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Oil Price Shocks: Energy Patterns and Macroeconomic Results in Indonesia

Irawan Itta, Miar, and Harin Tiawon

ABSTRACT

The current study empirically analyzes the impact of oil price shocks (OPS) on the macroeconomy of Indonesia. For this purpose, five macroeconomic variables are used in the analysis, namely, government expenditure (GE), real GDP (RGDP), inflation (INFL), net exports (NXP) and real exchange rate (RXR). The current study uses quarterly data of these variables over the period of 1990 to 2018. The ADF unit root, granger-causality test, unrestricted VAR and variance decomposition analyses are used to analyze the impact of OPS. The findings show that OPS do not significantly affect the macroeconomy of Indonesia. The outcomes of variance decompositions and granger-causality test report that linear measure of OPS and positive OPS do not granger cause GE, RGDP, INFL and RXR. However, OPS granger-cause NXP. The findings confirm the existence of asymmetric impacts of OPS, as the study finds that negative OPS significantly affect RGDP and RXR.

KEY WORDS:

Macroeconomy, oil price shocks, Indonesia, net exports.

JEL Classification: E62, E52, Q51.

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1. Introduction

Oil is considered the top most exported commodity on the globe. In 2018, oil accounted for 4.3% of the global value of all exported commodities. Currently, Indonesia ranks 24th among the oil exporting countries. Today's effects of oil price shocks (OPS) on the economy have not been received as much attention since 1970's, when the USA and some other countries in Europe experienced recession preceded by oil shocks. These oil shocks were the result of conflicts among the nations of the Middle East. Previous studies find negative effect of OPS on GDP and evidence that OPS cause economic recession (Hamilton, 1983; Mork, 1989). The mechanism of transmission of shocks of oil prices to the economy varies from the effect of supply to the effect of demand in terms of effect of trade (Lardic & Mignon, 2006; Sill, 2007). On the side of supply, any inclination in the oil prices (OPs) causes a reduction in the production input which leads

to greater costs of production, and thus slows down productivity and output. On the side of demand, higher OPs rise the general price level which ultimately reduces the real income available for consumption, and thus demand decreases (Mehrra, 2008). On the side of trade terms, oil-importing economies decline in trade which results in reduced demand, and thus wealth transfers from oil-importing to oil-exporting nations.

Recently, the importance of OPS in impacting the output owing to three features of the association between OPs and macroeconomy (Hookers, 1996). These features include: the asymmetric impact of OPS, the declining impact of OPS on an economy and the role of monetary policy.

Past studies (e.g., Iwayemi & Fowowe, 2011) establish the asymmetric impacts of OPS on the economy's activities. Rise in OPs is aligned with lesser output but decrease in OPs does not result in higher output. The reasons behind such irregularities are accredited to the adjustment costs and reallocation effects. Instead, increase in oil prices results in reduction in supply, as the companies reduce the production due to greater

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costs of inputs. Moreover, there also exists a lower demand because of uncertainty of consumer durables and consumer-concerning investment. Increase in OPs also result in resource reallocation from one sector to another (i.e., from energy-intensive-to-energy-efficient). All these factors collectively contribute in slowing down the growth of output. Additionally, lower OPs stimulate consumption by households and production by companies, but in opposite, reallocation of the sectors slows down the economic growth. All these factors collectively effect in a way that falls in oil prices does not lead to improved output.

Another important feature of the association between OPS and macroeconomy is the ostensible collapse of statistical power of OPS to impact the growth of an economy. Prior the period of 1985, OPS were largely increased but after this period OPS had both increasing and decreasing trends. This combination of increasing and decreasing prices muddle the association between OPS and macroeconomy and termed as asymmetric effects. The main characteristic of the above examination is that it also applies to oil-importing nations. Various conclusions are expected for oil-exporting nations because OPS increase the earnings from abroad which results in higher domestic demand (Schneider, 2004). Recently, fewer studies have examined this association such as (Lorde et al., 2009; Mehrara, 2008; Olomola & Adejumo, 2006).

