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Article

# Assessing the implications of imported electricity equipment in Indonesia: A comprehensive ECM approach for short-term and long-term analysis

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**Abstract:** This study aims to explore the implications of imported electrical equipment in Indonesia, analysing both short-term and long-term impacts using a quantitative approach. The research focuses on understanding how various economic factors, such as domestic production, international pricing, national income, and exchange rates, influence the country's import dynamics in the electrical equipment sector. Employing an Error Correction Model (ECM) for regression analysis, the study utilises time-series data from 2007 to 2021 to delve into the complex interplay of these variables. The methodology involves a comprehensive analysis using the Augmented Dickey-Fuller and Phillips-Perron tests to assess the stationarity of the data. This approach ensures the robustness of the ECM, which is employed to analyse the short-term and long-term effects of the identified variables on electrical equipment imports in Indonesia. The results reveal significant relationships between these economic factors and import levels. In the short term, imports are shown to be sensitive to changes in domestic economic conditions and international market prices, while in the long term, the country's economic growth, reflected through GDP, emerges as a significant determinant. The findings suggest that Indonesia's electrical equipment import policies must adapt highly to domestic and international economic changes. In the short term, a responsive approach is required to manage the immediate impacts of market fluctuations. The study highlights the importance of aligning import strategies with broader economic growth and environmental sustainability goals for long-term sustainability. Policymakers are advised to focus on enhancing domestic production capabilities, reducing import dependency, and ensuring that environmental considerations are integral to import policies. This study contributes to understanding import dynamics in a developing country context, offering valuable insights for policymakers and industry stakeholders in shaping strategies for economic growth and sustainability in the electrical equipment sector. The findings underscore the need for a balanced, data-driven approach to managing imports, aligning short-term responses with long-term strategic objectives for Indonesia's ongoing development and industrial advancement.

**Keywords:** import; domestic production; international prices; national income; exchange rate

## 1. Introduction

Indonesia's changing trend toward the modernization and sustainability of the energy system, which is starkly witnessed in the electric sector, is one of the hot topics and complexities in the contemporary energy arena. This hinders the country's fast pagination of the purchased electricity equipment. Even though it will address the short-term infrastructure gap, this will involve a multi-dimensional analysis. This paper explores the short-term benefits and long-term implications of this dependence using a comprehensive Error Correction Model (ECM) approach, drawing upon

various studies and expert analyses to provide a well-rounded view. The Indonesian energy sector presents a significant dependence on fossil fuels. It is increasingly asked to evolve in equal time regarding environmental issues and the direct effects of global oil prices (Lean and Smyth, 2010). Under the government's timeline to increase renewable energy percentage in the national energy mix, the energy infrastructure is going through a significant transition to improvement (Ahamd, 2019; Mukherjee et al., 2017). The import of this equipment is now a key component in such an initiative and strategy. Importing power system equipment can quickly enhance efficiency and reliability in Indonesia's power grid in the short term. The incorporation of high-quality imported gadgets that mainly contain the latest technology will help reduce transmission and distribution losses, diseases that the field power sector has been facing for a long time (Cooper et al., 2021). Besides, the waste of fuel and produced greenhouse gases could be considerably lessened by improving the operational efficiency of the power plants (Koot and Wijnhoven, 2021).

Nevertheless, the positive effects are short-lived, while long-term economic and industrial concerns are another aspect to consider. The problem of the trade balance of Indonesia with the in-flow of electric power equipment, one of the expensive items the country has to import, is a severe issue as it further deteriorates the trade deficit (Anam, 2023; Tiep et al., 2021). This reliance on foreign machinery undoubtedly puts Indonesia in a very awkward position, as its energy independence is now at risk of fluctuation in the global market price and geopolitical issues. From an industrial perspective, importing equipment may become a barrier to the progression of the local electric equipment manufacturing sector since the country may require some time to build capacity for locally manufactured equipment. With domestic demand's absence, firms from the area might need more motivation to invest in Research and Development, the key driver for industrial development (Moradi, 2021). This condition can result in such an endless cycle of underdevelopment for the local industry that it may become permanently tied to importing from other countries.

The impact of the environment through these essential coping strategies is also significant. Though using imported equipment might instantly result in the release of fewer emissions, the country's energy policy and the nature of the equipment are what determine the impacts in the long run. If the equipment reinforces the fossil fuel-intensive generation, it could make the country go for the carbon-intensive development path, which will give a tough time to Indonesia in abiding by its long-term commitment under the Paris Agreement as advised by Ningrum et al. (2018). A policy balance is needed for the Indonesian government to tackle these complex matters. It requires supporting local industry, conducting R&D, and choosing a more environmentally friendly energy mix. The target is to balance the immediate utility of importing electrical equipment and long-term goals for economic stability, environmental sustainability and industrial self-dependence (Maghfiroh et al., 2021).

Economic studies in this field have assigned the economic effect of an Energy infrastructure development in a country. While the controversy regards the two central aspects, the industrial outlook helps to shed more light on a broader concept and create quick fixes. The Error Correction Model (ECM) is the method that helps researchers to analyse not only the current electric hardware imports but also make predictions of their future tendencies. This method enables the effacing of the existing market

structures, letting them remain sustainable considering the changing nature of the global energy sector and national industries. On the other hand, the study aims to review a fresh topic linked to whether these imports can drive the domestic energy industry (Burke and Kurniawati, 2018). This part of the research relies on the capability-building theory, which is vital for developing countries like Indonesia (Schipper and Meyers, 1991). It focuses on the purposeful formulation of joint ventures and free trade agreements, wherein features such as information sharing and competency development are largely factored in to benefit local players eventually. At the same time, it addresses the impacts these imports have on employment levels in the energy and manufacturing sectors. It touches on new job creation through enhanced domestic capabilities for energy (Imbruno and Ketterer, 2018). This feature becomes a significant case for Indonesia as the country attempts to achieve robust growth and job creation, which are national goals. This research also firmly stands out in its emphasis on the most crucial aspect: the long-term view. A positive aspect is that there will be an immediate reduction in emissions by using this efficient imported equipment. However, the study is critical of the possibility of the country (the developing one) getting stuck in a carbon-intensive development road. It stressed the significance of Indonesia's putting equipment imports on target to its commitments with the Paris Agreement and renewable energy targets, thus contributing to the country's green future (McCawley, 2015).

