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OIL PRICE FLUCTUATION AND THEIR IMPACT ON INDONESIA MANUFACTURING INDUSTRY

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ABSTRACT

This study analyzes the effect of crude oil price fluctuations using the model approach of Fukunaga et al (2009) where crude oil price fluctuations are influenced by several components such as oil supply shocks, global demand shocks, and oil-specific demand shocks. Then analyze the effect of each component on the aggregate industry production index, food, beverage and tobacco industry production index, chemical and goods from chemical raw materials, petroleum, rubber and plastic industry production index, metal, non-machinery and equipment production index. The research method is VAR in difference and the analysis methods are Granger causality test, Impulse Response Function (IRF), and Forecast Error Variance Decomposition (FEVD). Global demand shocks and oil-specific demand shocks have a significant and positive effect on crude oil prices, while oil supply shocks have no significant effect. Oil-specific demand shocks have a significant effect on aggregate industry production index variables, while oil supply shocks and global demand shocks have no significant effect. The decomposition variables of oil price fluctuations, namely oil supply shocks, global demand shocks, oil-specific demand shocks, have no significant effect on the food, beverage and tobacco industry production index chemical and goods from chemical raw materials, petroleum, rubber and plastic industry production index, metal, non-machinery and equipment production index of metal, non-machinery and equipment.

Keywords: *Oil Supply Shocks, Global Demand Shocks, Oil-Specific Demand Shocks, Manufacturing Industry, VAR in Difference.*

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ABSTRAK

Penelitian ini menganalisis pengaruh fluktuasi harga minyak mentah dimana fluktuasi harga minyak mentah dipengaruhi oleh beberapa komponen seperti oil supply shocks, global demand shocks, dan oil-specific demand shocks kemudian menganalisis pengaruh dari masing-masing komponen tersebut terhadap indeks produksi industri manufaktur, indeks produksi industri makanan, minuman, dan tembakau, indeks produksi industri kimia dan barang-barang dari bahan kimia, minyak bumi, karet, dan plastik, serta indeks produksi industri barang dari logam, bukan mesin, dan peralatannya di Indonesia dengan pendekatan model Fukunaga et al (2009). Metode penelitian adalah VAR in difference dengan metode analisis adalah granger causality test, Impulse Response Function (IRF), dan Forecast Error Variance Decomposition (FEVD). Global demand shocks dan oil-specific demand shocks berpengaruh signifikan dan positif terhadap harga minyak mentah sedangkan oil supply shocks tidak berpengaruh signifikan. Oil-specific demand shocks berpengaruh signifikan terhadap indeks produksi industri manufaktur sementara oil supply shocks dan global demand shocks tidak berpengaruh signifikan. Variabel dekomposisi fluktuasi harga minyak yaitu oil supply shocks, global demand shocks, oil-specific demand shocks tidak berpengaruh signifikan terhadap indeks produksi industri makanan, mi-

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numan, dan tembakau, indeks produksi industri kimia dan barang-barang dari bahan kimia, minyak bumi, karet dan plastik, dan indeks produksi industri barang dari logam, bukan mesin, dan peralatannya.

Keywords: *Oil Supply Shocks, Global Demand Shocks, Oil-Specific Demand Shocks, Industri Manufaktur, VAR in Difference.*
JEL: Q31; L60; C10.

Introduction

Crude oil is one type of primary energy which is converted into various types of secondary energy such as gasoline and diesel and is used in the production process and distribution of the manufacturing industry. According to the Ministry of Industry (2012) until 2025 the manufacturing industry is dominated by the oil-intensive industry and diesel is still one of the main types of energy used in several sectors such as the food, beverage and tobacco industry with a projected total use of 45,223.6 gWh, while the industrial Chemicals and materials from chemicals, petroleum, rubber, and plastics are projected to require 24,750.8 gWh of diesel, the iron and steel base metal industry uses diesel as the main energy with a projected total demand of 5,094.9 gWh, and the need for diesel in the transportation equipment, machinery and equipment industry is estimated at 7,216.9 gWh.

The main challenge for the oil-intensive industry is the fluctuation of crude oil prices where oil prices rise and fall significantly over several periods of time. Based on data from the United State Energy Information Agency, from 1994 to 2000 the price of crude oil was stable at around 20 US$ per barrel, although in 1998 the price of oil fell in the range of 12 US$ per barrel. Then starting in 2003 the price increased quite significantly until its peak in 2008 reached 99 US$ per barrel. One year later the price dropped drastically to around 60 US$ per barrel. The price of crude oil increased significantly again in 2011 with the highest price of 111 US$ per barrel. After experiencing a drastic increase, then the price of crude oil fell drastically again with the lowest price reaching 40 US$ per barrel in 2016.

Kilian (2009) states that the main cause of oil price fluctuations is oil supply shocks caused by significant changes in the supply of crude oil, aggregate demand shocks caused by the accumulation of increasing global demand driven by the booming economies of countries in the world, and precautionary demand shocks due to expectations of the availability of crude oil in the future. The results of research by Fukunaga et al (2011) describe oil price fluctuations into three components by adopting the research model of Kilian (2009) and analyzing the dynamic impact of each component on the production index and price index of the manufacturing industry in the United States and Japan. The results show that changes in oil prices can affect each industry depending on the type of shocks underlying changes in oil prices and the characteristics of each industrial sector.

Previous studies such as the research of Asmara et al. (2011) in Indonesia made oil price fluctuations an exogenous variable, meanwhile there were various studies that proved that crude oil price fluctuations were influenced by various factors (Kilian, 2009; Fukunaga et al., 2011). Therefore, it is necessary to conduct research related to the factors that influence fluctuations in crude oil prices and the impact of each of these factors on the manufacturing industry in Indonesia. Using the concept of a research model approach by Fukunaga et al. (2011), this study aims to analyze the effect of each component of crude oil price fluctuations, namely oil supply shocks, global demand shocks, and oil-specific demand shocks on the aggregate manufacturing industry covering all sector (index of manufacturing industry production) and sectoral manufacturing industry (production index of food, beverage and tobacco indus-

try, production index of chemical industry and goods from chemicals, petroleum, rubber and plastics, industrial production index of metal goods, non-metal machinery and equipment).

Literature Review

Changes in crude oil production can be influenced by several factors such as geopolitical events and bad weather that disrupt the supply of crude oil and crude oil products to the market. Oil supply shocks affect oil price fluctuations by working through the supply side which will cause the supply of crude oil to decrease so prices increase. Crude oil is one of the main inputs in the production process of global industries. Increased production activity in the majority of industries in the world will increase demand for crude oil so that it will increase crude oil prices. Oil-specific demand shocks can be interpreted as expectations of producers and consumers of crude oil on future conditions and affect the fluctuations in crude oil prices by working through a supply and demand scheme. On the supply side, if producers expect that in the future the price of crude oil will be higher than today, then what is done is to temporarily stop the production process so that the supply of crude oil will decrease and cause the price of crude oil to increase. On the demand side, if consumers expect that in the future the price of oil will be higher than at present, then what is done is to buy oil in large quantities at this time to be stored as reserves for the future, this will have an impact on increasing demand while supply remains constant, causing crude oil prices increase.

