

Impact of Trade Remedy Policy on Indonesian Nickel Export to the European Union using Intervention ARIMA Method

Mochammad Riyaldi Alamsyah¹, Denny Saputera²

^{1,2}International Trade Study Program, Faculty of Economic and Business, Widyatama University, Indonesia

ABSTRACT: This research aims to analyze the impact of trade remedy policies on Indonesian nickel exports to the European Union using the Intervention ARIMA method. A quantitative approach was employed using quarterly time series data from 2013Q4 to 2022Q4 obtained from official trade statistics. The analysis was conducted through several stages, including stationarity testing using the Augmented Dickey-Fuller (ADF) test, model identification using Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF), parameter estimation, diagnostic testing, and intervention analysis using dummy variables. The results show that the best model obtained is ARIMA (0,0,0), indicating that the export data fluctuate randomly around the mean value without significant autoregressive or moving average components. Furthermore, the intervention analysis indicates that the trade remedy policy implemented in 2020Q1 has a negative coefficient, suggesting a tendency for export values to decline after the intervention period. However, the effect is statistically insignificant, indicating that the trade remedy policy did not significantly affect Indonesian nickel exports to the European Union during the observation period. These findings suggest that fluctuations in Indonesian nickel exports are influenced more by random movements and other external factors beyond the intervention variable used in this study.

KEYWORDS: Trade Remedy, Indonesian Nickel Export, Intervention ARIMA model, European Union, Time series Analysis

I. INTRODUCTION

International trade plays an important role in supporting global economic growth through the exchange of goods, services, capital, and technology among countries. Trade openness allows countries to specialize based on their comparative advantages, improve production efficiency, and expand market access. In developing countries such as Indonesia, international trade has become one of the main drivers of economic growth and foreign exchange earnings (Paul Krugman & Maurice Obstfeld, 2018). One of Indonesia's strategic export commodities is nickel. Indonesia is known as one of the world's largest nickel producers with abundant mineral reserves, placing the country in a strategic position within the global supply chain. The increasing demand for nickel, particularly for electric vehicle battery production, has significantly increased the importance of nickel in international trade (International Energy Agency, 2023). On the other hand, the European Union is one of the world's largest economic regions that frequently implements trade remedy policies, such as anti-dumping measures, countervailing duties, and safeguard measures, to protect domestic industries. The implementation of trade remedy policies may affect export performance by restricting market access and altering trade flows. In the context of Indonesian nickel exports, trade remedy policies implemented by the European Union are suspected to have influenced export patterns both in the short and long term (World Trade Organization, 2023). In econometric analysis, policy intervention can be viewed as an external shock capable of changing the structure of economic time series data. According to George E. P. Box and George C. Tiao (1975), intervention analysis can identify structural changes through level shifts or trend shifts in time series models. Therefore, the Intervention ARIMA model is considered an appropriate method to analyze the impact of trade remedy policies on Indonesian nickel exports to the European Union. Previous studies have examined the impact of trade policies on export performance using various econometric approaches. However, studies specifically analyzing the impact of trade remedy policies on Indonesian nickel exports using the Intervention ARIMA approach remain limited. Therefore, this study aims to analyze the impact of trade remedy policies on Indonesian nickel exports to the European Union using the Intervention ARIMA method.

II. LITERATURE REVIEW

A. International Trade

International trade theory explains the exchange of goods and services among countries as well as the economic benefits generated from such activities. Classical trade theory introduced by Adam Smith through the concept of absolute advantage states that

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countries tend to export goods that can be produced more efficiently than other countries. This idea was later developed by David Ricardo through the theory of comparative advantage, which explains that international trade remains beneficial as long as countries possess relative efficiency advantages in production (Paul Krugman & Maurice Obstfeld, 2018).

Furthermore, the Heckscher-Ohlin model explains that countries export goods that intensively use abundant production factors (Dominick Salvatore, 2016).

