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Structural Analysis of Import Oil and Gas in Indonesia

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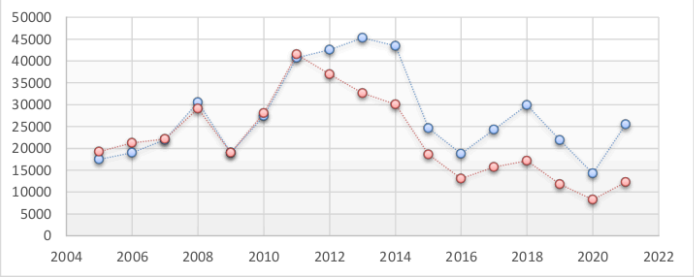
Abstract

s a world crude oil exporter, Indonesia can only meet omestic oil needs of 40% and 60% through imports. The vel of imports in the oil and gas sector, which is higher than exports, impacts the trade balance, which can threaten the stability of the domestic economy. This study analyzes oil and gas import policies using time-series data from 2005Q1-2021Q4 using the VECM approach. The study results show that GDP, inflation, world oil prices, and interest rates affect oil and gas imports. Structural analysis shows that inflation and world oil prices are essential in oil and gas import policies. The implications of the research show that apart from political policies, decisions on oil and gas imports must also pay attention to conditions of domestic inflation and international oil prices to stabilize domestic economic conditions.

INTRODUCTION

With an open economic system, Indonesia participates actively in export and import activities between countries. These activities are carried out to meet domestic needs and fulfill economies of scale and production. In addition, international trade impacts increasing state revenues and foreign exchange reserves. Some commodities traded are oil and gas, food and necessities, and other industrial needs. Based on the Ministry of Energy and Mineral Resources report, 60% of the national fuel demand is imported, which causes Indonesia's dependence on world fuel prices. Domestic needs are increasing and have not been matched by sufficient production levels, so oil and gas imports will continue to increase to meet domestic needs.

Figure 1. Graph of Export and Import of Oil and Gas



Source: BPS, 2022

Figure 1 shows that the trend of increasing oil and gas imports (blue lines) is more significant than exports (red lines), which can impact the trade balance deficit and threaten the stability of the domestic economy. The Central Bureau of Statistics noted that oil and gas imports from 2005-2019 (before COVID-19) increased by an average of 8.87% per year. Research on imports in Indonesia has been developed much like research Kartikasari & Khoirudin (2022); Andini Adhalia, A, R & Nurjanah (2020); Paramayuga (2017) and Machmud (2016). The research uses imported variables from goods and services and oil and gas. Other research develops import analysis on consumer goods (Prakoso & Hasmarini, 2022) in the agriculture and plantation sector (Yanti et al., 2022; Paipan & Abrar, 2020; Ristanto & Sarfiah, 2022; and Yovirizka & Haryanto, 2020), in services sector (Nisrina & Widyastutik, 2019) and analyze the determinants of imports and their relation to countries that have trade agreement (Sartika et al., 2018 dan Saputra, 2017).

Analysis of imports in the oil and gas sector in Indonesia is still slight. A study by Dinata et al. (2022) doing forecasting of oil and gas and non-oil and gas exports and imports in Indonesia, the results show that exports and imports in the oil and gas sector in 2021 will experience a decline, while the non-oil and gas sector will fluctuate and have an increasing trend compared to the previous year. Forecasting with Box-Cox transformation is more accurate than the original data used. Yuce Dural & Jahangir (2017) linked terrorist activities to oil and gas imports in Turkey; the results show that terrorist activities have a positive correlation to oil and gas imports; this cannot be separated from the unstable economic conditions in Turkey and the significant contribution of the oil and gas sector in Turkey.

Another study from Seo (2013) stated that the diversification of crude oil as a source of imports could increase the negotiating power of oil importers, thereby contributing to a reduction in the cost of importing crude oil in international trade. Furthermore, Seo (2013) found that petroleum products in the Korean market had a positive relationship with world oil prices, so it can be concluded that oil prices in Korea increased when world oil prices increased. The statement above shows that Indonesia, as a crude oil player, has a significant contribution to the oil supply in world trade because having a role as a crude oil exporter player can diversify and contribute to lower prices on oil imports from other countries. Ji et al. (2014) believe that global economic activity and international crude oil prices play an essential role in the price of domestic natural gas imports. Furthermore, international crude oil prices negatively affect domestic oil and gas imports, which are weak in North America, lagging in Europe, and insignificant in Asia. The insignificant effect of international crude oil prices on oil and gas imports in Asia is because domestic policies and macroeconomic conditions largely determine import decisions.