Basically, oil supply shocks will have an impact on increasing crude oil prices and affect the manufacturing industry working through the supply side. On the supply side, as one of the production inputs in the manufacturing industry, an increase in crude oil prices will increase production costs in the manufacturing industry. An increase in production costs will be responded by producers by reducing the amount of product output. Global demand shocks will have an impact on increasing crude oil prices and affect the manufacturing industry working from the demand side. Although crude oil prices have increased, global demand shocks basically indicate an increase in industrial production and global economic activity, so that international trade will increase demand for manufacturing industry output. Meanwhile, oil-specific demand shocks will have an impact on increasing crude oil prices and affect the manufacturing industry working from the demand side. On the demand side, the increase in crude oil prices will have an impact on reducing disposable income so that it will reduce demand and the number of manufacturing industry outputs will decrease.

Research Hypothesis

Based on the description of the theory and previous research, the following research hypotheses can be formulated:

1. Hypothesis 1: oil supply shocks have a positive effect on crude oil prices.
2. Hypothesis 2: global demand shocks have a positive effect on crude oil prices.
3. Hypothesis 3: oil-specific demand shocks have a positive effect on crude oil prices.
4. Hypothesis 4: oil supply shocks have a negative effect on the production index of the manufacturing industry, the production index of the food, beverage and tobacco industry, the production index of the chemical industry and goods made of chemicals, petroleum, rubber and plastics, the production index of the metal goods industry, not the machine, and its equipment.
5. Hypothesis 5: global demand shocks have a positive effect on the manufacturing industry production index, the food, beverage and tobacco industry production index, the chemical industry production index and goods from chemicals, petroleum, rubber, and plastics, the metal goods industry production index, not the machine, and its equipment.

6. Hypothesis 6: oil-specific demand shocks have a negative effect on the production index of the manufacturing industry, the production index of the food, beverage and tobacco industry, the production index of the chemical industry and goods made from chemicals, petroleum, rubber, and plastics, the industrial production index of goods of metal, not machinery and equipment.

Research methods

Types and Sources of Data

The data that used in this study are secondary data that obtained from the United States Energy Information Administration (EIA), British Petroleum in the BP Statistical Review, the Organization for Economic Cooperation and Development (OECD), and the Central Bureau of Statistics (Badan Pusat Statistik). This study uses time series data, which is in the period January 1994 - December 2019. The data used in this study are as follows:

1. Global crude oil production of member countries in thousand barrels per day for the period January 1994 - December 2019 to represent oil supply shocks.
2. The global manufacturing industry production index for the period January 1994 - December 2019 is a proxy for global demand shocks.
3. The price of WTI crude oil used is the spot price in US$ for the period January 1994 - December 2019 to represent oil-specific demand shocks.
4. Manufacturing industry production index for the period January 1994 - December 2019.
5. Production index of the food, beverage and tobacco industry for the period January 1994 - December 2019.
6. Production index of the chemical industry and goods from chemicals, petroleum, rubber, and plastics for the period January 1994 - December 2019.
7. Industrial production index of goods made of metal, non-machinery and equipment for the period January 1994 - December 2019.

Analysis Method

The analytical method used in this research is Vector Autoregressive (VAR) in difference using Microsoft Excel 2010 and Eviews 9 as a tool in processing data.

The research model can be written in the following equation:

$$\mathrm{WTI\_PRICE}_t = \alpha_{1i} + \sum\beta_{1i}\mathrm{CRUDEOIL\_PROD}_{t-3} + \sum\gamma_{1i}\mathrm{IIP\_WORLD}_{t-3} + \sum\delta_{1i}\mathrm{WTI\_PRICE}_{t-3} + \varepsilon_t \quad (1)$$

$$\mathrm{MACRO}_t = \alpha_{2i} + \sum\beta_{2i}\mathrm{CRUDEOIL\_PROD}_{t-1} + \sum\gamma_{2i}\mathrm{IIP\_WORLD}_{t-1} + \sum\delta_{2i}\mathrm{WTI\_PRICE}_{t-1} + \varepsilon_t \quad (2)$$

$$\mathrm{IIP\_INA\_31}_t = \alpha_{3i} + \sum\beta_{3i}\mathrm{CRUDEOIL\_PROD}_{t-2} + \sum\gamma_{3i}\mathrm{IIP\_WORLD}_{t-2} + \sum\delta_{3i}\mathrm{WTI\_PRICE}_{t-2} + \varepsilon_t \quad (3)$$

$$\mathrm{IIP\_INA\_35}_t = \alpha_{4i} + \sum\beta_{4i}\mathrm{CRUDEOIL\_PROD}_{t-1} + \sum\gamma_{4i}\mathrm{IIP\_WORLD}_{t-1} + \sum\delta_{4i}\mathrm{WTI\_PRICE}_{t-1} + \varepsilon_t \quad (4)$$

$$\mathrm{IIP\_INA\_38}_t = \alpha_{5i} + \sum\beta_{5i}\mathrm{CRUDEOIL\_PROD}_{t-2} + \sum\gamma_{5i}\mathrm{IIP\_WORLD}_{t-2} + \sum\delta_{5i}\mathrm{WTI\_PRICE}_{t-2} + \varepsilon_t \quad (5)$$

Dimana:

$\alpha_{1i}, \ldots, \alpha_{5i}$	= n x 1 intercept vector on VAR model
$\beta_{1i}, \ldots, \beta_{5i}$; $\gamma_{1i}, \ldots, \gamma_{5i}$; $\delta_{1i}, \ldots, \delta_{5i}$	= matrix n x n autoregressive coefficients of vector
$\mathrm{WTI\_PRICE}_t$	= crude oil price
$\mathrm{CRUDEOIL\_PROD}_{t-i}\ (i = 1, 2, 3)$	= oil supply shocks
$\mathrm{IIP\_WORLD}_{t-i}\ (i = 1, 2, 3)$	= global demand shocks

WTI_PRICE_{t-i} $(i = 1, 2, 3)$	= oil-specific demand shocks
$IIP\_INA\_31_t$	= production index of the food, beverage, and tobacco industry
$IIP\_INA\_35_t$	= production index of chemical industry and goods from chemicals, petroleum, rubber and plastics
$IIP\_INA\_38_t$	= production index of metal goods industry, non-machinery and equipment
ε	= vector of random error

Results and Discussion

Stationary Test

Table 1: Result of Stationarity Test

Variable	Level		First Difference		Second Difference	
	Critical Value (5%)	ADF Test Statistic	Critical Value (5%)	ADF Test Statistic	Critical Value (5%)	ADF Test Statistic
LCRUDEOIL_PROD	-3.424340	-3.947550*	-3.424435	-14.53673*	-3.424926	-9.945567*
IIP_WORLD	-3.424482	-2.970913	-3.424482	-6.477828*	-3.424482	-24.77496*
LWTI_PRICE	-3.424387	-2.281632	-3.424387	-13.51681*	-3.424579	-13.96423*
MACRO	-3.424387	-5.055788*	-3.424387	-4.965971*	-3.424435	-17.64057*
IIP_INA_31	-3.424387	-3.219251	-3.424387	-3.986042*	-3.424435	-17.52241*
IIP_INA_35	-3.424387	-4.279613*	-3.424387	-4.722880*	-3.424435	-17.62038*
IIP_INA_38	-3.424977	-2.849781	-3.424977	-3.087795	-3.424977	-9.884268*

