

Determination of macroeconomic factors on Indonesia's oil and gas imports: an ECM approach

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Abstract

The oil and gas trade deficit can negatively impact Indonesia's economy in the long term, highlighting the need to identify key factors influencing oil and gas imports. This study analyzes the effects of inflation, exchange rates, and foreign exchange reserves on oil and gas imports using the Error Correction Model (ECM), which captures both short-term and long-term dynamics. Monthly data from January 2003 to December 2023 were used, with a natural logarithm transformation applied to address non-stationarity. The results show that, in the long term, inflation and foreign exchange reserves significantly and positively affect oil and gas imports, while the exchange rate has a significant negative effect. In the short term, these variables show no significant impact except for the error correction term (ECT), which is negative and significant—indicating a gradual adjustment toward long-term equilibrium. The findings support policy efforts focused on maintaining price stability, exchange rate management, and adequate foreign exchange reserves to ensure a more sustainable oil and gas trade balance.

Keywords: Inflation, Exchange Rate, Foreign Exchange Reserves, Oil And Gas Imports, Error Correction Model

Abstrak

Defisit perdagangan minyak dan gas dapat berdampak negatif terhadap perekonomian Indonesia dalam jangka panjang, sehingga penting untuk mengidentifikasi faktor-faktor yang memengaruhi impor minyak dan gas. Studi ini menganalisis pengaruh inflasi, nilai tukar, dan cadangan devisa terhadap impor minyak dan gas menggunakan metode Error Correction Model (ECM), yang mampu menangkap hubungan jangka pendek dan jangka panjang. Data bulanan dari Januari 2003 hingga Desember 2023 digunakan dalam analisis ini, dengan transformasi logaritma natural untuk mengatasi masalah non-stasioneritas. Hasil penelitian menunjukkan bahwa dalam jangka panjang, inflasi dan cadangan devisa berpengaruh positif dan signifikan terhadap impor minyak dan gas, sementara nilai tukar berpengaruh negatif dan signifikan. Dalam jangka pendek, ketiga variabel tersebut tidak menunjukkan pengaruh signifikan, kecuali Error Correction Term (ECT) yang bernilai negatif dan signifikan, mengindikasikan proses penyesuaian menuju keseimbangan jangka panjang. Temuan ini mendukung perumusan kebijakan ekonomi terkait stabilitas harga, pengelolaan nilai tukar, dan kecukupan cadangan devisa untuk mendukung keberlanjutan perdagangan energi nasional.

Kata kunci: Inflasi, Nilai Tukar, Cadangan Devisa, Impor Migas, *Error Correction Model*

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1. Introduction

Indonesia has a high demand for oil and gas as the primary source of support for economic growth and infrastructure development. In line with the increasing population and economic growth, the need for energy also continues to increase. This makes the oil and gas sector essential for maintaining national stability. The government is working to improve efficiency and diversify energy sources to meet this need. One of Pertamina's subsidiaries, PT Pertamina Hulu Mahakam (PHM), successfully discovered new gas and condensate reserves at the Adiwarna- 1X exploration well in WK Mahakam, offshore East Kalimantan. This discovery is the second achievement for the subsidiary after previously finding oil and gas reserves at the Manpatu- 1X exploration well in early 2022. Nevertheless, so far the demand for oil and gas in Indonesia is still higher than its production. This can be seen from the value of Indonesia's oil and gas imports, which has a significant upward trend since the last few years. The track record also shows this that since 2009, Indonesia is no longer a member of the Organization of the Petroleum Exporting Countries (OPEC) due to the declining domestic oil production. This decline has caused domestic oil production to no longer be able to meet domestic consumption needs.

International trade has a crucial contribution to a country's economy, including Indonesia. The amount of a country's imports is influenced by the country's ability to produce goods with strong competitiveness compared to foreign products. If the country's competitiveness is low, then the need to import is also higher. However, international trade also has challenges and obstacles such as declining local industries, over-exploitation of developing countries, and low security of goods (Pradipta & Swara, 2015).

As a developing country, along with population growth, urbanization, and industrialization, Indonesia's energy demand continues to increase. Indonesia has abundant natural resources, including oil and gas. However, these potential resources have not been able to fulfill domestic energy needs fully. A report from the Ministry of Energy and Mineral Resources (MEMR, 2024) revealed that the production of oil and gas ready for sale or lifting oil and gas in Indonesia can still not meet the high demand for domestic fuel oil (BBM). In addition, the Ministry of Energy and Mineral Resources also reported that oil lifting in 2023 only reached 605,5 million barrels per day (mbopd). This value has decreased from the previous year and occurs naturally because no new sources have been found. However, the decline in oil production is only 1,2 percent. This is better than previous years which ranged from 3-7 percent.

One of the most needed energy sources is oil and gas. However, domestic oil and gas production can still not meet national needs. This causes Indonesia to rely on oil and gas imports to ensure the continuity of domestic energy supply. Based on data from the Central Bureau of Statistics (BPS, 2023), oil and gas imports accounted for around 17% of Indonesia's total imports in 2022. This shows how vital the role of international trade is in maintaining national energy sustainability. International trade plays an essential role in the global economy, allowing countries to fulfill domestic

needs that cannot be produced locally. As one of the main components of international trade, imports provide access to goods and services that are unavailable or less efficient if produced domestically. As such, imports can be essential to support economic development, improve quality of life, and accelerate technology transfer. However, over-reliance on imports can affect a country's financial stability.