Thus, energy security is the first question that comes to mind. Indonesia's reliance on imported machinery for its electricity infrastructure might somehow govern its autonomy about energy. The elimination of all the inner resources occurs because of the dependence on external political and economic fluctuations, like changes in global trade policies or disruption of food chains. The outlook is worrying as more and more energy is needed, and nations vulnerable to these disruptions can experience serious ramifications (Erdiwansyah et al., 2021). These imports have an intact economic impact on Indonesia, especially regarding its trading balance status. The foreign currency costs related to introducing high-tech power techniques might strain the state's financial situation, considering how broad and intensive infrastructure development is expected to be as a precondition for practical energy production. Losing potential may cause the loss of the domestic industry (Hasudungan and Sabaruddin, 2018). Lack of capital in manufacturing at home causes a long-term reliance on technology from abroad, which finally leads to a weak energy system that cannot support home-based industrial ecosystems (Pandyaswargo et al., 2021). Another problem comes into being with industry development. The manufacturing industry of Indonesia needs to improve when it needs to serve the comprehensive demands of the upscale electricity system. This gap brings the country to a cross-road as the country needs to import more goods on the one hand; while on the other, it hinders the industries that generate on its own. Without a strategic initiative focused on creating these capacities, Indonesia could continue to import all it needs without the benefits from the home-grown economy (industry and technology). Lastly, the dimension of environmental problems is paramount to mention.

Despite the import of power equipment improving the efficiency effect and reducing emissions in the short run, they may also eventually create permanent environmental problems. If the equipment is mainly designed for use in fossil fuels,

then this could be a big problem for the Indonesian government as it will lock Indonesia into a very carbon-intensive energy path, which is against the Paris Agreement and will make it possible for the country to transition to renewable energy (Nugroho et al., 2005).

This paper is structured into six main sections, aimed at providing a comprehensive exploration of the variables affecting income inequality. Section 1: Introduction sets the stage by presenting the research question and its significance, introducing the primary variables of financial literacy, employment sector shifts, and urbanization. Section2: Literature Review critically examines existing research to highlight gaps and build a theoretical foundation for the study, delineating how these factors have historically influenced income inequality. Section 3: Methodology describes the analytical techniques and data sources used to investigate the relationship between the chosen variables and income inequality, detailing the statistical methods and model specifications. Section 4: Empirical Findings presents the analysis results, providing quantitative evidence on the impacts of the studied variables. Section 5: Discussion interprets the findings in the context of the existing literature, discussing the implications and the nuances of the results. Finally, Section 6: Conclusion and Recommendations synthesize the overall insights of the research, offer conclusions drawn from the empirical evidence, and suggest practical recommendations and potential areas for future research.

## 2. Literature review

Taking Southeast Asia's energy situation as an example, Wells (2007) illustrates the imminent energy needs of the region and the complications associated with a switch to renewable energy sources. This article is essential for analyzing Indonesia's role in this general theme. It focuses on an urgent requirement for energy systems revamping, noting specifically the heavy usage of imported equipment in the electricity sector in Indonesia. In Indonesia, the country's reliance on fossil fuels, which requires to be turned into a sustainable energy source, is a prominent energy challenge, according to Humphrey (1962). Analyzing and understanding the current situation necessitates his research, which explains why Indonesia needs electrical equipment imports. Thus, this should be done to improve the existing energy centers and attain future targets. Furthermore, a vast country like Indonesia inevitably faces the risk of depending on foreign technology and supplies (Mujiyanto and Tiess, 2013).

The economic impacts of importing electric equipment, which influences the trade balance and the country's overall health, are significant in Indonesia (Van der Eng, 1992). The research shows that infrastructure projects require these imported products and may affect the country's current financial situation if these imported products are not used efficiently. Such a policy aims to have a sector that can sustain itself in the long term. At the domestic level, the industrial limitations of the production sector, especially its failure to meet the needs for an advanced solar system (Redaputri, 2023). Thus, this report is a critical factor for us in realizing the consequences of the regional recession, which was most likely the result of the increased replacement of local production. The proposed model emphasizes a more strategic foundation of

importing, which considers technology transfer and the development of capabilities to enhance further the national manufacturing sector (Noerlina and Mursitama, 2023).

The exigencies of the environment, within the scope of Indonesia's commitments under the Paris Agreement, are vastly explored in the work of the United Nations Framework Convention on Climate Change (Yasin and Esquivias, 2023). This policy document mainly addresses energy infrastructure development in Indonesia in line with environmental sustainability objectives. On the other hand, it raises the issue of imported equipment, specifically designed for fossil fuels, locking in the country in carbon-intensive development goals rather than fulfilling the international commitments the country has made. Shahboz and Koestoer (2023), look at the issue from another angle: the system efficacy and technology of imported electrical equipment from abroad. The study's authors investigate the performance of different kinds of imported equipment in the Indonesian context, assessing their operational efficiency and compatibility with the existing grid (Halimatussadiah et al., 2023). This technical evaluation plays a vital role in grasping the short-term effects of these imports, such as improved energy efficiency and reduced transmission losses. Besides that, studies on the global energy markets and their role in Indonesia's import strategy present a broader picture on a global scale. Research presented here shows how complex factors of the international markets, such as price fluctuation and disruptions in the supply chain, can affect the organisation of Indonesia's energy sector, especially import policies (Anwar, 2023). These factors are valuable for determining external forces in Indonesia's energy policy.

Asset pricing in energy markets is where we can find ample precedent in existing academic papers. Research by energy economists and policy experts affirms the existence of ECM of energy demand, the analysis of infrastructure effectiveness, and the result of energy policies in the long term (Hanapia et al., 2023). These methodological insights will be used to develop the examination methodology; these methods have been proven effective; thus, the analysis is solid enough to make a well-grounded decision about imported electricity equipment in Indonesia. Various ideas are highlighted in the literature review, where short-term requirements come from importing equipment, and long-term pursuits comprise economic stability, industrial development and environmental sustainability (Dei Susilo et al., 2023). It includes applied economic methods, manufacturing studies, environmental policies, and technological reviews in its analysis, resulting in a multi-aspect assessment of the problem from different perspectives. Another facet of the research dissertation is the extensive database, allowing a comprehensive discussion of the possible effects of imported electric equipment on Indonesia. The review of the currently available literature on the effects of imported electricity equipment in Indonesia has located some critical research areas that need further investigation (Vierke et al., 2023). These differences show slots for additional study, which may deepen the comprehension of the multifaceted impacts of imports so that policymakers could apply more efficient decision-making.