Source: Eviews

Determination of Lag Optimum

Table 2: Optimum Lag Length Test Results

Lag	AIC Crude Oil Price Fluctuation	AIC Crude Oil Price Fluctuation and Manufacturing Industry Production Index	AIC Crude Oil Price Fluctuation and Food, Beverage and Tobacco Industry Production Index	AIC Crude Oil Price Fluctuation and Industrial Production Index of Chemicals and Goods from Chemicals, Petroleum, Rubber and Plastics	AIC Crude Oil Price Fluctuation and Industrial Production Index of Metal, Non-Machinery and Equipment Industrial Products
0	-6.551974	-2.607131	-1.669493	-0.705838	-2.038911
1	-6.636464	-4.049949*	-3.465057	-3.250830*	-3.610919
2	-6.666981	-4.049226	-3.482068*	-3.171602	-3.620541*
3	-6.690772*	-4.046359	-3.478357	-3.091923	-3.619752
4	-6.657522	-3.997459	-3.409167	-2.960823	-3.555976
5	-6.623631	-3.940557	-3.347069	-2.831455	-3.495699
6	-6.600241	-3.893821	-3.310998	-2.827896	-3.471897
7	-6.558743	-3.826583	-3.250953	-2.710928	-3.405532
8	-6.553757	-3.795761	-3.232007	-2.575472	-3.369812

Determination of the optimum lag length, the results of which can be used in the Johansen cointegration test, Granger causality test and the formation of the VAR model. The

method for determining the optimum lag length is based on the Akaike Information Criterion (AIC) criteria in which these criteria can minimize the occurrence of underestimates and maximize the opportunity to get the actual lag length for small samples. Based on table 2, it can be seen that for the analysis of oil price fluctuations the recommended optimum lag length is 3. The recommended optimum lag length to analyze the effect of oil price fluctuations on the production index of the manufacturing industry in Indonesia is 1. The recommended optimum lag length to analyze the effect of price fluctuations oil on the production index of the food, beverage, and tobacco industries is 2. The recommended optimum lag length to analyze the effect of oil price fluctuations on the production index of the chemical industry and goods made of chemicals, petroleum, rubber and plastics is 1. Optimum lag length it is recommended to analyze the effect of oil price fluctuations on the industrial production index of metal goods, non-machinery, and equipment is 2.

Cointegration Test

The cointegration test that is used to analyze the existence of a long-term equilibrium relationship between two variables is the Johansen Cointegration Test method. The presence of cointegration can be determined by comparing the value of the trace statistic and the critical value at alpha 5% (α = 5%). If the trace statistic is greater than the critical value, it can be concluded that there is cointegration between the variables being analyzed. Based on table 3, there is no cointegration between variables in the overall analysis, so the analysis method used is VAR in difference.

Table 3: Cointegration Test Result

Analysis	Hypotesized Number of CE(s)	Trace Statistic	Critical Value (Trace) 0.05	Result
Crude Oil Price Fluctuation	None	20.72304	29.79707	No cointegration
	At most 1	6.635455	15.49471	
	At most 2	1.808250	3.841466	
Crude Oil Price Fluctuation and Manufacturing Industry Production Index	None	47.83984	47.85613	No cointegration
	At most 1	19.16673	29.79707	
	At most 2	8.028746	15.49471	
	At most 3	2.572050	3.841466	
Crude Oil Price Fluctuation and Food, Beverage and Tobacco Industry Production Index	None	34.79509	47.85613	No cointegration
	At most 1	19.90980	29.79707	
	At most 2	7.036331	15.49471	
	At most 3	1.743034	3.841466	
Crude Oil Price Fluctuation and Industrial Production Index of Chemicals and Goods from Chemicals, Petroleum, Rubber and Plastics	None	45.96695	47.85613	No cointegration
	At most 1	19.67396	29.79707	
	At most 2	8.196596	15.49471	
	At most 3	2.566273	3.841466	
Crude Oil Price Fluctuation and Industrial Production Index of Metal, Non-Machinery and Equipment Industrial Products	None	39.45881	47.85613	No cointegration
	At most 1	19.20628	29.79707	
	At most 2	6.834857	15.49471	
	At most 3	1.501095	3.841466	

VAR in difference Estimation

Based on the cointegration test results, it is concluded that the analysis carried out in this study is VAR in difference. The variable significance test was carried out by comparing the t-statistics of the VAR estimation results with the t-table value at a significance level of 5%. If the value of t-statistics > t-table, it can be concluded that a variable significantly affects the variable itself or other variables.

Table 4: VAR in difference Estimation Result of Crude Oil Price Fluctuation

Variable	Coefficient	t-stat
DLCRUDEOIL_PROD(-1)	-0.356768	[-0.61415]
DLCRUDEOIL_PROD(-2)	-0.820991	[-1.41184]
DLCRUDEOIL_PROD(-3)	-0.286623	[-0.48309]
DIIP_WORLD(-1)	0.009407	[1.52550]
DIIP_WORLD(-2)	0.014806	[2.41488]*
DIIP_WORLD(-3)	-0.000741	[-0.12122]
DLWTI_PRICE(-1)	0.223187	[3.83413]*
DLWTI_PRICE(-2)	0.019677	[0.32668]
DLWTI_PRICE(-3)	-0.093382	[-1.57750]
C	0.002267	[0.47468]

* Significant at 5% alpha

Through the Microsoft Excel program, the t-table value $_{df(0.05;312-3)}$ at alpha 5% for the VAR in difference estimation of the fluctuations in crude oil prices is 1.967671. Based on table 4, it can be seen that global demand shocks in the second lag have a positive and significant effect on crude oil prices as indicated by the value of t-statistics > t-table, that 2.41488 > 1.967671. In the second lag, the coefficient value is 0.014806 which means if there is an increase in global demand shocks of 1% in the second lag, then the price of crude oil in the current period will increase by 0.014806 per cent. Oil-specific demand shocks in the first lag also have a positive and significant effect on crude oil prices as indicated by the value of t-statistics > t-table, that 3.83413 > 1.967671. In the first lag the coefficient value is 0.223187, which means that if there is an increase in oil-specific demand shocks of 1% in the first lag, the price of crude oil in the current period will increase by 0.223187 percent.

Table 5: VAR in difference Estimation Result of Crude Oil Price Fluctuation and Manufacturing Industry Production Index

Variable	Coefficient	t-stat
DMACRO(-1)	0.906116	[48.9599]*
DLCRUDEOIL_PROD(-1)	3.082638	[0.47806]
DIIP_WORLD(-1)	0.041345	[0.61800]
DLWTI_PRICE(-1)	-0.122683	[-0.19317]
C	0.002052	[0.03860]

* Significant at 5% alpha

The value of t-table $_{df(0.05;312-4)}$ at 5% alpha for the VAR in difference estimation of the fluctuations in crude oil prices and manufacturing industry production index is 1.967696. Through table 5 it can be seen that the manufacturing industry production index is positively and significantly influenced by the variable itself which is indicated by the t-statistical value >

t-table, namely 48.9599 > 1.967696 in the first lag with a coefficient value of 0.906116 which means that if there is an increase in the manufacturing industry production index by 1% in the first lag, then the manufacturing industry production index in the current period will increase by 0.906116 percent.

