cunado and De-Gracia (2005) found a permanent effect of oil prices on inflation in the short-run and asymmetric effects of oil prices on production index. Another study of Cunado and De-Gracia (2005) conducted research for such Asian countries as Japan, Malaysia, Thailand, Singapore, South Korea, and the Philippines for the period 1975Q1-2002Q2. They revealed that in the long-run there was an effect of oil prices on inflation while in the short-run the effect of oil prices was limited.

Furthermore, Masih et al. (2011) looked into the relationship between oil price movements and economic activities. They found that there was a connection between oil prices and economic activites. Another study by Oladosu et al. (2018) found that the oil prices have impact on gross domestic product (GDP).

An increase in the price of oil can increase production costs so companies must raise prices to cover an increased cost of production. The increased production costs can cause a decrease in output so that it can affect production. Naranpanawa and Bandara (2012) and Reyes et al. (2009) found that an increase in fuel prices affected economic growth and poverty level.

3. DATA AND METHODOLOGY

3.1. Data
The data used in this study are the data on crude oil prices (in USD per barrel), interest rates (in %), consumer price indices and GDP. For the price of crude oil, that of Dubai crude oil is chosen because Indonesia had imported a lot of this raw extract. Consumer price index is used as a proxy for inflation, while GDP is used as a proxy for economic growth. The data on crude oil price, consumer price index and GDP are quarterly data over the period of 2000Q1 to 2017Q2. The data are taken from Bank St. Louis, United States.

3.2. Methodology
To test the effect of oil prices on inflation, interest rates and Indonesia's economic growth, this study uses the ARDL model proposed by Heij et al. (2004) and Pesaran and Shin (1999). Because there are three dependent variables comprising inflation, interest rates, and economic growth, and there is one independent variable, namely the price of crude oil, then to check the effect, the multivariate ARDL model was used which consists of three equations is used as follows:

$$INF_t = C_1 + \sum_{i=1}^{p_1} \alpha_{1i} INF_{t-i} + \sum_{i=0}^{q_1} \beta_{1i} OIL_{t-i} + \varepsilon_{1t} \qquad (1)$$

$$INR_t = C_2 + \sum_{i=1}^{p_2} \alpha_{2i} INR_{t-i} + \sum_{i=0}^{q_2} \beta_{2i} OIL_{t-i} + \varepsilon_{2t} \qquad (2)$$

$$EGR_t = C_3 + \sum_{i=1}^{p_3} \alpha_{3i} EGR_{t-i} + \sum_{i=0}^{q_3} \beta_{2i} OIL_{t-i} + \varepsilon_{3t} \qquad (3)$$

The OIL symbol represents crude oil prices, the INF symbol represents inflation, the INR symbol represents the interest rate, and the EGR symbol represents economic growth. Furthermore, ε_{it} (i=1, 2, 3) are errors, while C, α and β are regression equation parameters.

The models of (1), (2) and (3) above can be changed to form the following equations

$$D(INF_t) = \beta_{10}D(OIL_t) + \delta_1 Res1_{(t-1)} + \sum_{i=1}^{p_1-1}\alpha_{1i}D(INF_{t-i}) +$$

$$\sum_{i=1}^{q_1-1}\beta_{1i}D(OIL_{t-i}) + \varepsilon_{1t} \quad (4)$$

$$D(INR_t) = \beta_{20}D(OIL_t) + \delta_2 Res2_{(t-1)} + \sum_{i=1}^{p_2-1}\alpha_{2i}D(INR_{t-i}) +$$

$$\sum_{i=0}^{q_2-1}\beta_{2i}D(OIL_{t-i}) + \varepsilon_{2t} \quad (5)$$

$$D(EGR_t) = \beta_{30}D(OIL_t) + \delta_3 Res3_{(t-1)} + \sum_{i=1}^{p_3-1}\alpha_{3i}D(EGR_{t-i}) +$$

$$\sum_{i=1}^{q_3-1}\beta_{2i}D(OIL_{t-i}) + \varepsilon_{3t} \quad (6)$$

Where D(OIL) denotes the first difference form of OIL. The equations (4), (5) and (6) are called error correction models. The parameters δ_i (i=1,2,3) in the equations (4), (5) and (6) are omitted in the subsection result, if the variables in the equation are not cointegrated, so it would be the ARDL equation in the first difference. The *Res* variable is the error correction variable (residual variable) where equations (7), (8) and (9)