Over the past few years, Indonesia has experienced a trade deficit. Smith, A. (1776) stated that if a country continues to import more than it exports, it can experience dependency problems and trade deficits that can harm the domestic economy in the long run. This condition is shown by BPS data which shows that in recent years the value of Indonesia's oil and gas imports has always been greater than the value of oil and gas exports. This persistent gap reflects Indonesia's increasing reliance on imported oil and gas to meet domestic energy needs. The sharp rise in imports in 2014 and 2022, as seen in the graph, was not matched by export growth, highlighting a structural imbalance. This trend raises concerns over the sustainability of the national energy trade and underlines the urgency for effective policy intervention.



Figure 1. Indonesia's oil and gas exports and imports 2003-2023.

Dependence on oil and gas imports poses challenges, especially in maintaining economic stability amid fluctuations in macroeconomic variables. A study by the Organization for Economic Co-operation and Development (OECD) in 2021 stated that high dependence on oil and gas imports increases risks to macroeconomic stability, especially in the face of external shocks such as oil price spikes or weakening domestic currency exchange rates. This could lead to higher inflationary pressures, trade balance deficits, and fiscal instability, especially for countries that do not yet have adequate energy diversification.

Imports are closely related to inflation. Inflation can be defined as a general and persistent increase in prices. Under certain conditions, goods or services in a country may be more expensive than those in other cooperating countries. This condition can trigger international trade, namely imports (Sari & Rauf, 2018). This is because by importing, a country can get a good or service from another country at a cheaper price than in its own country. However, very high inflation can destabilize the economy and

weaken the currency's value. This will have the effect of suppressing people's purchasing power. Conversely, very low inflation can also weaken people's purchasing power. When purchasing power decreases, demand for goods, especially oil and gas, will also decrease, thus impacting the value of imports (Gunawan & Suropto, 2023). Apart from inflation, imports are also often associated with exchange rates. The exchange rate measures the value of the domestic currency against the international currency used in international trade as an agreed-upon transaction tool. When the rupiah weakens, imported products become more expensive. This will reduce the occurrence of import activities in Indonesia and vice versa (Widiyanto & Rakhmawan, 2020).

Foreign exchange reserves can finance import activities (Leonufna et al., 2016). This clearly shows that the value of imports is influenced by foreign exchange reserves. If a country's foreign exchange reserves are large, it can import a lot, and vice versa. Foreign exchange reserves include gold, foreign currency, and foreign currency receivables to international parties managed by Bank Indonesia. These reserves act as a buffer to support international trade and maintain economic stability, especially during periods of external shock. In the context of oil and gas imports, sufficient foreign exchange reserves ensure that Indonesia can continue to meet its energy needs despite fluctuations in global prices or exchange rate pressures.

This study examines the effects of exchange rate, inflation, and foreign exchange reserves on Indonesia's oil and gas imports. Unlike Putri & Yudha (2022), which focused only on crude oil imports and excluded inflation, this study broadens the scope by including inflation and using a longer time period. Both studies use the Error Correction Model (ECM), but this research aims to provide a more comprehensive analysis. Inflation is included because it influences domestic prices and purchasing power. Theoretically, higher inflation can make domestic energy less competitive, increasing import demand. Empirically, inflation affects trade and consumption patterns, especially in economies like Indonesia. Including this variable enhances the understanding of import determinants and can help guide more effective economic policy.

This study uses the Error Correction Model (ECM) to analyze the influence of exchange rate, inflation, and foreign exchange reserves on Indonesia's oil and gas imports. ECM is chosen because it can capture both short-term and long-term relationships among variables, which is especially important for time series data that often exhibit non-stationary behavior. Since this research uses monthly data over a long period, the ECM approach is considered suitable to provide more accurate and meaningful results. Moreover, ECM helps reveal how quickly deviations from long-term equilibrium are corrected over time, offering insights into the speed of market adjustment.

The purpose of this research is to understand how macroeconomic variables such as exchange rate, inflation, and foreign exchange reserves affect Indonesia's oil and gas import patterns. The findings are expected to support the government in

formulating more effective macroeconomic policies. Understanding the influence of inflation and exchange rates can help maintain price stability and manage the trade balance more efficiently. At the same time, better planning and utilization of foreign exchange reserves can improve the country's ability to support international trade activities. In the long term, these efforts can help reduce Indonesia's dependence on imported oil and gas, which in turn supports national energy security and promotes more sustainable economic stability.

2. Literature Review

Import

Imports refer to the purchase or entry of goods from abroad to meet domestic needs (Fajgelbaum & Khandelwal, 2014). Regulations are crucial to ensuring smooth trade and protecting domestic producers from foreign competition. International trade significantly impacts a country's economy, including Indonesia. Import levels depend on domestic competitiveness; lower competitiveness leads to higher imports. However, trade poses challenges like weakening local industries, exploitation of developing nations, and low product safety assurance (Pradipta & Swara, 2015). Imports provide access to scarce or inefficiently produced goods, supporting economic growth, welfare, and technology transfer. Yet, excessive reliance on imports can threaten financial stability.

