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Research Article

Analysis of the Downstreaming Policy and Factors Affecting Indonesia's Nickel Export Performance (HS 75), 2010–2023

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Abstract: Nickel has become a strategic mineral in the global industrial value chain, particularly for stainless steel production and electric vehicle battery manufacturing. As one of the world's largest nickel producers, Indonesia has implemented a downstream industrialization policy aimed at increasing value added and strengthening export performance. This study analyzes the effects of international nickel prices, destination countries' GDP per capita, exchange rates, and the downstreaming policy on the value of Indonesia's nickel exports (HS 75) over the period 2010–2023. The study employs a quantitative approach using panel data regression with secondary data covering five major export destination countries, namely China, Japan, South Korea, Thailand, and Singapore. Based on the Chow and Hausman tests, the Fixed Effects Model is selected as the most appropriate estimation technique, indicating the presence of country-specific heterogeneity among importing countries. The results show that destination countries' GDP per capita and international nickel prices have a positive and statistically significant effect on Indonesia's nickel export value. The downstreaming policy dummy variable also exhibits a positive and significant impact, suggesting that the nickel ore export ban implemented since 2020 has effectively shifted export composition toward higher value-added processed nickel products. In contrast, exchange rates are found to have no significant effect on export performance. Overall, the findings provide empirical evidence supporting the effectiveness of Indonesia's downstream industrialization policy and highlight the importance of global demand conditions in driving the performance of processed nickel exports.

Keywords: Downstreaming Policy; GDP; Nickel Export; Nickel Price; Panel Data;

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1. Introduction

Indonesia's nickel export performance has attracted increasing attention over the years. The performance of nickel exports is measured by the Free on Board (FOB) value, in which nickel exports consistently record the highest export value among other mining commodities. This indicates Indonesia's strong commitment to continuously contributing to the global supply of nickel. Indonesia is also recognized as one of the world's largest nickel-producing countries, alongside the Philippines, Russia, Australia, and Canada (Nickel Institute, 2022).

In response to the growing global demand for nickel, the Indonesian government has implemented a downstream industrialization (value-added) policy. Through the creation of added value, this policy is expected to enhance public welfare by generating more employment opportunities and increasing national wealth (Akhmadi, 2024).

Farrokhpay et al., 2019, said Nickel is recognized as an important metal globally, sourced primarily from sulfide and laterite deposits, with annual consumption reaching approximately 2 million tons. Asian countries—particularly China, Japan, and South Korea—serve as major suppliers of processed materials and components used in lithium-ion batteries (LIBs). Specifically, these three countries account for 86% of the total global supply of materials and components utilized in battery manufacturing (Maisel et al., 2023). Chinese firms dominate

the supply of anode materials (graphite) as well as nickel manganese cobalt oxide (NMC) and lithium cobalt oxide (LCO) cathode materials. Meanwhile, Japanese companies are the primary suppliers of nickel–cobalt–aluminum oxide (NCA) cathode materials (huisman et al., 2020). Among these countries, China is the largest player in lithium-ion battery cell production, accounting for approximately three-quarters (75%) of global battery cell output, thereby positioning itself as the leading country in the global lithium-ion battery industry.

Nickel downstreaming has demonstrated a significant impact on Indonesia's trade structure. Following the implementation of the policy, exports of processed nickel products increased substantially, particularly to major destination countries such as China, Japan, South Korea, Singapore, and Thailand, which serve as global hubs for battery manufacturing and nickel-based industries. At the same time, trade dynamics are also influenced by global macroeconomic factors, including movements in international nickel prices, exchange rates, and the economic growth of destination countries.

Therefore, it is essential to analyze how the implementation of downstream industrialization policies, together with external macroeconomic factors, affects Indonesia's nickel export performance. This study aims to examine the effects of international nickel prices, destination countries' gross domestic product (GDP) per capita, exchange rates, and downstreaming policy on the value of Indonesia's nickel exports (HS 75) over the period 2010–2023. The findings are expected to provide empirical evidence on the effectiveness of the downstreaming policy and offer valuable insights for policymakers in formulating future strategies for the development of Indonesia's national nickel industry.

