Do Various Sectors Respond to Oil Price Shocks? New Evidence for Indonesia as Emerging Market

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ABSTRACT

Oil is one of the world's most widely used factor inputs in the manufacture of goods and services. Generally speaking, we believe that oil-dependent sectors will be more sensitive to shocks in oil prices. This paper aims to evaluate the response of different sectors as an emerging market to oil price shocks in Indonesia. The monthly data is used from January 2000 to February 2019. This study uses the vector auto-regressive (VAR) model and the Impulse Reaction Function looks in-depth. The results show that shocks in oil prices can be significantly negative or positive for Indonesia's various sectors. First, we find that all Indonesia's sector index has the significant impact of oil price shocks. Second, the positive impact comes from the mining sector, while the remaining industries have a negative impact due to shocks in oil prices. The practical implications of this research are very useful not only to see the impact of Indonesia's role as an emerging market and net oil importer which is for the investor in the mining area but also to others sector and regulators.

**Keywords:** Oil Prices Shocks, Vector Auto-regressive Model, Impulse Reaction Function
JEL Classifications: Q4, M2

1. INTRODUCTION

Oil is one of strategic commodity for the global economy. Previous literature from the first (Hamilton, 1983; 1996; 2003; 2009; Hooker; 1996) focused that oil fluctuations have substantial effect statistically on the economy variables such as GDP, inflation, and exchange rate. The results are various around the countries either for emerging or developed country. However, other consideration given to the oil price may lead not only to macroeconomic variables but also to market data such as industry indices in each country. Overall, oil-dependent sectors will become more sensitive to the oil price shock. But even different sectors with an indirect connection to crude oil could be vulnerable to the fluctuation of oil prices. The goal of this research is therefore to evaluate the response of different sectors to oil price shocks as an emerging market in Indonesia. Unlike the most recent literature review focusing on the connection between oil price shocks and macroeconomic parameter, we focused on evaluating the response

of oil price shocks on industry indices. There are ten industry indices that can be evaluated in Indonesia. Fama (1990) claimed that stock market indices are widely seen as economic bellwethers forecasting shifts in business activity, specifically sector indices. The importance of those sector indices led us to do this research.

In Indonesia, Hersugondo et al. (2015) found that while changes in world oil prices do not have a significant impact on Indonesia's stock market return, the coefficient of regression indicates a potential negative effect. Riga et al. (2016) recorded major asymmetry reactions to stock returns in the Agriculture and Consumer Goods sector due to changes in the price of crude oil in the Agriculture and Consumer Goods sector. They didn't consider other sectors in Indonesia. For the best of our knowledge and by using newest time series by considering each sector in Indonesia, we could get different result regarding the respond of each sectors to oil price shocks. As we see in Figure 1, price of each sector indices are quite volatile. The highest volatility comes from

Figure 1: Plot of sector indices in Indonesia (in rupiah) 2000-2018
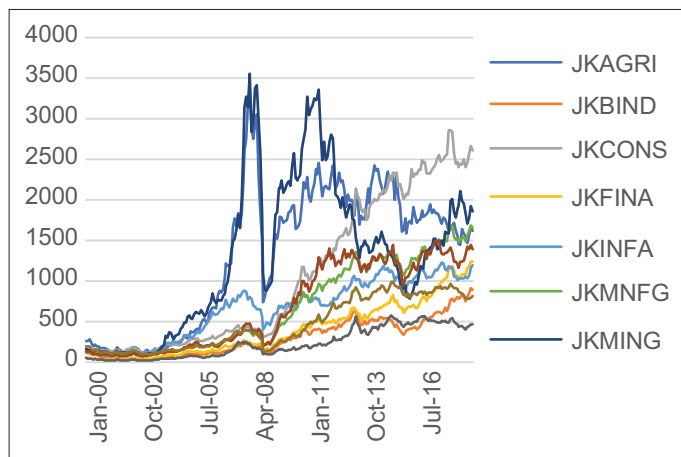
JKAGRI: Agriculture; JKBIND: Basic Industries; JKCONS: Consumer Goods; JKFINA: Finance; JKINFA: Infrastructure; JKMNFG: Manufacture; JKMING: Mining; JKMISC: Miscellaneous; JKPROP: Property; JKTRAD: Trade

mining index that is extremely related with oil price, followed by agriculture and consumer goods sector.