Mankiw (2009) identifies key factors influencing trade: (1) domestic and foreign prices, (2) exchange rates, (3) domestic and foreign consumer income, (4) import costs, and (5) government policies. Inflation reflects price changes and purchasing power, influencing trade. Foreign exchange reserves represent a country's international transaction capability, while exchange rates directly affect trade dynamics.

Inflation

Samuelson & Nordhaus W. (in Bakti & Alie, 2018) say inflation happens when there is a widespread rise in the prices of goods and services, including essential items like rice, automobiles, fuel, land, wages, and various capital goods. Meanwhile, Boediono (in Bakti & Alie, 2018) emphasizes that inflation is a general upward price trend over the long-term. Bank Indonesia reinforces this understanding by stating that inflation refers to a sustained and widespread rise in the prices of goods and services over a specific period. The quantity theory divides the causes of inflation into two categories: a) demand-pull inflation and b) cost-push inflation. Demand-pull inflation happens when the demand for goods and services surges quickly due to an overall increase in price levels. Conversely, supply-push inflation arises when production costs rise, reducing supply and driving up commodity prices. The leading cause of inflation is excess liquidity, which is a situation when the amount of money circulating in society exceeds the needs (Sutandi et al, 2021). This huge circulation makes sellers increase their goods or services so that it will slowly increase all prices of goods or services around them.

Exchange Rate

Simply put, the exchange rate represents the worth of one currency expressed in terms of another currency (Sutandi et al., 2021). Exchange rate is an indicator that compares the value of domestic currency and foreign currency used in international trade transactions. The exchange rate is vital in determining a country's purchasing power for goods and services from abroad. When the rupiah depreciates against foreign currencies, the price of imported products will increase, increasing the cost of acquiring goods and services from abroad. This condition tends to reduce import activities in Indonesia due to the increased cost burden that businesses and consumers must bear. On the other hand, the appreciation of the rupiah against foreign currencies tends to lower the price of imported products, making them more affordable for domestic consumers. This condition has the potential to trigger an increase in import volume, along with higher demand for goods from abroad (Widiyanto & Rakhmawan, 2020).

Foreign Exchange Reserves

Foreign exchange reserves are foreign currencies managed by the central bank as national assets. Amalia (in Pradipta & Swara, 2015) describes foreign exchange as a medium of exchange, payment, value measure, and global store of wealth. Reserves stem from international transactions and primarily finance imports and foreign debt, as the rupiah is not accepted internationally. They play a vital role in stabilizing currency value, maintaining liquidity during crises, and ensuring foreign obligations are met (Jena & Sethi, 2021). Reserves reflect investor confidence, support debt repayment, and serve as emergency buffers (IMF, 2005). Effective management strengthens economic resilience, while weak management limits authorities' crisis response.

Putri and Yudha (2022) conducted a study examining the determinants influencing Indonesia's crude oil imports between 2001 and 2020, employing the Error Correction Model (ECM) to address non-stationarity in the dataset. This methodological choice enabled the researchers to analyze both short-term dynamics and long-term equilibrium relationships among variables. Their findings indicated that, collectively, foreign exchange reserves, exchange rates, crude oil prices, and domestic production significantly influence Indonesia's crude oil import trends. However, distinct patterns emerged when comparing long-term and short-term effects. In the long run, foreign exchange reserves, crude oil production levels, and global oil prices demonstrated a statistically significant positive relationship with import volumes. Conversely, the exchange rate exhibited no substantial long-term impact. In the short term, all variables showed a positive and significant effect on imports. The study highlighted that exchange rate fluctuations primarily drive import adjustments in the immediate period, while their influence diminishes over extended horizons. These nuanced results underscore the importance of differentiating between temporal frameworks when formulating energy import policies.

Adewuyi (2016) analyzed Nigeria's petroleum import demand from 1984 to 2013 using the ARDL model and limit cointegration test, examining both long- and short-term determinants. The study found that the real effective exchange rate, along with other factors, drives long-term imports of refined fuels, including vehicle and distillate

fuels. In the short term, the exchange rate remains a significant factor influencing imports. These findings align with Alwell-Nteegah & Mansi (2016), who found that domestic prices, real income, and exchange rates negatively affected Nigeria's total import demand (1980–2014). Similarly, Kartikasari & Khoirudin (2022) confirmed that exchange rates significantly impact imports in the short term.

Azzahra & Kurniawan (2023) analyzed oil and gas imports using time series data from 2005 - 2021 with a quarterly period. In their research, researchers used the VECM approach analysis method. This study found that inflation and world oil prices affect oil and gas imports. Gunawan and Suropto (2023) also analyzed the determinants of oil and gas imports in Indonesia. Their research using the VAR method found a one-way relationship between inflation and oil and gas imports.

Ali et al. (2023) investigated how foreign exchange reserves impact the overall import demand in Ethiopia. This study used time series data with annual periods from 1985 to 2020. In their analysis, the researchers employed a regression analysis method using the nonlinear autoregressive distributed lag (NARDL) approach. After looking at the analysis process results, the researcher stated that in the long run, foreign exchange reserves, real income, relative price of imports, money supply, exchange rate volatility, and policy dummies significantly affect aggregate import behavior during the reference period. In that context, foreign exchange reserves, real income, and the exchange rate have a positive impact on import demand in Ethiopia. In contrast, relative price of imports and money supply have a negative impact.