$$Res1_{(t-1)} = INF_{t-1} - \frac{C_1}{1-\sum_{i=1}^{p_1}\alpha_{1i}} - \frac{\sum_{i=1}^{q_1-1}\beta_{1i}}{1-\sum_{i=1}^{p_1}\alpha_{1i}}OIL_{t-1} \quad (7)$$

$$Res2_{(t-1)} = INR_{t-1} - \frac{C_2}{1-\sum_{i=1}^{p_2}\alpha_{2i}} - \frac{\sum_{i=1}^{q_2-1}\beta_{2i}}{1-\sum_{i=1}^{p_1}\alpha_{2i}}OIL_{t-1} \quad (8)$$

$$Res3_{(t-1)} = EGR_{t-1} - \frac{C_3}{1-\sum_{i=1}^{p_3}\alpha_{3i}} - \frac{\sum_{i=1}^{q_3-1}\beta_{3i}}{1-\sum_{i=1}^{p_1}\alpha_{3i}}OIL_{t-1} \quad (9)$$

are the long-run equations with a long-run multiplier of crude oil prices against INF (inflation), INR (interest rates), and EGR (economic growth) consecutively $\frac{\sum_{i=1}^{q_1-1}\beta_{1i}}{1-\sum_{i=1}^{p_1}\alpha_{1i}}\%,, \dots \frac{\sum_{i=1}^{q_2-1}\beta_{2i}}{1-\sum_{i=1}^{p_1}\alpha_{2i}}\%$

and $\frac{\sum_{i=1}^{q_3-1}\beta_{3i}}{1-\sum_{i=1}^{p_1}\alpha_{3i}}\%$

To test the effect of crude oil prices on inflation, interest rates and economic growth in Indonesia, the researchers went through three steps: (1) testing stationary time series, (2) testing cointegration, and (3) estimating parameters of ARDL equations in (4), (5) and (6). These steps will be explained as follows.

The first step was the stationary test. The stationary test used was the Augmented Dickey-Fuller (ADF) stationary test developed by Dickey and Fuller (1979). For comparison, the researchers also used the Philip Perron (PP) test which was developed by Phillips and Perron (1988). The null hypothesis of these two tests is H_0: time series is not stationary versus alternative hypothesis H_0: time series is stationary.

The second step was cointegration test. The cointegration test between variables is only done if one or both of the time series (variables) in the models (1), (2) and (3) are stationary at the first difference. The cointegration test used was the Engle-Granger cointegration test. This test was conducted in the following stages: (1) estimating the regression between INF and OIL with residual Res1, between INR and OIL with residual Res2, and between EGR and OIL with residual Res3 and; (2) testing the stationarity of Res1, Res2, and Res3 with the ADF test. If the test results show that the residuals are stationary at the level, then it is said that the two time series are cointegrated.

The third step was to estimate the parameters of the models (4), (5), and (6) using the multivariate ordinary least square (OLS) method. This method assumes that errors ε_{1t}, ε_{2t} and ε_{3t} are dependent on each other or autocorrelated (IHS, 2017). The dependent test used was the Portmanteau mulativariate test. (Lutkepohl, 2004). In this sort of test, if there is a long-run effect, then checking the stability of the long-run coefficients of the ARDL model is conducted by using the CUSUM test and the CUSUM Square test proposed by Brown et al. (1975).

4. FINDINGS AND DISCUSSION

4.1. Findings
Stationary tests were the first step taken. The results of the ADF test and the PP test are summarized in Table 1. The 4 time series of inflation, interest rates, economic growth, and crude oil price oil prices are stasionary at first difference or integrated of order one, I (1).