Table 6: VAR in difference Estimation Result of Crude Oil Price Fluctuation and Food, Beverage and Tobacco Industry Production Index

Variable	Coefficient	t-stat
DIIP_INA_31(-1)	0.947691	[16.3906]*
DIIP_INA_31(-2)	-0.040218	[-0.70517]
DLCRUDEOIL_PROD(-1)	4.055272	[0.48783]
DLCRUDEOIL_PROD(-2)	7.096762	[0.85038]
DIIP_WORLD(-1)	-0.035641	[-0.40535]
DIIP_WORLD(-2)	-0.065481	[-0.75769]
DLWTI_PRICE(-1)	-0.576941	[-0.68892]
DLWTI_PRICE(-2)	0.835804	[0.97575]
C	0.018857	[0.27540]

* Significant at 5% alpha

Calculation result of the t-table value $_{df(0.05;312-4)}$ at alpha 5% for the estimated VAR in difference between fluctuations in crude oil prices and the food, beverage, and tobacco industry is 1.967696. Table 5 shows that the production index of the food, beverage, and the tobacco industry is influenced by the variable itself which is indicated by the value of t-statistics > t-table which is 16.3906 > 1.967696 in the first lag with a coefficient value of 0.947691 which means that if there is an increase in the production index of the food, beverage and tobacco industry by 1% in the first lag, then the production index of the food, beverage, and tobacco industry in the current period will increase by 0.947691 percent.

Table 7: VAR in difference Estimation Result of Crude Oil Price Fluctuation and Industrial Production Index of Chemicals and Goods from Chemicals, Petroleum, Rubber and Plastics

Variabel	Coefficient	t-stat
DIIP_INA_35(-1)	0.963795	[40.5303]*
DLCRUDEOIL_PROD(-1)	-22.50664	[-1.63390]
DIIP_WORLD(-1)	-0.066641	[-0.34352]
DLWTI_PRICE(-1)	0.291733	[0.17432]
C	-0.016952	[-0.12281]

* Significant at 5% alpha

The value of t-table $_{df(0.05;312-4)}$ at 5% alpha for the estimated VAR in difference of price fluctuations of crude oil and chemical industry and goods made from chemicals, petroleum, rubber, and plastics is 1.967696. Through table 7 the production index of the chemical industry and goods from chemicals, petroleum, rubber, and plastic is positively and significantly influenced by the variable itself which is indicated by the t-statistical value > t-table, namely 40.5303 > 1.967696 at the first lag with a coefficient value of 0.963795 which means if there is an increase in the production index of the chemical industry and goods from chemicals, petroleum, rubber and plastic by 1% in the first lag, then the production index of the chemical industry and goods from chemicals, petroleum, rubber and plastics in the current period will increase by 0.963795 percent.

Table 8: VAR in difference Estimation Result of Crude Oil Price Fluctuation and Industrial Production Index of Metal, Non-Machinery and Equipment Industrial Products

Variable	Coefficient	t-stat
DIIP_INA_38(-1)	0.930390	[16.1765]*
DIIP_INA_38(-2)	-0.034520	[-0.61406]
DLCRUDEOIL_PROD(-1)	3.242174	[0.41668]
DLCRUDEOIL_PROD(-2)	5.911341	[0.75652]
DIIP_WORLD(-1)	0.007592	[0.09246]
DIIP_WORLD(-2)	0.048542	[0.59984]
DLWTI_PRICE(-1)	-0.211499	[-0.26991]
DLWTI_PRICE(-2)	0.618404	[0.77145]
C	-0.020555	[-0.31886]

* Significant at 5% alpha

The value of t-table $_{df(0.05;312-4)}$ at 5% alpha for the estimated VAR in difference of fluctuations in prices for crude oil and industrial goods made of metal, non-machinery, and equipment is 1.967696. Through table 8 it can be seen that the industrial production index of metal, non-machine, and equipment products is positively and significantly influenced by the variable itself which is indicated by the t-statistical value > t-table, namely 16.1765 > 1.967696 in the first lag with the coefficient value is 0.930390, which means that if there is an increase in the industrial production index of metal, non-machine, and equipment industrial production by 1% in the first lag, then the industrial production index of metal, non-machine, and equipment industrial production in the current period will increase by 0,930390 percent.

Stability Test Results

The purpose of the stability test is to ensure that the VAR model with the chosen optimal lag is stable so as to produce valid and consistent estimates of IRF and FEVD. The VAR system can be declared stable if all polynomial roots up to the optimal lag have a modulus of not more than one and all of them lie within the unit circle. Based on the results of the VAR stability test, it can be concluded that all the VAR models used in this study were stable. The results of the VAR stability test can be seen in appendix 1.

Granger Causality Test Results

Table 9: Granger Causality Test Results of Crude Oil Price Fluctuations

Hypothesis	F-Stat	*p-value*
LCRUDEOIL_PROD does not Granger Cause LWTI_PRICE	0.87449	0.4546
LWTI_PRICE does not Granger Cause LCRUDEOIL_PROD	1.80373	0.1465
IIP_WORLD does not Granger Cause LWTI_PRICE	1.95805	0.1203
LWTI_PRICE does not Granger Cause IIP_WORLD	5.06764	0.0019*
IIP_WORLD does not Granger Cause LCRUDEOIL_PROD	1.18532	0.3155
LCRUDEOIL_PROD does not Granger Cause IIP_WORLD	1.94069	0.1230

* Significant at 5% alpha

The Granger causality test aims to determine the causal relationship between variables where the causal relationship that occurs between variables can be in the form of a one-way, two-way, or no relationship. The decision to reject or accept the null hypothesis in the

Granger causality test is made based on the p-value, H0 is rejected, which means a variable will affect other variables if the p-value is less than the 5% significant level (α = 0.05).

Based on table 9, it can be seen that there is no relationship between the variables of oil supply shocks and global demand shocks with oil prices.

Table 10: Granger Causality Test Results of Crude Oil Price Fluctuation and Manufacturing Industry Production Index

Hypothesis	**F-Stat**	***p-value***
LCRUDEOIL_PROD does not Granger Cause MACRO	50.8019	7.2921
MACRO does not Granger Cause LCRUDEOIL_PROD	0.69610	0.4047
IIP_WORLD does not Granger Cause MACRO	35.5012	6.9600
MACRO does not Granger Cause IIP_WORLD	0.02405	0.8769
LWTI_PRICE does not Granger Cause MACRO	10.2193	0.0015*
MACRO does not Granger Cause LWTI_PRICE	0.46901	0.4940

* Significant at 5% alpha

Based on the table, it can be seen that there is no causal relationship between the oil supply shocks and global demand shocks variables on the manufacturing industry production index, but there is a one-way causality relationship between the oil-specific demand shocks variable and the manufacturing industry production index.

Table 11: Granger Causality Test Results of Crude Oil Price Fluctuation and Food, Beverage and Tobacco Industry Production Index

Hypothesis	F-Stat	p-value
LCRUDEOIL_PROD does not Granger Cause IIP_INA_31	0.46901	0.6261
IIP_INA_31 does not Granger Cause LCRUDEOIL_PROD	0.35071	0.7045
IIP_WORLD does not Granger Cause IIP_INA_31	0.56949	0.5664
IIP_INA_31 does not Granger Cause IIP_WORLD	0.03250	0.9680
LWTI_PRICE does not Granger Cause IIP_INA_31	0.91107	0.4032
IIP_INA_31 does not Granger Cause LWTI_PRICE	0.92368	0.3982

Based on table 11, it can be seen that there is no relationship between the variables of oil supply shocks, global demand shocks, and oil-specific demand shocks on the production index of the food, beverage, and tobacco industries.

