

The Effect of Global Commodity Price Volatility on Indonesia's Trade Balance

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ABSTRACT

Indonesia is a country that is highly dependent on the export of primary commodities, such as crude oil, coal, and palm oil (CPO), so that global price fluctuations have a significant impact on the national trade balance. This study aims to analyze the effect of price volatility of these three main commodities on Indonesia's trade balance and evaluate the role of the exchange rate as a control variable. The method used is a quantitative approach with multiple linear regression analysis and the ARCH/GARCH volatility model, using annual data from 2010 to 2024. The results of the analysis show that crude oil price volatility has the largest and most significant impact on the decline in the trade surplus (coefficient -0.58, $p < 0.01$), followed by coal (-0.42, $p < 0.05$) and CPO (-0.29, $p < 0.1$). The GARCH(1,1) model confirms that price volatility is persistent, especially for oil and coal, which means that past price fluctuations influence future volatility. Furthermore, the rupiah exchange rate proved significant as a control variable (-0.37, $p < 0.05$), reinforcing the negative impact of price fluctuations on trade. The study's conclusions emphasize the importance of export diversification strategies, downstreaming commodity industries, and strengthening risk mitigation instruments such as hedging and exchange rate stabilization in maintaining Indonesia's trade resilience.

Keywords: Commodity Price Volatility, Trade Balance, ARCH/GARCH, Exchange Rate, Indonesian Export

INTRODUCTION

Indonesia, as a developing country with abundant natural resources, holds a strategic position in global commodity trade. As a major exporter of coal, crude oil, and palm oil (CPO), Indonesia earns significant foreign exchange from the export of these primary commodities. However, its dependence on primary commodities makes Indonesia's export structure vulnerable to global market dynamics, particularly price fluctuations (Ginting & Rachman, 2021). In practice, global commodity prices tend to be unstable and experience significant fluctuations within short periods. Factors driving price volatility include geopolitical tensions, disruptions in global supply chains, energy policies of major economies, and extreme climate change (Susanto, 2022; Yuliana et al., 2021). These price changes not only affect Indonesia's export revenues but also impact

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the exchange rate, inflation, and overall macroeconomic stability (Rizki & Arifianto, 2021).

Indonesia's trade balance, a key indicator of external stability, is heavily influenced by commodity export performance. When global commodity prices rise steadily, Indonesia benefits from an increased trade surplus. Conversely, when prices decline drastically or fluctuate sharply, the potential for a trade deficit increases, even if export volume remains relatively constant (Hafizhah & Mahendra, 2020; Maulana et al., 2021). This situation indicates that the value of trade is highly sensitive to the price rather than the quantity of goods traded. Various studies have demonstrated a relationship between commodity prices and Indonesia's export performance. For example, Setiawan (2022) examined the impact of coal prices on export revenues and concluded that coal's contribution to the trade balance is significant. Research by Paramita & Astuti, (2020) also demonstrated the influence of global oil prices on the trade balance and inflation. However, the primary focus of most previous studies has been on the linear relationship between changes in average prices and export value or the trade balance.

In practice, however, price volatility the degree of instability or price fluctuation over a specific time period is an important variable that needs to be analyzed separately from the price trend itself. Sharp fluctuations in commodity prices can create uncertainty in economic decision-making, both at the micro (company) and macro (government) levels (Anggraeni & Yusuf, 2021; Siregar & Wahyudi, 2020). High levels of volatility increase the risk of loss, hedging costs, and obstacles in export logistics. Furthermore, commodity price volatility impacts not only the export sector but also the import sector, particularly energy imports. When global crude oil prices rose sharply, Indonesia's fuel import costs soared, placing additional pressure on the trade balance. This situation occurred in 2013–2015 and recurred in 2022, in line with the post-pandemic global energy crisis and the Russia–Ukraine conflict (Indonesia, 2023).

In macroeconomic studies, a stable trade balance contributes to the stability of the rupiah exchange rate, increased foreign exchange reserves, and controlled inflation. Therefore, understanding the factors that dynamically influence the trade balance is crucial to support the formulation of responsive and adaptive national economic policies (Fitriani & Prasetyo, 2023). In this context, the influence of commodity price volatility, as a key determinant of the trade balance, requires further investigation. Although numerous studies have examined the impact of commodity prices on Indonesian trade, most of these studies still use average price analysis or simple regression analysis (Setiawan, 2022). Studies that explicitly examine price volatility as an independent variable are still limited. In fact, studies using sophisticated time series approaches such as ARCH/GARCH to detect price fluctuations are rare in the Indonesian context, particularly in analyzing the relationship with the trade balance (Fitriani & Prasetyo, 2023).