The second step was to test the cointegration between crude oil prices and inflation, between oil prices and interest rates, and between crude oil prices and economic growth. The cointegration test results can be seen in Table 2. Based on the p-value of the tau-statistics, it is concluded that crude oil prices and interest rates are cointegrated. Meanwhile crude oil prices and inflation as well

Table 1: Stationary test results

Variable	ADF test statistic		Phillips-perron test statistic	
	Constant	Constant and trend	Constant	Constant and trend
INF	−2.9284	−1.1482	−2.9868	−1.1432
D (INF)	−7.1427*	−7.9707*	−7.1399*	−7.9695*
INR	−2.2891	−3.5834	−2.0332	−2.5461
D (INR)	−4.9015*	−4.8718*	−3.6311*	−3.6038**
EGR	0.7867	−3.1999	0.9973	−3.1549
D (EGR)	−10.3742*	−10.2769*	−10.3387*	−10.2648*
OIL	−1.6463	−1.1805	−1.6716	−1.2359
D (OIL)	−6.8614*	−6.8614*	−6.7409	−6.8611

*,**,***Mean significant at significance level 1%, 5%, 10% respectively.
ADF: Augmented dickey-fuller

as crude oil prices and economic growth are not cointegrated. Thus, the prices of crude oil and interest rates have a long-run relationship. By contrast, neither crude oil prices and inflation nor crude oil prices and economic growth have not long-run relationship.

The third step was estimating the parameters of the regression equations (4), (5) and (6). Based on the results of time lag evaluation results, the estimated ARDL models consist of (1) the ARDL model of the one-way relationship from crude oil prices to inflation is the ARDL (0.0) in the first difference, or simple regression model, (2) the ARDL model of the one-way relationship from crude oil prices to interest rate is the ARDL(3,1) error correction model and written ARDL-ECM(3,1), and (3) a one-way relationship model from oil prices to economic growth is the ARDL model (1,0). The estimation results are summarized in Table 3 in panels A, B and C.

In the Table 4, the Panel A shows that there is no short-run effect of crude oil prices on inflation. The results of the cointegration test also show that in the long run, crude oil prices do not affect inflation. Conversely, the Panel B of Table 4 shows that there are

long-run and short-run effects of crude oil prices on interest rates. In the long run, for every 1% increase in crude oil prices, interest rate drops by 0.26%. Furthermore, in the Panel C of the Table 4 shows that there is no significant effect of crude oil prices on economic growth. Meanwhile, the results of the cointegration test found that in the long run, crude oil prices do not has influence on economic growth.

The ARDL(0,0), ARDL-ECM (3,1) and ARDL (1,0) models are valid ones as they correspond to the P-value statistics of the Breusch-Godfrey serial correlation LM test statistics which is >5%. Or in other words, the residuals of the ARDL models do not have autocorrelation (Bahmani-Oskooee and Aftab, 2017). Furthermore, based on the CUSUM tests and CUSUM square test, the ARDL model coefficients of the long-run relationship between crude oil prices and interest rates are stable as shown in the Figure 1.

Furthemore, the finding of this study report on multivariate ARDL error requirement $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t})'$. In accordance with the results of the multivariate autocorrelation test with the Portmanteau test, error ε_t has autocorrelation. It means that the use of multivariate OLS method is valid. The results of multivariate Pormanteau autocorrelation test are given in the Table 3.

4.2. Discussion

The analysis results show that there are no short-run and long-run effects of oil prices on inflation. The results of this study are in line with the results of research conducted by Iwayemi and Fowowe (2011), and Roeger (2005) who found that there was no connection between oil prices and inflation. If the rise in oil prices significantly affects the cost of production, the rise in prices will affect inflation. On the contrary, if the rise in oil prices does not affect the rise in production costs, the rise in oil prices does not affect inflation. The empirical facts show that the increase in oil prices during the period 2001Q1-2017Q2 has no significant effect on the production costs. Therefore, the increase in oil prices has no impact on inflation.

Table 2: Engle-granger cointegration test

Dependent variables	Independent variables	Residual variables	ADF Test	
			Tau-statistics	P-value
INF	OIL	Res1	−2.7155	0.5757
INR	OIL	Res2	−4.3043	0.0456
EGR	OIL	Res3	−2.3591	0.7439

ADF: Augmented dickey-fuller

Table 3: Portmanteau autocorrelation test

Lag	Q-statistic	P-value
1	22.7100	0.0069
2	30.0237	0.0372
3	43.5254	0.0231
4	52.8301	0.0348
5	57.4295	0.1012