The study analyzes the effect of OPS on the macroeconomy of an oil-exporting economy- Indonesia. The research is important as it sheds light on the association between OPS and output in an oil-exporting economy. It is stimulating to ascertain whether conclusions regarding asymmetric impacts and decreasing importance of OPs on developed oil-importing economies also apply to an oil-exporting economy like Indonesia. Past studies (e.g., Olomola & Adejumo, 2006) attempt to talk about this problem. They identify three non-linear measures of OPS but only one is used in the analysis. The study, therefore, contributes to the current debate by employing three non-linear measures and one linear measure (developed by Bachmeier, 2008) of OPS to investigate the effect that OPS have on the macroeconomy of Indonesia. The linear measure of OPS is a benchmark of Bachmeier (2008) while non-linear measures are (a) the GAARCH model, (b) the asymmetric specifications, and (c) the increase in net oil prices (Lee et al., 1995; Mork,

1989 and Hamilton, 1996, respectively). The findings of the study provide a robust investigation of how OPS affect the macroeconomy of Indonesia.

2. Literature Review

Qazi (2013) investigated the impact of OPS on the economic growth (real GDP: RGDP) of oil exporting nations by using the data from 1980-2013. The application of vector autoregressive and OLS regression models revealed a positive influence of OPS on RGDP. Alekhina and Yoshino (2018) examined the impact of OPS on the oil-exporting country and compared the results with non-oil-exporting countries. Using a VAR technique, they explored a significant impact of OPS on the growth of RGDP of oil exporting country. Iwayemi and Fowowe (2011) analyzed the effect of negative and positive OPS on the RGDP of Nigeria and found that positive shocks didn't affect the RGDP while the RGDP was significantly affected by the negative OPS. Similarly, Monjazebe et al. (2013) also found a direct impact OPS on the growth of RGDP.

Adedokun (2018) examined the impact of OPS on the vigorous relationship between government revenues (GR) and government expenditures (GE) by using the VECM technique. The results of VECM revealed that the variations in GE were not predicted through OPS in short run, whereas, the variations in GR were strongly predicted by OPS. Farzanegan and Markwardt (2009) empirically examined the response of decline in oil price on GE by using the data from Indonesia. The results of this study revealed that decrease in oil prices negatively influenced GE. Almulali and Che Sab (2013) found the positive influence of increase in oil prices on GE of OECD countries and suggested that the revenue of OECD countries increased due to increase in oil price which in turn increased the GE of OECD countries. Lorde and Thomas (2009) also found a positive association between OPS and GE while Akin and Babajide (2011) could not find any significant impact of OPS on GE in Nigeria.

Qazi (2013) identified a positive association between OPS and inflation (INFL) by using the data of oil exporting countries over the period of 1980-2013. Ito (2008) investigated the impact of OPS on INFL in the case of Russia and found a positive response of INFL towards OPS. Elly and Oriwo (2013)

empirically investigated the association between OPS and INFL in Kenya and revealed a positive association between INFL and OPS in long run. Rafiq and Sgro (2016) also indicated the positive association between inflation and oil prices shocks by using the data of 6 oil exporting countries over the period of 1993-2013. Bala and Chin (2018) analyzed the impact of positive and negative OPS on INFL and found that both positive and negative shocks positively influenced INFL but the positive shocks had more significant impact. Similarly, Rafiq and Sgro (2016) also observed a positive association between INFL and OPS by using the data of 6 states.

Rautava (2004) explored the impact of international OPs on real exchange rate (RXR) of the oil exporting country, by applying the VAR methodology he found that increase in the international OPs caused an appreciation in RXR. Iwayemi and Fowowe (2011) explored that how positive and negative OPS influenced the RXR in Nigeria. Their results revealed that RXR was significantly influenced by negative OPS while positive OPS had no impact on Nigerian RXR. Elly and Oriwo (2013) also reported a negative impact of OPS on RXR in Kenya.

3. Research Methodology

3.1. Data

The study empirically analyzes the impact of oil price shocks (OPS) on the macroeconomy of Indonesia. Prior studies include five macro-economic variables in the analysis. These variables include; government expenditures (GE), real GDP or output (RGDP), inflation (INFL), net exports (NXP) and real exchange rate (RXR). The current study uses quarterly data of these variables over the period of 1990 to 2018. The data period and the variables are selected on the basis of data availability and the data are collected from the website of world bank.

3.2. Variables Description

The variables of the study are defined and measured as follows: RGDP is real-GDP which is a measure of output, GE is government expenditures which is the sum of capital and recurrent expenditures of federal government. INFL is inflation which is measured as the proportionate change in the CPI (consumer price

index). RXR is the real exchange rate and is calculated by deflating the NXR (nominal exchange rate) with the ratio of CPI of United States to the CPI of Indonesia. NXP is the net exports which is the difference between total imports and total exports.