A study by Ji et al. (2014) shows that domestic macroeconomic conditions play an essential role in import policy decisions in the oil and gas sector. The need for oil and gas is critical in the wheels of the economy, both in terms of production and consumption. When Hamilton (1983) demonstrated a strong relationship between changes in oil prices and GDP in America. Research linking oil and gas from analyzing oil and gas prices and export and import policies in the oil and gas sector has developed widely. The research contributes to exploring oil and gas import policies with shocks to domestic macroeconomic conditions. A gap of research in this study is the analysis

of imports in the oil and gas sector and the response to shocks in macroeconomic conditions. The use of time-series data in this study also applies cointegration analysis to identify macroeconomic conditions' long- and short-term effects on oil and gas imports in Indonesia. The advantages of applying cointegration to time-series data as stated in the study by Johansen (1988), Panagiotidis & Rutledge (2007), and Aminarta & Kurniawan (2021) as a correction of short-term errors to find its balance in the long term.

The importance of using macroeconomic variables in building models, especially on imports in the oil and gas sector, to explain fluctuations in the level of import demand so that quality imports can be predicted, vital planning and formulation of appropriate policies (Ahad & Dar, 2018). Factor determinants of price changes and country income by proxy of GDP can play an essential role in import policy (Tang, 2003; Aziz & Bhaban, 2012). Early research from Faini et al. (1988) showed that economic size, per capita income, and trade openness are significant determinants of import elasticity. As a developing country based on its relatively large economic size, Indonesia indicates that macroeconomic conditions can play an essential role in import policy, particularly in the oil and gas sector. The objective of the macroeconomic analysis of imports is to obtain quality imports that can stimulate the domestic economy so that they do not threaten the stability of the domestic economy.

RESEARCH METHODS

The research uses quarterly time-series data from 2005Q1-2021Q4; total, there are 68 quarters. This research uses the Vector Error Correction Model (VECM) approach. The VECM approach is applied to eliminate problems in the short term and achieve balance in the long term. The variables used in the model as regressors are imports in the oil and gas sector, and as regressors are gross domestic product (GDP), inflation, the rupiah exchange rate against the dollar, interest rates, and world oil prices. Data from Bank Indonesia, the Central Bureau of Statistics and FRED Economic Data, and St Louis's FED.

In building a model on time-series data, you must ensure that the variable used does not have a unit root problem. If there is a unit root problem, then it can produce a spurious model (Rusdi, 2011). The unit root test used in the model uses the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) approach. The KPSS approach is applied because the KPSS test power is more vital for deterministic data processing with trend with noise and random walk with drift (Fajar, 2016), and the KPSS approach can capture structural change (Keblowski & Welfe, 2004). The developed model adopts research from Aminarta & Kurniawan (2021) and the equation as follows:

$$Y_t = A_0 + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \varepsilon_t \quad \text{.....(1)}$$

Where Yt is a vector with size (nx1) in which there are variables in the form of VAR, A0 is an intercept vector with size (nx1), A1 to Ap is a coefficient matrix with size (nxn) at values 1 to p = 1, 2, 3, etc. and et is an error vector with size (nx1). The VECM model can apply structural analysis consisting of impulse response function (IRF) and Forecast Error Variance Decomposition (FEVD). In addition, the

cointegration model is applied to obtain short- and long-term estimates (Johansen, 1988). The specific models are as follows:

$$\Delta LnImp_t = \beta_{12} + \beta_{13}\begin{bmatrix}\gamma\\ \mu\end{bmatrix} LnImp_{t-1} + \sum_{i=1}^{n}\varphi_{11i}\Delta LnImp_{t-1} + \sum_{j=1}^{m}\varphi_{12j}\Delta LnGDP_{t-1} + \sum_{k=1}^{q}\varphi_{13k}\Delta Inf_{t-1} + \sum_{l=1}^{q}\varphi_{14l}\Delta LnEr_{t-1} + \sum_{m=1}^{q}\varphi_{15m}\Delta LnPrice_{t-1} + \sum_{n=1}^{q}\varphi_{16n}\Delta r_{t-1} + \varepsilon_t \quad \text{.....(2)}$$

The strong poi for VECM estimation is the coefficient of the error correction teonem (θECM_{t-1}). The error correction model was used to measure the speed of ljustment. In VECM, Imp, GDP, inf, Er, Price, and r are assumed tendogenousto establish the short- and long-term relBeta β_{12} is unrestricted intercept; $\sum_{i=1}^{n}\varphi_{11i} - \sum_{n=1}^{q}\varphi_{16n}$ are the matrix of coefficient measuring for short-run estimation; γ present and the matrix coefficient of long-run coefficient; μ is the restricted intercept in the cointegration vector in the model; ε_t is the error term.