Table 12: Granger Causality Test Results of Crude Oil Price Fluctuation and Industrial Production Index of Chemicals and Goods from Chemicals, Petroleum, Rubber and Plastics

Hypothesis	**F-Stat**	***p-value***
LCRUDEOIL_PROD does not Granger Cause IIP_INA_35	67.1377	6.8575
IIP_INA_35 does not Granger Cause LCRUDEOIL_PROD	0.78636	0.3759
IIP_WORLD does not Granger Cause IIP_INA_35	97.2939	4.0091
IIP_INA_35 does not Granger Cause IIP_WORLD	0.17555	0.6755
LWTI_PRICE does not Granger Cause IIP_INA_35	53.4223	2.3292
IIP_INA_35 does not Granger Cause LWTI_PRICE	1.46346	0.2273

Based on table 12, it can be seen that there is no relationship between the variables of oil supply shocks, global demand shocks, and oil-specific demand shocks on the production index of the chemical industry and goods made of chemicals, petroleum, rubber and plastics.

Table 13: Granger Causality Test Results of Crude Oil Price Fluctuation and Industrial Production Index of Metal, Non-Machinery and Equipment Industrial Products

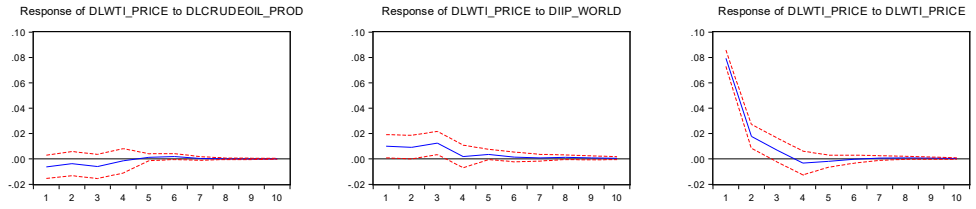
Hypothesis	F-Stat	*p-value*
LCRUDEOIL_PROD does not Granger Cause IIP_INA_38	0.08466	0.9188
IIP_INA_38 does not Granger Cause LCRUDEOIL_PROD	0.29071	0.7479
IIP_WORLD does not Granger Cause IIP_INA_38	0.33241	0.7175
IIP_INA_38 does not Granger Cause IIP_WORLD	0.74658	0.4748
LWTI_PRICE does not Granger Cause IIP_INA_38	0.76288	0.4672
IIP_INA_38 does not Granger Cause LWTI_PRICE	0.43010	0.6508

Based on table 13, it can be seen that there is no relationship between the variables of oil supply shocks, global demand shocks, and oil-specific demand shocks with the industrial production index of metal goods, not machinery, and equipment.

Impulse Response Function (IRF) Estimation Result

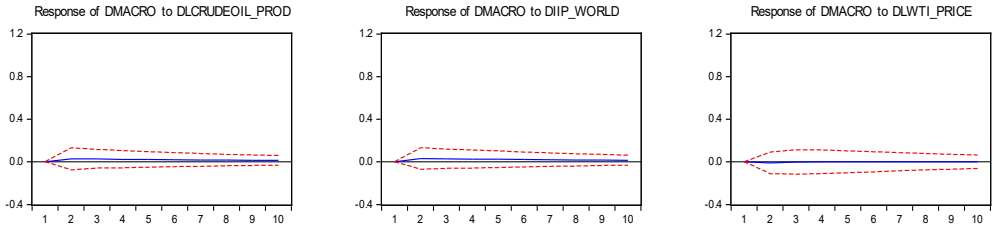
Impulse Response Function (IRF) is one of the analyzes used to read the results of the VAR model through the response given by a variable in each period when other variables experience shocks. If the impulse response image shows a movement that is getting closer to the equilibrium point (convergence) or returns to the previous balance, it means that the shocks do not have a permanent effect on the variable.

Figure 1: Impulse Response Function of Crude Oil Price Fluctuation



Based on Figure 1, it can be seen that the response given by crude oil prices when there are oil supply shocks, global demand shocks, and oil-specific demand shocks is close to zero (convergence) in the 6th to 7th periods.

Figure 2: Impulse Response Function of Crude Oil Price Fluctuation and Manufacturing Industry Production Index



Based on Figure 2, it can be seen that the response given by the manufacturing industry production index when there are oil supply shocks, global demand shocks, and oil-specific demand shocks is close to zero (convergence) in the 4th to 6th periods.

Based on Figure 3, it can be seen that the response given by the food, beverage and tobacco industry production index when there are oil supply shocks, global demand shocks, and oil-specific demand shocks is close to zero (convergence) in the 5th to 6th periods.

Figure 3: Impulse Response Function of Crude Oil Price Fluctuation and Food, Beverage and Tobacco Industry Production Index

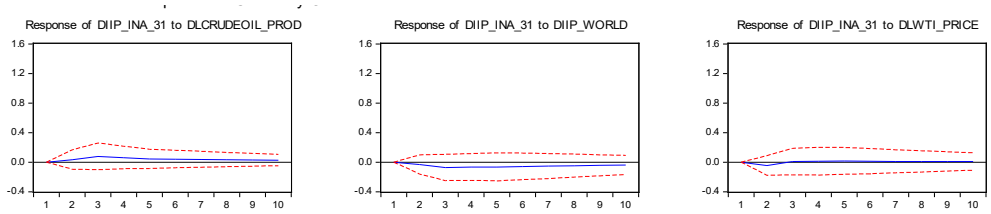
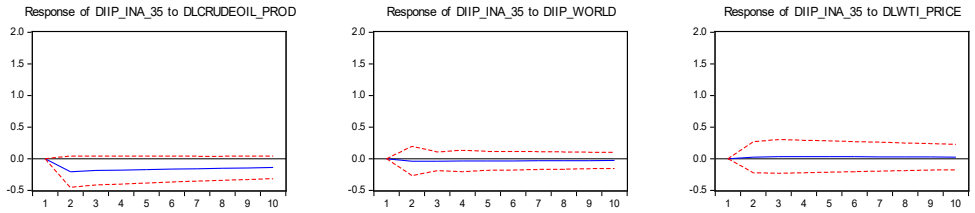
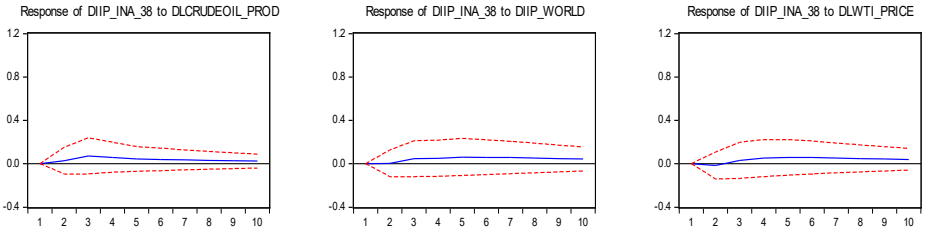


Figure 4: Impulse Response Function of Crude Oil Price Fluctuation and Industrial Production Index of Chemicals and Goods from Chemicals, Petroleum, Rubber and Plastics



Based on Figure 4, it can be seen that the response given by the production index of the chemical industry and goods from chemicals, petroleum, rubber and plastics when there are oil supply shocks, global demand shocks, and oil-specific demand shocks is close to zero (convergence) in 2nd to 7th period.

Figure 5: Impulse Response Function of Crude Oil Price Fluctuation and Industrial Production Index of Metal, Non-Machinery and Equipment Industrial Products



Based on Figure 5, it can be seen that the response given by the industrial production index of metal goods, not machinery, and equipment when there are oil supply shocks, global demand shocks, and oil-specific demand shocks is close to zero (convergence) in the second period.