Pradipta & Swara (2015) analyzed the effects of foreign exchange reserves, inflation, exchange rates, and GDP on non-oil and gas imports in Indonesia from 1985 to 2012 using multiple linear regression. The study found that all variables significantly influenced imports, but individually, only GDP and foreign exchange reserves had a positive and significant impact. The exchange rate had a significant negative effect, while inflation showed no significant impact. These findings align with Asif et al. (2020), who found that the real effective exchange rate negatively affected crude oil import demand in Pakistan. Gede (2017) examined the impact of exchange rate fluctuations and inflation on trade using monthly data from 2007 to 2015 and path analysis. Based on data from Bank Indonesia and BPS, the study included trade balance, exchange rate, and inflation variables. The findings revealed that inflation, exchange rate fluctuations, and imports significantly negatively affected the trade balance. However, individually, only imports and exports had a direct influence, while the exchange rate and inflation showed no partial effect. These studies highlight the complex relationships between macroeconomic variables and trade, emphasizing the importance of exchange rate stability and economic policy in managing imports and trade balance.

Kartikasari & Khoirudin (2022) investigated the impact of inflation, exchange rates, money supply, and interest rates on imports in Indonesia, both in the short and long term. According to the researchers, stability between imports and exports is a key to conducting international trade. The research methodology uses the Vector Error

Correction Model (VECM) analysis approach to process secondary time series data for the period 2011-2020. The findings of this study reveal different patterns between short-term and long-term impacts. In the short run, the exchange rate and money supply are shown to significantly impact imports. In contrast, inflation and interest rates do not significantly affect this period. Meanwhile, imports are not significantly affected by the exchange rate, inflation, and money supply in the long run, but only by interest rates.

3. Research Method

This study uses 252 secondary data observations every month from January 2003 to December 2023. Four variables were used in this study: the price of oil and gas imports (in million US dollars), the value of the country's foreign exchange reserves (in million US dollars), the rupiah exchange rate against the US dollar (in rupiah), and the percentage of inflation. The Central Bureau of Statistics (BPS) provided data on the value of imports of gas and oil. The percentage of inflation can be found on the Bank Indonesia (BI) website. Go to the Fred.stlouisfed website to find out about currency rates. Information about the nation's foreign exchange reserves can also be found on the id.tradingeconomics.com website.

The study utilizes both descriptive and inferential analysis. Descriptive analysis employs graphs to illustrate predictor and response variables and presents measures of central tendency (mean, median, mode) along with standard deviations. Inferential analysis applies the Error Correction Model (ECM) to examine the short-term and long-term effects of inflation, foreign exchange reserves, and exchange rates on oil and gas imports. The data processing follows these steps:

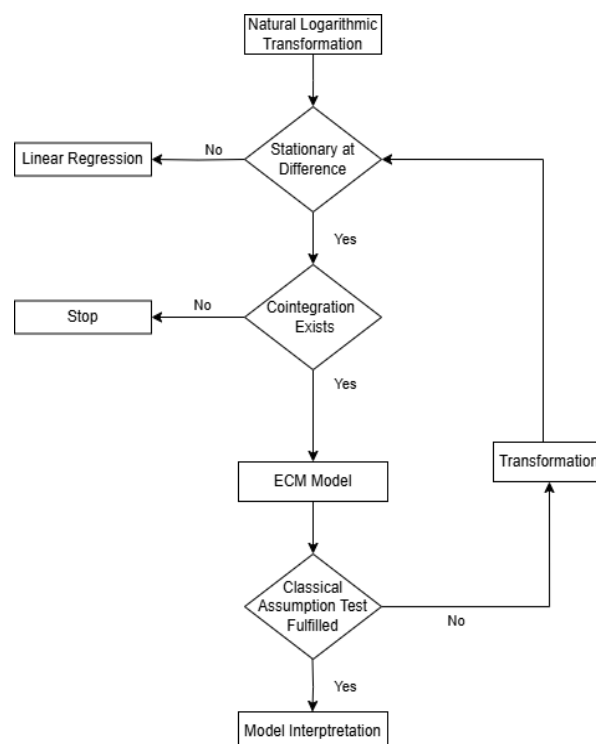


Figure 2. Flow chart of ECM modeling (adapted from Gujarati, 2004).

Stationarity

Stationary is a statistical characteristic of a process that produces time series data that remains constant with mean, variance, and covariance unaffected by time (Laura et al., 2023; Zega et al., 2024). A spurious connection with a high R-square value but no statistical significance may result from analysis of data that does not satisfy the stationarity requirements (Gujarati, 2003). Stationarity can be tested through time series plots, Autocorrelation Function (ACF), and Partial Autocorrelation Function (PACF) values. ACF and PACF plots of squared errors assess variance stationarity. Additionally, unit root tests, such as the Augmented Dickey-Fuller (ADF) test, can evaluate trend components like random walks (Hanifah & Kartiasih, 2018; Putri et al., 2017).