RESULT AND DISCUSSION

Diagnostic Tools

Table 1 describes the results of data stationarity using the KPSS approach. Decision-making in the KPSS approach differs from other approaches in the stationarity test. H0 in KPSS is stationary data, showing the opposite hypothesis in other approaches. Decision-making on the KPSS approach: If the t-statistics value of KPSS is less than the critical value, then the null hypothesis is accepted. The level form shows that only imports and world oil prices are stationary.

Table 1. Stationery Test

Variables	Level Trend and Intercept	First Difference Trend and Intercept
Imp	0.184***	0.150***
GDP	0.993	0.094***
Inf	0.860	0.025***
Er	0.931	0.113***
Price	0.400*	0.096***
r	0.809	0.069***

If the data is not stationary at I(0), then the level 1 or I(1) differencing method can be used. (Eka et al., 2017). Table 1 shows that all variables used in the stationary model are in I(1). According to Bahmani-Oskooee Bohl (2000), appropriate lag selection determines the long-run estimation. Lag specification conducted by LR Statistics test (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Information Criterion (HQ). Based on the vector autoregressive (VAR) model, the optimal lag for the model is "1" (Table 2) is chosen using the AIC (Sarfraz et al., 2020).

Table 2. Lag Specification

Lag	LogL	LR	FPE	AIC	SC	HQ
0	19.132	NA	2.673-08	-0.410	-0.208	-0.331
1	320.047	536.005	6.82e-12*	-8.689*	-7.272*	-8.131*
2	338.785	29.864	1.20e-11	-8.150	-5.518	-7.113

3	376.335	52.804	1.24e-11	-8.198	-4.352	-6.683
4	423.056	56.942*	1.03e-11	-8.533	-3.473	-6.540

Another tool is the VAR stability test, which conducts the stability of VAR estimation for structural analysis on impulse response function (IRF) and variance decomposition (VD). Table 3 shows that the value of the inverse root's characteristic of the AR polynomial is stable because the AR roots table has a value of modulus less than one (1).

Table 3. VAR Stability Test Result

Root	Modulus
0.983009	0.983009
0.868658	0.868658
0.764877 - 0.153544i	0.780137
0.764877 + 0.153544i	0.780137
0.423987	0.423987
-0.208949	0.208949

One of the advantages of the VECM model is the application of the cointegration method with the Johansen approach. The purpose of implementing the cointegration test is to build a model on short-term and long-term estimates and their balance. In the cointegration-based approach, Johansen (1988) produces the value of the trace statistic and the maximum eigenvalue. Table 4 shows that the trace statistics and top eigenvalue results are consistent with cointegration in the model. The results of the trace statistics show that there are three cointegrations, and the maximum eigenvalue is two cointegrations.

Tabel 4. Johansen Cointegration Test

Hypothesized		Trace Statistic		
no. of CE(s)	Eigenvalue	Statistics	Critical value	Prob.
None*	0.514	135.375	95.753	0.000
At most 1*	0.459	88.406	69.818	0.000
At most 2*	0.332	48.431	47.856	0.044
At most 3	0.226	22.154	29.797	0.290
At most 4	0.067	5.487	15.494	0.755
At most 5	0.014	0.918	3.841	0.337
		Maximum Eigenvalue		
None*	0.514	46.969	40.077	0.007
At most 1*	0.459	39.974	33.876	0.008
At most 2	0.332	26.277	27.584	0.072
At most 3	0.226	16.667	21.131	0.188
At most 4	0.067	4.568	14.264	0.795
At most 5	0.014	0.918	3.841	0.337

Granger Causality Test

Causality tests to determine whether the endogenous variables can be treated as exogenous variables. Those connection patterns were discovered by examining empirical data sets for probabilistic causality theories (Parvin et al., 2023). The causality test in this study was carried out using the Granger causality test.