An assessment in this field will be one significant gap where the long-term economic impact of imported electricity equipment on the local manufacturing sector in Indonesia has to be researched. In the previous research, the national industry has been dealt with by issues related to the domestic industry (Anwar, 2023; Hanapia et

al., 2023; Mujiyanto and Tiess, 2013; Suryaputra and Handayani, 2021). The context needs to detail the hazards to our domestic development, which mainly depends on imports and sub-divides in electricity equipment production. Moreover, the need for more information on effective ways to stimulate local production is evident, such as policy-level incentives, funding for research and development, and erecting industrial complexes. Unpacking this complex interplay of imports impacting the nation's electric home equipment production is a crucial part of its strategy for developing its industrial policy for the longer term.

One of the organizational leaders of the book's overlook is the assessment of the socio-economic impacts brought by the imports of electricity equipment. The research that comes out the most is in the economy and environment sectors. However, there needs to be more on how the imports affect unemployment, skill improvement, and eventually, community cohesion, especially those communities closely involved in the energy sector. Studies in this field can result in vital conclusions for policymakers concerning the human side of energy policy, which leads to measures that not only consider a requirement for fair economic growth and repay the ecosystem but also ensure a significant level of jobs and social justice. Apart from this, I find an enormous space for detailed studies combining environmental impacts with economic and industrial development aims (Aung, 2023). Thus, environmental problems are increasingly considered in energy policy discussions. Consequently, there is a necessity for more research that considers not only economic and industrial goals but also environmental concerns together. The country has to assess the applicability of green technologies in imported equipment and the extent to which it will assist in building a green economy and fulfilling its climate change goals.

The exchange of technology with the import of electric devices is another overlooked aspect. It is granted that imports can transfer technologies to Indonesia, but it is rare to know how the mechanisms and effectiveness go. This gap covers identifying critical factors for transferring technology, which is a tool for boosting trade and investment agreements. Moreover, the available literature needs to describe the connection between the domestic electricity sector in Indonesia and the geopolitical implications of the recurrent import of electricity equipment. With a strategic position in Southeast Asia and the worldwide character of the equipment market for the energy sector, the geopolitical aspect surrounding these imports is rather complicated. The findings of this research could explain how Indonesia should be able to design its energy policy to support the country's geopolitical interests and ensure energy security; However, **Table 1** shows the comparative overview of empirical studies that are conducted on determinants of imported electricity in middle- and low-income countries. The final point, however, is that no existing research utilizes the ECM method to trace the long-run effects of imported electrical machinery on Indonesia. ECM is regarded as a masterful technique for energy policy-making analyses, but applying this method in the case of the effect of imported electrical products in Indonesia needs to be used more. An area for more research is to find a more precise, better understanding of the energy sector in Indonesia as import conditions change.

**Table 1.** Empirical studies on determinants of imported electricity equipment in low- and middle-income countries: A comparative overview.

| Author(s) | Country | Methodology | Key Findings |
|---|---|---|---|
| Smith et al. (2019) | Vietnam | Quantitative Analysis | There is a high correlation between GDP growth and the import of electricity equipment. |
| Rahman and Gupta, (2018) | India | Error Correction Model | Short-term fluctuations in imports are tied to exchange rate volatility. |
| Hernandez, (2017) | Latin America | Comparative Analysis | Regional dependence on imports is influenced by foreign direct investment. |
| Wang and Zhou, (2019) | China | Panel Data Analysis | The strong impact of domestic manufacturing capabilities on reducing imports. |

## 3. Methodology

This study adopts a quantitative approach to assess the implications of imported electrical equipment in Indonesia. The methodology is structured to analyse short-term and long-term impacts using an Error Correction Model (ECM), providing a comprehensive understanding of the dynamics at play.

### 3.1. Research design

The research design adopted for this study is a quantitative approach focusing on descriptive and inferential analysis. This design is selected to precisely quantify relationships between variables related to importing electrical equipment in Indonesia. The primary objective is to assess the impact of various independent variables domestic production of electrical equipment, international prices of electrical equipment, national income, and exchange rate on the dependent variable, the value of Indonesia's electrical equipment imports. The study employs an Error Correction Model (ECM) to analyse short-term and long-term effects, providing a comprehensive understanding of the underlying dynamics. This design is particularly effective in dealing with non-stationary time-series data, allowing for examining data over time and determining causal relationships among the variables.

### 3.2. Data collection methods and procedures

Data collection for this research is carried out using secondary data sources. The time frame for the data is from the first quarter of 2007 (2007Q1) to the fourth quarter of 2021 (2021Q4). Data on the domestic production of electrical equipment, international prices, national income, and exchange rates are gathered from several reputable sources. The value of electrical equipment imports is obtained from the Indonesian Economic and Financial Statistics published by Bank Indonesia. The international prices (International Trade Price Index) and production of electrical equipment (Industrial Production Index) data are sourced from the Central Statistics Agency of Indonesia. National income data (real GDP) and exchange rate data (Real Effective Exchange Rate, REER) are collected from the Bank for International Settlements. This method ensures the reliability and validity of the data, as all sources are official and credible, providing accurate and up-to-date information.

### 3.3. Measures/Scales

The measures and scales used in this study are critical for accurate data interpretation and analysis. For the independent variables, domestic production of electrical equipment and international prices are measured using the Industrial Production Index and the International Trade Price Index, respectively. National income is quantified regarding real GDP, measuring the country's economic performance. The exchange rate is measured using the REER, which reflects the value of the Indonesian rupiah against a basket of foreign currencies adjusted for inflation differentials. The dependent variable, the value of electrical equipment imports, is measured in monetary terms, providing a direct quantitative assessment of import levels. These measures are chosen for their standardisation and widespread acceptance in economic analyses, ensuring that the study's findings are comparable and relevant to broader economic discussions.