2. Preliminaries or Related Work or Literature Review

The development of research on Indonesia's nickel export performance reflects a growing scholarly interest in the role of nickel as a strategic commodity within global industries and the country's downstream industrialization policy. Previous studies have primarily focused on export competitiveness, commodity price dynamics, and macroeconomic determinants. Widiyanti and Saputra (2023) find that destination countries' GDP per capita and exchange rates have a positive and statistically significant effect on Indonesia's processed nickel exports. (Rahman & Pasaribu, n.d.), employing an Error Correction Model (ECM), demonstrate that in the long run, nickel production, international prices, and the Revealed Comparative Advantage (RCA) index positively influence nickel exports. Aula (2020) emphasizes that exchange rates and production exert a significant impact on nickel export volumes in the long term, while inflation shows a significant short-run effect. Additional evidence is provided by (Yenny & Wahyudi, 2023), who apply a Vector Error Correction Model (VECM) to examine the relationship between nickel prices, exchange rates, and stock prices, revealing that nickel prices have a significant influence on exchange rates and financial markets.

From a theoretical perspective, this study draws on international trade theory, particularly the concepts of comparative advantage and value added, which position downstream industrialization as a strategy to enhance export competitiveness through improvements in product quality (Ricardo; Krugman & Obstfeld). Strategic trade policy theory is also relevant, as export restrictions on raw materials and support for domestic processing industries indicate active state intervention aimed at strengthening a country's strategic position in global markets. In addition, demand–supply theory explains how international nickel prices and the economic conditions of importing countries proxied by GDP per capita influence demand for Indonesian nickel products(Pandyaswargo et al., 2021).

Although the existing literature has examined the relationship between macroeconomic factors and nickel exports, several research gaps remain. First, most previous studies rely on single-country time-series data, which do not adequately capture cross-country dynamics among Indonesia's major nickel importing partners. Second, prior research has not explicitly assessed the impact of the downstream industrialization policy on the value of nickel exports following the 2020 nickel ore export ban, particularly through a panel data regression approach across major destination countries. Moreover, much of the existing literature focuses on export competitiveness or financial market linkages rather than evaluating the effectiveness of industrialization policies in promoting processed nickel exports.

Accordingly, this study contributes to the literature by employing a panel data approach covering the period 2010–2023 across five of Indonesia's major nickel export destination countries to examine the roles of international nickel prices, GDP per capita, exchange rates, and the downstreaming policy indicator. This focus provides empirical insights into the

effectiveness of downstream industrialization in enhancing Indonesia's nickel export performance and enriches the literature on trade policy and resource-based industrialization.

Table 1. Previous Studies.

Authors and Years	Scope of Topic	Methods	Conclusion	Research Gap
Widiyanti & Saputra (2023)	Competitiveness and Determinants of Indonesia's Processed Nickel Exports	Panel Data Regression	Revealed Comparative Advantage (RCA), GDP per capita, and exchange rates have a positive and statistically significant effect on nickel exports.	It does not examine the impact of the downstreaming policy and does not focus on the post–nickel ore export ban period.
Rahman & Pasaribu (2022)	Export Value of Indonesian Nickel (HS 75)	Error Correction Model (ECM)	In the long run, production, prices, and the Revealed Comparative Advantage (RCA) have a positive effect, while in the short run, RCA and the Economic Complexity Index (ECI) are statistically significant.	It does not account for differences across export destination countries and does not include a downstreaming policy dummy variable.
Aula (2020)	Indonesia's Nickel Export Volume	ECM Time Series	Production, prices, and exchange rates are significant in the long run, while inflation is significant in the short run.	The analysis is limited to the period before the implementation of downstreaming and does not focus on exports of HS 75 (processed nickel) products.
Afdania (2022)	Export Competitiveness of Nickel in South Sulawesi	Regresi Time Series	Production and prices have a positive effect, while exchange rates and inflation have a statistically significant negative effect.	The study has a regional focus and does not examine national HS 75 exports or the impact of the downstreaming policy.

3. Proposed Method

Research Design

This section outlines the research methodology in a step-by-step manner, starting from data collection and processing to model analysis. The study adopts a quantitative approach using panel data regression to examine the effects of macroeconomic variables and the downstreaming policy on the value of Indonesia's nickel exports (HS 75) to five major export destination countries over the period 2010–2023.

The data are obtained from the World Bank and UN Comtrade, with the downstreaming policy captured through a dummy variable, coded as 0 for the pre-policy period and 1 for the post-policy period. The analysis is conducted using EViews software and involves estimating the Common Effects Model (CEM), Fixed Effects Model (FEM), and Random Effects Model (REM). The most appropriate model is selected based on the Chow test, Hausman test, and Lagrange Multiplier (LM) test.