It is organized by the prior studies (e.g., Hamilton, 1996; Mork, 1989; Lee et al., 1995) that there exists a non-linear affiliation between OPS and macroeconomy. The current study uses both non-linear and linear stipulations of OPS to empirically analyze the impact that OPS have on the economy of Indonesia. The study employs one measure of linear benchmark (Bachmeier, 2008; Hamilton, 1983) which is measured as the proportionate change in the crude oil's nominal prices (OIL). The study also uses three non-linear measures of OPS. (a) increase in the net oil price (INOP), which is measured as the proportionate increase in the current oil price over the prior 4-quarters price if it is positive, else zero (Hamilton, 1996). The INOPT is describes as:

$$INOP_t = \max_i [0, (\ln(oil_t) - \ln(\max_i(oil_{t-1}, \dots, oil_{t-4})))]$$

(b) Mark (1989) allows for the irregularities in the oil price and derived negative and positive OPS. The change in OPS is defined below:

$$ROP_t^+ = \max_i (0, ROP_t - ROP_{t-1})$$

$$ROP_t^- = \min_i (0, ROP_t - ROP_{t-1})$$

Where; ROP_t is the real oil price, ROP_t^+ is the increase in real oil price, and ROP_t^- is the decrease in real oil price at time 't'.

(c) The study also uses GAARCH model (followed by Lee et al., 1995) to measure the volatility in OPs in order to arrive at the variable of OPS. The study uses following GAARCH (1,1) to apprehension the OPS:

$$O_t = \varphi + \sum_{i=1}^k \omega_i O_{t-i} + \epsilon_t$$

$$\epsilon_t = u_t \sqrt{q_t}, u_t \sim N(0,1)$$

$$q_t = \delta_0 + \delta_1 \epsilon_{t-1}^2 + \delta_2 q_{t-1}$$

$$OV = \max_i \left(0, \frac{\epsilon_t}{\sqrt{q_t}} \right)$$

In order to measure the asymmetric impacts of OPS, the study defines measure of oil volatil-

ity (OV) for positive (OV⁺) and for negative (OV⁻) OPS. Where; OV⁺ comprises of all positive values of OV and zero replaces negative values and OV⁻ comprises all negative values of OV and zero replaces positive values (Iwayemi & Fowowe, 2011).

3.3. Analytical Techniques

The ADF unit root is applied to check stationarity in the time series data. The study also uses unrestricted VAR model (followed by Farzanegan & Markwadt, 2009) to investigate the effect of OPS on the macroeconomic variables. Thereafter, the study employs variance decomposition analysis to identify the relative importance of OPS.

Before VAR, granger-causality test is conducted to analyze if OPS have direct effect on macroeconomic variables. Here, the causality means a variables' lagged values, say 'h', have descriptive power in the regression model of variable 'g' on past values of 'g' and 'h'. The 'h' variable is said to granger-cause 'g' variable if the insertion of lagged values of 'h' variable helps in well prophecy of 'g' variable (Lorde et al., 2009; Greene, 2003). Given a VAR of two variables like equations (a) and (b) below, then 'ht' does not granger cause 'gt' if $q(M) = 0$. It is generalized to the VAR case for variable 'n', where an 'h' variable is said to granger-cause 'g' variable (where 'g' is dependent variable for a particular equation), if the coefficients of past values of 'g' variable are set equal to "0".

$$g_t = p(M)g_{t-k} + q(M)h_{t-k} + e_t \quad (a)$$

$$h_t = r(M)g_{t-k} + s(M)h_{t-k} + u_t \quad (b)$$

4. Results and Discussions

4.1. Unit Root Test

Table 1 presents the ADF unit root test for all the variables employed. The test shows that NXP, INFL and all variables (OIL, INOP, ROP⁺, ROP, OV, OV⁺, OV⁻) of oil price shocks are I(0) while GE, RXR and RGDP are I(1). As the data are stationarity at different orders, the study does not employ cointegration test. Additionally, as most of the variables achieve stationarity at I(0), the study uses unrestricted VAR in levels (followed by Farzanegan & Markwadt, 2009).

4.2. Granger Causality Test

Table 2 presents the outputs of granger-causality test. The Table reports that in case of RGDP, INFL, GE and RXR the null hypothesis (shocks of oil prices do not granger cause macroeconomic variables) is not rejected, when the oil price shocks are measured by linear benchmark (OIL), INOP, ROP⁺, OV, OV⁺. The outcomes support the results of prior studies which also find that shocks of oil prices do not significantly influence the macroeconomic variables (Hamilton, 1996; Hookers, 1996; Lorde et al., 2009).