Forecast Error Variance Decomposition (FEVD) Estimation Result

Forecast Error Variance Decomposition (FEVD) explains how innovation in one variable is against other variable components in VAR. The result of FEVD estimation is the proportion of sequential movements caused by shocks in the variable itself and also by other variables.

Table 14: Forecast Error Variance Decomposition of Crude Oil Price Fluctuation

Period	DLWTI_PRICE	DLCRUDEOIL_PROD	DIIP_WORLD
1	100.0000	0.000000	0.000000
2	99.23131	0.077272	0.691420
3	96.98192	0.479638	2.538446
4	96.87402	0.520530	2.605449

Period	DLWTI_PRICE	DLCRUDEOIL_PROD	DIIP_WORLD
5	96.67147	0.538854	2.789677
6	96.59736	0.583307	2.819337
7	96.58745	0.585275	2.827279
8	96.56867	0.585135	2.846194
9	96.56282	0.585060	2.852119
10	96.55924	0.585035	2.855721

Based on table 14 shows the estimated variance decomposition of crude oil price fluctuations where in the 10th period, the contribution made by oil supply shocks and global demand shocks is 0.58 percent and 2.85 percent, respectively.

Table 15: Forecast Error Variance Decomposition of Crude Oil Price Fluctuation and Manufacturing Industry Production Index

Period	DMACRO	DLCRUDEOIL_PROD	DIIP_WORLD	DLWTI_PRICE
1	100.0000	0.000000	0.000000	0.000000
2	99.88022	0.052285	0.061166	0.006330
3	99.83946	0.072784	0.082876	0.004876
4	99.81861	0.082163	0.095229	0.004002
5	99.80618	0.087676	0.102662	0.003485
6	99.79809	0.091217	0.107536	0.003152
7	99.79252	0.093650	0.110902	0.002924
8	99.78852	0.095395	0.113321	0.002761
9	99.78556	0.096685	0.115111	0.002640
10	99.78333	0.097661	0.116466	0.002548

Table 15 shows the estimated variance decomposition of crude oil price fluctuations and the manufacturing industry production index where in the 10th period, the contribution made by oil supply shocks, global demand shocks, and oil-specific demand shocks was 0.09 percent, 0.11 percent, and 0.002 percent, respectively.

Table 16: Forecast Error Variance Decomposition of Crude Oil Price Fluctuation and Food, Beverage and Tobacco Industry Production Index

Period	DIIP_INA_31	DLCRUDEOIL_PROD	DIIP_WORLD	DLWTI_PRICE
1	100.0000	0.000000	0.000000	0.000000
2	99.83223	0.044994	0.041096	0.081680
3	99.56209	0.197909	0.180007	0.059994
4	99.45823	0.242859	0.247316	0.051594
5	99.41031	0.245220	0.295762	0.048710
6	99.37619	0.249034	0.328046	0.046729
7	99.35127	0.252855	0.350941	0.044935
8	99.33370	0.255266	0.367456	0.043582
9	99.32047	0.257022	0.379926	0.042584
10	99.31045	0.258376	0.389352	0.041818

Table 16 shows the estimated variance decomposition of crude oil price fluctuations and the production index of the food, beverage, and tobacco industries where in the 10th

period, the contribution made by oil supply shocks, global demand shocks, and oil-specific demand shocks was 0.25 percent, 0.38 percent, and 0.04 percent, respectively.

Table 17: Forecast Error Variance Decomposition of Crude Oil Price Fluctuation and Industrial Production Index of Chemicals and Goods from Chemicals, Petroleum, Rubber and Plastics

Period	DIIP_INA_35	DLCRUDEOIL_PROD	DIIP_WORLD	DLWTI_PRICE
1	100.0000	0.000000	0.000000	0.000000
2	98.97672	0.979055	0.033644	0.010580
3	98.69673	1.226789	0.051010	0.025471
4	98.55723	1.353863	0.056441	0.032468
5	98.47370	1.428720	0.060636	0.036947
6	98.41872	1.478363	0.063095	0.039826
7	98.37973	1.513444	0.064936	0.041892
8	98.35079	1.539519	0.066271	0.043417
9	98.32851	1.559583	0.067309	0.044594
10	98.31090	1.575454	0.068126	0.045524

Table 17 shows the estimated variance decomposition of crude oil price fluctuations and the production index of the chemical industry and goods from chemicals, petroleum, rubber and plastics where in the 10th period, the contribution made by oil supply shocks, global demand shocks, and oil-specific demand shocks were 1.57 percent, 0.06 percent, and 0.04 percent, respectively.

Table 18: Forecast Error Variance Decomposition of Crude Oil Price Fluctuation and Industrial Production Index of Metal, Non-Machinery and Equipment Industrial Products

Period	DIIP_INA_38	DLCRUDEOIL_PROD	DIIP_WORLD	DLWTI_PRICE
1	100.0000	0.000000	0.000000	0.000000
2	99.95149	0.035069	0.000638	0.012804
3	99.69489	0.193158	0.069905	0.042042
4	99.51498	0.253663	0.125032	0.106327
5	99.36514	0.265886	0.197247	0.171730
6	99.24605	0.273541	0.253567	0.226846
7	99.15036	0.279737	0.302267	0.267640
8	99.07781	0.283711	0.339480	0.298994
9	99.02188	0.286506	0.368653	0.322959
10	98.97916	0.288562	0.390977	0.341303

Table 18 shows the estimated variance decomposition of crude oil price fluctuations and the industrial production index of metal, non-machinery, and equipment industrial production in the 10th period. The contribution of oil supply shocks, global demand shocks, and oil-specific demand shocks is 0.28 percent, 0.39 percent, and 0.34 percent, respectively.

Crude Oil Price Fluctuation Analysis

Based on the results of the VAR test in difference oil supply shocks have no significant and positive effect on crude oil prices, global demand shocks have a significant and positive effect on crude oil prices, and oil-specific demand shocks have a significant and positive effect

on crude oil prices. Although, according to the causality test results, the Granger oil supply shocks and global demand shocks have no effect on crude oil prices. The Granger causality test aims to determine whether oil supply shocks, global demand shocks, and oil-specific demand shocks cause crude oil prices, which means how much value of the oil price variable in the current period can be explained by the value of the oil supply shocks, global demand variable shocks, and oil-specific demand shocks in the previous period. So it can be analyzed from the results of the estimated error variance decomposition (FEVD), where the contribution to crude oil prices given by oil supply shocks and global demand shocks is 0.58 percent and 2.85 percent, respectively. While oil-specific demand shocks of 96.55 percent. Based on the impulse response function (IRF) test results, the effect of oil supply shocks, global demand shocks, and oil-specific demand shocks on crude oil prices occurs in the short term. This is consistent with the research results by Arezki et al. (2017), where an oil supply and demand shock results in large oil price movements from time to time in the short term, and changes in supply and demand for oil determine the future oil price cycles.