Indonesia is one of emerging market in the world and one of net oil importer country. Indonesia is the third largest emerging country after China and India in Asia, and as a net oil importing country, Indonesia has grown since 2004. The reason Indonesia became a country of net oil importers because our production was unable to meet the high demand. In 2009, Indonesia also withdrew from the member of Petroleum Exporting Countries Organization (OPEC). As an emerging market and a net importer of oil, Indonesia would have different reactions to oil price shocks.

It is surprising that little research has been carried out on the nexus between different industry indices and oil price shocks in Indonesia specifically. In order to fill this void, the latest evidence comes from each sector indices in Indonesia over the period from January 2000 to February 2019. This study uses the vector auto-regressive (VAR) model and the Impulse Reaction Function looks in-depth. Our paper makes several contributions. First, by using the latest time series, we find the impact of oil price shocks on each industry in Indonesia as an emerging market and as a net oil importer. Our results show that oil price shocks are important in Indonesia for each field, while the impact could be on Indonesia as a net oil importer, whether short-term or long-term. Second, oil price fluctuations can be negative or positive, which is the message for investors investing in Indonesia. By looking at the nexus between oil price shocks and stock return indices, they can predict the performance of each sector index. It's important for politicians as well. Not only on macroeconomic variables, but also on stock indices, they should control the impact of oil price shocks. Second, we add analysis of literature by finding the link between oil price shocks and Indonesia's individual sector indices.

The following is the structure of this article. Section 2 describes the review of the literature. Section 3 presents the data and methodology. Section 4 looks at the empirical outcome. Section 5 concludes the research and allows future work to be done.

2. LITERATURE REVIEW

While there are numerous empirical studies on oil price shocks and macroeconomic shocks, less is known about the nexus between oil price shocks and individual industry indices, especially in Indonesia. Hamilton (1983) reported that there was a statistically significant correlation between oil price and macroeconomic variables in the US before 1972. The irony was that fluctuations in oil prices and recession were associated in the U.S. at least until 1972. Hooker (1999) agreed with the conclusion of Hamilton. He revealed that after 1980, the impact of the price of oil decreased. He concluded that oil prices are endogenous to the economy of the United States. Hooker was using Granger cause between oil prices and variety of US macroeconomics variable. After his research, almost all research related with oil price using Vector Auto-Regressive (VAR) model that stated that all variables are endogenous. Even after two decades since his first seminal paper related oil price, Hamilton (2000) focused on oil price shocks in his research. He clarified that oil prices were substantial on macroeconomic variables. It was because these disrupt consumer and corporate spending on one or more specific sectors. Oil price shocks also had a significant impact on the gross domestic product (GDP), consumer price index (CPI), and exchange rates of oil importing countries or oil exporting countries. In oil exporting countries, macroeconomic variables are more sensitive to changes in oil prices than to oil importing countries. Even from small oil price shocks, the macroeconomic variables are sensitive in India, Pakistan, Bangladesh, Srilanka, and Bhutan. Nearly all related research focuses on the link between shocks in oil prices and macroeconomic variables. While less research that focused on oil price shocks and major sector, Meuskens and Ogundare (2017) concluded that there is no significant relationship between the financial performance of the agricultural sector and the oil and gas and transport sector reflect a limited relationship to oil price shocks in Malaysia. Asteriou and Bashmakova (2013) reported that shocks in oil prices have the greatest impact on the return of emerging stocks. This conclusion comes from ten countries in Central and Eastern Europe.

In Indonesia, as emerging countries, many researchers (Hsing, 2012; Kuboniwa et al., 2014; Izraf et al., 2015; Hersugondo et al., 2015; Cunado et al., 2015; Riga et al., 2016; Fah and Shi, 2017; Luthfi, 2017) focus also on oil price shocks on macroeconomic without considering each sector. Setiawati and Wiryono (2018) stated linear oil shocks have limited impact on all macroeconomic variables is limited in the short term in Indonesia.