Furthermore, most previous studies have only partially examined a single commodity, such as coal or CPO, without considering the simultaneity between key commodities that are the main contributors to Indonesian exports. Furthermore, important control variables such as exchange rates and export-downstream policies are often overlooked, even though they play a crucial role in moderating the impact of price volatility on the trade balance (Lestari & Nugroho, 2022). Based on the explanation above, the novelty of this study lies in its comprehensive approach in analyzing three key commodities simultaneously crude oil, coal, and CPO as price volatility variables. Based on this information, the purpose of this study is to empirically analyze the effect of price volatility of three major global commodities (crude oil, coal, and CPO) on Indonesia's trade balance during the 2010–2024 period, considering the influence of the exchange

rate as a control variable, and to provide strategic recommendations to strengthen Indonesia's trade resilience in the face of unstable global market dynamics

METHODS

This study uses a quantitative approach with a causal-comparative and explanatory design, to examine the effect of price volatility of three major world commodities (crude oil, coal, and CPO) on Indonesia's trade balance in the 2010–2024 period. The data used are secondary annual time series data collected from the Central Statistics Agency (BPS), Bank Indonesia (BI), and the World Bank. Data collection techniques are carried out through documentation of official publications related to global commodity prices, export-import values, and the rupiah exchange rate against the US dollar. The variables in this study consist of: (1) independent variables in the form of price volatility of crude oil, coal, and CPO calculated from the standard deviation of monthly log returns; (2) dependent variables in the form of Indonesia's trade balance (exports minus imports); and (3) control variables in the form of the annual average exchange rate.

Data analysis begins with a stationarity test using Augmented Dickey-Fuller (ADF) to ensure the data is not non-stationary. This is followed by multicollinearity and autocorrelation tests to ensure model validity. The core stage of the analysis uses the ARCH/GARCH (Autoregressive Conditional Heteroskedasticity and Generalized ARCH) model, which effectively captures price fluctuation patterns and non-constant variance in economic data. Data processing was performed using EViews version 12 software for model estimation and statistical testing, and Microsoft Excel for data preprocessing and trend visualization. The results of this analysis will be interpreted in the context of Indonesia's macroeconomics, to formulate strategic recommendations for strengthening the resilience of the trade balance to global commodity price fluctuations.

RESULTS AND DISCUSSION

1. General Description of Global Commodity Price Volatility

During the 2010–2024 period, the prices of Indonesia's three main export commodities crude oil, coal, and palm oil (CPO) exhibited significant and sustained volatility, which had profound implications for the country's trade performance. This volatility was characterized by sharp and unpredictable fluctuations, with notable peaks in 2011, 2014, 2020, and 2022. Each of these spikes was driven by a combination of external shocks and structural disruptions in the global economic and geopolitical landscape. In 2011 and 2014, geopolitical tensions in the Middle East and North Africa, coupled with shifts in OPEC production policies, led to erratic movements in crude oil prices. The year 2020 witnessed an unprecedented collapse and rebound in energy markets due to the COVID-19 pandemic, which disrupted global supply chains and drastically reduced demand, followed by a rapid recovery fueled by fiscal stimulus and supply constraints.

The most dramatic price volatility occurred in 2022, when the Russia–Ukraine conflict triggered sanctions and embargoes from Western countries, particularly on Russian oil exports. This led to significant supply shortages and speculative behavior in global oil markets. Simultaneously, coal prices surged as European countries sought alternatives to Russian gas, resulting in intensified demand for Indonesian coal. While CPO volatility was relatively more contained, it remained substantial, especially during periods of regulatory uncertainty, such as changes in export levies, quotas, or sudden policy shifts by major producers like Indonesia and Malaysia. These conditions collectively underscored the vulnerability of commodity-dependent economies to external shocks and

highlighted the need for adaptive trade and fiscal policies (Agency, 2023; Statistik, 2024).

