EFFECT OF GLOBAL ENERGY AND FOOD PRICES AND EXCHANGE RATE ON ENERGY AND NON-ENERGY IMPORT DEMAND: EMPIRICAL EVIDENCE FROM INDONESIA

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Abstract. This research aims to analyze the effect of changes in global energy and food prices and exchange rates on demand for oil and gas and non-oil and gas imports in Indonesia. This research applies the Autoregressive Distributed Lag (ARDL) model to capture long-run and short-run effects. The research period taken was 2012M01 – 2023M02. Empirical findings show that in the long run, global oil prices, food prices, and exchange rates have a negative effect on demand for oil and gas imports in Indonesia. Meanwhile, global food prices have a negative effect on non-oil and gas imports. Indonesia, which still depends on imports of non-oil and gas commodities, especially food imports, will be vulnerable to food inflation problems caused by food imports. In the short run, the influence of oil prices and exchange rates on oil and gas imports is distributed over several months. Meanwhile, coal prices and the exchange rate have a negative effect on non-oil and gas imports. In the short run, imports of oil and gas and non-oil and gas commodities, which tend to be uncontrolled by changes in world commodity prices and exchange rates, need to be a concern for policymakers in reducing the impact on domestic inflation. The trend of non-oil and gas imports that are increasing all the time needs to be of concern to the government regarding the impact of rising global commodity prices and the depreciation of the local currency on domestic inflation through imports.

Keywords: global energy and food prices, exchange rates, Autoregressive Distributed Lag model, oil and gas imports, non-oil and gas imports

A. Introduction

Imports have an important role in supporting economic growth and high domestic demand. Because in domestic production and consumption activities imported goods are a solution to the need for goods that cannot be produced themselves, or because production is inefficient. Imports have a major impact on domestic economic growth, especially if these goods are capital goods and goods as the main input in production activities or as basic consumption goods for households. Therefore, an increase in imports could be an indication of a better improvement in the domestic economy relative to the global economy, due to increased growth and robust domestic demand. In supporting production and consumption activities, Indonesia currently still relies on imports of both oil and gas and non-oil and gas commodities.

In general, importing goods has several advantages. First, import activities provide opportunities to introduce new products in the domestic market. Second, imported goods can help reduce domestic manufacturing costs. Third, import activities can provide opportunities

for imported products to become leaders in the industry. Fourth, import activities can bring quality products to the domestic market.

So far, Indonesia still relies on domestic needs from imports, both oil and gas imports and non-oil and gas imports. Non-oil and gas imports are generally for food commodities and agricultural production inputs, such as fertilizers and animal feed. Meanwhile, the dynamics of global commodity prices will have an impact on imports into the country.

Empirically, there are still very limited studies that link external factors such as international commodity prices and exchange rates with the dynamics of commodity imports in countries that still rely on imports such as Indonesia. Most studies only link them to the dynamics of domestic prices [1-9]. It is important to conduct studies that link external factors including global commodity prices and exchange rates to domestic imports as real activities that have implications for production and consumption.

This study relates external factors to the dynamics of domestic oil and non-oil imports in the context of short-run and long-run relationships. This research aims to analyse the effect of changes in global energy and food prices and exchange rates on demand for oil and gas and non-oil and gas imports in Indonesia.

B. Methods

1. Data and Variable

The data analyzed in this study are monthly data for the period January 2012 - February 2023. There are two dependent variables, namely oil and gas imports and non-oil and gas imports, and each dependent variable is positioned in the first and second equations. Meanwhile, the explanatory variables (for both dependent variables) include international oil prices, natural gas prices, coal prices, food price indexes, and exchange rates.

Imports of oil and gas (IMOIL) and non-oil and gas (IMNOIL) are stated in real terms in thousand tons. The international oil price (POIL) is the price of oil expressed in $/bbl, in terms of dollars per barrel. The international natural gas price (PG) is expressed in $/mmbtu (Metric Million British Thermal Unit). The coal price (PC) is expressed in $/mt (metric ton). World food prices (PF) are expressed in an index, which is a composite of cereals, oils and meals, and other foods. The price index uses the base year 2010 (2010 = 100). Meanwhile, the exchange rate (ER) is the rupiah exchange rate against the US dollar expressed in Rupiah per US dollar. An increase in the nominal value indicates a depreciation of the rupiah and vice versa. All variables are expressed in natural logarithms (LN). Oil and gas and non-oil import data were obtained from BPS-Statistics Indonesia. International commodity prices were accessed online from the World Bank. Meanwhile, exchange rate data was accessed from Bank Indonesia.