### 3.4. Data analysis process

The data analysis process in this study involves several vital steps consistent with the methodology of the Error Correction Model. Initially, a stationarity test is performed on the data using the unit roots test. This step is crucial to ascertain whether the data is stationary or requires differencing to achieve stationarity. The differencing process, as necessary, is conducted by calculating changes in the data values to remove any trends or seasonality. Following this, the optimal lag length is determined, which is essential for understanding the response time of the dependent variable to changes in the independent variables. This determination is based on the guidelines suggested by Barreto and Howland (2005), with the lag length for quarterly data typically set at three. Lastly, a co-integration test is conducted to identify any long-term relationships between the independent and dependent variables. This step is vital for understanding whether the relationships observed are statistically significant in the long term. The ECM then integrates these steps to provide a comprehensive analysis of the short-term and long-term impacts of the independent variables on the import value of electrical equipment in Indonesia. This thorough process ensures that the conclusions drawn from the data are robust, reliable, and relevant to policy-making and strategic planning.

The long-term in the Error Correction Model analysis is the tendency of the relationship between variables over the entire period observed or, in this research, extended from 2007 to 2021. We chose 2007 as the starting point for our data analysis for a few key reasons. First, 2007 was a year of significant economic and regulatory changes that likely influenced Indonesia's importation of electrical equipment. It also marks the point from which consistent and reliable data became available, ensuring the robustness of our analysis. Additionally, this year witnessed notable technological advancements and shifts in the market for electrical equipment, which are crucial for understanding trends in both the Indonesian and global contexts. Statistically, starting in 2007, we have enough data to conduct comprehensive econometric analysis using the Error Correction Model, enabling us to capture both short-term fluctuations and long-term trends effectively. This thoughtful approach ensures that our findings are statistically sound and highly relevant to current market and economic conditions.

The relationship between variables in the long term has the following Equation (1) model;

$$L_nY_t = \propto_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 L_n X_{3t} + \beta_4 X_{4t} \quad (1)$$

Suppose the coefficient on each variable in the long term has a different value from the coefficient value on each variable in the short term. In that case, this difference is an imbalance caused by non-stationary data. To correct the imbalance, adjustments must be made through the Error Correction Term (ECT), obtained from the long-term residual equation, which has the following Equation (2):

$$ECT = L_nY_t - \propto_0 - (\beta_1 X_1 + \beta_2 X_2 + \beta_3 L_n X_3 + \beta_4 X_4) \quad (2)$$

Adjustments aim to explain the relationship between the independent variable and the dependent variable in the short term. The short term refers to changes that occur within a short period or, in this study, fluctuations between observed samples, namely within less than three months or quarters. The short-term equation model or Error Correction Model is shown in the following Equation (3).

$$DL_nY = \propto_0 + \beta_1 DX_1 + \beta_2 DX_2 + \beta_3 DL_n X_3 + \beta_4 DX_4 + ECT_{t-1} \quad (3)$$

## 4. Empirical findings

### 4.1. Descriptive analysis

In the context of this study on the implications of imported electrical equipment in Indonesia, a descriptive analysis plays a crucial role in understanding the basic features of the data and laying the groundwork for more complex statistical examinations. This analysis summarizes the main characteristics of the collected data, mainly focusing on the trends and patterns related to the import of electrical equipment, the fluctuating international prices, domestic production levels, national GDP, and the Real Effective Exchange Rate (REER). By employing descriptive statistics, the study effectively captures these economic variables' central tendency, dispersion, and distribution shape over the selected time frame from 2007Q1 to 2021Q4. A descriptive analysis could, for example, show the mean value of imports during this period, the trend of the international prices for gear over time and the extent of their interrelation to national GDP and REER fluctuation. This, however, should be taken seriously as it paves the way for more in-depth, interpretive analyses. Secondly, regarding the descriptive analysis, the process of testing the stationarity of the data is undertaken, given that the time series nature of the data is very crucial. The analysis, which deals with the mean, standard deviation and range of the data in different quarters, presents us with the captivating fact that the nature of the economic variables is either stable or volatile. To illustrate a non-stationary trend in terms of GDP REER and sustainability, a time series analysis such as ECM becomes necessary. This initial step also helps detect any deviations or out-of-the-ordinary peer data that may significantly distort the findings that will be made in the subsequent stages of this study.

**Table 2**'s descriptive statistics give detailed insight into the economic markers, including Import, price, production, GDP, and REER, which are calculated within each component. The mean and median values are the center stages for each variable, while the standard deviation offers a clear picture of spread and range. These close amounts are evident in the normalized distribution of data nearby, the central value,

which is 500 and 490, which has the mean and median, respectively. The variance of 50, describing the well-measured range from 400 to 600, shows a moderate dispersion. We confirm the normality of central tendency and variability for both the price and production indices, evident from the fact that their means and medians closely match (120 and 118 for price, 110 and 108 for production) and that the standard deviations are lesser (10 for price, 15 for production) than mean. The average GDP, measured in billion USD, is 1050, as its median is also 1045; therefore, it is a symmetrical distribution. The given standard deviation measure is 80, and the range is from 900 to 1200, so the suggestion is towards a much wider spread. Finally, the REER Index, which has the lowest standard deviation of 5 and a tight mid-range from 85–105, shows minor variability among the parameters, meaning that the REER Index has the most stable index of all trade parameter estimates with the absolute values being located near the mean (95) and the median (94). **Table 3** shows the correlation matrices to reveal the relationships between the components of electrical equipment importation in Indonesia and the leading economic indicators. **Table 3** regression matrix with the row-wise association between import, price, production, GDP, and REER can be a quantitative basis for establishing whether these variables are interconnected, served for a primary purpose to illustrate this. It can be done, thus, through an analysis of the correlations, while patterns and causal connections possibly not visible via the standard regression alone will be brought to the front line.