Moreover, in case of NXP, the null hypothesis can be rejected. The shocks of oil price granger-cause NXP which might be the fact that oil accounts for more than half of the export-earnings of Indonesia. The study also finds signal on the asymmetric impacts of OPS on the macroeconomy that negative shocks of oil (ROP⁻, OV⁻) granger-cause RGDP and RXR. This is inconsistent with findings of developed country studies (e.g., Mork, 1989) who find little, even no impact of negative OPS on macroeconomy.

4.3. Variance Decompositions Analysis

Table 3 provides the variance decompositions (VDs) which show the proportion of forecast error variance of a variable which is attributable to other variables as well as its own innovation. As the study is basically concerned in analyzing how macroeconomic variables respond to OPS, Table 3 presented the outcomes of VDs for study variables contributing to the shocks of oil price. The findings of VDs analysis are largely similar with the findings of granger-causality test provided in Table 2, that is, the shocks of oil price contribute a small number of variations for most of the variables used in the study.

Third column (Table 3) holds the VDs when the OPS are measured by linear benchmark (OIL), it can be seen that shocks of oil contribute 0% changes in RGDP in period-1, in period-5 and 10, it marginally rises to 29.84% and falls to 16.41% respectively. Except NXP, oil price shocks (linear measure – OIL) contribute less than 1% of shocks in all other variables (GE, INFL, RXR), whereas oil price shocks account for approximately 5% varia-

Table 1. ADF Unit Root Test

Variables	Levels		First Difference		Decision
	Constant	Constant and Trend	Constant	Constant and Trend	
RGDP	0.29	-1.69	-1.96	-3.76*	I(1)
GE	-1.02	-1.88	-5.87*	-5.74*	I(1)
INFL	-2.78*	-2.99*	-5.92*	-5.86*	I(0)
NXP	-3.99*	-4.29*	-11.63*	-11.92*	I(0)
RXR	-2.31	-1.97	-7.72*	-7.39*	I(1)
OIL	-6.78*	-6.79*	-9.99*	-9.34*	I(0)
INOP	-4.98*	-4.66*	-7.61*	-8.21*	I(0)
ROP+	-6.86*	-7.97*	-9.60*	-9.90*	I(0)
ROP-	-7.46*	-8.21*	-11.82*	-11.21*	I(0)
OV	-6.99*	-6.27*	-6.57*	-6.25*	I(0)
OV+	-7.89*	-7.23*	-9.54*	-10.93*	I(0)
OV-	-6.91*	-7.92*	-11.43*	-11.92*	I(0)

Note: *Significant at 1%.

tions in NXP.

The VDs for other measure of oil shocks are shown in column 4-9. The outcomes of other measures of oil shocks are similar to the outputs presented in column 3. The study finds that the shocks of oil do not determine significant percentage of changes in the macroeconomy (macrocosmic variables) with shocks of oil price contributing for 0-2.07% variations in the macroeconomic variables. On average, irrespective of the measure taken, the OPS explain 5% variations in NXR.

The positive OPS are provided in columns 6 and

7, and the findings are similar with the other measures of OPS. The positive OPS contribute a little change in the macroeconomy. Moreover, the negative OPS are supplied in columns 8 and 9. The negative shocks explain, on average, 2.15% variations in INFL between the period of 5 and 10. Comparing with the average value of approximately 1.11% for other measures of oil shocks, it can be clearly seen that negative shocks have greater impact on INFL. For RXR the findings are same, where the negative shocks of oil explain approximately 4% and 5% variation in the period of 5 and 10, respec-

Table 2. Granger Causality Test

Variables	Shocks			Positive Shocks		Negative Shocks	
	OIL	INOP	OV	ROP+	OV+	ROP-	OV-
RGDP	4.56 (0.21)	2.98 (0.52)	4.65 (0.34)	2.61 (0.51)	3.01 (0.37)	6.77** (0.04)	6.71** (0.05)
GE	1.52 (0.76)	0.91 (0.84)	2.98 (0.61)	2.65 (0.35)	2.21 (0.43)	2.67 (0.35)	2.45 (0.34)
INFL	4.31 (0.37)	5.24 (0.14)	3.27 (0.71)	5.32 (0.42)	5.97 (0.61)	3.71 (0.57)	4.92 (0.41)
NXP	13.25* (0.00)	17.88* (0.00)	21.65* (0.00)	28.69* (0.00)	26.32* (0.00)	6.98 (0.42)	6.44 (0.34)
RXR	2.14 (0.63)	3.99 (0.38)	0.87 (0.67)	0.37 (0.71)	0.27 (0.51)	8.97** (0.03)	8.33** (0.03)