Population, Sample Size, and Sampling Approaches

The population of this study comprises all destination countries of Indonesia's nickel exports (HS 75) recorded in international trade during the period 2010–2023. From this population, the sample was determined using a non-probability purposive sampling technique by selecting countries that represent Indonesia's main nickel export markets, exhibit significant and consistent export values over the observation period, and have complete data availability for research variables, including nickel export values, international nickel prices, gross domestic product (GDP), exchange rates, and policy-related dummy variables. Based on these criteria, five destination countries China, Japan, South Korea, Thailand, and Singapore were selected as the research sample. The study therefore employs panel data,

combining cross-sectional data across countries and time-series data from 2010 to 2023, resulting in a total of 70 observations.

Data Analysis

The data analysis in this study employs a quantitative approach using panel data regression to examine the effects of international nickel prices, economic size, exchange rates, and downstream policy on Indonesia's nickel export performance (HS 75) to selected destination countries during the period 2010–2023. Panel data were constructed by combining cross-sectional data from five major export destination countries China, Japan, South Korea, Thailand, and Singapore with time-series data covering fourteen years. Prior to model estimation, descriptive statistical analysis was conducted to provide an overview of data characteristics and trends. The regression analysis was performed using the Random Effect Model (REM) to control for unobserved country-specific heterogeneity that may influence export performance but remains constant over time. Model selection was supported by standard panel data specification tests, including the Chow test and Hausman test. To ensure the robustness of the estimation results, classical assumption tests were also conducted, covering multicollinearity and heteroskedasticity. All variables were transformed into natural logarithms, except for dummy variables, in order to reduce data variability and allow coefficient interpretation in terms of elasticities. The estimation results are then interpreted to assess both the magnitude and direction of the influence of each explanatory variable on Indonesia's nickel export performance.

Regressions Model:

$$\ln Yit = \alpha + \beta 1 \ln GDPit + \beta 2 \ln PRICEt + \beta 3 \ln KURSit + \beta 4 DUMMYt + \epsilon it$$

lnEXPit denotes the logarithm of export value of nickel to country iii in year ttt, PRICEtPRICE_tPRICEt is the world nickel price, lnGDPit is the logarithm of GDP per capita of the importing country, lnPRICEit is the logarithm of the International Nickel Price, lnEXCHit is the logarithm of the exchange rate, and HILt is a dummy variable representing the nickel downstreaming policy (1 for post 2020 period, 0 otherwise).

4. Results and Discussion

Results

Volatility Nickel's Export Value

Indonesia's Nickel Export Growth illustrates a dramatic structural shift in the national nickel trade, particularly following the implementation of downstream (hilirisasi) policies. In the pre-2020 period, nickel export values exhibited high volatility, fluctuating sharply in line with global commodity prices and on-off export policies for raw nickel ore. Spikes in growth rates, such as those observed in China in 2013, were often followed by sharp contractions, reflecting the sensitivity of raw materials to market dynamics.

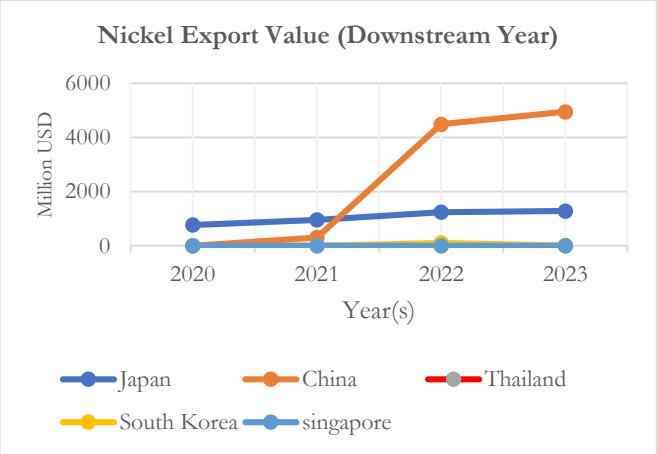

Figure 1. Nickel's Export Value.

A fundamental turning point occurred when the Indonesian government permanently banned the export of raw nickel ore starting January 1, 2020. This policy immediately triggered an extraordinary surge in 2021, when nickel export growth to China soared by approximately 1,200%, followed by significant increases to South Korea as well. This surge indicates the initial success of the downstream program, shifting focus from low-value ore exports to

higher-value processed products such as ferronickel and nickel pig iron (NPI), which automatically multiplied foreign exchange earnings.