The Augmented Dickey-Fuller (ADF) test is the most commonly used method for stationarity testing, accounting for autocorrelation in the error term when a time series is non-stationary (Aktivani, 2021). It evaluates the trend component as a random walk using the model:

$$\Delta y_t = \delta y_{t-1} + \mu_t$$

The hypothesis used in the ADF test is as follow:

$H_0 : \delta = 0$ Data has a unit root (data is not stationary)

$H_A : \delta < 0$ Data does not have a unit root (stationary data)

The test compares the t-statistic with the McKinnon critical values at 1%, 5%, and 10% significance levels. H_0 is rejected if the p-value is greater than the chosen alpha or if the t-statistic is smaller than the critical value. Testing proceeds from the level to the first difference. This study uses 1% significance level.

Cointegration Test

Cointegration is a concept that explains the stable long-term relationship between non-stationary variables (Engle & Granger, 1987). Two variables are considered cointegrated if they are non-stationary at level but become stationary at the same differencing order, with stationary residuals at level. Bhardwaj & Gupta (2022) highlight that after stationarity testing, a cointegration test is conducted to assess the long-term relationship between predictor and response variables. In this study, the stationarity of long-term residuals (ε_t) was checked using the ADF method, with the following hypotheses:

H_0 : Predictor and response variables are not cointegrated

H_A : Predictor and response variables are cointegrated

The test compares the t-statistic with the McKinnon critical values at 1%, 5%, and 10% significance levels. H_0 is rejected if the t-statistic is smaller than the critical value or if the p-value exceeds the significance level. Testing is conducted at level, and this study employs a 1% significance level.

Error Correction Model (ECM)

Error Correction Model (ECM) is used to analyze cointegrated time series data, correcting deviations from long-term equilibrium (Adwendi & Kartiasih, 2016). ECM

integrates short-term dynamics with long-term relationships, addressing spurious regression issues (Sulaiman et al., 2014). The long-term and short-term model used in this study are specified as follows.

$$\ln IM_t = \beta_0 + \beta_1 \text{Inflation}_t + \beta_2 \ln CDEV_t + \beta_3 \ln ER_t + \varepsilon_t$$

$$\Delta \ln IM_t = \beta_0 + \beta_1 \Delta \text{Inflation}_t + \beta_2 \Delta \ln CDEV_t + \beta_3 \Delta \ln ER_t + \gamma \text{ECT}_{t-1} + \mu_t$$

Where, $\ln IM_t$ is natural logarithm of oil and gas imports, Inflation_t is inflation rate, $\ln CDEV$ is the natural logarithm of foreign exchange reserves, $\ln ER$ is natural logarithm of exchange rate, ε_t is the error component or long-run residuals, t is the time. In the short-term model, Δ denotes the first difference (change) of the variable. ECT_{t-1} is error correction term the lagged error correction term, representing the previous period's deviation from long-term equilibrium. The coefficient γ indicates the speed of adjustment toward long-run equilibrium. A negative and statistically significant γ value confirms the presence of cointegration and indicates that deviations from equilibrium are gradually corrected over time (Kartiasih & Setiawan, 2020).

Natural logarithm transformation helps address assumption violations in ECM model testing (Agustina, 2020), particularly heteroscedasticity and non-normally distributed residuals. It also simplifies equation interpretation. Ters & Urban (2018) highlights its role in stabilizing data variance. In this study, logarithmic transformation was applied to ensure data stationarity and stabilize variable variance.

4. Results and Discussion

4.1. Results

The summary statistics in Table 1 reflect fluctuations in the economy. Oil and gas imports average USD 2230.52 million with a standard deviation of USD 976.80 million, indicating the influence of global oil prices and import policies. Inflation averages 5.61% with a standard deviation of 3.30%, reflecting price instability due to changes in demand, supply, or monetary policy. Foreign exchange reserves average USD 93.28 billion with a standard deviation of USD 37.85 billion, indicating reliance on capital flows and trade, with a minimum of USD 30.3 billion signaling economic stress. The exchange rate averages 11,577.63 Rupiah with a standard deviation of 2,445.65 Rupiah, showing high volatility driven by interest rate differentials, foreign investment, or global sentiment. These fluctuations highlight economic uncertainty requiring sound macroeconomic policies.

Table 1. Summary Statistics

Variables	Mean	Min	Median	Max	Std. Dev.
Oil and Gas Imports	2230.517	500.900	2055.550	4455.300	976.795
Inflation	5.609	1.320	4.860	18.380	3.303
Foreign Exchange Reserves	93.277	30.300	108.000	147.000	37.849
Exchange Rate	11577.630	8279.000	11379.500	16367.000	2445.652

Source: Authors calculation.

Indonesia's oil and gas imports (2003–2023) fluctuated but trended upward (Figure 3a), with sharp declines during the 2008 financial crisis, the 2014 oil price drop, and the 2020 COVID-19 impact, followed by gradual recovery. Inflation also fluctuated but showed a long-term decline (Figure 3b), peaking in 2005–2006 due to economic instability before steadily decreasing, reaching its lowest in 2020 amid weaker economic activity and stable fiscal policies. The link between volatile energy imports and declining inflation reflects structural shifts, including better monetary policies and reduced reliance on imports. However, rising import costs during currency depreciation remain a challenge for energy security and price stability.

