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Within the Indonesia Trade of 2003 – 2024 and Future Predictions: Data Analytic Approach

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Abstrak

Perdagangan internasional merupakan komponen dalam perhitungan Produk Domestik Bruto (PDB). Surplus perdanganan turut menjadi salah satu tumpuan yang diharapkan dapat memberikan dampak signifikan terhadap pertumbuhan ekonomi di banyak negara berkembang. Di Indonesia, neraca perdagangan menunjukkan adanya surplus selama 2003 s.d. 2024, yang ditunjukkan oleh besarnya ekspor daripada impor. Namun, pengaruhnya terhadap pertumbuhan ekonomi masih diperdebatkan dan memerlukan investigasi lebih lanjut. Berdasarkan data ekspor – impor tahun 2003 sampai dengan 2024 dan menggunakan pendekatan data analisis, studi ini menemukan bahwa belum terdapat perubahan signifikan atas komoditas ekspor dan impor. Pendekatan deskriptif menunjukkan bahwa material mentah masih menjadi komoditas yang terus diekspor (sekitar 32,2% rata-rata per tahun), serta Indonesia juga terus bergantung atas barang pabrikan lainnya dari luar negeri dengan rata-rata tahunan sekitar 31%. Pola ini mengindikasikan bahwa Indonesia belum sepenuhnya beralih dari perdagangan berbasis komoditas ke produk ekonomi yang memiliki nilai tambah lebih tinggi. Selain itu, pendekatan Kausalitas Granger menunjukkan adanya efek *lag* atau keterlambatan dari ekspor (satu tahun lag) dan impor (dua tahun lag) terhadap pertumbuhan ekonomi. Walaupun optimisme neraca perdagangan tetap terjaga yang dihasilkan dari model proyeksi *Exponential Smoothing* untuk ekspor dan impor, Indonesia masih memiliki tantangan yang harus diselesaikan. Beberapa langkah yang dapat diambil di antaranya adalah penguatan industrialisasi dalam negeri yang mengedepankan nilai tambah, kebijakan hilirisasi, penyesuaian tarif atau bea masuk dan keluar, integrasi ekonomi regional, dan investasi infrastruktur dan penguatan sumber daya manusia untuk meningkatkan produktivitas dalam negeri dan mengurangi ketergantungan pada pasar luar negeri.

Kata kunci: ekspor-impor, data analisis, perdagangan internasional, kausalitas granger, prediksi

Abstract

International trade is directly calculated within Gross Domestic Product (GDP). The trade surplus is one of the pillars that is expected to have a significant impact on economic growth, especially in many developing countries. In Indonesia, the trade balance has shown a surplus for the past few years, as indicated by the large exports compared to imports in 2003 to 2024. However, its impact on economic growth is still debated and requires further investigation. Based on export-import data from 2003 to 2024 and using a data analysis approach, this study found that there have been no significant changes in export and import commodities over years. The descriptive approach shows that raw materials are still dominated the exports (around 32.2% on average per year), and Indonesia also continues to depend on other manufactured goods from international market for around 31% yearly average. This pattern indicates that Indonesia has not fully shifted from commodity-based trade to economic products that have higher added value. In addition, the

Granger Causality approach shows a lag effect or delay from exports (one year lag) and imports (two year lag) to economic growth. Although, optimism about the trade balance remains maintained, resulting from the Exponential Smoothing projection model for exports and imports, Indonesia still has challenges to overcome. Some steps that can be taken include strengthening domestic industrialization that prioritizes added value, downstreaming policies, adjustments to import and export tariffs, regional economic integration, and infrastructure investment and strengthening human resources to leverage domestic productivity and reduce foreign market dependency.

Keywords: export-import, data analysis, international trade, granger causality, prediction

INTRODUCTION

The current era of globalization has driven the world into open-trade economy. Trade openness facilitates the exchange of a wide range of commodities among countries, fostering economic growth (Kong et al., 2021) and attracting foreign investment (Lien, 2021).