However, the 2021 surge should be interpreted with caution, as much of it was a drastic correction against the previous contraction in raw nickel export values. After the base effect subsided, export growth in 2022 and 2023 showed a slowing trend (normalization), though it remained above pre-pandemic and pre-downstream policy growth levels. The data also highlights increasing market dependence on China, which serves as the main trading partner and largest investor in Indonesia's smelter industry, while other traditional trade partners such as Japan and Thailand experienced more moderate fluctuations.

Thus, this clearly visualizes the value-added transition and consolidates China's role as the central hub in Indonesia's processed nickel supply chain.

The initial descriptive analysis indicates that the value of Indonesia's nickel exports (HS 75) fluctuated throughout the study period. A significant decline occurred in 2020 following the implementation of the ban on raw nickel ore exports. However, in the period after 2021, export values increased sharply, particularly to China, reflecting a structural shift in exports from raw materials toward higher value-added nickel products.

International nickel prices exhibit high volatility, with sharp increases during the 2021–2022 period driven by rising global demand from the electric vehicle battery industry. Meanwhile, GDP per capita in destination countries shows an upward trend,indicating potential growth in demand for Indonesia's processed nickel imports.

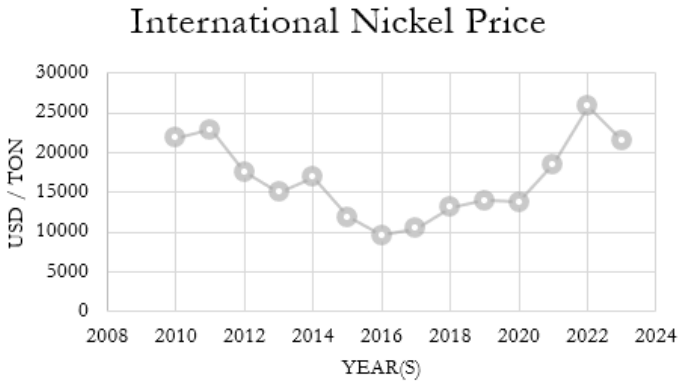

Figure 2. International Nickel Price.

At the beginning of the study period (2010–2012), nickel prices remained at relatively high levels, reflecting strong global demand, particularly from the stainless steel industry. During the 2013–2016 period, nickel prices declined sharply due to global oversupply and a slowdown in global economic growth, reaching their lowest point in 2016.

In the 2017–2020 period, nickel prices began to recover gradually, although they remained at moderate levels. A more pronounced increase occurred from 2021 to 2022, driven by rising demand for nickel as a key input in electric vehicle battery production and the acceleration of the global energy transition. In 2023, nickel prices experienced a correction but remained at relatively higher levels compared to the pre-2020 period.

GDP per capita of Indonesia's nickel export destination countries over the 2010–2023 period indicate a generally upward trend, despite fluctuations in certain years. Singapore consistently records the highest GDP per capita among the destination countries, reflecting its advanced economic structure and strong purchasing power. Japan and South Korea also exhibit relatively high and stable GDP per capita levels, consistent with their characteristics as industrialized economies with strong manufacturing bases.

Meanwhile, China and Thailand have lower GDP per capita levels compared to the other three countries but display substantial growth throughout the study period. The increase in GDP per capita in these destination countries suggests an expansion of economic and industrial activities, which potentially raises demand for industrial inputs such as processed nickel. Overall, the evolution of GDP per capita across destination countries reflects their economic capacity to absorb Indonesia's processed nickel exports.

Best Model Selection

According to Widarjono (2007:258), there are three methods for model selection, namely the Chow test, the Hausman test, and the Lagrange Multiplier (LM) test. The following are the results of each model selection test.

Table 2. Best Model Selection.

Test	Proof	Interpretation
Chow Test	0,00 < 0,05	FEM
Hausman Test	1,00 > 0,05	REM
LM Test	0,00 < 0,05	REM

Source: Processed Data, Eviews12, 2025.

Based on the results of the Chow test, Hausman test, and Lagrange Multiplier test, the Random Effect Model is identified as the most appropriate model for this study.

Classical Assumption Tests

To ensure the validity of the estimated model, a series of classical assumption tests were conducted. The normality test indicates that the residuals are normally distributed, thereby satisfying the basic assumption of regression analysis. The multicollinearity test shows no high correlation among the independent variables, as the correlation coefficients remain below the critical threshold, indicating that the model is free from multicollinearity issues.