Oil supply shocks do not have a significant effect but have a contribution to crude oil prices according to the research results of Kilian (2009), when political events occur which result in disruption of crude oil supply so that the amount of crude oil increases. Basically, the increase in the price of crude oil as a result of insecurity triggered by future supply constraints of crude oil. So, it can be said that the shock of crude oil demand or special demand for oil has a greater role in the fluctuation of crude oil prices than the shock of oil supply. Global demand shocks and oil-specific demand shocks have a significant effect on crude oil prices with a fairly large contribution which is in accordance with Fukunaga's research (Fukunaga et al., 2011). Oil-specific demand shocks have the largest and most persistent effect on significantly increasing oil prices. Global demand shocks also have a large and persistent effect on persistent increases in oil prices, while oil supply shocks have only a minor and temporary effect on rising oil prices. Based on these results, it can be stated that the effect of each component of the shock on crude oil prices differs in magnitude and persistence.

Oil Price Fluctuation and Manufacturing Industry Analysis

The results of the VAR in difference test (t-test) of crude oil price fluctuations and the manufacturing industry production index are the decomposition variables of oil price fluctuations, namely oil supply shocks, global demand shocks, oil-specific demand shocks, which have no effect on the manufacturing industry production index variable. However, based on the results of the Granger causality test, the variable oil-specific demand shocks statistically significantly affect the production index of the manufacturing industry. If analyzed from the results of the estimated variance decomposition of crude oil price fluctuations and the manufacturing industry production index, the contributions made by oil supply shocks, global demand shocks, and oil-specific demand shocks are 0.09 percent, 0.11 percent, and 0.002 percent, respectively.

Oil supply shocks, global demand shocks, and oil-specific demand shocks did not have a significant effect but did contribute to the manufacturing industry production index variable. According to Segal (2007), oil shocks are only one of the variables that affect the production index of the manufacturing industry, so it cannot be said that oil shocks are a determining factor for the decline in the performance of the manufacturing industry production index. The most important component of the impact of oil shocks on output is monetary policy. If oil shocks increase inflation, the monetary authority will then increase interest rates so that economic activity will decline. In the 1970s, the majority of the global economy experienced a

downturn due to high inflation and slow economic growth, where oil shocks contributed but were not the only determining variable.

Based on the results of the VAR in difference test, each decomposition variable of oil price fluctuations, namely oil supply shocks, global demand shocks, and oil-specific demand shocks did not have a significant effect on the variable production index of the food, beverage, and tobacco industries, the production index of the chemical and industrial goods industries. goods from chemicals, petroleum, rubber, and plastics, and industrial production index of goods made of metal, non-machinery, and equipment. This is in accordance with the results of the Granger causality test that there is no relationship between each decomposition variable of oil price fluctuations, namely oil supply shocks, global demand shocks, oil-specific demand shocks, and the food, beverage, and tobacco industry production index, industrial production index chemicals and goods made of chemicals, petroleum, rubber and plastics, and the index of industrial production of goods made of metal, non-machine, and equipment. Meanwhile, based on the results of the estimated error variance decomposition, the contributions made by oil supply shocks, global demand shocks, and oil-specific demand shocks to the production index variables of the food, beverage, and tobacco industries are 0.25 percent, 0.38 percent, and 0.04 percent, respectively.

The contribution made by oil supply shocks, global demand shocks, and oil-specific demand shocks to the production index of the chemical industry and goods made from chemicals, petroleum, rubber, and plastics was 1.57 percent, 0.06 percent, and 0.04 percent, respectively. Oil supply shocks, global demand shocks, and oil-specific demand shock to the industrial production index of metal, non-machine, and industrial equipment goods were 0.28 percent, 0.39 percent, and 0.34 percent, respectively. So, it can be stated that the response of each manufacturing industry sector to oil supply shocks, global demand shocks, and oil-specific demand shocks shows almost the same results and is in accordance with the research of Jo et al. (2017) that the output response to oil price fluctuations has a pattern which is very similar across industry sectors.

Oil-specific demand shocks have no significant effect on the production index of the food, beverage, and tobacco industry, the production index of the chemical industry and goods made of chemicals, petroleum, rubber, and plastics, and the production index of the metal, non-machine, industrial production index, and equipment but has a contribution to the industrial output of the sector. These results can be analyzed from two points of view, namely demand and supply. From the demand side, according to Soojin Jo et al. (2017), global crude oil price fluctuations impact the manufacturing industry through the discretionary income effect transmission channel. The increase in global crude oil prices will trigger an increase in fuel prices. Since the demand for fuel oil is price inelastic, an increase in oil prices acts as an unanticipated oil tax for consumers. It will have an impact on reducing real disposable income and triggering a reduction in consumption levels, especially for complementary energy consumption goods, such as reducing industrial aggregate demand and changing industrial output in a general way.

However, fluctuations in global crude oil prices have no significant effect on changes in industrial output, based on the results of the Bangun (2012) research caused by the policy of providing fuel subsidies covering premium, diesel, and crude oil by the Indonesian government which serves as a countereffect of oil tax for consumers when there are fluctuations in oil prices. According to The Habibie Center report, subsidies are given because the selling price of fuel set by the government is lower than the market price or the cost of procurement

(Salim et al., 2014). Fuel subsidies are intended to ease the burden on the incapable group in obtaining fuel so that it is expected to have an impact on the affordable price of other staple commodities. According to the Ministry of Finance, the total value of fuel subsidies provided fluctuated from 2005 to 2019 with the largest value being 240.0 trillion rupiah or about 61.2% of the total subsidies in 2014 while the smallest subsidy value was 41.1 trillion rupiah or about 20.3% of the total subsidies in 2019.

On the supply side, fluctuations in crude oil prices are seen as cost shocks or productivity shocks in oil-importing countries. When there is an increase in oil prices, it will increase production costs so that producers reduce the use of oil which has an impact on capital and labor productivity. The biggest impact of the mechanism of transmission of cost shocks or productivity shocks is industrial output, especially in the oil-intensive industry. In this regard, the results of the study that oil-specific demand shocks did not have a significant effect on the variable production index of the food, beverage, and tobacco industries, the index of the production of chemical industries and goods from chemicals, petroleum, rubber and plastics, and the industrial production index of goods from metals, not machinery, and equipment but contributed to the industrial sector in accordance with the results of research by Fukunaga et al. (2011) that the production response in oil-intensive Industry in the United States against fluctuations in crude oil prices caused by oil-specific demand shocks is not too large. This can happen because the percentage of oil costs to the overall cost of production is quite low.

Based on data from the Ministry of Energy and Mineral Resources (2019) which shows the amount of energy consumption of the manufacturing industry sector per type of energy, the average use of fuel oil decreased every year from 2009 to 2019 where in 2009 the amount of consumption was 59,451 thousand BOE and fell to 26,685 thousand BOE in 2019. Energy use in the manufacturing industry as one of the most widely sourced production inputs from coal and gas with the average amount of consumption increased every year from 2009 to 2019. The amount of coal consumption in 2009 was 82,587 thousand BOE increased to 167,412 thousand BOE in 2019. While the amount of gas consumption in 2009 was 89,101 thousand BOE increased to 94,160 thousand BOE in 2019. Meanwhile, according to the Dewan Energi Nasional (2019), some of the industrial sub-sectors that consume the most energy, namely the metal, food, beverage, and fertilizer industries, began to switch to other types of energy such as natural gas, most commonly used to meet the demands of the metal and fertilizer industry (as raw materials) with a total consumption of about 83% of the total natural gas demand in the industrial sector as well as new and renewable energy (EBT) especially. used for the food industry. Some food industries also still use biomass as fuel.