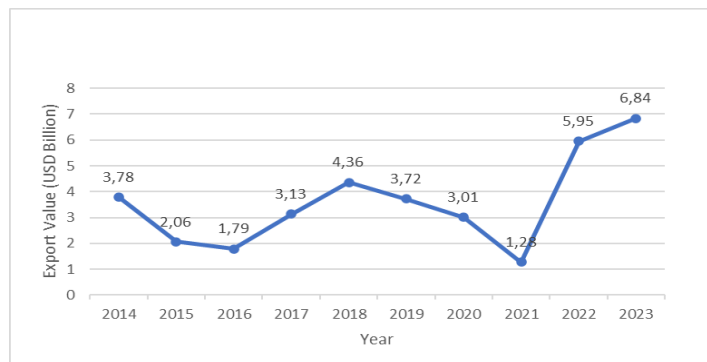


Figure 1: Indonesia Nickel Export Trend Based on UN Comtrade (2014-2023)

In the case of Indonesia, abundant nickel reserves provide a comparative advantage in exporting mineral commodities such as nickel. Modern trade theory also emphasizes the role of economies of scale, technological innovation, and trade policies in shaping international trade patterns. Within the framework of the World Trade Organization, countries are allowed to implement trade remedy policies to protect domestic industries, although such policies may also affect export performance and global trade flows.

B. Export Theory

In an open macroeconomic framework, exports are one of the main components of Gross Domestic Product (GDP), represented by the equation:

$$Y=C+I+G+(X-M).$$

Where exports (X) reflect foreign demand for domestic goods and services (N. Gregory Mankiw, 2019). Export growth contributes to economic expansion, foreign exchange earnings, and employment creation. Therefore, export stability is considered an important indicator of a country's economic performance. According to international trade and open economy theory, export performance is influenced by several factors, including international commodity prices, exchange rates, global demand, and trade policies (Dominick Salvatore, 2016). For primary commodities such as nickel, global prices play a significant role in determining export values. Exchange rate movements may also affect export competitiveness in international markets.

Countries that rely heavily on primary commodity exports tend to be more vulnerable to global price fluctuations and external trade policies. The declining terms of trade theory proposed by Raúl Prebisch and Hans Singer explains that raw material exporting countries often experience price instability and trade pressures from industrialized countries (Michael Todaro & Stephen C. Smith, 2015). In the context of nickel exports, trade remedy policies may further increase market uncertainty by restricting market access.

Therefore, export performance is influenced by both internal and external factors, including international trade policies. In this study, Indonesian nickel export values are used as the main variable to analyze the impact of trade remedy policies on export dynamics.

C. Trade Remedy

Trade remedy is a trade policy instrument legally recognized within the international trading system to protect domestic industries from unfair trade practices or harmful import surges. Within the framework of the World Trade Organization, trade remedy measures are regulated under several major agreements, including the Anti-Dumping Agreement, the Agreement on Subsidies and Countervailing Measures (SCM), and the Agreement on Safeguards (WTO, 2023). These instruments allow member countries to implement temporary protection measures in order to maintain domestic industrial stability without violating the principles of free trade. Anti-dumping duties are imposed when imported products are sold at prices lower than their normal value in the exporting country, causing material injury to domestic industries in the importing country. Meanwhile, countervailing duties are applied in response to government subsidies provided to exporters that may distort market competition (Dominick Salvatore, 2016). Both measures aim to create a fair competitive environment in international trade.

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In contrast, safeguard measures do not require evidence of unfair trade practices. These measures are implemented when a significant increase in imports threatens domestic industries. Safeguards are generally temporary and may take the form of additional tariffs or import quotas. Economically, such measures may reduce import volumes, increase domestic prices, and create uncertainty for exporting countries. The European Union is recognized as one of the most active users of trade remedy instruments globally. In recent years, the European Union has intensified the use of anti-dumping and anti-subsidy measures, particularly on metal and strategic mineral products. This indicates that trade remedy policies function not only as instruments of industrial protection but also as strategic tools in global trade and industrial policy.