Furthermore, the heteroskedasticity test confirms the absence of heteroskedasticity, suggesting that the residual variance is constant. With all classical assumptions fulfilled, the regression estimates can be considered BLUE (Best Linear Unbiased Estimator) and are therefore suitable for further analysis.

Normality Test

The normality test aims to examine whether the residuals (errors) of the regression model are normally distributed. This test is important to ensure the validity of the classical assumptions in regression analysis. In this study, the normality test is conducted using the Jarque–Bera (JB) test, and the significance value is greater than 0.05, which is commonly used in panel data regression analysis.

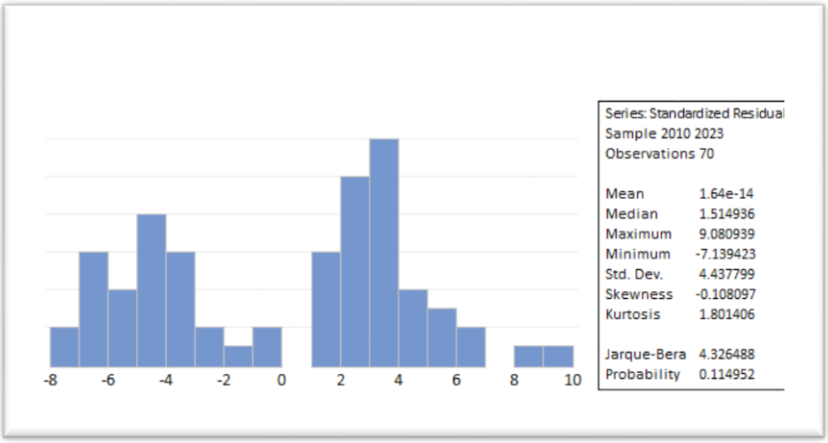

Figure 3. Normality Test.

As shown in the figure above, the data are normally distributed since the Jarque–Bera statistic has a probability value of 0.114952, which is greater than 0.05.

Multicolliniearity Test

Multicollinearity occurs when independent variables in a regression model are perfectly or nearly perfectly correlated. In a well-specified regression model, the independent variables should not exhibit perfect or near-perfect correlation. According to the rule of thumb, multicollinearity is indicated when the correlation coefficient exceeds 0.8. The results of data processing for the multicollinearity test are presented as follows**:**

Table 3. Multicollinierity Test.

	LOG(GDP)	LOG(PRICE)	LOG(KURS)	DUMMY
LOG(GDP)	1.000000	-0,008767	0,003738	0,083650
LOG(PRICE)	-0,008767	1.000000	-0,001475	0,425382
LOG(KURS)	0,003738	-0,001475	1.000000	0,014858
DUMMY	0,083650	0,425382	0,014858	1.000000

Source: Processed Data, Eviews12, 2025.

The multicollinearity test was conducted using a correlation matrix among the independent variables. The results show that all correlation coefficients among the independent variables are well below the threshold value of 0.8, indicating the absence of multicollinearity in the model. Therefore, the regression model satisfies the assumption of no multicollinearity.

Heterokedasticity Test

Table 4. Heterokedasticity Test.

Variable	Coefficient	Std. Error	t-Stat	Prob
C	-0,157222	6,439161	-0,024417	0,9806
LOG(GDP)	0,010175	0,361056	0,028180	0,9776
LOG(PRICE)	0,160387	0,514190	0,311923	0,7561
LOG(KURS)	-0,106877	0,140474	-0,760834	0,4495
DUMMY	0,651750	0,339007	1,922526	0,0589

Source: Processed Data, Eviews12, 2025.

The heteroskedasticity test in this study was conducted using the Glejser test. Based on the test results, the probability values for GDP, international nickel prices, exchange rates, and the downstreaming policy dummy are all greater than 0.05. This indicates that there is no significant relationship between the independent variables and the absolute value of the residuals. Therefore, it can be concluded that the panel regression model used in this study is free from heteroskedasticity problems, implying that the residual variance is constant and the model satisfies the homoskedasticity assumption. This condition suggests that the estimated regression coefficients are efficient and reliable for drawing valid inferences.

Hypothesis Testing

Uji t (parsial), Uji F (simultan), dan Uji R^2 (*r squared*) akan dilakukan dalam uji hipotesis. Uji hipotesis regresi data panel menggunakan model *Random Effect Model* (REM) sebagai berikut:

Partial Test (t- Test)

Degrees of freedom = 0,05

Table 5. Partial Test.