However, long-term challenges persist, as stated by Nguyen & Le (2021). Free trade policies can lead to dependency and intense competition, especially for country with low industrialization level. In his paper, Chen (2022) emphasizes the need for trade protection policies in the current complex international trade landscape, citing evidence of developed countries monopolizing global trade. Therefore, the current dynamic of international market poses challenge to developing countries, such as Indonesia, in achieving development goals (Longdong & Halim, 2023) through global competition.

In Indonesia, the economy has arguably benefited from open-trade situation. Net export contributed around -1,5% to 1,5% of annual economic growth between 2011-2024 (Figure 1). However, Figure 2 suggests that net exports have played a relatively minor role in the overall economy growth, averaging only about 2% of total GDP over the past two decades. This aligns with Pertiwi et al. (2023); Nulhanuddin & Andriyani (2020); Apriliana et al. (2021); and Naila et al. (2024), which highlighted the insignificant evidence in export-supported GDP in Indonesia. These studies holds opposing argument for the several previous studies regarding the positive impact of exports on the economy. Research by Stievany & Jalunggono (2022), utilizing the Error Correction Model (ECM), showed the possitive effect of export and import to the Indonesia's economic around 1989 – 2018. Pasaribu & Nasution (2024) also highlights the strong positive correlation between real GDP growth and non-oil and gas exports over the period 2010-2020.

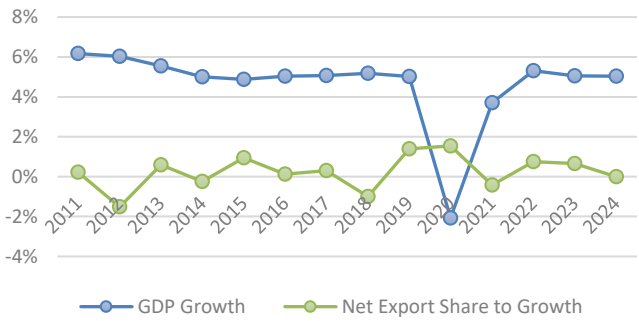

Figure 1. Indonesian Economic Growth from 2011 – 2024
Source: BPS (2025)

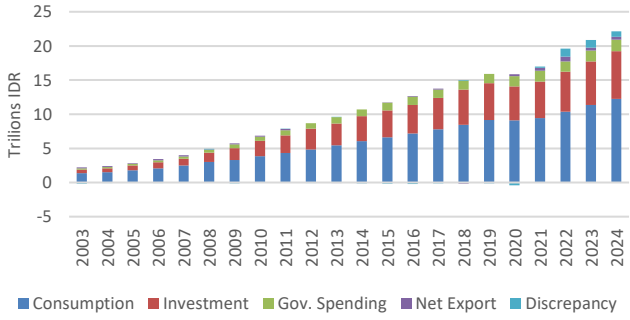

Figure 2. Indonesia Gross Domestik Product (GDP) from 2003 – 2024
Source: BPS (2025)

Despite ongoing debates, exports should not be dismissed as nonessential to economic stability

(Dave et al., 2021). From another perspective, numerous studies have acknowledged the broader economic impact of trade. For instance, Suwarno et al. (2021) determines the significant effect of Indonesian export on the foreign exchange reserves. Nominally, Syamsi et al. (2020) have proven the increasing GDP over Indonesia's export performance. As we can see in the Figure 2, export accounted around Rp4.911 trilion, contributing 22% of national GDP, in 2024.

Within open-economic model, it has been widely known that import has counterproductive effect on the GDP. The respective claim has been highlighted by Pane (2023) for 2016 – 2020. Import implies finance outflow from the Indonesian resident to another country in order to have the imported goods. Despite of the counterproductive in calculation, import benefited the sectoral development. Especially, import of raw materials supported the industrial operationability (Alkaf, 2020; Yunan, 2023), thus contributing to economic added value and sustaining the job availability. However, such state could lead to prolonged dependency on foreign inputs for industrial production (Alkaf, 2020).

Given these dynamics and previous findings, it is crucial to reexamine detailed information on Indonesia's trade in international markets within the most recent data available, specifically in 2003 to 2024. Research is needed to detail the traded commodity and reassess the causal relationship between exports-import, and economic growth, as well as rising market prices to export-import. This will help to reveal the new findings of the currently debated Indonesia open trade effect. Moreover, such study can serve as a foundation for future trade projections, helping to anticipate potential challenges and sustain economic optimism.