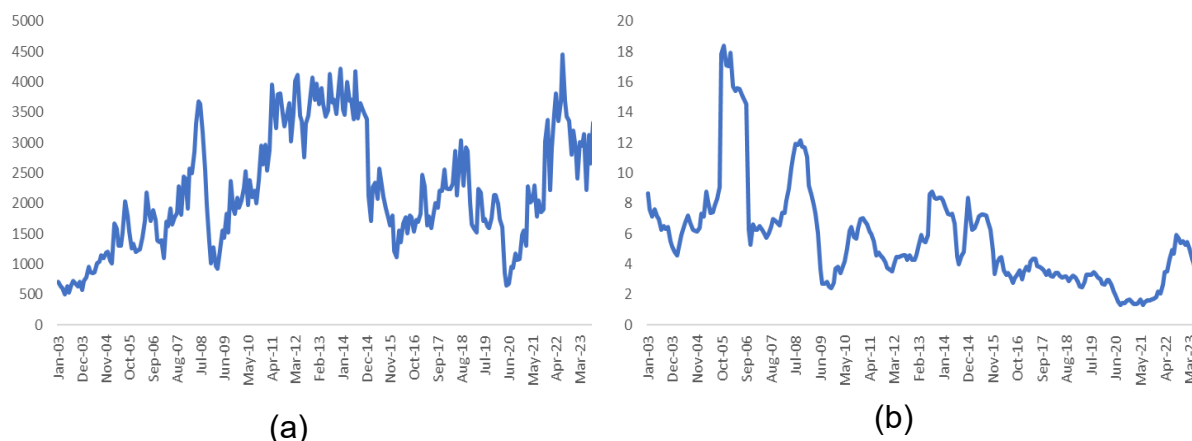


Figure 3. (a) Indonesia's oil and gas imports 2003-2023; (b) Indonesia's inflation 2003-2023.

From 2003 to 2023, Indonesia's foreign exchange reserves trended upward, signaling economic stability and stronger international liquidity. This growth enhances resilience to external shocks, mitigating exchange rate volatility and capital flow fluctuations. Figure 4(b) shows rupiah fluctuations driven by global interest rates, commodity prices, and major trading partners' policies. However, rising reserves (Figure 4a) provide Bank Indonesia with stronger tools to stabilize the exchange rate, reduce market volatility, and boost investor confidence.

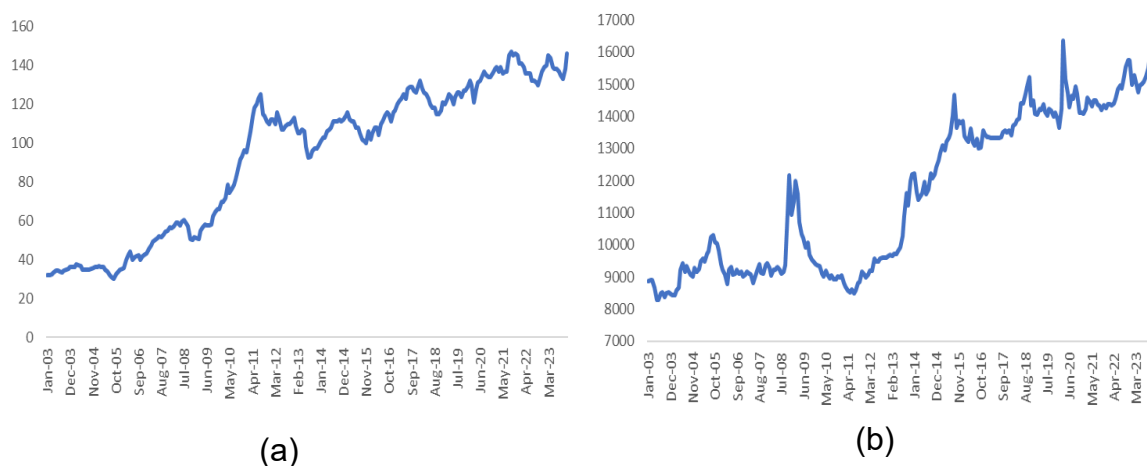


Figure 4. (a) Indonesia's Foreign Exchange Reserves 2003-2023; (b) Indonesia's Exchange Rate 2003-2023.

Stationary Test

The stationary test is used to ensure that the data used does not produce spurious regression results. The stationary test in this study uses the Augmented Dickey-Fuller (ADF) test with a significance level of 1%. This test is applied to oil and gas imports, inflation, foreign exchange reserves, and exchange rate variables.

Table 2. Unit Root Test Result

Variables	Data at level		Data at first difference	
	t-statistic	Prob.	t-statistic	Prob.
LnIM	-3.1954	0.0214	-18.9393	0.0000
Inflation	-1.8056	0.3772	-7.6093	0.0000
LnCDEV	-1.6260	0.4677	-13.0578	0.0000
LnER	-0.8195	0.8115	-12.6477	0.0000

Based on Table 2, information is obtained that all variables used, namely oil and gas imports, inflation foreign exchange reserves, and exchange rates are not stationary at the level. This is evidenced by the resulting p-value that is greater than the significance level used, which is 1%. Therefore, to achieve stationarity, a further test is carried out on the first difference. The results of the stationary test at the first difference show that all variables used, namely oil and gas imports, inflation of foreign exchange reserves, and exchange rates are stationary at the first difference. This can be seen from the p-value which is smaller than the 1% significance level. Thus, the decision obtained is to reject H_0 which means there is no unit root (stationary). Therefore, it can be said that the necessary condition for a co-integrated regression relationship is fulfilled.