Variabel	Koefisien	Std. Error	t-statistic	Prob
C	-50,12031	20,64132	-2,428154	0,0180
LOG(GDP)	4,750864	1,608031	2,954460	**0,0044**
LOG(HARGANIKEL)	1,737309	0,946812	1,834903	**0,0310**
LOG(KURS)	0,275171	0,763941	0,360199	0,7199
DUMMY	0,797851	0,680159	1,173036	**0,0146**

Source: Processed Data, Eviews12, 2025.

Simultant Test (F-Test) & R-Squared ($R^{2)}$

Root MSE	2.004662	R-squared	0.852256
Mean dependent var	1.959095	Adjusted R-squared	0.812234
S.D. dependent var	2.355513	S.E. of regression	2.080336
Sum squared resid	281.3069	F-statistic	5.865320
Durbin-Watson stat	1.672132	Prob(F-statistic)	0.000430

Figure 4. F-Test & R-Squared.

Based on the regression output, the F-statistic value is 5.865320 with a Prob(F-statistic) of 0.000430. This probability value is lower than the significance level used ($\alpha = 0.05$). Therefore, it can be concluded that, simultaneously, all independent variables included in the model have a significant effect on the dependent variable. This implies that the combination of all independent variables jointly is able to explain the variation in the dependent variable in the panel regression model employed.

The coefficient of determination (R-squared) is used to measure the extent to which the model explains the variation in the dependent variable influenced by the independent variables. Based on the regression results, the R-squared value is 0.852256, or equivalent to 85.22%. This indicates that 85.22% of the variation or changes in the dependent variable can be explained by the independent variables included in the model. The remaining variation is explained by other factors outside the model or by variables not included in the regression equation**.**

Effect Of GDP Per capita on the Indonesian Nickel Exports

The regression coefficient of the GDP per capita variable shows a positive value of 4.750864, indicating that a 1% increase in GDP per capita leads to a 4.75% increase in nickel export value, assuming other independent variables remain constant. The empirical results show that the GDP per capita variable has a positive coefficient of 4.750864 with a probability value of 0.0044, which is less than the significance level of 0.05. This indicates that, partially, GDP per capita has a positive and significant effect on nickel export value during the period 2010–2023.

These findings are consistent with the hypothesis that higher GDP levels lead to higher export output, as GDP reflects the intensity of economic activity in importing countries. Higher GDP per capita indicates stable economic conditions in importing countries, which, according to the export demand and supply theory proposed by Krugman and Obstfeld, stimulates greater demand for imported goods.

Krugman (2003), in his book International Economics: Theory and Policy, explains that demand in the context of international trade is influenced by prices, consumer preferences, and income levels. One important factor is income per capita, where a country's import demand increases as per capita income rises, since consumers and domestic industries are able to purchase more production inputs and consumer goods.

In line with the world demand theory proposed by Krugman and Obstfeld, international demand for a commodity is determined not only by relative prices but also by the income levels of consuming countries. When major export destination countries such as China, Japan, and South Korea experience economic growth reflected in rising GDP per capita, their demand for nickel as an industrial raw material tends to increase. This condition shifts the world demand curve to the right, ultimately leading to an increase in export volumes from exporting countries such as Indonesia.

The GDP per capita variable of destination countries has a positive and significant effect on Indonesia's nickel export value. This finding is consistent with international trade theory, which states that higher income levels in a country tend to increase demand for imported goods, including nickel. Indonesia's main export destination countries, such as China, Japan, and South Korea, exhibit relatively stable economic growth and possess large nickel-based industries, particularly for stainless steel production and electric vehicle batteries. Therefore, an increase in GDP per capita in destination countries expands demand capacity, which is reflected in the rising value of Indonesia's nickel exports. These results are in line with the theory proposed by Krugman and Obstfeld and are consistent with the findings of (Mulyadi, 2017), who concluded that GDP per capita has a positive and significant effect on exports.

Effect Of International Nickel Price on the Indonesian Nickel Exports

The regression coefficient of the nickel price variable shows a positive value of 1.737309, indicating that a 1% increase in the nickel price leads to a 1.73% increase in export value, assuming other independent variables remain constant. The empirical results show that the international nickel price variable has a positive coefficient of 1.737309 with a probability value of 0.0310, which is lower than the 5% significance level ($\alpha = 0.05$). This indicates that, partially, international nickel prices have a positive and significant effect on the value of nickel exports during the period 2010–2023.

These results are consistent with the hypothesis that higher commodity prices lead to higher trade output, as price is a key component in determining export value (export value = price × volume). In other words, when global nickel prices increase, the total value of Indonesia's nickel exports also rises, even if export quantities remain constant.

