Indonesia's Electronic Export Potential in The Global Market with Gravity Panel Model Approach

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Article Info	ABSTRACT
	The objective of this research is to compute the potential exports of Indonesian electronics to 14 countries from 2007 to 2022 by employing a panel-gravity methodology and the PPML technique. The study's findings have substantiated a robust and statistically significant correlation between Indonesia's electronic exports and the principal factor of the gravity model, specifically the gross domestic product (GDP) of Indonesia and its trading counterparts. The findings about the electronic export potential of Indonesia indicate that there is much room for improvement in order to enhance the country's exports to nine specific nations. Therefore, the consolidation of the electronics industry's position as a prospective industry can be achieved by strategically focusing on specific countries. In order to harness the potential advantages of electronics exports, it is imperative for policymakers to enhance infrastructure and regulatory frameworks pertaining to the electronics sector. *This is an open access article under the CC BY-SA license.*

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1. INTRODUCTION

International trade has a very important role in a country's economy. For Indonesia, international trade is one of the main pillars in economic development and national development. Research examining the impact of exports on Indonesia's Gross Domestic Product (GDP) by [38] shows that exports have a significant positive impact on Indonesia's GDP. Another study by [39] exports in the industrial sector have a positive and significant influence on Indonesia's economic growth in the short and long term. In line with Indonesia's national industrial development plan as outlined in Government Regulation Number 14 of 2015 concerning the 2015-2035 National Industrial Development Master Plan (RIPIN). The regulation stipulates 14 priority industrial sectors that are considered to have high export potential to boost Indonesia's economic growth. Priority industries are grouped into flagship industries, supporting industries, and upstream industries. One of the industries set in the priority industry is the electronics industry. The electronics industry is included in the category of mainstay priority industries, namely priority industries that play a major role. as the prime mover of the economy in the future.

Before the 1970s, Indonesia relied heavily on imports for most of its electronic goods. The period from 1969 to 1985 saw a significant shift in government policy, namely

towards industrialization in lieu of imports. During this time, the government actively promoted and facilitated the establishment of joint ventures and technical cooperation initiatives between foreign companies and domestic companies, with the help of state financing. Investment flows from foreign companies throughout the 1980s became a catalyst for the development of the electronics sector in Indonesia. These companies are Panasonic, National, Sanyo, Grundig, and Philips. The decision of the Indonesian government to switch from an import-substitute industrialization strategy to an export-oriented development model has resulted in significant growth in the electronics industry. Foreign direct investment (FDI) inflows into the sector increased sharply and were mostly aimed at manufacturing international market destinations. [1]

Figure 1. Export Growth Rate of Indonesian Electronic Products 2001 – 2022
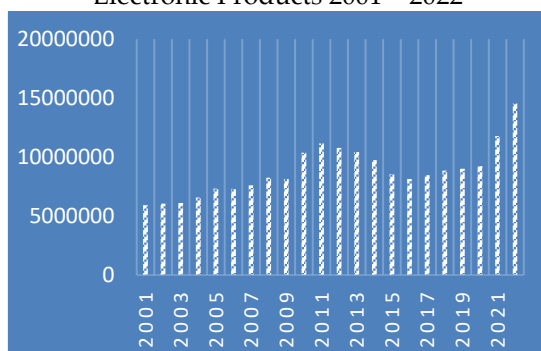
Source: BPS, processed by Pusdatin Ministry of Industry

The growth of electronic exports in general shows an increasing trend, in figure 1 Indonesia's electronic exports experienced a percentage growth of 146.02% from 2001 to 2022. Certain years show significant spikes in exports such as 2010 and 2022. Growth in 2022 is quite significant, considering that the global economy is still not fully recovered due to the COVID-19 pandemic. This data reflects the development of the electronics industry in Indonesia. The increase in electronic exports can reflect the growth of the domestic electronics industry and the potential competitiveness of Indonesian electronic products in the global market. In line with research by analyzing the competitiveness of

Indonesia's leading export commodities in the international market. This study used a quantitative approach with index analysis [2] Revealed Comparative Advantage (RCA) to analyze export data of Indonesia's leading commodities to 19 trading partner countries from 2010 to 2014. found that electronics is one of Indonesia's leading export commodities. The RCA value for electronic commodities is 1.02, which shows that Indonesia has a comparative advantage in producing electronics. However, the sector is experiencing increased competition from other ASEAN countries, as well as ongoing challenges from companies in China [3]

The study will focus on actual exports of electronic exports over a period of time, which are historical data that illustrate real performance within a market, with estimates that are the result of analytical models that utilize various independent variables to predict future export levels. By comparing between actual and estimated exports it is possible to assess the potential to increase the value of Indonesia's electronics exports. Studies on Indonesia's export potential still do not exist, and very few studies on electronics exports. This is a priority mainstay sector that plays a major role as the prime mover of the economy in the future. For this reason, export potential research needs to be carried out to support government policy, this study uses gravity model research methods that are commonly used in analyzing export market potential. The model assumes that the volume of trade between countries is influenced by economic size, distance and other variables that affect the macroeconomy.