To answer such question, this study utilizes data analytics methods for Indonesian export-import data from 2003 to 2023 from Statistics Indonesia (BPS) and ASEAN Statistics, and international commodity prices from World Bank. As previously stated, the research aims to comprehensively analyze Indonesia's international trade, encompassing the identification and analysis of its dynamics, uncovering the causality between trade openness and the national economy, and making future trade predictions, all of which aim to support evidence-based policymaking.

RESEARCH METHOD

This research employs data analytic approach. Runkler (2020) defines data analytic as a systemic method in using data for supporting decission making processes. Data analytic encompases many aspects, such as descriptives analysis, functional regression, statistical inference, prediction, and even machine learning (Gertheiss et al., 2024). The flow of this research, utilizing the descriptive analysis, statistical inference, and prediction, is summarized in Table 1.

Table 1. Research Flow

	1	2	3
Steps	Descriptive Analysis	Statistical Inference	Prediction
Goals	Summarize and present historical trade data in a clear, understandable, and actionable way	Draw conclusions and make generalizations about the broader relationships of export-import and economic output	Make a projection of future export and import based on the best tested model
Methods	Pandas Library and Microsoft Excel	VAR Granger Causality	ARDL, MA, and Exponential Smoothing

Source: Author (2025)

In this study, Indonesia 2003-2023 export-import data, along with the commodity prices index, will be analyzed using a data-driven methodological approach. The methods employed include descriptive analysis, causality analysis, and predictive analysis, each of which will be detailed in the respective subsections. The data analysis will be conducted using Python programming libraries within the Jupyter Lab.

Descriptive analysis

The descriptive analysis is used to understand the recent dynamic in Indonesian global trade.

This method will identify the primary contributors of Indonesian export and import, and assess their performance over time.

Causality analysis

Causality testing in this research accomodates Granger Causality Test. Granger Causality is a method widely known to discover causal effect of variables (Shojaie & Fox, 2022). The causality analysis will be conducted using Vector Autoregressive (VAR) Model.

Granger causality provides valuable framework in analyzing relationships between variables (Zhu et al., 2020). Such method provides valuable understanding wihtin complex phenomenon (Gifford & Oliver, 2021). Through VAR, the ganger causality model could accomodate multiple time series variables (Karakostas & Pantelidis, 2024; Triacca, 2021). Despite of those advantages, its limitation must be considered with caution and awareness. One fundamental limitation of granger causality lies on its implication of numerical-specific causality (Cekic et al., 2019). Granger causality result returns whether variable 1 granger causality variable 2 in a statistical sense, and not determining the actual numerical impact of variable 1 to variable 2.

In this research, since VAR models require stationary data, a stationarity test will be performed using the Augmented Dickey-Fuller (ADF) Test (Larasati & Utomo, 2023). If the test fails to confirm stationarity, differencing method will be applied (Ryan et al., 2025) to tranform the data into stationary form.

Predictions

It is widely noted that there is no one fit-for-all prediction model with 100% accuracy. However, numerous studies show the notable insight from prediction methods (Curchoe, 2020; Westphal & Brannath, 2020) in estimating future trends based on historical data and relevant parameters.

Within this research, the author utilizes Autoregressive Distributed Lag (ARDL), Moving Average (MA), and Exponential Smoothing in forecasting the export and import for 2024 – 2026. Before the prediction process, those prediction methods are tested using Mean Squared Error (MSE) and Root Mean Square Error (RMSE) to determine the best method (Ağbulut et al., 2021) in predicting future values.

RESULT AND DISCUSSION

Indonesia's International Trade Over 2003 – 2024

Indonesia has contributed over US$3,62 trillion in export and US$3,19 trillions in import of goods to the global markets between 2003 and 2024. Summarize the trade data across 2003 to 2024 (Figure 3), the contributions have accounted in overall trade surpluses around US$424,83 billion over the past 22 years.