This finding is in line with the study by oleh (Izzah & Damayanti, 2023), which also found that prices have a positive and significant effect on export value. This result supports the demand-side–driven export value principle, whereby an increase in global market prices provides greater benefits for exporting countries, particularly Indonesia as one of the world's major nickel suppliers. Consequently, fluctuations in international nickel prices serve as an important indicator influencing the export performance of the metal mining sector, especially nickel.

Furthermore, the positive and significant effect of international nickel prices on export value can be explained through the commodity price mechanism, in which rising global nickel prices increase the value of export transactions even when export volumes remain relatively stagnant. This is consistent with the Indonesia's Nickel Story report and the findings of (Santoso et al., 2024), which indicate that the export ban on raw nickel ore implemented since 2020 has led to increased domestic production, coinciding with a surge in global nickel prices, particularly during the 2021–2022 period.

Role Of Exchange Rate on the Indonesian Nickel Exports

The regression coefficient of the exchange rate variable shows a positive value of 0.27517, indicating that a 1% increase in the exchange rate leads to a 0.27% increase in export value, assuming other independent variables remain constant. However, the empirical results show that the exchange rate variable has a positive coefficient of 0.275171 with a probability value of 0.7199, which is greater than the 5% significance level. This indicates that, partially, the exchange rate does not have a statistically significant effect on the value of nickel exports during the period 2010–2023.

The positive coefficient of the exchange rate variable is contrary to the theory proposed by Paul Krugman, which suggests that when the currency of a trading partner depreciates, goods from exporting countries become more expensive for the destination country, thereby reducing export demand. However, the insignificant effect found in this study indicates that exchange rate movements do not play a decisive role in determining nickel export value.

In line with the findings of Prasetyo & Marwanti, 2017, in the Journal of Development Economics, exchange rates tend to be inelastic with respect to primary commodity exports, as changes in exchange rates are not immediately responded to by exporters. This inelasticity arises due to production lags, long-term trade contracts, and limited short-run demand responsiveness, implying that exchange rate depreciation or appreciation does not directly affect export volumes in the short term. This explains why the exchange rate variable in this study is also statistically insignificant, considering that nickel is a strategic industrial commodity whose market is largely determined by manufacturing demand, trade policies, and contractual agreements rather than short-term exchange rate fluctuations. Therefore, nickel exports can be characterized as exchange rate inelastic.

The results further indicate that the exchange rates of destination countries do not have a significant effect on Indonesia's nickel export value. This insignificance can be explained by the characteristics of the nickel market as a strategic industrial commodity with relatively inelastic demand. Major destination countries such as China, Japan, South Korea, Thailand, and Singapore require nickel as a critical input for stainless steel production and electric vehicle batteries, resulting in stable demand despite exchange rate fluctuations. Moreover, international nickel trade transactions are generally denominated in U.S. dollars (USD) and based on long-term contracts, implying that changes in local currency per USD (LCU/USD) in destination countries do not directly affect trade prices or volumes. In this context,

international nickel prices and industrial demand are more dominant determinants of export performance than exchange rate movements. This condition suggests that exchange rate changes are not a primary consideration for industry players in nickel import decisions, which explains the statistically insignificant effect of the exchange rate variable on Indonesia's nickel export value.

Nevertheless, the relationship between exchange rates and nickel exports is not entirely negative, as strong industrial demand in major destination countries such as China and Japan plays a crucial role. Both countries are among the pioneers in electric vehicle (EV) production, where nickel demand tends to be highly inelastic with respect to exchange rate movements due to the essential role of nickel as a production input (Fallah & Fitzpatrick, 2022). As a result, fluctuations in exchange rates do not substantially alter import decisions for nickel, reinforcing the insignificant impact of exchange rates on Indonesia's nickel exports.

Effect Of Nickel Downstreaming Policy on the Indonesian Nickel Exports

The regression coefficient of the downstreaming policy dummy variable shows a positive value of 0.797851. This coefficient indicates that the period after the implementation of the downstreaming policy increases export value by approximately 122%, calculated using the formula Percentage Change = (e^0.797851 − 1) × 100% (Wooldridge, 2020), assuming other independent variables remain constant. The statistical test results show that the probability value of the downstreaming policy dummy is 0.0146, which is lower than the 5% significance level (0.0146 < 0.05). Statistically, this provides strong evidence that the difference between the pre- and post-downstreaming policy periods has a substantial and consistent impact on increasing nickel export value.