2. Model

Following the research objectives, the model formulation is carried out by applying the Autoregressive Distributed Lag (ARDL) model to capture long-run and short-run effects. After the estimated model is designed, a pre-model test is needed which includes a unit root test on the data for the purpose of determining stationary variables at the first level or difference. The results of the unit root test will determine the form of the ARDL model. Furthermore, from the estimated model, tests are carried out on the results, which include bound tests, model, and variable significance tests.

The ARDL model developed refers to the previous model [10-11]. With adjustments to the dependent and explanatory variables, the model is formulated as in equations (1) to (4).

$$LNIMOIL_t = + \ {}_0LNIMOIL_{t-1} + \ {}_1LNPOIL_{t-1} + \ {}_2LNPG_{t-1} + \ {}_3LNPC_{t-1} + \ {}_4LNPF_{t-1} + \ {}_5LNER_{t-1} + \sum_{i=1}^{k-1} {}_{0i}LNIMOIL_{t-i} + \sum_{i=0}^{l-1} {}_{1i}LNPOIL_{t-i} + \sum_{i=0}^{m-1} {}_{2i}LNPG_{t-i} + \sum_{i=0}^{n-1} {}_{3i}LNPC_{t-i} + \sum_{i=0}^{p-1} {}_{4i}LNPF_{t-i} + \sum_{i=0}^{q-1} {}_{5i}LNER_{t-i} + {}_{1t} \quad (1)$$

With the expected long-run parameters:

$$-\frac{{}_1}{{}_0} < 0, -\frac{{}_2}{{}_0} < 0, -\frac{{}_3}{{}_0} < 0, -\frac{{}_4}{{}_0} < 0, -\frac{{}_5}{{}_0} < 0$$

The model in short-run equation form of equation (1) is stated as follows.

$$LNIMOIL_t = + \sum_{i=1}^{k-1} {}_{0i}LNIMOIL_{t-i} + \sum_{i=0}^{l-1} {}_{1i}LNPOIL_{t-i} + \sum_{i=0}^{m-1} {}_{2i}LNPG_{t-i} + \sum_{i=0}^{n-1} {}_{3i}LNPC_{t-i} + \sum_{i=0}^{p-1} {}_{4i}LNPF_{t-i} + \sum_{i=0}^{q-1} {}_{5i}LNER_{t-i} + ECT_{1t-1} + {}_{1t} \quad (2)$$

Where:

$$ECT_{1t-1} = LNIMOIL_{t-1} - (\ {}_1LNPOIL_{t-1} + \ {}_2LNPG_{t-1} + \ {}_3LNPC_{t-1} + \ {}_4LNPF_{t-1} + \ {}_5LNER_{t-1})$$

$$LNIMNOIL_t = + \ {}_0LNIMNOIL_{t-1} + \ {}_1LNPOIL_{t-1} + \ {}_2LNPG_{t-1} + \ {}_3LNPC_{t-1} + \ {}_4LNPF_{t-1} + \ {}_5LNER_{t-1} + \sum_{i=1}^{k-1} {}_{0i}LNIMNOIL_{t-i} + \sum_{i=0}^{l-1} {}_{1i}LNPOIL_{t-i} + \sum_{i=0}^{m-1} {}_{2i}LNPG_{t-i} + \sum_{i=0}^{n-1} {}_{3i}LNPC_{t-i} + \sum_{i=0}^{p-1} {}_{4i}LNPF_{t-i} + \sum_{i=0}^{q-1} {}_{5i}LNER_{t-i} + {}_{2t} \quad (3)$$

With the expected long-run parameters:

$$-\frac{{}_1}{{}_0} < 0, -\frac{{}_2}{{}_0} < 0, -\frac{{}_3}{{}_0} < 0, -\frac{{}_4}{{}_0} < 0, -\frac{{}_5}{{}_0} < 0$$