As shown in the Figure 3, Indonesia's trade balance has mostly recorded surpluses, with a significant increase over the past four years. Even during the COVID-19 pandemic, exports continued to rise. However, the trend also highlights a steady increase in imports, growing from US$32,55 billion in 2003 to US$264.71 billion

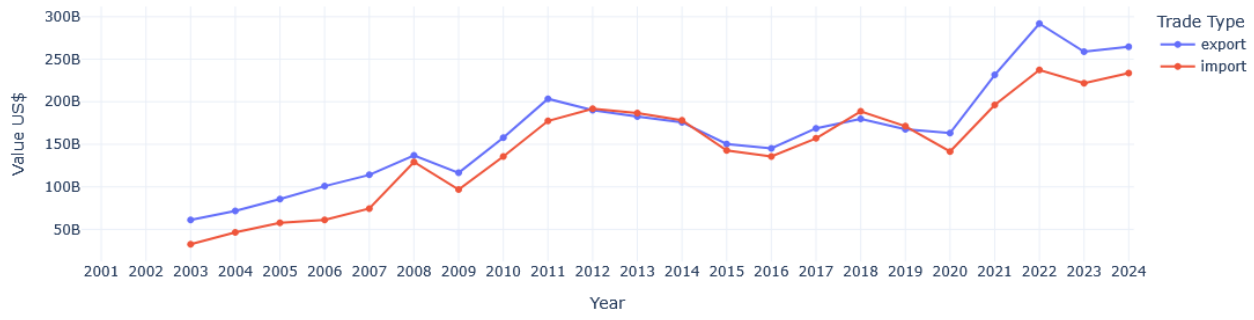

Figure 3. Indonesian Export-Import (2003 – 2024) in US$
Source: ASEAN Statistics (2025)