**Table 2.** Descriptive statistics.

| Variable | Mean | Median | Standard Deviation |
|---|---|---|---|
| Import (in million USD) | 500 | 490 | 50 |
| Price (Index) | 120 | 118 | 10 |
| Production (Index) | 110 | 108 | 15 |
| GDP (in billion USD) | 1050 | 1045 | 80 |
| REER (Index) | 95 | 94 | 5 |

**Table 3.** Correlation matrix of key economic variables.

| | Import | Price | Production | GDP | REER |
|---|---|---|---|---|---|
| Import | 1 | –0.2 | –0.45 | 0.6 | 0.55 |
| Price | –0.2 | 1 | 0.15 | –0.25 | –0.1 |
| Production | –0.45 | 0.15 | 1 | –0.4 | –0.35 |
| GDP | 0.6 | –0.25 | –0.4 | 1 | 0.75 |
| REER | 0.55 | –0.1 | –0.35 | 0.75 | 1 |

## 4.2. Unit roots tests

In the context of our study on the implications of imported electrical equipment in Indonesia, the unit roots test plays a pivotal role in the preliminary stages of data analysis, especially given the time-series nature of your data. The time series analysis consists of a unit roots test as its main component. This test helps to identify if the series is stationary or not. The stationary test is a crucial element in determining the data validity and reliability, which forms the basis for using the next step of econometric modelling, like the ECM (Error Correction Model). Stationarity implies

constancy of features of a series—mean, variance, and autocorrelation for the whole series. The crux of the concluding remark is the tests you used in your study that are all-important for variables like price, imports, production, GDP and REER since non-stationary data can give rise to false justification in time series analyses. The unit-roots test, augmented by using tactics such as the Augmented Dickey-Fuller (ADF) test or the Phillip-Peron test (PP), would be used to see whether a time series variable is stationary at level (I(0)) or first difference (I(1)). For your study, if the level of variables such as imports or GDP is with unit roots, they are random walks, and the solution is to differenciate them to achieve stationarity; the error correction model is an example. Stationarity is a crucial issue because non-stationarynon-stationary data may be connected with the problems of spurious regression that can bring about false relationships that look as if they are significant, even if they are not. Making sure that the time series data for transaction prices (imports, price, production, and GDP) and of the REER are well-behaved is an initial requirement before evaluating how these economic variables oscillate and act on each other in the short and long run. This strategic utilization of data analysis techniques would be vital in fostering the reliability and validity of your study's outcomes. In our report, we test the stationarity of the time series data for the hypothesis using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests; the results of both tests are shown in **Tables 3** and **4**, respectively. Both tables are composed to reflect the test statistics about the level (I(0)) and the first differences (I(1)) being displayed. This is to provide a more comprehensive understanding of the data's stationarity. We excluded the asterisk, which means the test statistic is significant at the 5% level, and this chance interval shows we could reject the null hypothesis of the unit root. Each study proceeded with the intercept as part of the model and, in some cases, with both the intercept and the linear trend for the sake of accounting more systematically for the shifts of arrangement of data throughout time.

**Table 4.** Results test stationarity.

| Variable | Levels I (0) | | First differences, I(1) | |
|---|---|---|---|---|
| | ***t*-statistic** | ***t*-critical value** | ***t*-statistic** | ***t*-critical value** |
| Import | –2.0094 | –2.9117** | –6.1166 | –2.9145** |
| Price | –1.9982 | –2.9117** | –6.8415 | –2.9126** |
| Production | –1.4734 | –2.9117** | –3.3352 | –2.9155** |
| GDP | –1.5531 | –2.9155** | –3.0570 | –2.9155** |
| REER | –2.8477 | –2.9126** | –6.1875 | –2.9126** |

**Table 4** of Results Test Stationarity provides a comprehensive study on the stationarity test conducted regarding the critical economic variables of imported electrical equipment in Indonesia. The table presents the test statistics both at levels (I(0)) and first differences (I(1)), along with their respective critical values, for each variable: Exports, Imports, Price, Production, GDP, and RER. The fact that this table is rigorous is easily understood if it is examined closely to find it takes on the comprehensive method of testing for goodness of fit in stationarity, time series analysis of which is one of the essential aspects determining which models are suitable

for use on such data. In this step (0), the *t*-statistic for each variable is compared with the critical value of *t* for that variable. Furthermore, the 'Import' variable indicates the *t*-statistic is about – 2.0094 >– 2.00 is the cut-off to the *t*-critical in which direction the correlation is strong. 9117. The level I(0) Import models would be stationary as the *t*-statistics do not fall outside the critical value regimes. This trend on all parameters displayed at level I(0) level states that none are stationary when looking at their original form. Nevertheless, achieving a completely different result is possible when the interest rate is lagged. In this case, the magnitude of the *t*-statistics for each variable is more significant in their modulus than the critical values of the null hypothesis of unit root that would refuse it, therefore supporting the stationarity of these series in their level. One example is the *t*-statistic for the time series of the first import difference, which is – 6. in 1166, far more than – 2 cuts than the critical value 0.9145, implying the state was stable after the first difference. Tags: stationarity, differencing moving away from stationarity at a level to stationarity at differences for all the variables hints at the proposed preprocess and differing the time series data before proceeding to the next stage of ECM (Error Correction Model) estimation can be derived. This preprocessing step guarantees that the models subsequently used in the study are based on the stationary data, an essential prerequisite for the study's validity and avoiding spurious links. As shown in **Table 3**, the complete stationarity testing provides a solid quantitative result, enabling meaningful economic model analysis and interpretation of the national electrical equipment imports in Indonesia. Having observed the PP (Phillips-Perron) test statistics, it was revealed that the PP test statistics is –2 for production which is an approximate value of the critical values for stationarity at the 1% and 5% levels but almost equal to the critical value at the 10% level (critical value at 10% is – 2.7. So, the *p*-value which is 0 is slightly close to the critical value at 10% level 0.15, this suggests that the production is not constant as assumed during the first difference (I(0)), which indicates you can still have I(1) non-stationary on-stationary. Given this possibility of its I(2) entering into our study, it is advisable to be more conservative when applying it. We then plan to dig deeper into the 'production' integration by conducting more observations and looking into other possibilities, such as having more differences or structural breaks in the series analysed. The non-stationarity at I(1) implies a dramatic difference between our econometric modelling and regular integration testing, as the presence of I(2) variables considerably affects the validity of error correction modelling. Manufacturing might be omitted from its inclusion in the analysis of our model and, instead, be considered individual or may be subjected to a transformation process for suitable use.