Therefore, trade remedy measures have significant economic implications for exporting countries because they may affect export prices, trade volumes, and market access. In this study, trade remedy policy is treated as an external intervention that may influence the export pattern of Indonesian nickel exports to the European Union.

D. Trade Remedy Policy

From the perspective of international trade, protectionist policies often emerge as a response to domestic political and economic pressures. The political economy of trade policy explains that trade policies are frequently influenced by the interests of domestic industries seeking protection from foreign competition (Paul Krugman & Maurice Obstfeld, 2018). Therefore, the implementation of trade remedy measures is driven not only by economic considerations, but also by political interests and industrial strategies. From a microeconomic perspective, tariffs and import restrictions tend to increase domestic prices and reduce import quantities. For exporting countries, such policies may reduce foreign demand for exported products, thereby decreasing export volumes and export values. At the macroeconomic level, trade restrictions may also affect trade balances, exchange rates, and economic growth (N. Gregory Mankiw, 2019). In the context of nickel commodities, restrictions on market access may reduce foreign exchange earnings derived from exports.

Economic integration theory also explains the existence of trade diversion effects, namely shifts in trade flows resulting from trade policies. When a country implements trade remedy measures, exporting countries may redirect their exports to alternative markets. However, this adjustment process may not occur immediately and can create short-term export volatility.

From an econometric perspective, trade policies can be considered external shocks capable of altering economic data patterns. George E. P. Box and George C. Tiao (1975) explain that policy interventions may be identified through level shifts or trend shifts in time series models. Therefore, the Intervention ARIMA model is considered an appropriate approach for analyzing the impact of trade remedy policies on Indonesian nickel exports.

Overall, trade remedy theory suggests that such policies may create structural changes in international trade through price mechanisms, market access restrictions, and market adjustment processes. In this study, the European Union's trade remedy policy is treated as an intervention variable that may influence the export value of Indonesian nickel exports.

E. ARIMA MODEL and The Intervension ARIMA

The Autoregressive Integrated Moving Average (ARIMA) model is one of the most widely used time series methods for analyzing and forecasting data based on historical patterns. The model was systematically developed by George E. P. Box and Gwilym M. Jenkins in *Time Series Analysis: Forecasting and Control* (Box & Jenkins, 1976). This approach, commonly known as the Box-Jenkins methodology, has been widely applied in economics, finance, and international trade analysis. In general, the ARIMA model is written as $ARIMA(p,d,q)$, where (p) represents the autoregressive (AR) component, (d) represents the differencing process required to achieve stationarity, and (q) represents the moving average (MA) component. The AR component explains the influence of previous observations on current values, while the MA component captures the influence of past error terms. ARIMA models are commonly used when time series data exhibit trends or non-stationary behavior, requiring differencing to obtain stable statistical properties (Damodar N. Gujarati & Dawn C. Porter, 2009). In international economic analysis, ARIMA models are frequently used to examine export performance, commodity prices, exchange rates, and other macroeconomic variables. One of the main advantages of the ARIMA approach is its ability to capture historical patterns without relying on many exogenous variables. However, in policy analysis, the ARIMA model can be extended into an Intervention ARIMA model to measure the impact of specific events or policy changes on observed variables.

The Intervention ARIMA model was first introduced by George E. P. Box and George C. Tiao (1975) as a method for identifying the effects of external events on time series data. In this approach, a policy or external event is treated as an intervention variable that may generate temporary or permanent effects on the observed series. The intervention model generally uses dummy variables to distinguish periods before and after the implementation of a policy. Through this approach, researchers can identify changes in the level, trend, and overall structure of time series data resulting from policy intervention.

In this study, the European Union's trade remedy policy is treated as an external shock affecting Indonesian nickel exports. The policy may alter export patterns through changes in export value, market access, or long-term trade trends. Therefore, the

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Intervention ARIMA model is considered an appropriate method for empirically analyzing the impact of trade remedy policies on Indonesian nickel exports to the European Union.