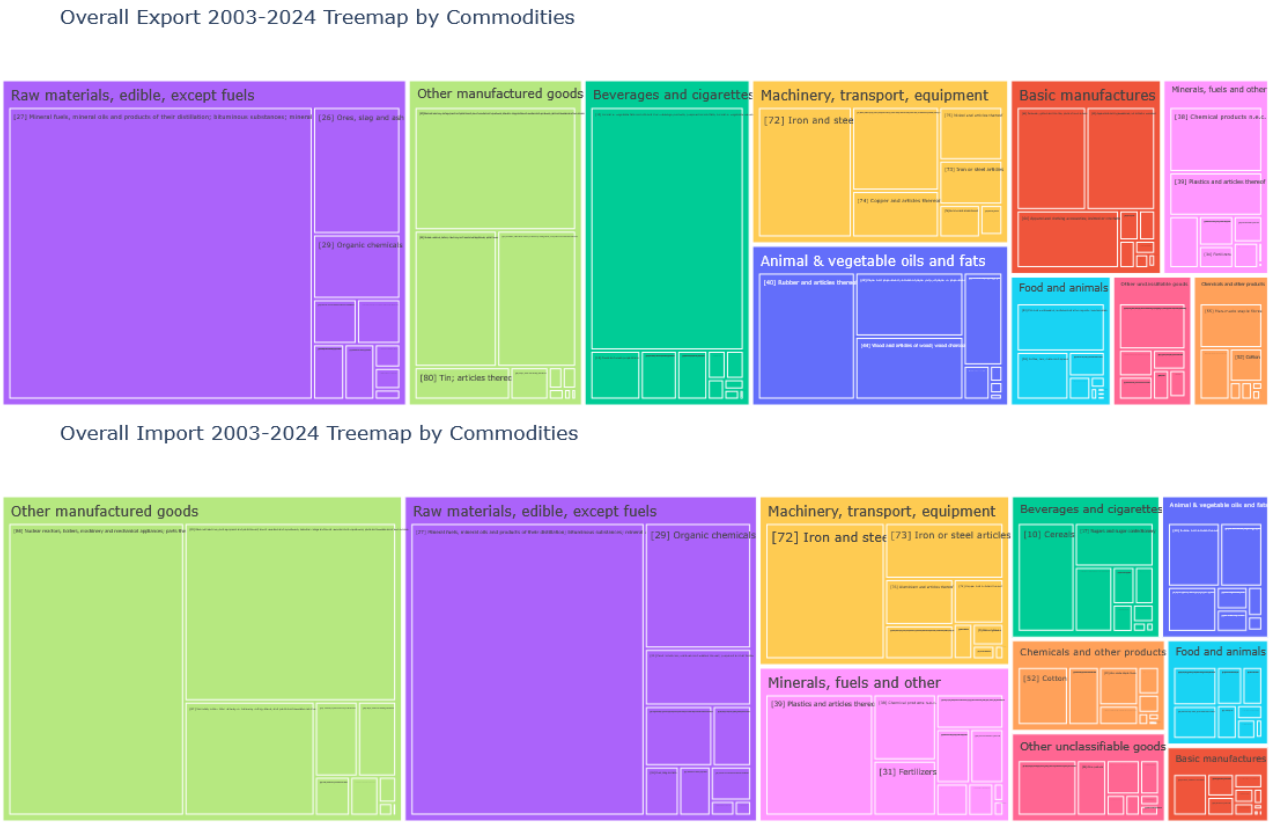

Figure 4. Aggregated Indonesian Globally Traded Goods Treemamp in US$
Source: ASEAN Statistics (2025)

in 2024. This increasing trade balance represents strengthened international competitiveness and positive development (Hojjat, 2014), such as lowering the unemployment rate and providing more higher-paying positions in manufacturing and production sectors. Based on the Compound Annual Growth Rate (CAGR), Indonesia's import growth rate (7,84% annually) is currently surpassing the export growth rate (7,23% an.). Such case, commonly occur when domestic income increases (Ndou, 2021) due to increased exports.

On the other hand, there is a notable differences in the types of goods being exported and imported. Indonesia's exports are primarily driven by raw materials and edible goods (excluding fuels) for around 32,03% (Figure 4). Meanwhile, imports are dominated by other manufactured goods (31,71%) and raw materials (excluding fuels) (27,99%).

findings indicate Indonesia's limited industrial competitiveness in the global market, highlighting its dependency on manufactured goods, particularly in categories such as nuclear reactors, boilers, machinery, mechanical appliances, and raw materials.

Breaking it down to a yearly perspective, Figure 5 highlights that the most-traded commodities have remained unchanged over the past 22 years. The data indicates a consistent trend of exporting raw materials, with a rapidly increasing demand for them. Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes [HS-2: 27] contributed around 25,7% of export value in 2003, and approximately 21% in 2024. Additionally, the country's dependency on other manufactured goods is also clearly supported by the data, as shown by an annual increase of 11.14%, rising from US$8.76 billion in 2003 to US$74.02 billion. It is also noticable that Indonesia's import have been dominated by raw materials as well, which contributing