In 2018, research started focusing on oil price fluctuation and market data which is world sectors. Huang et al. (2018) used the world industry indices of Morgan Stanley Capital International (MSCI) to find out if those sectors respond simultaneously to oil price shocks. In joint frequency and network analysis, they used wavelet coherence. That research found that it could be sensitive even to sectors that have an indirect relationship with oil price. Huang et al. (1996) reported

that a rise in oil prices results in a negative reaction from stock markets as an increase in inflation rates leads to a decrease in the discount rate. From previous findings, rising oil prices do not favour either the oil importing country's stock market or the economic situation.

Specifically, Hersugondo et al. (2015) found that only in Malaysia's capital market and the Thai capital market does the world oil price have a significant effect. They concluded, there was no significant effect on the stock market in Indonesia. Riga et al. (2016) investigate the relation between volatility in oil prices and indices in the industry. By using OLS they conclude that significant asymmetry reaction happened to agriculture and consumer good sectors in Indonesia. Thus, for the best of our knowledge, this research will use 10 sectors in Indonesia and oil price both from WTI or Brent.

3. DATA AND METHODOLOGY

To investigate the respond of shocks of oil price on each sector, monthly data from January, 2000 to February, 2019 are used. The stock indices data for 10 sectors in Indonesia are from yahoo finance database. Those sectors are agriculture (JKAGRI), basic industries (BIND), consumer goods (JKCONS), finance (JKFINA), infrastructure (JKINFA), manufacture (JKMNFG), mining (JKMING), property (JKPROP), trade (JKTRAD), and miscellaneous sectors (JKMISC). The data shows in Figure 1. While, Figure 2 shows us the world oil price either WTI or Brent come from investing database. We used both WTI (West Texas Intermediate) and Brent index that represents the world oil price. WTI is the commodity of the oil futures contract of the New York Mercantile Exchange. North Sea Brent or short Brent index is the world's leading price benchmark for crude oil in the Atlantic Basin and is used to price two-thirds of the world's internationally traded supplies of crude oil. WTI and Brent are the most popular benchmark that is why we used both of those indicators as oil price.

To do VAR model, we are making some transformation for the original variables. It must be constant for all variables. We also measure the return of each sector indices. Equation 1 shows us linear oil price that we use in this research, while equation 2 shows us to measure the return of each sector indices.

Figure 2: World Oil Price, 2000-2018
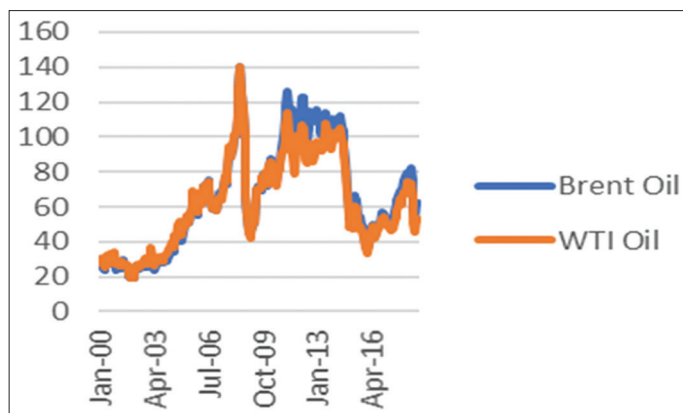
$$\Delta Oil = \ln Oil_t - \ln Oil_{t-1} \qquad (1)$$

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} \qquad (2)$$

We use unrestricted VAR to model the dynamic relationship between variables. VAR model is a model for two or more time series where each variable is modelled as a linear function of all variables ' past values, plus disturbance that has zero means give all observed variables ' past values. An important characteristic of the VAR model is that all variables are considered endogenous, which means that the dependent variable could affect the independent variable and could affect each other. First, we need to identify our data. Our data must be stationary before we use it in this research. If the data has a trend, we will do it in different data until there is no trend in the data. We are also monitoring the cointegration. Because there is no cointegration in these variables, we do not use the VECM model but the VAR model. The VAR model must pass all the residual diagnostic. Too major residual diagnostics are serial correlation and heteroscedasticity. The model that passed the residual diagnostic can be analysed using impulse reaction function.