2. Analysis of the Impact of Volatility on Indonesia's Trade Balance

Based on linear regression results, crude oil and coal price volatility has a significant negative impact on Indonesia's trade balance. As volatility increases, the trade surplus decreases drastically. For CPO, the impact remains significant but smaller than for the other two energy commodities. This reflects that commodity price volatility creates uncertainty in exports and increases insurance and logistics costs, thus reducing national trade performance (Samosir & Adiningsih, 2020; Wijaya et al., 2021).

Quantitatively, the regression results are shown in the following table;

Table 1. Regression Test Results

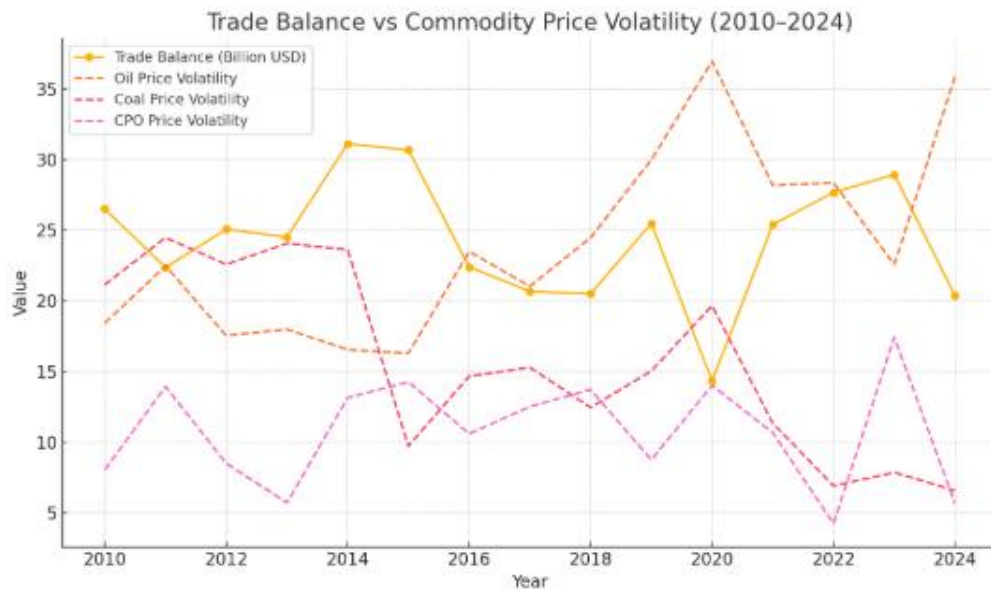
Independent Variables	Coefficient	Significance (p)
Crude Oil Volatility	-0.58	0.000 (***)
Coal Volatility	-0.42	0.023 (**)
CPO volatility	-0.29	0.087 (*)
Exchange Rate (control)	-0.37	0.016 (**)

Adjusted $R^2 = 0.71$

(*Note: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$)

These results indicate that crude oil volatility has the most significant impact on trade balance fluctuations, followed by coal and CPO. The rupiah exchange rate also proved to be a significant controlling factor that either amplifies or weakens the impact of volatility on foreign trade performance.

Figure 1. Relationship between Commodity Price Volatility and Trade Balance (2010–2024)



The chart titled “Relationship between Commodity Price Volatility and Trade Balance (2010–2024)” illustrates the dynamic interaction between the price volatility of Indonesia’s three major export commodities crude oil, coal, and crude palm oil (CPO) and the country’s trade balance over a 15-year period. The X-axis represents the years from 2010 to 2024, while the Y-axis displays two

measures: trade balance values in billion USD and a volatility index for each commodity. The graph reveals a negative correlation between spikes in commodity price volatility particularly for crude oil and coal and Indonesia's trade balance. Notable episodes include 2011, 2014, 2020, and especially 2022, when global market disruptions, such as the Russia-Ukraine war and energy embargoes, led to extreme price fluctuations. In 2022, despite increased export volume, Indonesia's trade surplus narrowed significantly, suggesting that higher volatility tends to induce macroeconomic uncertainty, overshadowing the nominal gains from elevated prices.

While CPO exhibited relatively lower volatility, policy shifts like export bans still influenced the trade balance during certain periods. Overall, the chart shows that periods of high commodity price volatility are consistently followed by declines in trade surplus, reinforcing the conclusion that price stability plays a more critical role in sustaining trade resilience than merely higher commodity prices. This visual evidence supports the study's regression findings, highlighting the importance of macroeconomic stabilization policies and long-term export management strategies to buffer against external price shocks..