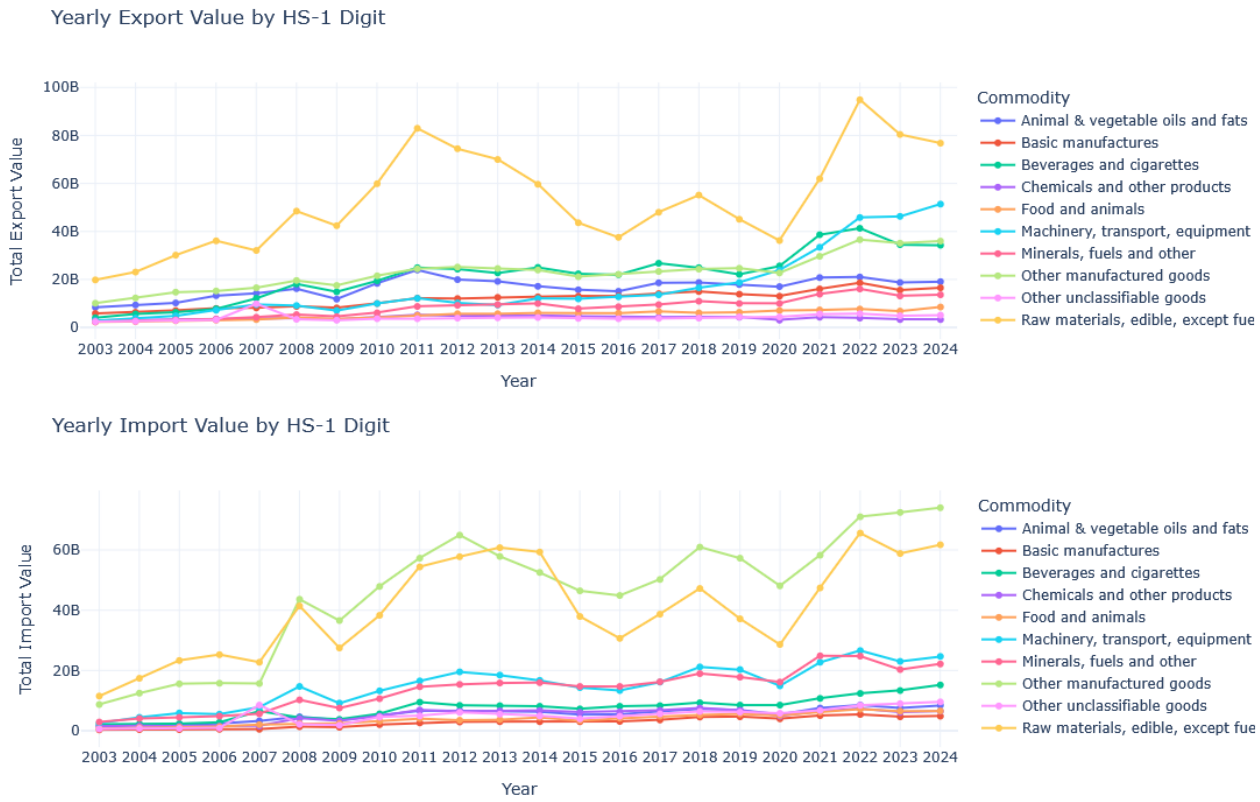

Figure 5. Indonesia Internasional Commodity Trades in US$
Source: ASEAN Statistics (2025)

around 29,4% annually. Specifically, the top two commodies imported by Indonesian are Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes (20,2% yearly-average share), and reactors, boilers, machinery and mechanical appliances; parts thereof (14,2% yearly-average share). This high imports of raw materials are considered as consequence of increasing domestic productivity (Ministry of Finance, 2022).

This condition underscores the need for further industrial investment in Indonesia (Elfaki et al., 2021). Kim & Sumner (2021) highlight the ongoing trend of industrial policies in both developing and developed countries aimed at stimulating economic growth. However, the main challenge for Indonesia lies in strengthening its industrial sector competitiveness against leading countries in the global market. To tackle this issue, State and Local Government needs to design incentive policy for research & development in the industrial development, thus endorsing the industrial development.

In response to competitiveness challenges, the government budget should prioritize infrastructure development, workforce upskilling, legal certainty, and public-private collaborations (Rame et al., 2023). Furthermore, future challenges in domestic industrial development must be anticipated. Kusumawati & Indarto (2024) emphasize the need of policy breakthroughs in the era of technological advancement. A critical concern is the than IDR232,65 T in national losses recorded due to cybercrime activities by 2023 (Rame et al., 2023), highlighting the urgent need for strengthened digital security policies.

Moreover, adjustment in tariff policies can be utilized to reshape the Indonesia's trade characteristics within the new world trade environment (Ing et al., 2017). Tariffs can serve as a mechanism to regulate capital outflows and inflows, particularly by influencing the final

cost of goods. For instance, higher import tariffs lead to increased prices of imported goods, reducing their competitiveness in the domestic market and subsequently lowering demand for such goods.

Reassesing the Causality of Open Economy

As stated earlier, the causality analysis of export and import on the Indonesian economy is conducted using Granger causality testing within a VAR framework. Within this framework, lagged and stationary variables are utilized to determine the time-delayed causal relationships.

However, the ADF test indicates that the data is not stationary in its original form. Therefore, the differencing method is applied to transform the data into a stationary series. Table 1 presents the ADF statistics and critical p-values at each step of differencing. The results confirm that stationarity is achieved after two rounds of differencing (see Table 2).