III. RESEARCH METHODS

This research employs a quantitative approach using time series data to analyze the impact of trade remedy policies on Indonesian nickel exports to the European Union. The data used in this study are quarterly secondary data covering the period from 2013Q4 to 2022Q4. Export data were obtained from UN Comtrade, which provides international trade statistics on export and import activities among countries.

The analytical method used in this study is the Intervention Autoregressive Integrated Moving Average (ARIMA) model. The ARIMA approach is applied to identify patterns in time series data and to measure the impact of policy intervention on export performance. In this study, the intervention variable represents the implementation of the European Union's trade remedy policy in 2020Q1.

The analysis procedure consists of several stages. First, a stationarity test was conducted using the Augmented Dickey-Fuller (ADF) test to determine whether the data were stationary. Stationary data are required to avoid spurious regression and to ensure the validity of the time series estimation process.

Second, model identification was carried out using the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) correlograms to determine the appropriate ARIMA model specification. The best model selection was based on the Akaike Information Criterion (AIC), where the model with the smallest AIC value was selected as the optimal model.

Third, parameter estimation was conducted using the Maximum Likelihood estimation method in EViews software. After the estimation stage, diagnostic tests were performed to evaluate the adequacy of the model. The diagnostic process included residual autocorrelation testing to ensure that the residuals satisfied the white noise assumption, as well as residual normality testing using the Jarque-Bera test.

Finally, intervention analysis was conducted by introducing a dummy variable into the ARIMA model. The dummy variable was assigned a value of 0 before the implementation of the trade remedy policy and 1 after the policy implementation period. The intervention model used in this study can be expressed as follows:

$$Y_t = C + \omega D_t + \varepsilon_t$$

where Y_t represents Indonesian nickel exports to the European Union, C represents the constant term, ω represents the intervention coefficient, D_t represents the intervention dummy variable, and ε_t represents the error term. Through this approach, the study aims to identify whether the trade remedy policy significantly affected Indonesian nickel exports to the European Union.

IV. RESULT AND DISCUSSION

A. DESCRIPTIVE GRAPHIC

The trend of Indonesian nickel exports to the European Union during the period 2013Q4–2022Q4 shows fluctuating movements. Several periods experienced increases and declines in export value, indicating that nickel exports were influenced by various internal and external factors, including global commodity prices, international demand, and trade policies. Around the implementation period of the European Union's trade remedy policy in 2020Q1, export values tended to decline, although the movement remained relatively volatile across subsequent periods.

The fluctuation in export values indicates that Indonesian nickel exports did not follow a stable long-term trend. This condition suggests that export performance was highly sensitive to external market conditions and global trade dynamics.

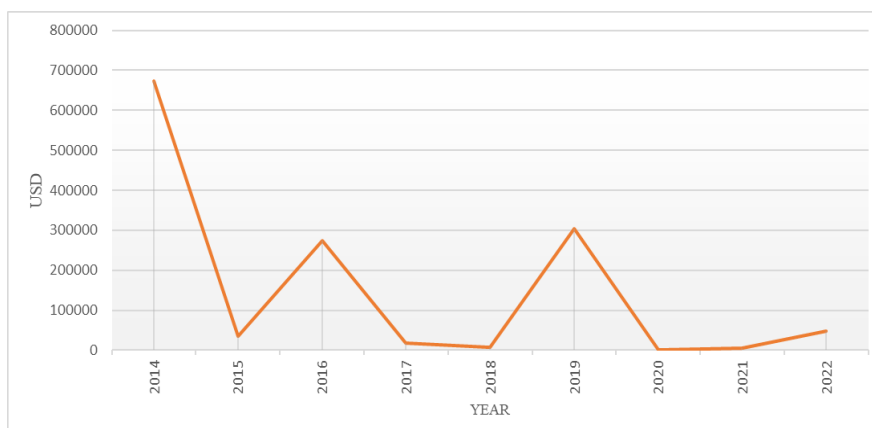


Figure 2: Data on Indonesian Nickel Exports to Europe

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B. STATIONARY TEST RESULTS

The stationarity test was conducted using the Augmented Dickey-Fuller (ADF) test. The test results indicate that the export data were stationary at the level form because the probability value was lower than the 5 percent significance level. Therefore, differencing was not required in the ARIMA modeling process.