2. LITERATURE REVIEW

Studies on Indonesian electronics are still very few, especially with the focus of electronic export research. Research by found that the liberalization of ACFTA has led to a decline in the performance of Indonesian electronics companies in several sectors, such as computers and communication equipment. This is due to competition from Chinese electronics companies that have cost and technology advantages. using a quantitative

approach with Revealed Comparative Advantage (RCA) index analysis and gravity model to analyze Indonesia's electronic sector trade data from 2003 to 2011. The trading performance of Indonesia's electronic sector showed an increasing trend after the implementation of CAFTA. The RCA value for Indonesia's electronics sector increased from 0.83 in 2003 to 1.02 in 2011. This shows that Indonesia has a comparative advantage in producing electronics for the ASEAN and Chinese markets. concluded that Indonesia has a role as user input in the global value chain of electronic products. This is shown by Indonesia's low RCA value for electronic commodities. Indonesia has a comparative advantage in producing electronic components, such as LCD display panels, cables, and other electronic components. analyze the effect of internal R&D activities on the accumulation of organizational technical knowledge, with the role of mediating absorptive capacity to build innovation capabilities in the electronics industry. This study used a quantitative approach with structural equation modeling (SEM) analysis to analyze data from 130 employees of PT Hartono Istana Teknologi (Polytron). Research shows that factors of labor productivity, FDI, number of companies have a positive influence on the competitiveness of Indonesia's leading manufacturing sector. [4] [5][6][7][8].

The first study to examine trade flows using the gravity model was one that argued that Newton's law of gravity, described as trade between two countries, could be influenced by the size of the economy and the distance between the two countries. Next [9] James E. Anderson, an economist, who developed the empirical econometric approach trade gravity model in 1979. This model has become an important tool in international economics and assists researchers in understanding factors that influence trade flows between countries, such as economic size, geographic distance, and differences in economic characteristics. Since then, models of trade gravity have continued to evolve, and many studies have been

conducted to expand and modify those models in order to address the various variables that affect international trade. The study by Yang used gravity models to examine Pakistan's rice export potential to 144 countries. The results confirm the positive relationship between Pakistan's rice exports and the main components of the gravity model, namely Pakistan's GDP and trading partners, income differences, common borders, and WTO membership, as well as inverse relationships with distance, exchange rates, and trade agreements. used gravity models to analyze data on Vietnamese handicraft exports to 50 trading partner countries from 2007 to 2017. Using trading partner GDP, exchange rate, trading partner population, distance, cultural similarity, APEC membership and inflation. Trading partner GDP, trade population, distance, cultural similarity and APEC membership factors have a significant positive impact on Vietnam's handicraft exports. Meanwhile, inflation and exchange rates have a significant negative impact. The research aims to measure the efficiency and export potential of Chinese products to countries along the Belt and Road Initiative (BRI) under interconnection. The study used an extended border stochastic gravity model to analyze export data of Chinese steel products to 54 countries along the BRI from 2003 to 2018. The study used gravity models to analyze data on Russian exports to 108 countries from 2000 to 2020. The results showed that the incomes of Russia's trading partners and domestic production capacity have a significant positive impact on Russia's global export flows. Geographical distance has a significant negative impact on Russia's global export flows. Other variables, such as similar cultures, similar histories, populations, and exchange rates, do not have a significant impact on Russia's global export flows. The study used gravity models to analyze agricultural trade data between countries in Latin America and the Caribbean from 1995 to 2019. The results showed that importing countries' GDP and cultural similarities had a significant positive impact on agricultural

trade between countries in Latin America and the Caribbean, while distance and free trade agreements had a significant negative impact. [10][11] [12][13][14].

3. METHODS

Panel Gravity Models are used in international trade analysis to accommodate panel data that includes time and country dimensions simultaneously. However, some flaws in this model have been discovered by a number of previous researchers. These weaknesses include potential endogeneity-related issues, such as those already pointed out by [15], [16], as well as those related to zero trade mentioned by [17], [18] and heteroscedasticity issues. To overcome the endogeneity dilemma, several suggestions have been put forward by [19] and [20], namely by introducing different types of fixed effects when estimating gravity models. [21] argues that the use of panel data analysis such as FE is appropriate to control for possible endogeneity errors caused by unobserved heterogeneity. In addition, [22] it developed a Poisson Pseudo Maximum Likelihood (PPML) estimation approach for gravity models and claims that this approach is effective in dealing with heteroscedasticity in trade data. Then, [22] it provides evidence that the PPML estimation method also provides consistent results in the face of zero trade observation cases. PPML with panel data can overcome biases obtained from heterogeneity [23].