Global demand shocks have no significant effect on the variables of the food, beverage, and tobacco industrial production index, the chemical and goods industrial production index of chemicals, petroleum, rubber and plastics, and the industrial production index of goods of metals, not machinery, and equipment but contribute to the industrial output of the sector. According to Fukunaga et al. (2011) the increasing global demand for all manufacturing industry commodities that cannot be predicted will gradually increase output, especially for the manufacturing industry with the largest export market. But global demand shock does not affect the output of the manufacturing industry in Indonesia, it can be caused because global demand shock is not the only major factor in international trade. According to Kahfi (2016) some of the main factors determining Indonesia's manufacturing exports are the GDP of trade partner countries, the stability of the rupiah exchange rate, bureaucratic processes and trading time in international trade, tariffs, and cooperation such as free trade agreements (FTA).

Oil supply shocks have no significant effect on the variables of the food, beverage, and tobacco industrial production index, the chemical industry production index and goods from chemicals, petroleum, rubber and plastics and the industrial production index of goods from metals, not machinery, and equipment but contribute to the industrial output of the sector. The largest contribution of oil supply shocks was 1.57 percent to the chemical industry production index and goods from chemicals, petroleum, rubber and plastics. This can be caused because Indonesia as one of the crude oil producers in the world, so oil supply shocks have contributed to changes in industrial output, especially petroleum refining. In accordance with research by Fukunaga et al. (2011) that oil supply shocks gradually and persistently will have an impact on reducing oil refining production. But oil supply shocks are not the only determining factor in crude oil output, according to the Dewan Energy Nasional (2019) Indonesia's crude oil production since 1995 has decreased significantly from 1.6 million barrels per day to 778 barrels per day in 2018 due to a natural decline in reserves and the lack of optimal application of Enhanced Oil Recovery (EOR) technology in most old oil fields in Indonesia as well as low investment. Exploration. In2009, Indonesia's crude oil production amounted to 346,313 thousand bbl, and every year the amount of production decreased. In 2019, Indonesia's crude oil production was 272,025 thousand bbl (Ministry of Energy and Mineral Resources, 2019).

Conclusion

1. Oil supply shocks had no significant effect but contributed 0.58 percent to crude oil prices. Global demand shocks had a significant effect with a contribution of 2.85 percent to crude oil prices. Oil-specific demand shocks had a significant effect with contributions of 2.85 percent and 96.55 percent to crude oil prices.
2. Oil supply shocks had no significant effect but contributed to the variable manufacturing industry production index of 0.09 percent. Global demand shocks had no significant effect but contributed to the variable manufacturing industry production index of 0.11 percent. Meanwhile, oil-specific demand shocks have a significant effect on the variable manufacturing industry production index with a contribution of 0.002 percent.
3. Variable decomposition of oil price fluctuations i.e. oil supply shocks, global demand shocks, oil-specific demand shocks have no significant effect but have contributed to the variables of the food, beverage, and tobacco industry production index, the chemical industry production index and goods from chemicals, petroleum, rubber and plastics, and the industrial production index of goods from metals, not machinery, and equipment. The contribution made by oil supply shocks, global demand shocks, and oil-specific demand shocks to variable food, beverage, and tobacco industry production indexes is 0.25 percent, 0.38 percent, and 0.04 percent, respectively. The contribution made by oil supply shocks, global demand shocks, and oil-specific demand shocks to the chemical industry production index and goods from chemicals, petroleum, rubber and plastics was 1.57 percent, 0.06 percent, and 0.04 percent, respectively. The contribution made by oil supply shocks, global demand shocks, and oil-specific demand shocks to the industrial production index of goods from metals, not machinery, and equipment is 0.28 percent, 0.39 percent, and 0.34 percent, respectively.

Limitations of Research

Based on the results of research and discussion, it can be known that in this study there are still shortcomings such as:

1. The data used to project *oil supply shocks* represents only a portion of oil-producing countries, including those registered as members of unions such as OPEC and the *Persian Gulf Nation*. As well as countries that have international oil companies such as the UK which owns *British Petroleum* (BP), Saudi Arabia with *Saudi Aramco*, *China National Petroleum Corporation* (CNPC) with Chinese state ownership, and *Statoil* owned by Norway.

2. The data used to project *global demand shocks* is the average of the production index values of the manufacturing industries of OECD countries, Brazil, and South Africa where they represent only a small fraction of the world economy today.

3. This research only focuses on the manufacturing industry and some sectors that fall into the *oil-intensive industry* category, while sectors in the less *oil-intensive industry* category are not included as research objects.

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Appendix. VAR stability Test Result

Roots of Characteristic Polynomial	
Endogenous variables: DLWTI_PRICE DLCRUDEOIL_PROD DIIP_WORLD	
Exogenous variables: C	
Lag specification: 1 3	
Date: 06/23/21 Time: 14:46	
Root	Modulus
0.729716	0.729716
-0.385283 - 0.434469i	0.580695
-0.385283 + 0.434469i	0.580695
0.327245 - 0.385002i	0.505288
0.327245 + 0.385002i	0.505288
0.078440 - 0.456389i	0.463081
0.078440 + 0.456389i	0.463081
-0.372802 - 0.024737i	0.373622
-0.372802 + 0.024737i	0.373622

No root lies outside the unit circle.
VAR satisfies the stability condition.

Roots of Characteristic Polynomial	
Endogenous variables: DMACRO DLCRUDEOIL_PROD DIIP_WORLD DLWTI_PRICE	
Exogenous variables: C	
Lag specification: 1 1	
Date: 06/23/21 Time: 14:52	
Root	Modulus
0.905600	0.905600
0.290429	0.290429
-0.171043	0.171043
0.001125	0.001125

No root lies outside the unit circle.
VAR satisfies the stability condition.

Roots of Characteristic Polynomial	
Endogenous variables: DIIP_INA_31 DLCRUDEOIL_PROD DIIP_WORLD DLWTI_PRICE	
Exogenous variables: C	
Lag specification: 1 2	
Date: 06/23/21 Time: 14:55	
Root	Modulus
0.901538	0.901538
0.553062	0.553062
-0.454631	0.454631
-0.128831 - 0.331184i	0.355359
-0.128831 + 0.331184i	0.355359
0.104049 - 0.223946i	0.246937
0.104049 + 0.223946i	0.246937
0.083305	0.083305
No root lies outside the unit circle.	
VAR satisfies the stability condition.	

Roots of Characteristic Polynomial	
Endogenous variables: DIIP_INA_35 DLCRUDEOIL_PROD DIIP_WORLD DLWTI_ PRICE	
Exogenous variables: C	
Lag specification: 1 1	
Date: 06/23/21 Time: 14:57	
Root	Modulus
0.958874	0.958874
-0.381199	0.381199
0.102503	0.102503
-0.056214	0.056214
No root lies outside the unit circle.	
VAR satisfies the stability condition.	

Roots of Characteristic Polynomial	
Endogenous variables: DIIP_INA_38 DLCRUDEOIL_PROD DIIP_WORLD DLWTI_ PRICE	
Exogenous variables: C	
Lag specification: 1 2	
Date: 06/23/21 Time: 14:59	

Root	Modulus
0.889469	0.889469
0.548668	0.548668
-0.463278	0.463278
-0.115209 - 0.329209i	0.348786
-0.115209 + 0.329209i	0.348786
0.110769 - 0.227344i	0.252893
0.110769 + 0.227344i	0.252893
0.055406	0.055406

No root lies outside the unit circle.
VAR satisfies the stability condition.