Table 2. ADF Stationary Test

Step	Export	Import	GDP	Price
0	0,19	-1,56	2,93	-4,91*
1	-3,96*	-3,22*	0,63	
2			-6,08*	

*notes data stationary level after differencing (p. val < 0,05).
Source: Author Analysis

The findings of this research suggest that export and import have no significant causality on the economic outputs according to the granger causality. Table 3 indicates that neither export nor import, with a three-year lag, significantly granger-cause GDP. However, there is some evidence that exports influence GDP with a one-year lag, though its significance level is only marginally critical (p = 0.098). the significant effect of imports to the economy is taken account within two-year lag. On the other hand, the rising international price index does not appear to granger-cause Indonesia trade, highlighting its insignificant influence on economic fluctuations for both Indonesia's export and import.

Table 3. VAR Granger Causality T-Stats

Notation	Lag=1	Lag=2	Lag=3	Joint (Granger)
Ex → GDP	1.655*	0.556	1.168	1.624
Im → GDP	1.345	-2.415**	-0.509	2.112
Price → Ex	-1.261	0.902	0.057	0.612
Price → Im	-1.004	0.747	-0.006	0.385

*Significant under 10%; **Significant under 5%
Source: Author Analysis

This finding aligns with the Millia et al. (2021) that highlight the positive effect of export to the Indonesian economy within the long-run, or especially in time-delayed condition. The current finding of delayed export effect is also supported by Dhea (2022) and Rangkuti et al. (2022), who stated that exports have an insignificant effect in the short term but a major influence in the long run. Furthermore, Todorova (2022) states the export's direct multiplier effects on the savings, consumptions, and national current accounts. In the most cases, developing countries's economic growth relies on their exporting capacity (Maheswari & N, 2024). These evidence suggests that exports generally have a positive impact on Indonesia's GDP, both in the nominal calculation and growth dimensions.

According to this findings, the signficant impact of imports to the GDP occur with two-year lag. Such condition is also found in the Hapsari et al. (2020) study, which indicate the time-delayed effect of import. However, recent study also notes insignificant findings of import (Irdiansyah & Soelistyo, 2024; Mu'arif & Soebagyo, 2023; Zulzilah et al., 2022).

Taken those findings to subject, it is clear that there is time-affected export impact to economy. This underscores the necessity for Indonesia to reassess and refine its international trade policies to maximize the long-run benefits of exports. Specifically, the government should implement strategies that not only increase export volumes but also enhance the value-added of exported goods.

Future Trade Projections

The initial stage of prediction involves testing its predictive power. The author divides the known data into training (2003–2018) and testing (2019–2023) sets. The training set serves as the

basis for predicting the testing observations. Afterward, the predicted values are compared with the actual export-import values to calculate the MSE and RMSE.

Table 4. Prediction Methods Evaluation

Methods/Models	MSE	RMSE
Export		
ARDL	4,76E+21	6,9E+10
MA	6,57E+21	8,11E+10
Exp. Smoothing*	4,32E+21	6,57E+10
Import		
ARDL	5,66E+20	2,38E+10
MA	1,93E+21	4,4E+10
Exp. Smoothing*	5,31E+20	2,3E+10

*Best prediction method.
Source: Author Analysis

The evaluation results (Table 4) show the best estimator of future values. Exp. Smoothing is considered as best model in projecting the future export with lowest MSE and RMSE among other methods. Import prediction can be conducted using Exp. Smoothing as well, which notes lowest RMSE around 2,3+10. In simpler term, Exponential Smoothing model can be used further to predict the future export and import due to its low error score as noted by MSE or RMSE.

Table 5. Prediction on Export and Import in US$

Components	2025	2026	2027
Export	276,83 B	288,8 B	300,64 B
Import	247,68 B	261,48 B	275,15 B

Source: Author Analysis

Accomodating the best model, we can clearly see the optimism of future trade as in Figure 6. The export will be increasing through the years, ranging from US$276,83 billions in 2025 to US$300,64 B in 2027. The prediction of import reflect the current increasing trend, which projected to be US$247,68 B in 2025 to US$275,15 B in 2027. Such possitive trend will most likely happen under the surging domestic production and increasing international recognition.