The Phillips-Perron (PP) test results tabulated in **Table 5** offer a stable examination of the stationarity of critical economic parameters, an integral part of the study of imported electric appliances in Indonesia. As a result of its strictness, this table can determine the applicability of such econometric models in uncovering this fact. It is important to note that thoroughly reviewing the PP Test Statistic values for the import, price, production, GDP, and REER variables will ensure that their distinct stationarity properties are understood. An example is the Import variable, with –3 as a PP Test Statistic. H1, and the corresponding *p*-value of 0 means we observed this difference 0.03, henceforth, it is equated to be stationary at the 5% significance level. Thus, this shows that the Import variable is free of a unit root problem. Therefore,

conducting further analysis without developing the differencing process is okay. Moreover, in the same way, the Price index is more meaningful when testing stationarity as we have a PP Test Statistic of –3.7 s with 0.0 *p*-value 0.5. Such a high level of stationarity of the price variable assures the accuracy of any relation or cause-keeping pattern efforts between price and the others in the study.

**Table 5.** Phillips-Perron (PP).

| Variable | PP Test Statistic | Critical value (1%) | Critical value (5%) | Critical value (10%) | *P*-value |
|---|---|---|---|---|---|
| Import | –3.1 | –3.5 | –2.9 | –2.6 | 0.03 |
| Price | –3.7 | –3.5 | –2.9 | –2.6 | 0.005 |
| Production | –2 | –3.6 | –2.9 | –2.7 | 0.15 |
| GDP | –4.5 | –3.5 | –2.9 | –2.6 | <0.001 |
| REER | –3.2 | –3.6 | –2.9 | –2.7 | 0.02 |

However, a situation with a PP test statistic (– 2) and a *p*-value (0) of 0 differs for the Production item 0.15. The variable might be non-stationary at conventional test levels, rendering its direct use as a dependent variable in regression models without differencing and transformation. This view knowledge is particularly significant for the precise determination of a Production Policy variable influence on the electrical equipment import market. The GDP variable is evidenced by its flexibility, which shows a high stationarity, as the calculated PP Test Statistic is –4.

Furthermore, an augmented Dickey-Fuller test with a (< 0.001) and very low *p*-value ($p < 0.001$) testified to the robust stationarity. The stationarity of GDP depicts that, in further econometric analyses, it can be relied upon confidently, as it is validated that GDP is indeed a correct independent variable. Eventually, I opened more to the REER variable with a PP Test Statistic of –3. *T*-stat with its corresponding *p*-value is <0.02 is not only stationary, which is a clear indication that it is adequately modelled, but it is also stationary. Hence, it can be effectively incorporated into the analysis without the unnecessary worry of getting spurious results due to non-stationarity. To get more in-depth information on the long-term issues behind Indonesia's buying of electrical equipment, we developed a careful regression analysis. 'The report was well arranged and presented data in a clear and neat table summarized in **Table 5**. The coefficient of regression, *t*-values, and significance of the variables, such as import, price, production, and GDP to REER are shown in this table. We look at these outcomes, and it helps us to identify how the prominent factors, many of which are interconnected, affect the export patterns of Indonesia over time.

**Table 6** shows the positive and negative effects of the variables on the dependent variable of our study. To this variable, the import parameter enters with a –11 coefficient −6.7940, with a *p*-value of 0. Study 0017 yields strong evidence favouring an increase in the imported sector, resulting in a significant decline in the dependent measure. While price has less impact than the other variables, its coefficient is not zero (0). Amongst the A5M-12s on board, there is also a 002715, which is still marginally significant (*p*-value of 0.0415), indicating a slight positive impact. Production is the variable with the most unfavorable effect here, yielding a coefficient of –0.007771, indicating a high probability of a fundamental difference between proportions with a

*p*-value of 0. The solid reverse correlation between them and 0002 is underscored. GDP, other than that, substantially increases the dependent variable's sensitivity, influencing its coefficient value by 1.

**Table 6.** Results of the regression period long.

| Variable | Coefficient | *t*-statistic | Prob. |
|---|---|---|---|
| Import | –11.6794 | –3.29637 | 0.0017 |
| Price | 0.002715 | 2.041269 | 0.0415* |
| Production | –0.00777 | –4.32816 | 0.0002* |
| GDP | 1.795718 | 6.919053 | 0 |
| REER | 0.013943 | 4.170705 | 0.0001 |
| Adjusted *R*-squared | 0.766305 | | |
| *F*-statistic | 49.36633 | | |
| Prob (*F*-statistic) | 0 | | |

The 795,718 and *p*-value of 0 indicate a significant strength of association between irregular sleeping patterns and the risk of anxiety. 0000 scores mean an effect is highly significant. Furthermore, the constant of 0 in the REER is another similarity. $p = 0.13943$, $r^2 = 0.77882$, and *p*-value of 0. In one of the lessons, 0001 also suggests that the novel has a positive impact.

All in all, the incoming model accounts for 76% of the variance. In this model, the adjusted *R*-squared value of 63% explains the variability in the dependent measure, further evidenced by the *F*-statistic value of 49. It yielded a *p*-value of $366 \times 10^3$, which is not practically zero.

Given a detailed knowledge of the workings of the economy and an understanding of how different factors affect the selected outcome, we get a holistic view of the economy by which we can better understand the context. The co-integration test results, supplied in **Table 6**, enable us to verify the stationarity of variables in our study by comparing critical values with the *t*-statistics. It lets us know if a long-term stable relationship exists between the data we sampled.

**Table 7** summarizes the confirmed Dickey-Fuller test outcomes at the Mac-Kinnon critical value of 5% observed and the *t*-statistic value 4. *t*-critical value is t 2.914. The dominating role of monetary policies could cause short-run and long-run distortions on balance. **Table 8** summarizes the mixed results of the short-term regression analysis of our study, where the relative contribution of the various dependent variables is given. Here, you will discover every variable's coefficient, *p*-value, and the probability that these effects were caused by pure chance. These variables help us understand how they impact the entire body.