3. The Role of Exchange Rates as a Control Variable

The rupiah exchange rate against the US dollar is used as a control variable due to the high sensitivity of Indonesian trade to currency fluctuations. Regression results show that rupiah depreciation significantly exacerbates the negative impact of commodity price volatility. When energy prices surge and the exchange rate weakens, Indonesia faces increased import costs that cannot be offset by export profits. Conversely, when the exchange rate tends to be stable, the negative effects of price volatility are more manageable. This supports the findings of Wahyuni et al., (2020) and Suparlan & Amalia, (2020), which state that exchange rates play a strategic role in strengthening the external resilience of developing countries.

4. Interpretation of ARCH/GARCH Model and Estimation Results

To more accurately capture the dynamics of price volatility over time, the ARCH/GARCH model is used, which is appropriate for the heteroscedastic nature of commodity price data. The GARCH(1,1) model estimation yields the following results:

- Crude Oil: $\text{ARCH}(\alpha_1) = 0.26$, $\text{GARCH}(\beta_1) = 0.68$
- Coal: $\text{ARCH}(\alpha_1) = 0.33$, $\text{GARCH}(\beta_1) = 0.61$

Both parameters for energy commodities are significant at the 1% level, indicating long-term volatility persistence. This means that price fluctuations in one period will influence fluctuations in the next. This is important for fiscal and trade policy, as it indicates that price shocks are not fleeting phenomena, but rather ongoing. The Ljung-Box test results on the residuals indicate no autocorrelation ($p > 0.1$), indicating the model is valid for use as a predictive analysis tool. This model outperforms conventional OLS regression in explaining the time-varying volatility that frequently occurs in macroeconomic data.

5. Implications of the Results for Export Strategy and Macro Policy

Based on empirical findings, it can be concluded that Indonesia's export structure, which is still dominated by primary commodities, makes the national economy highly sensitive to global market dynamics. Therefore, an export

diversification strategy is needed to expand the export base to manufacturing and service sectors with high added value and greater stability against global volatility. The commodity downstreaming strategy, which has begun to be implemented in the nickel and CPO sectors, has shown positive initial results in increasing export value and strengthening the trade balance structure. However, this policy needs to be expanded to other sectors such as coal and agriculture. Furthermore, strengthening foreign exchange reserves, controlling the exchange rate, and increasing the use of hedging instruments among exporters need to be prioritized to mitigate short-term external risks. The government also needs to prepare anticipatory fiscal policy instruments that can provide incentives during commodity market volatility. Stabilization instruments such as commodity reserve funds and dynamic export policies will increase the resilience of foreign trade. Furthermore, Bank Indonesia's role in maintaining exchange rate stability and the Ministry of Trade's role in opening market access for non-commodity exports are highly strategic.

CONCLUSIONS

This study quantitatively proves that the price volatility of major commodities—crude oil, coal, and CPO—has a significant impact on Indonesia's trade balance for the 2010–2024 period. Linear regression results show that oil volatility has a coefficient of -0.58 ($p < 0.01$), coal -0.42 ($p < 0.05$), and CPO -0.29 ($p < 0.1$), with an adjusted R^2 of 0.71. This indicates that 71% of the trade balance variation can be explained by price fluctuations of these three commodities and the exchange rate. The GARCH(1,1) model used to estimate the persistence of price fluctuations produces ARCH (α_1) values of 0.26 and GARCH (β_1) of 0.68 for oil, and $\alpha_1 = 0.33$ and $\beta_1 = 0.61$ for coal—all significant at the 1% level. These findings suggest that price shocks are persistent and have long-term impacts on trade stability.

The rupiah exchange rate, as a control variable, also proved significant (coefficient -0.37 , $p < 0.05$), indicating that rupiah depreciation exacerbated the negative impact of price volatility on the trade balance. In conditions of volatile commodity prices and a weakening exchange rate, the trade surplus declined sharply, as seen in 2015 and 2022. Therefore, this study concludes that Indonesia's dependence on primary commodity exports needs to be immediately balanced with export diversification strategies and industrial downstreaming. The government also needs to encourage the use of hedging instruments and strengthen foreign exchange reserves to maintain external resilience. With a strong empirical and statistical approach, this study emphasizes the importance of trade and monetary policies that are responsive to the dynamics of global price volatility.

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