Stationary data indicate that the statistical properties of the series, such as mean and variance, remained relatively constant over time. This condition is important to ensure the validity and reliability of the ARIMA estimation process.

Variable	ADF stat.	Probability	Conclusion
Exports Value Indonesian nickel to Europe	-5.831380	0.0000	Stationary at Level

Source: Author's computation Using EViews12

C. ARIMA MODEL IDENTIFICATION AND ESTIMATION

Model identification was performed using the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) correlograms. Based on the Automatic ARIMA Forecasting procedure in EViews, the best model selected was ARIMA (0,0,0) because it had the smallest Akaike Information Criterion (AIC) value among the estimated models.

The ARIMA (0,0,0) model indicates that the export data fluctuate randomly around the mean value without significant autoregressive or moving average components. This finding suggests that historical export values did not exhibit strong systematic patterns capable of explaining future movements.

Model	AIC	SIC	Conclusion
ARIMA (0,0,0)	25.543394	25.53288	Best Model

Source: Author's computation Using EViews12

D. DIAGNOSTIC TEST RESULTS

Diagnostic testing was conducted to evaluate whether the residuals satisfied the white noise assumption. The correlogram of residuals showed no significant autocorrelation, indicating that the model residuals were randomly distributed.

Furthermore, the Jarque-Bera normality test indicated that the residuals were not normally distributed because the probability value was below the 5 percent significance level. However, in time series analysis, residual normality is not considered the primary requirement as long as the residuals satisfy the white noise assumption. Therefore, the ARIMA model remained appropriate for further analysis.

Test	Probability	Conclusion
White Noise Test	0.000000	No Auto Correlation
Jarque-Bera Test	0.0000	Residual Not Normal

Source: Author's computation Using EViews12

E. INTERVENTION ARIMA RESULT

The intervention analysis was conducted by introducing a dummy variable representing the implementation of the European Union's trade remedy policy in 2020Q1. The estimation results indicate that the intervention dummy variable had a negative coefficient of -3929.940, suggesting a tendency for Indonesian nickel exports to decline after the implementation of the trade remedy policy.

However, the probability value of 0.8111 was greater than the 5 percent significance level, indicating that the effect was statistically insignificant. This finding suggests that the trade remedy policy did not significantly affect Indonesian nickel exports to the European Union during the observation period.

Variable	Coefficient	Probability	Conclusion
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INTV	-3929.940	25.53288	Best Model
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Source: Author's computation Using EViews12

F. DISSCUSION

The insignificant effect of the trade remedy policy indicates that fluctuations in Indonesian nickel exports were influenced more by external market conditions and random movements than by the trade remedy policy itself. Although the intervention coefficient shows a negative direction, statistically the policy did not produce a significant structural change in the export series during the observation period. This finding suggests that the implementation of the European Union's trade remedy policy was not strong enough to substantially alter Indonesia's nickel export performance. Several factors may explain this result. First, global demand for nickel remained relatively strong throughout the observation period, particularly due to the rapid expansion of the stainlesssteel industry and the increasing demand for electric vehicle batteries. Nickel is considered one of the most strategic mineral commodities in the global energy transition, causing international demand to continue increasing despite trade restrictions in certain regions. As one of the world's largest nickel producers, Indonesia still maintained an important position in the global supply chain, which may have reduced the direct impact of trade remedy measures imposed by the European Union.

Second, Indonesia's comparative advantage in nickel production may have contributed to the resilience of export performance. According to international trade theory, countries with abundant natural resources tend to maintain export competitiveness because they are able to produce commodities at relatively lower production costs. Indonesia's large nickel reserves and growing downstream industry may have strengthened the country's bargaining position in international trade, thereby reducing the effectiveness of external trade restrictions.