Here is the VAR equation:

$$Y_t = \alpha + \sum_{i=0}^{n} \beta i Y_{t-i} + \sum_{i=0}^{n} Y i X_{t-i} + \varepsilon_t \qquad (3)$$

Where α is an ($n \times 1$) VAR intercept vector, β, and γ are the Ith ($n \times n$) matrices of the autoregressive coefficient for is = 1, 2,…, n and error is the ($n \times 1$) generalization of white noise process.

4. EMPIRICAL RESULT

Table 1 summarizes all variables under study of VAR model over the period January 2000 and Feb 2019. The mean, standard deviation, skewness, kurtosis, and Jarque-Bera statistics of our variables in this research are shown in Table 1. The results show that not zero is the mean of all variables. In addition, the standard sample deviations are within the range of 0.06025 and 940.326, indicating the sector return in the consumer goods sector (RCONS) is the least volatile variable, while the mining price (JKMING) is the most volatile. However, the results show that dlnBrent, dlnWTI, JKAGRI, JKINFA, RBIND, RAGRI, RINFA, RMISC, RMNFG and RTRAD are skewed to the left while the remaining variables are skewed to the right. The highest level of kurtosis is the mining sector return (RMING), which shows that the extreme changes in this mining index tend to occur more frequently. In contrast, for all variables, the Jarque-Bera statistics refuses normality at the 10% rate.

Table 2 present the unit root test. For the stationary of all variables, we conduct Augmented Dicky-fuller (ADF) unit root test (Dickey and Fuller, 1979). The null hypothesis is the variable has unit root test. If the probability is lower than our significant level, we can reject the null hypothesis. Since we consider that VAR must use

Table 1: Summary statistics

Variable	Mean	SD	Skewness	Kurtosis[a]	Jarque-Bera
Brent oil	65.502	30.591	0.33515	2.000984	13.8099***
WTI oil	62.479	26.7728	0.31991	2.158154	10.6685***
dlnBrent	0.00379	0.09163	−0.68438	4.560174	41.1026***
dlnWTI	0.00282	0.09382	−0.57291	4.06828	23.4163***
JKBIND	302.990	230.412	0.58476	2.30857	17.6125***
JKAGRI	1,333.43	859.2084	−0.1751	1.73502	16.4385***
JKCONS	1060.48	914.380	0.49204	1.60274	27.8685***
JKFINA	400.568	332.156	0.72016	2.47805	22.394***
JKINFA	663.165	364.570	−0.27867	1.72	18.597***
JKMING	1,306.86	940.326	0.42896	2.27693	12.0115***
JKMISC	691.747	526.593	0.13594	1.25358	29.8073***
JKMNFG	684.783	539.609	0.32972	1.47868	26.2327***
JKPROP	233.370	185.924	0.45665	1.67196	24.7875***
JKTRAD	464.968	316.065	0.32583	1.41403	28.052***
RBIND	0.01174	0.07756	−0.38634	3.99077	15.06288***
RAGRI	0.01322	0.09971	−034048	6.16708	100.1312***
RCONS	0.01352	0.06025	0.2977	4.7076	31.2071***
RINFA	0.01168	0.06893	−0.16968	4.64093	26.7912***
RFINA	0.01599	0.07015	0.02151	4.3208	16.6632***
RMING	0.01587	0.10631	1.00028	9.21645	406.9185***
RMISC	0.01350	0.07876	−0.43184	5.42281	63.1269***
RMNFG	0.01246	0.06207	−0.36903	4.97114	42.27095***
RPROP	0.01309	0.08619	0.10422	3.81188	6.70395***
RTRAD	0.00858	0.06829	−0.84519	7.66919	235.2856***