This projection mimics the ongoing economic optimism, supporting Indonesia's goal of becoming high-income country by 2045 (Muhyiddin, 2019). The World Bank (2025) also highlights that increased exports have nearly balanced the Indonesian current account, which could lead to better external position and reduce exchange rate risk. However, such optimism must be accompanied by a sustainable and inclusive economic strategy (Abdullah & Gunawan, 2024). As stated by Asian Development Bank (2025), the robust and stable domestic demand is the actual key in maintaining Indonesian economic output despite the rising global dynamics and commodity price volatility (The World Bank, 2025). Therefore, more pro-jobs and pro-equality policy should be promoted in leveraging resident's welfare along with the increasing international exposure. An inclusive and sustainable economy helps close income inequality gaps, fosters generational wealth, and enhances environmental quality.

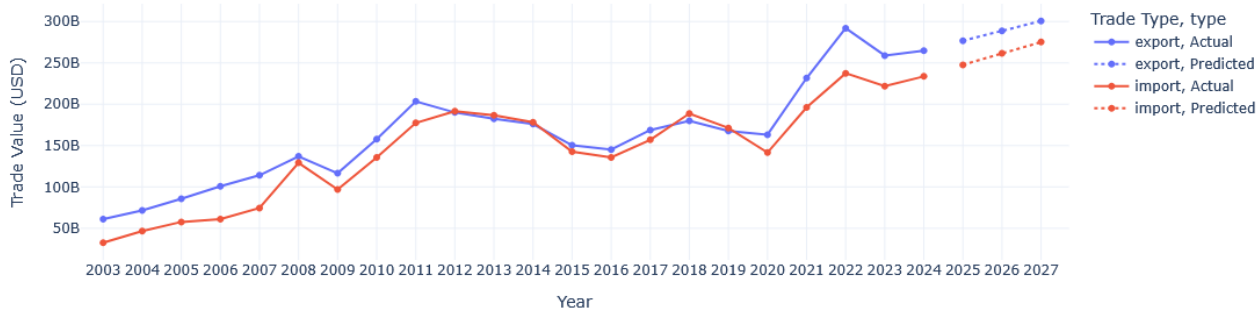

Figure 6. Export – Import Projections for 2025 – 2027 in US$
Source: ASEAN Statistics (2025); and Author Analysis

CONCLUSIONS AND RECOMMENDATIONS

Through data analytic methods, it is evident that Indonesia's international trade has consistently generated surpluses. From 2003 to 2023, Indonesia exported over US$3.35 trillion while importing approximately US$2.96 trillion worth of goods globally.

However, the main problem lies on the composition of traded goods. Indonesia focussed mainly on exporting the raw materials (32,2% yearly-average), while its import is constructed mostly from other manufactured goods (31% yearly-average) and additional raw materials (29,4% yearly-average). This situation highlights the domestic dependencies for manufactured goods from other countries. Furthermore, an imbalance can be drawn by importation of raw materials, which also dominately contributes Indonesia's exports.

From a different perspective, Granger Causality testing reveals that Indonesia's export activity drives economic growth with a two-year lag. This underscores the need for a proactive international trade policy and a stronger push for domestic industrialization.

Using Exponential Smoothing for export forecasts and ARDL for import forecasts, future trade balances align with optimistic economic trends. Exports are projected to reach US$300.64 billion in 2025, while imports are expected to decline to approximately US$275.15 billion in the same year.

Considering these findings, Indonesia still has room for improvement to enhance export-import policy. The development can be done in several ways, such as:

1. Enhancing Industrial value-added production through research & development incentives.
2. Emphasize the downstreaming policy in order to prevent more raw materials export and creating the additional value for exported goods.
3. Encourage regional economic integration by creating the commodities-industrial mindmap among the provinces/districts/cities.
4. Public budget shifting for infrastructure and human capital investments, which aim to leverage domestic productivity and reduce the import of manufactured goods.
5. Tariff adjustment which subjects the trade sustainability in the long run.

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The full data processing can be viewed through the author's Google Colab. Accessing through Google Chrome is advised.

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