Long-term Model

Long-run models are built based on variables that are not stationary at the level. The model describes the long-run equilibrium relationship between the independent and dependent variables. Although the variables show fluctuations or instability in the short-term, the model is able to capture a consistent and stable relationship pattern in the long-term.

Table 3. Long-term Equation Estimations Results

Variables	Coefficient	Std. Error	t-statistic	Prob.
C	13.2996	1.1653	11.4121	0.0000
Inflation	0.0653	0.0079	8.2052	0.0000
LnCDEV	1.2297	0.0672	18.2757	0.0000
LnER	-1.2330	0.1416	-8.7073	0.0000
R-squared	0.5879			
Adjusted R-squared	0.5829			
F-statistic	117.949			
Prob (F-statistic)	0.0000			

Based on Table 3, the long-term equation is obtained as follows

$$\ln \widehat{IM}_t = 13.2996 + 0.0653 \text{ Inflation}_t + 1.2297 \text{ LnCDEV}_t - 1.2330 \text{ LnER}_t$$

The long-term econometric model shows that inflation and foreign exchange reserves positively impact oil and gas imports, while the exchange rate has a significant

inverse effect. A 1% rise in inflation increases imports by 0.065%, and a 1% growth in reserves drives a 1.22% surge in demand. Conversely, a 1% exchange rate appreciation reduces imports by 1.233%, highlighting its dampening effect on competitiveness. The model's adjusted R^2 of 0.588 suggests that 58.8% of import variability is explained by these factors, while the remaining 41.2% may stem from geopolitical shifts, technological changes, or market volatility. These findings stress the need for monetary stability, reserve management, and exchange rate policies in strategic energy planning to mitigate import-related risks.

Cointegration Test

Cointegration test is used to analyze the long-term relationship between oil and gas imports, foreign exchange reserves, and exchange rate variables. According to Engle & Granger (1987), if the variables are not stationary at the level but have a stationary linear combination, it can be stated that the variables are cointegrated. That is, although in the short-term each variable experiences fluctuations or unstable changes, there is a stable equilibrium relationship in the long-term.

Table 4. Cointegration Test Results

	t-statistic	Prob.
Augmented Dickey-Fuller (ADF)	-5.0645	0.0000

Based on Table 4, it is obtained that the Error Correction Term (ECT) variable of the long-term equation has a p-value smaller than the 1% significance level, which means that the error variable is stationary at level. This shows that there is cointegration or there is a long-term relationship between each variable, namely oil and gas imports, inflation, foreign exchange reserves, and exchange rates. Since there is cointegration in the data, the short-term ECM model can be performed.

Short-term Model

The short-term model is formed by using variables that are stationary at first difference and the Error Correction Term (ECT) generated from the long-term model.

Table 5. Long-term Equation Estimations Results

Variables	Coefficient	Std. Error	t-statistic	Prob.
C	0.0061	0.0113	0.5386	0.5906
D(Inflation)	0.0181	0.0116	1.5607	0.1199
D(LnCDEV)	0.0631	0.4062	0.1553	0.8767
D(LnER)	-0.0212	0.4534	-0.0467	0.9627
ECT(-1)	-0.1680	0.0354	-4.7397	0.0000
R-squared	0.0855			
Adjusted R-squared	0.0706			
F-statistic	5.7543			
Prob (F-statistic)	0.0001			

Based on Table 5, the short-term equation is obtained as follows

$$\Delta \ln \widehat{IM}_t = 0.006 + 0.018 \Delta \text{Inflation}_t + 0.063 \Delta \text{LnCDEV}_t - 0.021 \Delta \text{LnER}_t - 0.168 \text{ECT}_{t-1}$$

Based on the equation obtained, it is known that the Error Correction Term (ECT) has a significant influence in the short-term. The negative ECT coefficient indicates that the ECT variable from the equation formed has a negative and significant influence on oil and gas imports in Indonesia. The ECT coefficient value illustrates the adjustment model towards long-term equilibrium after a deviation (Johansen, 1988). In this short-term equation, the ECT coefficient value is -0,1680. An ECT coefficient of -0.168 implies that approximately 16.8% of the disequilibrium from the previous period is corrected in the current period, meaning that full adjustment towards the long-run equilibrium would take several periods. While, Inflation, foreign exchange reserves, and exchange rate variables are not significant in the short run.

Classical Assumption Test

The classical assumption test ensures the ECM model meets required assumptions, making the analysis results valid. In this study, the normality test was analyzed using the Jarque-Bera test, while the non-autocorrelation test was conducted through the Breusch-Godfrey LM test. The homoscedasticity assumption is tested with the Heteroskedasticity test: Breusch-Pagan-Godfrey, while multicollinearity detection is done by reviewing the Variance Inflation Factor (VIF) value.

Table 6. Classical Assumption Test

Test	t-statistic	Prob.
Jarque-Bera test	3.7409	0.1540
Breusch-Godfrey LM test	1.3828	0.2528
Heteroskedasticity test: Breusch-Pagan-Godfrey	0.5946	0.6668
Jarque-Bera test	3.7409	0.1540
Multicollinearities	VIF	
D(Inflasi)	1.0757	
D(LnCDEV)	1.2879	
D(LnER)	1.2892	
ECT(-1)	1.0736	

Based on Table 6, it is found that the assumption tests of normality, non-autocorrelation, homoscedasticity have been fulfilled. This can be seen from the resulting p-value greater than the 5% significance level in each assumption test. In addition, in the multicollinearity test, the Variance Inflation Factor (VIF) value for all variables is below 10, which indicates that there is no strong linear relationship between the independent variables, so the assumption of non-multicollinearity is met.