Table 2: Unit root test

Variable	t-statistic	Prob.
DLNBRENT	−12.65379	0.0000
DLNWTI	−12.85890	0.0000
RAGRI	−12.53059	0.0000
RBIND	−12.49077	0.0000
RCONS	−14.04307	0.0000
RFINA	−13.84013	0.0000
RINFA	−13.96670	0.0000
RMING	−11.55527	0.0000
RMISC	−13.33755	0.0000
RMNFG	−12.85412	0.0000
RPROP	−13.18796	0.0000
RTRAD	−11.80403	0.0000

DLNBRENT: Change Brent oil price; DLNWTI: Change WTI oil price; RAGRI: Return of agricultural sector indice; RBIND: Return of basic industry sector indice; RCONS: Retun of consumer good sector indice; RFINA: Return of finance sector indice; RINFA: Return of infrastructure sector indice; RMING: Return of mining sector indice; RMISC: Return of miscellaneous sector indice; RMNFG: Return of manufacture sector indice; RPROP: Return of property sector indice; RTRAD: Return of Trade sector indice

Table 3: Variance decomposition analysis

Dependent variable	Period	Oil shocks
RAGRI	1	3.461811
	5	5.238161
RBIND	1	2.08877
	5	1.914792
RCONS	1	0.019485
	5	0.190855
RFINA	1	0.1702275
	5	0.366416
RINFA	1	0.039298
	5	2.093528
RMING	1	8.834881
	5	10.81312
RMISC	1	1.425636
	5	1.43718
RMNFG	1	0.338277
	5	3.374735
RPROP	1	0.004545
	5	0.607553
RTRAD	1	0.942476
	5	1.392032

stationer data, we need to look through which variables that has a trend or not. Because we process the data by modifying it into difference data. All the data are stationer.

Since, the main objective of this research is to assess the response of different sectors to oil price shocks as an emerging market in Indonesia. We show Figures 3 and 4 containing the impulse reaction function for the responses to the oil price linear variables from either WTI (Figure 3) or Brent (Figure 4) for each sector indices. IRF is a useful graph for understanding how a standard shock deviation or variable innovation affects another variable and how it develops over time.

Figure 3 shows us, the respond of sector indices, namely basic industry (RBIND), consumer goods (RCONS), finance (RFINA), infrastructure (RINFA), miscellaneous (RMISC), manufacture (RMNFG), property (RPROP), and trade (RTRAD) were negative until the third quarter, thus indicating change of linear oil price shocks from Brent oil had negative effect on output. The respond of mining (RMING) was the only one positive response which lasted until fourth quarter. While the respond of agriculture (RAGRI) was positive but not lasted like return in mining sector. All dependent variables are significant as visually because both interval bounds are jointly above or below the zero line, this indicate statistical significance level and at a specific horizon. In Figure 4 shows us the respond of each dependent variables from oil price of WTI oil. The results give the same significance conclusion, except for respond of agriculture (RAGRI). The