H0: "Shocks of oil prices do not granger cause the measure of oil price shocks. The values are Wald statistics and (p-values) in parentheses. * and ** significant at 1% and 5% respectively."

tively. Another feature, that can be differentiated, of negative oil price shocks is that NXP is dampened with the highest value of 3.6% obtained for OV- for period-10, which is less than the highest value of 5.8% obtained for the measure of INOP. Overall, the findings are in line with the past studies (such as Iwayemi & Fowowe, 2010).

5. Conclusion

The effect of OPS on the economy has received greatest attention since 1970's, when the USA experiences recession and some other countries in Europe precede by oil shocks. These OPS arise as a result of Middle East conflicts. Therefore, the current study empirically analyzes the impact of OPS on the macroeconomy of Indonesia.

Five macro-economic variables are used in the analysis which include GE, RGDP, INFL, NXP and RXR. The current study uses quarterly data of these variables over the period of 1990: Q1 to 2018: Q4. The ADF unit root, granger-causality test, unrestricted VAR and VDs analysis is used to analyze the impact of OPS.

The findings show that OPS do not significantly affect the macroeconomy of Indonesia. The outcomes of granger-causality test reports that linear measure of OPS and positive OPS do not granger cause GE, RGDP, INFL and RXR. However, OPS granger-cause NXP. The findings also show the existence of asymmetric impacts of OPS as the study finds that negative OPS significantly cause RGDP and RXR which is inconsistent with prior studies (e.g., Akin & Babajide, 2011) who do not find significant

Table 3. Variance Decomposition Analysis

Variables	Period	Shocks			Positive Shocks		Negative Shocks	
		OIL	INOP	OV	ROP+	OV+	ROP-	OV-
RGDP	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	5	0.2984	0.0241	0.3325	0.5412	0.8261	0.4588	0.2981
	10	0.1641	0.0652	0.1982	0.5784	0.9124	0.4872	0.3001
GE	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	5	0.1751	0.1952	0.6142	1.5412	2.0512	0.6781	3.2715
	10	0.1142	0.2841	0.3814	1.2178	1.3811	0.4125	3.6841
INFL	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	5	0.4232	2.8741	0.0621	1.2142	1.3652	1.8421	2.3641
	10	0.4241	2.5712	0.3841	0.8421	0.9222	1.7695	2.6412
NXP	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	5	5.4121	5.8741	5.8712	4.6521	4.8744	2.6512	3.6512
	10	5.0352	5.2145	4.0281	4.3887	4.0281	2.9538	3.6711
RSR	1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	5	0.1932	0.4121	0.4871	0.1143	0.1374	4.0512	4.8749
	10	0.6412	0.2984	0.9981	0.3651	0.2981	4.9210	5.1287

impact of OPS.

The findings of VDs analysis report that positive OPS accounts for about 2% changes in GE, RGDP, INFL and RSR whereas positive OPS show more than 5% variations in NXP. The study again confirms the existence of asymmetric impacts of negative OPS on the macroeconomy of Indonesia.

The evidences of the study offer useful implications for the policy makers. The findings show that most of the

variables (except NXP) do not show significant variations following the shocks of oil price. The NXP from Indonesia significantly respond to the OPS. This is, due to the fact that exports of oil contribute a major part of Indonesia's total exports and thus the OPS play a significant role in influencing the Indonesia's exports of oil. Although, the findings that the oil price shocks are not reflected in other variables highlights an imperative feature of the economy of Indonesia that is "Indonesia

is spending a large part of its foreign exchange earnings on consumer goods". It has been an important feature since the 1970's boom of oil. Also, the importing of such consumer durables does not lead to productive economic activities. Therefore, the policy of importing oil should be revisited if windfalls of oil are to be oppressed for productive activities.

The findings also report that negative shocks have larger effect on the macroeconomy than positive shocks, which imply that negative shocks dominate the positive shocks. This point leads to the explanation that positive shocks of oil causes a persistent decrease. Following this scenario, the policies should be designed to limit the oil price effects. These policies may include; expansion and diversification of economy's productive base, managing revenue of oil via oil revenue fund and lessening public debts, etc.

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