Table 5. Granger Causality Test

Hypothesis	Prob	Conclusion
LnPrice does not Granger Cause Inf	0.0149	LnPrice ⟶ Inf
LnEr does not Granger Cause LnPrice	0.0188*	LnEr ⟶ LnPrice
LnPrice does not Granger because r	0.0191	LnPrice ⟶ r
LnEr does not Granger Inf	0.0493	LnEr ⟶ Inf
Inf does not Granger LnGDP	0.0138	Inf ⟶ LnGDP
r does not Granger Inf	0.0415	r ⟶ Inf

Table 5 shows that only a one-way relationship occurs in the variables LnPrice with Inf and r, LnEr with Inf, Inf with GDP and r with Inf, and LnImp as dependent variables does not guarantee cause to all regressors. At the same time, a two-way relationship (cause and effect) occurs between the LnPrice variables and LnEr.

VECM Estimation

Table 6 shows the results of the VECM estimation in the short and long term. In the short term, only the world oil price variable affects imports. The positive effect of world oil prices on oil and gas imports indicates that increasing world oil prices will increase imports in the oil and gas sector. This can occur due to high domestic demand and production levels that need to be improved, so the need for imports is heightened. The increase in international oil prices added to the rise in oil and gas sector imports, resulting in an increasing trade balance deficit, which could trigger domestic economic stability. Samah Nuryati (2008) stated that an increase in international oil prices would push domestic oil prices, which could increase inflation.

Tabel 6. VECM Estimation

Variables	Coefficient
Short term	
ΔLnImp(-1)	-0.189
	(-1.153)
ΔLnGDP(-1)	-0.352
	(-1.123)
ΔInf(-1)	
ΔLnEr(-1)	1.412
	(1.322)
ΔLnPrice(-1)	0.702
	(3.022)***
Δr(-1)	-0.092
	(-0.874)
EC_t	-0.685
	(-3.967)***
Long Term	
LnGDP(-1)	-0.216
	(-2.161)*
Inf(-1)	17.923
	(5.158)***
LnEr(-1)	0.634

	(1.595)
LnPrice(-1)	-0.487
	(-2.433)**
r(-1)	-0.230
	(-3.864)***

However, in the long run, world oil prices hurt oil and gas imports in Indonesia. An increase in world oil prices will reduce the level of imports in the oil and gas sector; this will impact increasing domestic production because dependence on oil imports when prices increase will cause a trade balance deficit, which can disrupt the stability of the domestic economy. In the long run, it shows that an increase in domestic inflation can lead to a rise in oil and gas imports. This can happen when the demand for an item increases; producers will increase their production capacity by adding production factors, one of which is through the oil and gas sector, so that high oil demand encourages imports in the oil and gas sector to increase, this is in line with research developed by Andini Adhalia, A, R & Nurjana (2020). Interest rates negatively affect imports; increasing interest rates will reduce imports in the oil and gas sector. The increase in interest rates is used to normalize increases in domestic prices, thus encouraging consumption and importer restrictions on credit, which can reduce overall import levels and imports in the oil and gas sector; this is in line with research by Kurniasari Monica (2019). The VECM estimate produces an error correction term (ECt) value of -0.685, indicating that a correction will occur if there is an error in the short term. The balance will be obtained in the long term with an adjustment process that takes seven quarters.