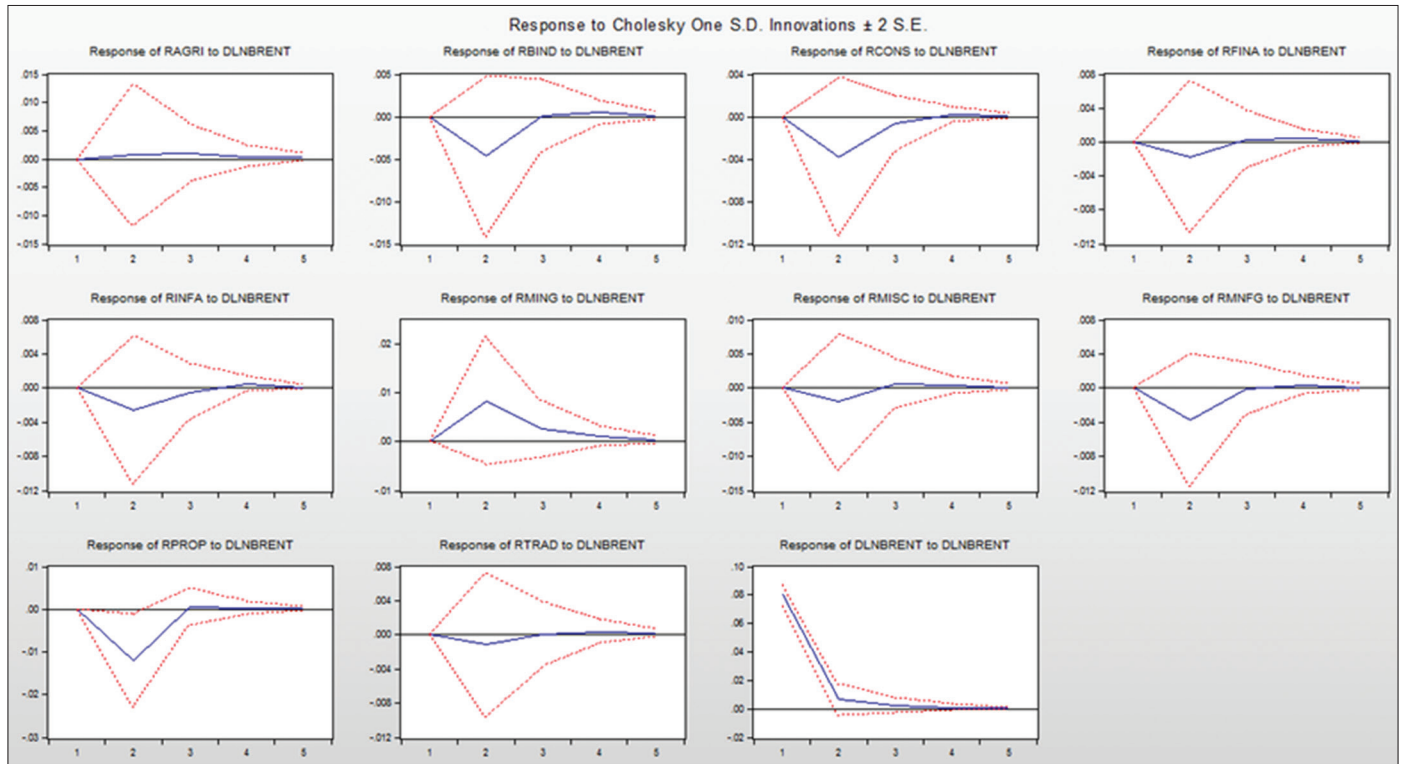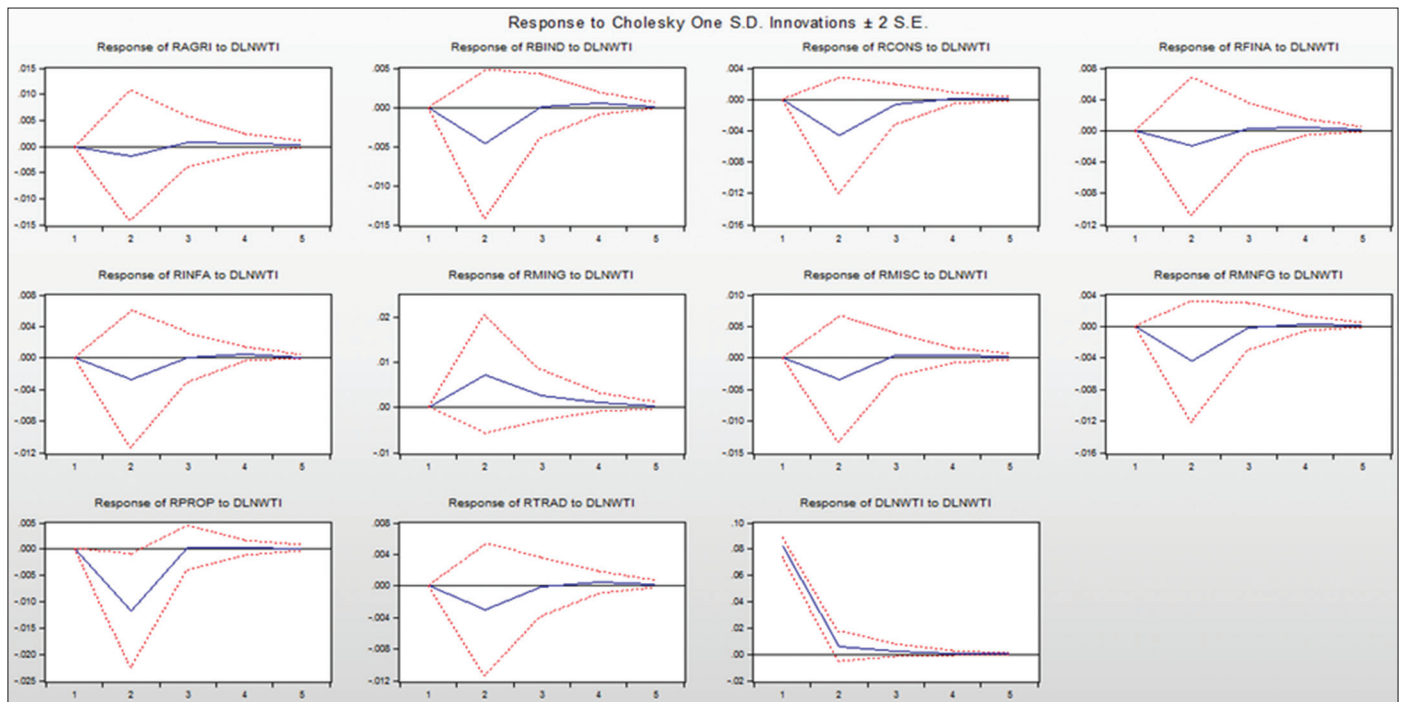**Figure 3:** Impulse response function of shocks to DLNBRENT