This finding is consistent with the long-term objectives of the nickel ore export ban policy, which prioritizes structural transformation rather than short-term economic gains. The downstreaming policy, initially introduced in 2014 and reaffirmed in January 2020, represents a manifestation of economic nationalism. This strategy is supported by Law No. 4/2009 on Mineral and Coal Mining and its implementing regulations issued by the Ministry of Energy and Mineral Resources. Within the framework of rational choice theory, as explained by (Santoso et al., 2024), Indonesia's decision to ban nickel ore exports can be regarded as a rational policy choice. This decision aligns ideological, economic, and political interests with the objective of maximizing domestic value added and strengthening state sovereignty over natural resources. The significance of the downstreaming policy can be analyzed from several perspectives.

First, downstreaming represents a long-term policy that requires substantial investment in smelter infrastructure, technology transfer, and the development of downstream industrial ecosystems. The strong impact on nickel export value becomes evident once domestic production capacity reaches maturity and processed nickel products successfully penetrate global markets.

Second, the policy has succeeded in increasing export volumes despite a surplus in the international market that has exerted downward pressure on global nickel prices due to capacity expansion in Indonesia and China. The significance of the downstreaming dummy variable indicates that the export value of Indonesia's processed nickel products has increased dramatically. Santoso et al. (2024) note that although global nickel prices have tended to decline since 2022–2023 due to oversupply, the downstreaming policy has successfully increased total export value through higher export volumes of high value-added products.

Third, the significance of the downstreaming policy dummy reflects the de facto impact of policy implementation. It suggests that the time lag between the de jure implementation of the policy in January 2020 and its de facto economic impact is relatively short or negligible within the observation period of this study. This implies that investment processes, smelter construction, and the achievement of full operational capacity despite being time-consuming have contributed significantly to export value during the study period. As a result, the downstreaming policy has rapidly demonstrated its effectiveness in boosting exports of processed nickel products(Putra & Samputra, 2023).

Overall, the results of this study are consistent with the analysis of Santoso et al. (2024), which argues that downstreaming policy is more appropriately understood as a rational instrument that integrates ideological and political dimensions rather than as a purely economic variable with immediate measurable effects. The policy plays a critical role in laying the foundation for long-term industrialization, enhancing Indonesia's competitiveness in the electric vehicle industry, and strengthening national economic independence. Therefore, even

though the downstreaming dummy variable may not always appear immediately dominant in short-term economic metrics, substantively the policy carries broad strategic implications for Indonesia's structural economic transformation.

In line with this perspective, (Ibnu Khaldun, 2024) finds that the nickel downstreaming policy has increased exports of iron and steel, which can be explained by several factors. The impact of mining policy in Indonesia, particularly for nickel, is best evaluated 10 to 15 years after the enactment of Law No. 4/2009. During the first decade, smelter development one of the law's key objectives had not yet produced significant outcomes. By 2016, only 12 companies were processing nickel, primarily into nickel pig iron, nickel matte, and ferronickel (Haryadi, 2017). The limited realization of mineral processing facilities by state-owned and private investors up to 2016 highlights the challenges of developing smelter infrastructure, especially for laterite nickel processing (Hidayat, 2022).

5. Conclusions

This study analyzes the determinants of Indonesia's nickel exports (HS 75) to five major destination countries China, Japan, South Korea, Thailand, and Singapore during the period 2010–2023 using a fixed effect panel data model. The empirical results demonstrate that international nickel prices, GDP per capita of destination countries, and Indonesia's downstream policy significantly influence the value of nickel exports, while exchange rates do not exhibit a statistically significant effect.

The positive and significant impact of GDP per capita indicates that demand-side factors play a crucial role in driving Indonesia's nickel exports, reflecting the importance of industrial activity and purchasing power in importing countries. Similarly, international nickel prices remain a key determinant of export performance, highlighting Indonesia's strong exposure to global commodity market dynamics. Importantly, the downstream policy dummy shows a positive and significant effect, providing empirical evidence that Indonesia's nickel downstreaming policy has successfully increased export value by shifting exports toward higher value-added nickel products.

Overall, the findings suggest that resource-based industrialization through downstream policies can enhance export performance when supported by strong global demand. These results contribute to the literature on commodity-based trade and industrial policy and provide policy-relevant insights for resource-rich developing countries pursuing value-added export strategies. Future research may incorporate product-level disaggregation or firm-level data to further capture the structural transformation of nickel exports.

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