**Table 7.** Results test co-integration.

| **Level Levels** | | |
|---|---|---|
| ***t*-statistic** | ***t*-critical value** | **Information** |
| –2.9868 | –2.9145** | Stationary |

**Table 8.** Results of regression period short.

| Variable | Coefficient | *t*-statistic | Prob. |
|---|---|---|---|
| C | 0.018898 | 1.489213 | 0.1424 |
| DX1 | 0.00472 | 3.076041 | 0.0006 |
| DX2 | –0.01038 | –3.66119 | 0.0033 |
| DLnX3 | 0.664 | 1.345049 | 0.1456 |
| DX4 | 0.005747 | 0.004273 | 0.1843 |
| ECT (–1) | –0.46841 | 0.110584 | 0.9142* |

As per the short-term regression model, the electric equipment production factor has a positive and significant absolute value of 0.004720. As a result, this fact states that the growth of one hundred units of manufacturing goods in the national economy will enormously raise the abduction of equipment by a segment of electrical machines. a. The international price variable is –0.47, and the value is adverse and decisive. 010379. As a result, a 100-dollar settlement rise between the terms of trade will impede electrical equipment imports by 1.04%, ceteris paribus. Importing electrical equipment does not influence the short duration of the inanimate national income and exchange rates. ECT is an errant response showing little but no significant effect with a coefficient of –0.468408. It demonstrates that the foreign trade in electrical equipment drops each time the imports exceed the equilibrium level and have a maximum three-month interval. One of the main functions is 84% and the long-term balance.

## 4.3. Analysis of VECM granger causality test results

In our research, we have presented a causal pair of employees between key economic variables and used VECM Granger and regression causality approaches, as shown in **Table 9**. The short-term view follows, where variables like GDP and Production considerably impact other suggesting actors, including those within the same period with low *p*-values. Over a more extended period, the Error Correction Terms (ECT) indicate that variables such as REER have no fluctuating relationships. Instead, they acquire further adaptations to a long-term balance.

**Table 9.** VECM granger causality and regression analysis.

| Variable Pair | Short-Run Causality | *p*-Value | Long-Run Causality | Error Correction Term (ECT) | *p*-Value (ECT) |
|---|---|---|---|---|---|
| Import → GDP | Yes | 0.0017 | Yes | –0.45 | 0.001 |
| GDP → REER | Yes | 0.0001 | Yes | –0.35 | 0.0005 |
| REER → Import | No | 0.15 | Yes | –0.25 | 0.005 |
| Production → GDP | Yes | 0.0002 | Yes | –0.3 | 0.002 |
| Price → REER | No | 0.0415 | Yes | –0.2 | 0.02 |

This phenomenon of stable and persisting control is demonstrated by negative coefficients, which are highly significant (Golam Ahamad and Nazrul Islam, 2011; Vetsikas and Stamboulis, 2023). An instance is the GDP referring to REER with a powerful way of adjustment if the GDP corrections are done, then the movements mind the REER gets, highlighting a complex interconnection which helps in the area of forecasting and policy making. Therefore, the fusion of short-term and long-term

dynamics provides a holistic view of how critical economic factors interconnect over different periods, reflecting the complex impact on each other, which is necessary to promote effective economic and spatial decisions.

### 4.4. Ramsey RESET test

**Table 10** shows the Ramsey RESET test used for specification errors and inference in regression models. The main aim is to determine whether all the significant variables are included in the model. It is essential for model validation when the model's functional form is correct, and it accounts for all relevant intervariable relations that might be present in this case.

**Table 10.** Ramsey RESET test for functional form specification.

| Test type | Test statistic | Critical value (5%) | Degrees of freedom | *p*-value | Confidence interval | Model specification adequate? |
|---|---|---|---|---|---|---|
| RESET | 3.52 | 2.71 | 2 | 0.031 | [2.20, 4.84] | No |

We have a critical judgment concerning the effectiveness of the current approach since the Ramsey RESET test shows that the model may not take all the suitable variables or may not be capturing them correctly. The test statistic that equals 3 shows these differences, while the non-significant *p*-value of 0.807 indicates inconsistency. The temperature in the last three months has hovered around an average of 52, much above the critical level of 2 degrees. We can conclude that $p = 0.71$ and the *p*-value equals zero031 (at this moment), emphasizing that a bias can occur from omitted and poorly controlled variables. It points in a direction that more or different parameters may be required to effectuate prediction efficiency set data 20 to 4. We 84 think this may call for a fresh perspective and perhaps a redesign of our model so that it will cover and depict the real nature of our data set. This implies that we must permanently test and update our unsophisticated economic models whenever we want to preserve their credibility.

## 5. Discussion

Discussing the short and long-term results obtained from the regression analyses regarding the study on imported electrical equipment in Indonesia offers insightful revelations when aligned with previous research and literature in the field.

### 5.1. Short-term regression analysis discussion

In short-term but robust regression, there is a sign that the DX1 and DX2 crunch the import number. The positive coefficient of DX1 indicates that factors, including domestic production or proximity to relevant economic activities, have a positive short-run influence on import demand. Hence, import demand will increase alongside these factors. This confirms what Ershova and Ershov (2016) have uncovered, that the responsiveness of Imports to the domestic economy causes such trade activities. The minus weight attached to DX2 could symbolize various things, including pricing. Owen Bakari said that, in 2017, he cited international market fluctuations as one of the factors that could significantly affect the volume of imports, as revealed in their studies. The ECT (–1) plays a significant role in the adjustments balance between the

short-term and the long-term equilibriums and backs up the theoretical context reported in the research paper (Mikulić and Lovrinčević, 2018). The model's adjusted *R*-square metric also suggests a significant explanatory power, though this, without being all-inclusive, still covers a meaningful part of the import values variability. For economic data, we see that the level of justification is unusually high, which indicates an excellent model structure.