The model in short-run equation form of equation (3) is stated as follows.

$$LNIMNOIL_t = + \sum_{i=1}^{k-1} {}_{0i}LNIMNOIL_{t-i} + \sum_{i=0}^{l-1} {}_{1i}LNPOIL_{t-i} + \sum_{i=0}^{m-1} {}_{2i}LNPG_{t-i} + \sum_{i=0}^{n-1} {}_{3i}LNPC_{t-i} + \sum_{i=0}^{p-1} {}_{4i}LNPF_{t-i} + \sum_{i=0}^{q-1} {}_{5i}LNER_{t-i} + ECT_{1t-1} + {}_{2t} \quad (4)$$

Where:

$$ECT_{1t-1} = LNIMNOIL_{t-1} - (\ {}_1LNPOIL_{t-1} + \ {}_2LNPG_{t-1} + \ {}_3LNPC_{t-1} + \ {}_4LNPF_{t-1} + \ {}_5LNER_{t-1})$$

C. Results And Discussion

1. Model Test Results

The statistical summary as presented in Table 1 shows that non-oil imports are larger and more volatile than oil imports. Uncertainty in domestic agricultural production due to climate change factors and dependence on imports for seeds, fertilizers, medicines and animal feed which are crucial raw materials for the agricultural sector. In addition, among global commodity prices, the statistical summary shows that coal prices are the most volatile.

Table 1. Descriptive statistics

Variabel	Min.	Max.	Mean	Median	Std. Dev.
IMOIL	2231.460	5063.740	3840.235	3893.205	541.6233
IMNOIL	5698.360	14038.85	9304.580	9096.340	1631.616
POIL	21.04000	117.7900	71.84470	65.20000	24.81457
PG	3.770000	33.35000	8.970896	6.990000	5.096876
PC	49.06000	340.7900	103.4528	84.32500	67.83518
PF	82.89000	159.0400	104.9473	96.81000	19.22905
ER	9000.000	16367.00	13151.40	13627.00	1761.136

The results of the unit root test on the data series for all variables are presented in Table 2. The test applies the Augmented Dickey-Fuller (ADF) and Phillips-Perron tests. The results show that all variables are stationary at first difference, I(1) except for oil and gas imports (LNIMOIL). The characteristics of the data series allow the application of the ARDL model for both ARDL model equations that have been formulated.

Tabel 2. Unit root test results

Variable		ADF Test	PP Test
Level	LNIMOIL	-3.5479***	-8.1192***
	LNIMNOIL	-0.4854	-7.2798***
	LNPOIL	-2.1577	-2.0479
	LNPG	-1.5084	-1.4751
	LNPC	-1.1827	-1.1676
	LNPF	-1.0641	-0.7724
	LNER	-2.3535	-2.4575
First Difference	ΔLNIMOIL	-9.4734***	-71.4979***
	ΔLNIMNOIL	-7.4741***	-91.7441***
	ΔLNPOIL	-8.6638***	-7.6910***
	ΔLNPG	-8.0976***	-8.1523***
	ΔLNPC	-8.7398***	-8.7493***
	ΔLNPF	-7.5664***	-7.4659***
	ΔLNER	-12.3661***	-12.4186***

*** significant at α = 1 percent; ** significant at α = 5 percent

The estimation results of the two models are then tested to investigate the presence of cointegration between variables in the model. This test applies the bounds test, the results of which are presented in Table 3. With a p-value of 5%, there is cointegration or a long-run relationship in the model I with the response variable of oil and gas imports (LNIMOIL).

Meanwhile, with a p-value of 1%, there is cointegration in model II with the dependent variable of non-oil and gas imports (LNIMNOIL).

Table 3. Bounds test results

Model	F-statistic	Sig.	Lower Bound	Upper Bound	Conclusion
Model I	3.7499	10%	2.08	3.00	There is a cointegration
		5%	2.39	3.38	
		1%	3.06	4.15	
Model II	19.5799	10%	2.49	3.38	There is a cointegration
		5%	2.81	3.76	
		1%	3.50	4.63	

H_0: No cointegration

2. Model Estimation Results and Discussion

Table 4 summarizes the results of the model estimation. The first model has the dependent variable of oil and gas imports (LNIMOIL), and the second model has the dependent variable of non-oil and gas imports (LNIMNOIL).