Table 4: Estimation results of the multivariate ARDL using multivariate OLS

Independent variables	Dependen and constant variables	Coefficient	t-Statistics
Panel A: ARDL (0,0) Model			
D (INF)	D (OIL)	0.0008	0.0457
	Breusch-Godfrey Serial Correlation LM Test:	0.7730	
Panel B: ARDL-ECM (3,1) Model Short-run effect			
D (INR)	D (INR(-1))	1.0409	9.0151*
	D (INR(-2))	-0.3792	-2.5037**
	D (INR(-3))	0.1815	1.5312
	D (OIL)	-0.1091	-2.4822**
	D (OIL(-1))	0.1555	3.6880*
	Res2(-1)	-0.1080	-2.7110*
Long-run effect			
INR	C	-0.2593**	-1.8801
	OIL	3.1590**	5.5641
	Breusch-Godfrey Serial Correlation LM Test:	0.1058	
Panel C: ARDL l (1,0) Model			
D (EGR)	D (RGR(-1))	0.8456	12.9718*
	D (OIL)	0.0062	1.1235
	Breusch-Godfrey Serial Correlation LM Test:	0.7730	

*,**,*** mean significant at significance level 1%, 5%, 10. OLS: Ordinary least square

Figure 1: CUSUM and CUSUM square tests regarding the stability of the ARDL model between crude oil prices and interest rates
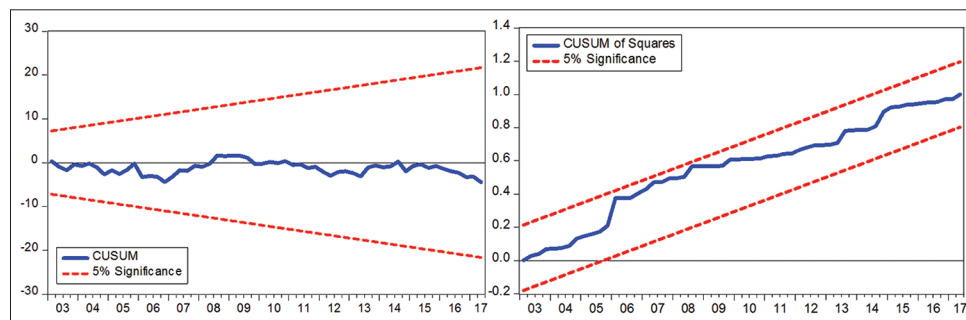
In addition, this study reveals that there are short-run and long-run influences of oil prices on interest rates. This finding agrees with Lowinger and Wihlborg (1985) who found that the increase in oil prices affected the increase in interest rates. It is also in harmony with Cologni and Manera (2008) as they revealed that the increase in oil prices will directly affect the increase in spending for oil consumption and as a result the aggregate savings are reduced. The increased consumption spending leads to an increase in the money supply. Changes in the money supply will affect the interest rate, which in turn will affect one's portfolio, namely the function of liquidity preferences. The empirical facts of this study show that oil prices over the period of 2001Q1 to 2017Q2 do not affect inflation in the short-run and the long run so interest rates must be reduced to encourage increased investment.

Moreover, the results of the analysis show that there is no effect of an increase in oil prices on economic growth both in the short and long run. This occurs because the increase in oil prices does not affect inflation. So it does not affect the increase in production output. Therefore, the increase in oil prices does not affect economic growth. Thus, the result of this study conflicts with Saidi et al. (2019) who found that there was an effect of oil prices on economic growth in Southeast Sulawesi.

5. CONCLUSIONS

The aim of this study is to examine the effect of crude oil prices on inflation, interest rates, and economic growth in Indonesia. To check the effect, the data used are time series data composed of Dubai crude oil prices, consumer price index, and GDP. The price of Dubai crude oil is used as a proxy for crude oil price. The index of consumer prices is used as a proxy for inflation. Meanwhile, GDP is used as a proxy for Indonesia's economic growth.

To analyze the data, the ARDL equations system or multivariate ARDL model was used. To calculate the parameters of the multivariate ARDL model, the multivariate OLS method was employed.

This study has revealed that (1) there is no a short-term effect of crude oil prices on inflation, while the long-run effect of crude oil prices on inflation does not exist, (2) there is a long-term and short-term effect of crude oil prices on interest rates. In the long run, for every 1% rise in oil prices, the rate of interest falls by 0.26%, and (3) there is no effect of oil prices on economic growth both in the long-term and short-term.

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