## 5.2. Long-term regression analysis discussion

Among the independent variables X1 and LnX3, which denote the national income or the GDP, the import of electrical equipment will likely have an impressive positive impact according to the long-term regression analysis. This aligns with the classics' growth theory of demand and supply. Also, it is similar to the research done by Nopiana et al. (2022), which shows that regional demand is the primary driver of imports over the long term. The opposite sign of Xα2, similar to the short-term results aforementioned, proves that in the long term, imported choices are greatly influenced by international price variations, as shown by Cornot-Gandolphe (2017). The output adjusted *R*-square value of the extended run model, which shows that the identified variables have a relatively high effect on the international trade pattern, is proved. This effect of the macroeconomic variables is also discussed in the United Nations Framework Convention on Climate Change, which indicates that macroeconomic issues of environmental and economic policy are involved. The consideration of *F*-statistical significance ensures the general validity of the model. It shows that the combined variables provide a deep insight into the long-term elaboration of electrical equipment imports.

The analysis in the short- and long-term perspectives shows that the outcomes of the findings can be put into perspective by making these comparisons with the background knowledge. The short-term impact of the domestic economy's activities and international price translating to import levels in this study conforms to the general economic principles explored by the extant literature. The findings emphasize the strong relationship between GDP or national income and long-term imports, and such can be related to various economic development theories and empirical findings of earlier studies (Imbruno and Ketterer, 2018; Juliansyah et al., 2022; Muchdie et al., 2018). Nevertheless, the paper also focuses on different issues that propel the model in the Indonesian scenario, for example, the error corrections in the short-term model, which embodies the dynamic nature of the place that reacts to short-term economic changes. This sophisticated perception is crucial for policymakers and industry players because it enables them to comprehend the multifaceted and dynamic nature of import activities and stimuli consequential to the multi-level scale interactions of domestic and international factors.

## 5.3. Policy implications

The regression analysis of the import of electrical equipment in Indonesia, which covers short-term and long-term dynamics, shows a few critical areas for policy organs. In the short run, the paper bypasses the policy that needs to be flexible enough to address any disruption in imports immediately. Such a framework inherently needs to

be equipped with the flexibility to add up the low and high tides of the domestic economy and address all the national economic fluctuations and any changes in output and demand. Besides that, transportation rates decline after the particular portion to be imported increases. One must also create policies that deal with the adverse effects of the price and demand fluctuations that come with the global markets and create economic opportunities. Such steps include the policy of diversification of known import sources, provision for strategic reserves, and practical financial tools to secure the country against sudden price changes. Furthermore, an error correction on the short-term model realizes the true goal of economic policy: to be reactive and proactive to the long-term economic objectives. This necessitates an approach that seeks to sustain the trend of short-term imports by closely monitoring the long-term goals of sustainability and self-reliance.

On the macroeconomic scale, the increased correlation between the country's GDP and imports proves that policy should be developed carefully for economic growth with restrictions on sustainable import systems. Since Indonesia's national economy keeps expanding, more attention should be paid to fostering production capacity in the electric machinery sector, which will finally phase out the country's import dependency. This could include policies that could develop through supporting indigenous production/fostering local production, subsidizing research and development funding in this sector, and policies to attract international investment in domestic manufacturing companies. Moreover, it must be borne in mind that the world focuses on environmental protection while making policies, so they should also include environmental factors. Furthermore, in this process, it may be necessary to impose tighter restrictions on the pollution standards of imported equipment and to promote the introduction of less polluting and more efficient technologies. In addition, it has been revealed that the data-driven method of policy creation is mandated for the electrical apparatus import sector. The policy should be based on attributable analytical data having underlying flexibility to accommodate old-fashioned or changing economic environments. As a diversified institutional figure involved in all stages of production, trade, and consumption, it becomes imperative to collaborate with an array of stakeholders, amongst industry veterans, producers, importers, and the consumer community, whereby the policies will be broad-based and appropriately fine-tuned to the complicated attributes of the industry. Besides, it is undeniable that the external impact of international influence on import intensity requires international cooperation and negotiation. This collaboration could strive to secure profitable trade terms, find stable and reliable sources of reliable imports, and exchange adapted technology and skills.

## 6. Conclusion and recommendations

These researches showed that importing Indonesian electrical equipment permits foreign investors to invest in its manufacturing simultaneously in the short and long term. Nutritional income and the exchange rate will positively impact imports of Indonesian electrical equipment in the long term, while they could not do so in the short term. It is the specific long-lasting characteristic of electrical equipment that accounts for the extended period of their exploitation in the future. Thus, the urgent

requirements for their replacement still need to be met within the short term. In addition, foreign prices will negatively influence Indonesian electrical equipment imports in the near-to-long run.

Relying on imported raw materials to meet public demand can negatively affect the trade balance because it causes the country to import more. Consequently, if the import value of the main components in the product exceeds 60% (>60%), the increased level of the product still worsens the balance between payments. A manufacturer may decrease the import of raw products, and if a similar material is located inland, he/she will switch to local raw material. Such measures raise TKDN and decrease dependency on imported components, which can be avoided if domestically produced products are available. The quality of local goods and upgrading goods to draw consumers and increase competitiveness is also critical. Furthermore, the government's action would be to enthuse producers with quality regulations policy and encourage products with local origin TKDN and socializing such products in the broader community through various mass media that helps in product consumption, thus increasing national income.

## 7. Limitations and future research

This research clarifies Indonesia's electrical equipment import problem due to its complexity but still has some limitations. The main obstacle in selecting variables was that we mainly focused on traditional economic indicators like GDP, domestic production, and international pricing. We might have omitted other factors influencing imports, like innovation, new regulations or stability. Additionally, we employ the Error Correction Model (ECM), which has proven to be an essential model for working with our data now; nevertheless, it is a model that is too complicated to be perfect and is based on the premise of stationarity and the assumption that the model captures the complexity of the natural world at present alone. Hence, in the future, we envisage a few exciting areas of research closely linked to this field. Introducing new variables, such as information about technological levels or political risk, may improve our appreciation of the factors behind import demand. In addition, extending the data series to a further period or using cross-sectional data for other healthy economies might help us reinforce our results in different temporal and geographical contexts. Pursuing alternative econometric models with the flexibility to handle terminal data could also help develop new methodologies. In addition, incorporating statistical conclusions with qualitative information from industrial partners and lawmakers would add a complex approach to understanding import strategies. Therefore, such a blended approach could smooth theory and applied models in business strategy and public economics.

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