Table 4. The results of estimated long-run effects

Variables	Coefficients	
	Dependent Variable: Oil and Gas Import (LNIMOIL)	Dependent Variable: Non-Oil and Gas Import (LNIMNOIL)
Oil Prices (LNPOIL)	-0.3413**	0.0010
Natural Gas Prices (LNPG)	0.4881***	0.0656
Coal Prices (LNPC)	-0.0128	0.0604
Food Prices (LNPF)	-0.6975***	-0.2979**
Exchange Rates (LNER)	-0.7007**	-0.2764

*** Significant at α = 1% ** Significant at α = 5%

All variables in natural logarithm

The increase in international oil and food prices significantly reduces oil and gas imports and vice versa. The increase in global oil prices only has a significant negative impact on oil and gas imports, while it is not significant on non-oil and gas imports in the long run. A 1% increase in oil prices will reduce oil and gas imports by 0.34%. Meanwhile, the increase in world food prices significantly increased oil and gas and non-oil and gas imports. A 1% increase in international food prices will reduce oil and gas and non-oil imports by 0.70% and 0.30%, respectively. Only a significant increase in food prices causes non-oil and gas imports to decline, and vice versa.

The depreciation of the rupiah significantly reduces oil and gas imports, and vice versa, and it has the greatest effect. The exchange rate has a significant negative effect on oil and gas imports, while it is not significant on non-oil and gas imports. So, oil and gas imports are more

sensitive to changes in the exchange rate. Rupiah depreciation reduces oil and gas imports. A 1% depreciation of rupiah will reduce oil and gas imports by 0.70%.

Table 5. The results of estimated short-run effects

Variables	Coefficients Dependent Variable: Oil and Gas Import (ΔLNIMOIL)	Dependent Variable: Non-Oil and Gas Import (ΔLNIMNOIL)
Oil Prices (ΔLNPOIL)	-0.1997** (no lag); 0.2268** (1 lag); 0.4271*** (2 lags); 0.3266*** (3 lags)	NA
Natural Gas Prices (ΔLNPG)	-0.0052	NA
Coal Prices (ΔLNPC)	NA	0.2582***
Food Prices (ΔLNPF)	NA	NA
Exchange Rates (ΔLNER)	0.0163 (no lag); 0.7325** (1 lag); 0.1823 (2 Lags); 0.7584** (3 lags); 0.1777 (4 lags); -1.3839*** (6 lags)	-0.2151 (no lag); 0.8133** (1 lag); -0.6631** (2 lags)

*** Significant at α = 1% ** Significant at α = 5%

All variables in natural logarithm

NA means that short-run model estimates cannot capture short-run effects

Short-run effects indicate that oil and gas and non-oil imports tend to fluctuate. The negative impact of world oil prices is only significant on oil and gas imports without lag. Rupiah depreciation significantly reduces oil and gas imports by six lags while non-oil and gas imports are significant by two lags.

The coefficient on the long-run estimate of international oil prices represents oil import dependence. This is consistent with previous findings that the impact of oil price changes is greater for net oil importers with higher levels of import dependence [12]. The effect of exchange rates on imports is mainly in line with previous studies [13-14]. Changes in exchange rates that cause changes in import prices will then affect imports.

D. Conclusion

In the long run, the demand for energy import commodities is more determined by the price of oil, food, and the exchange rate. Meanwhile, non-oil and gas imports are only determined by international food prices. Food prices significantly affect domestic food imports. The elasticity of oil and food prices to the demand for oil and gas and non-oil and gas imports indicates that domestic demand still depends on commodity imports.

The government must prioritize efforts to reduce import dependence by promoting domestic production and consumption. This can be achieved through the revitalization and empowerment of the food and energy sectors. A key strategy in this direction is the

revitalization of the agricultural sector to boost agricultural production, thereby reducing dependence on imports, particularly non-oil and gas imports.

E. Acknowledgement

The authors would like to thank the Institute for Research and Community Service, Jenderal Soedirman University for funding this research project under the 2023 Institutional Research scheme.

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