Figure 4: Impulse response function of shocks to DLNWTI

respond of agriculture (RAGRI) was negative until two and half quarter. The reason is oil price from WTI tends to lower than Brent Oil. The main reason for the negative response from all sectors except mining is to look at the microeconomic nexus, nearly all sectors use oil as a direct or indirect production factor, their earnings are affected by higher oil prices. If those companies were unable to pass on the rising cost to their customers, the profit would fall.

We also showed the impact of oil shocks studied by analysing the decomposition of the forecast error variance. The moving average-based variance decomposition examines the proportion of a variable's forecast error variance that is attributable to its own innovations and other system variables. Since the purpose of this study is to demonstrate how the industry indices react to oil price shocks, only variables attributable to oil shocks are listed for the decomposition of each sector indices. Table 3 shows that

oil shocks are <1% of the variance in return for consumer goods, finance, property in Indonesia as determined by oil price. Changes in oil prices, however, account for between 8.8% and 10% of the difference in return in the mining sector for all periods of time for either 1 month or 5 months. This number is greater than other variables that depend on it.

5. CONCLUSION

This study was designed to evaluate the response of different sectors as an emerging market to oil price shocks in Indonesia. The empirical results show that first, in the short run, the impact of linear oil shocks on all the variables examined is limited. For basic industry (RBIND), consumer goods (RCONS), finance (RFINA), infrastructure (RINFA), miscellaneous (RMISC), manufacture (RMNFG), property (RPROP), and trade (RTRAD) were negative until the 3rd month, thus indicating change of linear oil price shocks either from Brent oil or WTI had negative effect on output. Our result is adding what previous literature had done from Riga et al. (2016) that only concern with agriculture and consumer goods sector. Hersugondo et al. (2015) found that although shifts in world oil prices do not have a significant impact on Indonesia's stock market return, the coefficient of regression indicates a potential negative effect. We found those negative effects are significant and comes from impulse reaction function. The only one sector that had positive outcome is mining sector. Second, shock of oil price shocks can be negative for all sectors except mining sector, those are the signal for investor that invest in Indonesia. Third, we add literature review by finding the nexus between oil price shocks and each sector indices in Indonesia using newest time series evidence from January 2000 to February 2019.

Hence, we conclude that there are different reactions to the oil price changes in each sector in Indonesia due to the significant effects of the time horizon-wide reaction. Nonetheless, there is a need for a more detailed description of how the oil price change impacts each field, this will be discussed in further research.

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