4.2. Discussion

Effect of Inflation on Oil and Gas Imports

The empirical insights from Tables 3 and 5 indicate that inflation has a positive and statistically significant effect on oil and gas imports in the long run, while its short-term impact remains negligible. This result is consistent with the findings of Kartikasari and Khoirudin (2022), who similarly observed no short-term correlation between inflation and energy import dynamics. Elevated inflation drives up the costs of domestic goods and services, including energy resources, creating a potential price disparity. If domestic energy prices become more expensive than imported ones, market players

may choose to import oil and gas because it is cheaper. Additionally, sustained inflationary pressure often signals a decline in the currency's purchasing power, which can shape long-term import strategies. Over extended periods, sustained price imbalances between local and global markets incentivize firms to prioritize oil and gas imports as a strategic measure to optimize operational costs. Consequently, while short-term inflationary fluctuations may not yield immediate observable effects, prolonged instability fosters a gradual shift toward greater reliance on imported energy sources. This trend highlights the imperative of robust price stabilization frameworks and prudent management of foreign exchange reserves to mitigate imbalances and sustain equilibrium in domestic energy demand.

Effect of Foreign Exchange Reserves on Oil and Gas Imports

Based on the results from Table 3 and Table 5, the analysis shows that foreign exchange reserves have a positive and significant influence on oil and gas imports in the long run. However, a different pattern emerges in the short-term, where the effect does not look significant. This finding is consistent with previous research conducted by (Putri & Yudha, 2022), who observed significant effects in both the short and long term. However, this study found differences in the short-term, namely the absence of a significant effect of foreign exchange reserves on oil and gas imports. The difference in findings in the short-term can be explained through several contextual factors. First, market players may take time to respond to changes in foreign exchange reserves. For example, oil and gas imports are often based on long-term contracts, which are not easily adjusted even if reserve levels change. Second, exchange rate stability maintained by monetary authorities may also reduce the sensitivity of oil and gas imports to fluctuations in foreign exchange reserves in a short period.

The increase in foreign exchange reserves reflects the country's better financial capacity, especially to finance import needs, including oil and gas. Large foreign exchange reserves provide flexibility to meet domestic oil and gas demand through imports. In addition, foreign exchange reserves also help protect economies that depend on energy imports from the impact of oil price fluctuations, which are often influenced by external factors (Khudhair & Ghadeer, 2023). With adequate foreign exchange reserves, the government can maintain exchange rate stability so that the cost of oil and gas imports remains under control. This allows the volume of oil and gas imports to continue to increase despite external pressures, such as rising world oil prices.

Effect of Exchange Rate on Oil and Gas Imports

Analysis of Tables 3 and 5 reveals that exchange rate changes significantly affect Indonesia's oil and gas imports in the long run, while in the short term, the effect is not significant. This supports the results of previous studies (Adewuyi, 2016; Asif et al., 2020; Effiong, 2022), which also found a negative and significant long-term relationship between exchange rates and energy imports. Specifically, depreciation of the Indonesian rupiah elevates the domestic currency cost of imported oil and gas, thereby curbing demand and reducing import volumes. The inverse relationship shows that a weaker exchange rate can limit oil and gas imports because the cost becomes higher,

leading to lower demand. Although short-term effects may not be visible, long-term currency depreciation becomes a structural constraint that influences how much energy a country can afford to import. These results emphasize the importance of maintaining exchange rate stability to manage energy import strategies and ensure consistent supply.

5. Conclusion

This study examines the interplay between inflation, exchange rate fluctuations, and foreign exchange reserves in shaping Indonesia's oil and gas imports using the ECM framework. Empirical findings show that, in the long run, inflation and foreign exchange reserves have a significant positive impact on imports, as rising inflation increases reliance on foreign energy, while higher reserves enhance fiscal capacity for imports. Conversely, currency depreciation raises import costs, reducing volumes. In the short term, these variables show no significant effects, suggesting temporary adjustments or delayed responses. The Error Correction Term (-16.8% per month) indicates a strong self-correcting model, gradually restoring equilibrium. The model explains 58.8% of import variability, with the rest influenced by external factors like geopolitical shifts and global supply chain disruptions. These findings highlight the importance of macroeconomic stability, exchange rate management, and strategic reserve policies in ensuring energy security and economic resilience.

Based on the findings, economic policy should prioritize controlling inflation to stabilize domestic energy prices, as high inflation raises oil and gas import costs and pressures purchasing power. Stable monetary and fiscal policies, including price controls and targeted subsidies, are essential to reducing energy price volatility and import dependence. Maintaining exchange rate stability is also crucial to mitigating its impact on import costs. The government can intervene in the forex market and implement sound policies to minimize excessive exchange rate fluctuations. Additionally, optimizing foreign exchange reserve management ensures efficient import funding without straining the balance of payments. Well-managed reserves can also support energy diversification by promoting renewable energy development, gradually reducing dependence on oil and gas imports and enhancing long-term energy security.

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