In addition, the ARIMA (0,0,0) model selected in this study indicates that the export series behaved similarly to white noise, meaning that export movements fluctuated randomly around the mean value without significant autoregressive or moving average components. This condition suggests that historical export values did not contain strong systematic patterns capable of explaining future export movements. As a result, the intervention effect became statistically difficult to detect because the fluctuations in the data were dominated by irregular and random movements rather than by a stable trend or structured pattern.

The insignificant statistical result may also indicate that the impact of trade remedy policies requires a longer adjustment period before becoming fully reflected in export data. In international trade, policy effects are often transmitted gradually through changes in market access, production decisions, trade diversification, and export destination adjustments. Exporting countries may respond to trade restrictions by redirecting exports to alternative markets or by adjusting trade strategies, thereby reducing the immediate impact of the policy on overall export performance.

Furthermore, the implementation period of the trade remedy policy coincided with several global economic disruptions, including fluctuations in commodity prices and the economic uncertainty caused by the COVID-19 pandemic. These external factors may have had a stronger influence on Indonesian nickel exports than the trade remedy policy itself. Consequently, it becomes difficult to isolate the direct effect of the intervention policy from broader global economic dynamics affecting international trade during the same period.

From the perspective of international trade theory, trade remedy policies are generally expected to reduce market access and create barriers to trade. However, the empirical findings of this study indicate that the policy did not significantly alter Indonesian nickel export patterns during the study period. This suggests that Indonesia's nickel exports were more strongly influenced by global market demand, commodity price movements, and external macroeconomic conditions than by the trade remedy measures implemented by the European Union. Therefore, the findings imply that external market dynamics played a more dominant role in determining Indonesian nickel export performance than policy intervention alone.

V. CONCLUSIONS

This study aims to analyze the impact of the European Union's trade remedy policy on Indonesian nickel exports using the Intervention ARIMA approach. Based on the empirical results, the best model identified for the export series is ARIMA (0,0,0), indicating that the data fluctuated randomly around the mean value without strong autoregressive or moving average patterns. The stationarity and diagnostic tests also confirmed that the model was appropriate for time series analysis. The intervention analysis shows that the trade remedy policy implemented in 2020Q1 had a negative coefficient, suggesting a tendency for Indonesian nickel exports to decline after the policy implementation period. However, the effect was statistically insignificant, indicating that the trade remedy policy did not significantly affect Indonesian nickel exports to the European Union during the observation period. These findings suggest that fluctuations in Indonesian nickel exports were influenced more by external market conditions, global commodity demand, and broader economic dynamics than by the trade remedy policy itself. The results also indicate that Indonesia's position as one of the world's major nickel producers contributed to the resilience of export performance despite trade

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restrictions imposed by the European Union. Strong global demand for nickel, particularly from the stainless steel and electric vehicle industries, may have reduced the direct impact of trade remedy measures on export activities.

Based on these findings, several policy recommendations can be proposed for the Indonesian government. First, the government should strengthen export market diversification in order to reduce dependence on a limited number of trading partners and minimize the risks associated with trade restrictions from certain regions. Expanding export destinations to emerging markets may help maintain export stability during periods of trade policy uncertainty.

Second, the government should continue accelerating the downstream development of the nickel industry to increase the added value of exported products. By promoting the production of processed nickel products and battery-related industries, Indonesia may strengthen its competitiveness and reduce vulnerability to external trade barriers targeting raw material exports.

Third, improving trade diplomacy and international cooperation is essential to address potential trade disputes and maintain market access. The Indonesian government should actively engage in international trade negotiations and strengthen its position within the World Trade Organization framework to protect national trade interests.

Finally, future research is encouraged to incorporate additional macroeconomic variables, such as exchange rates, global nickel prices, and international demand indicators, in order to obtain a more comprehensive understanding of the factors affecting Indonesian nickel exports. Further studies using alternative econometric approaches may also provide deeper insights into the long-term effects of trade policies on export performance.

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