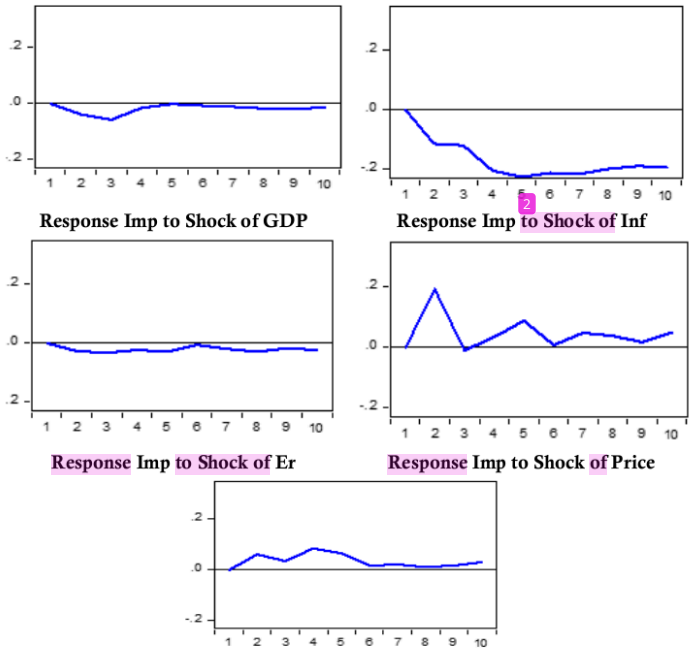
Impulse Response Function

Structural analysis uses the impulse response function (IRF) approach with one standard deviation. The IRF method in this study is used to see how oil and gas imports respond when shocks occur to other variables in the model with ten-time horizons. Figure 2 shows that shocks to the GDP variable will be negatively affected over time by the imported variable in the oil and gas sector. This is in line with the VECM estimate in the longer term. State income has increased, so the need for oil and gas imports will decrease. An increase in state revenue means a decrease in dependence on imports, which is reinforced by research conducted by Ji et al. (2014). An increase in domestic prices in the long term will cause the inflation rate to increase so that people's purchasing power will decrease. The decline in people's purchasing power led to a decrease in economic activity from the demand and supply sides, thereby reducing the use of production factor capacity from the oil and gas sector. This led to a decrease in oil and gas imports at a certain level. Inflation shocks responded negatively to oil and gas imports, which aligns with research developed by Almaya et al. (2021).

The negative response of oil and gas imports when there is a shock to the exchange rate variable indicates that exchange rate volatility will reduce imports in the oil and gas sector. Exchange rate volatility causes limited international trading ability; when the exchange rate weakens, it will cause high import prices that can reduce the ability to import oil and gas; this aligns with research by Dewayani Kesumajaya (2015). The positive response of oil and gas imports when there is a shock to international oil prices is in line with research by Seo (2013), who found that increased

imports can occur when world oil prices increase due to increased economic activity. Hence, an increase in imports encourages economic growth.

Figure 2. Graph of Impulse Response Function with One Standard Deviation



The positive response of oil and gas imports when shocks occur in interest rates indicates that changes in monetary policy through interest rates do not encourage changes in import policy; this is in line with findings from Hamilton (1983). Structural decomposition is used to see the proportion of variations in the variables used in the model. This study uses the variance decomposition method to analyze the proportion of macroeconomic variables to import policies in the oil and gas sector.

Variance Decomposition

Table 7. Forecast Error of Variance Decomposition

Period	S.E.	Imp	GDP	Inf	Er	Price	r
1	0.344	100.000	0.000	0.000	0.000	0.000	0.000
2	0.430	69.763	0.824	7.005	0.392	19.954	2.059
3	0.466	65.027	2.208	12.577	0.802	17.054	2.328
4	0.524	53.960	1.846	24.967	0.840	13.939	4.445
5	0.581	43.791	1.499	35.329	0.919	13.623	4.836

6	0.627	40.218	1.305	41.737	0.795	11.707	4.235
7	0.671	36.822	1.171	46.699	0.776	10.724	3.804
8	0.705	34.330	1.127	50.183	0.869	10.009	3.479
9	0.738	33.321	1.083	52.335	0.847	9.186	3.225
10	0.770	31.702	1.034	54.408	0.867	8.870	3.117

Table 7 shows that inflation and World oil prices have a large variability or decomposition proportion to oil and gas imports. This indicates that import policies in the oil and gas sector, besides being used to meet domestic needs and as a factor of production, must consider conditions of domestic inflation and oil prices in the World. The condition of domestic inflation reflects people's purchasing power so that imports in the oil and gas sector can encourage the recovery of people's purchasing power, which is reflected in stable inflation conditions and pay attention to world oil prices so as not to burden the trade balance because it can disrupt domestic economic stability.

CONCLUSION

This research explores the influence of macroeconomic variables and structural analysis on import policies in Indonesia's oil and gas sector. The study uses time-series data from 2005Q1-2021Q4. Stationarity test results show that all variables have no unit root problem in I (1). The model on imports in the oil and gas sector has cointegration at level 3 so that all the variables used are in balance in the long run. The VECM estimation results show that in the long run, all independent variables (except the exchange rate) in the model affect oil and gas imports. The difference in the long-term and short-term effects is indicated by the world oil price variable, which has a positive impact in the short term, so an increase in world oil prices will encourage an increase in oil and gas imports. However, the opposite occurs in the long term.

Structural analysis of the model uses the IRF approach and variance decomposition, where oil and gas imports are more responsive to shocks in inflation and world oil prices. The variance decomposition results show that these two variables have high variability in oil and gas imports. This research implies that apart from political policies, policies regarding oil and gas imports must pay attention to inflation and world oil prices. Future research can complement existing research by linking the effect of global uncertainty in the model due to a massive increase in global uncertainty in recent years.

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