The initial structure of the gravity model initiated by has the following composition:[9]

$$lnEx_{pij} = \beta_0 + \beta_1 lnY_i + \beta_2 lnY_j + \beta_3 lnDIST_{ij} + \varepsilon_{ij} \quad (1)$$

Where $lnEx_{pij}$ represents the logarithm of exports between countries i and j, lnY_i is the logarithm of the income (GDP) of country I, lnY_i is the logarithm of the income (GDP) of country j, $lnDIST_{ij}$ is the logarithm of the geographical distance between countries i and j, β_0, β_1, β_2, β_3 are the parameters to be estimated, and εij is the random error.

In this study including specific variables in equation (1) then the equation of gravity can be written as:

$$lnY_{ij} = \beta_0 + \beta_1 lngdpind_i + \beta_2 lngdpprt_j + \beta_3 lnjarak_{ij} + \beta_4 lnnt + \beta_5 lnopen + \beta_6 dfta + \varepsilon_{ij} \quad (2)$$

Where, y_{ij} is the electronic export of the country i to the country j, gdpindi and gdpprtj is the GDP of the country i and the country j, the distance is the distance of the country i and j, nt is the exchange value of the country i against the country j, open represents the economic openness of the country i and j, dfta is the variable dummy of the FTA free trade agreement.

In equation (2), it will be difficult to perform the calculation if it contains data valued at 0. For this reason, a transformation of the equation is carried out into:

$$exp(lnY_{ij}) = exp (\beta_0 + \beta_1 lngdpind_i + \beta_2 lngdpprt_j + \beta_3 lnjarak_{ij} + \beta_4 lnnt + \beta_5 lnopen + \beta_6 dfta + \varepsilon_{ij}) \quad (3)$$

Become:

$$Y_{ij} = \beta_0 + \beta_1 gdpind_i + \beta_2 gdpprt_j + \beta_3 jarak_{ij} + \beta_4 nt + \beta_5 open + \beta_6 expdfta + \varepsilon_{ij}$$

Table 1. Data and Data sources

No	Data Type	Data Sources
1	Export	ITC-Trademap
2	GDP	World Bank
3	Geographical distance	CEPII)
4	Exchange rate	World Bank
5	Economic openness	World Bank

4. RESULTS AND DISCUSSION

4.1 Model specifications for panel analysis

In this section, several tests will be performed to select which of the three panel analysis methods (pooled OLS, FE, RE) is appropriate for each model. The F test results reject the null hypothesis of pooled OLS, so FE is more appropriate to use than pooled OLS. Comparison tests for pooled and RE show that it is statistically significant, so the ER

method is more appropriate to use than pooled OLS. Finally, the Hausman test rejects the null hypothesis, so the FE method is preferred over the RE due to the inconsistent estimation of the coefficients of the RE method. The results of these tests are presented in Table 2. Therefore, FE will be preferred for both models. Furthermore, this paper conducts normality test, multicolonicity test and heterokedastis test.

Table 2. Model Analysis Panel Test

Method	Result	Conclusion
Pooled OLS day FE	Test Hausman = 13.87. prob>chi2 = 0.0031.	Select FE
Pooled OLS day RE	Test Hausman = 16.15 Prob>chi2 = 0.0028	Select RE
FE and RE	Test Hausman = 27. 51 Prob>chi2 = 0.0000	Select FE

Source: Estimated results

The results of the Breusch-Pagan/Cook-Weisberg test (Table 3) are statistically significant, leading to heteroscedasticity when using FE. Therefore, perform robust FE and PPML to work around this issue.

Table 3 Heterokedastis Test

Variable	Result
And	chi2(1) = 150.11 Prob > chi2 = 0.0000

Source: Estimated results

Table 4 presents the impact of various factors on Indonesia's electronics exports through various gravity model approaches. The dependent variable is the electronic export value in the basic gravity model with FE and PPML.

FE and PPML methods show a significant positive impact of importers' GDP on Indonesia's electronics exports. This shows that the higher the income (GDP) of a trading partner, the higher the value of exports. In line with tudi by [29], [26], and [27] who in research using a gravity model found that importers' GDP has a positive effect on

Indonesia's exports. Exchange rate variability (nt), in the FE model shows a significant positive influence, but in PPML shows a positive but very insignificant impact with a standard error of 0.623 far above 0.05. Studies by [30], [28], [29], [31], explain that the exchange rate has a positive effect on Indonesian exports and has a positive impact on the Indonesian economy.

For FTAs, both FE and PPML methods have an insignificant effect. In line with studies by [32], [33], and [34] which found that FTAs have an insignificant impact on Indonesia's exports. Furthermore, PPML shows that the distance of importing countries has a negative and significant impact on Indonesia's electronics exports, while FE shows a positive but not statistically significant impact. In many economic contexts, particularly in the gravity model of trade, it is often assumed that the geographical distance between two locations has a negative influence on trade or exports between them. This assumption is based on the intuition that the farther away two locations are, the higher the transportation, logistics, and distribution costs that can make trade or export more expensive and difficult. The results of studies using the PPML method are in line with these assumptions and are also in accordance with the results of research conducted by [35], [36], and [37].

Table 4. Mode Estimation Results

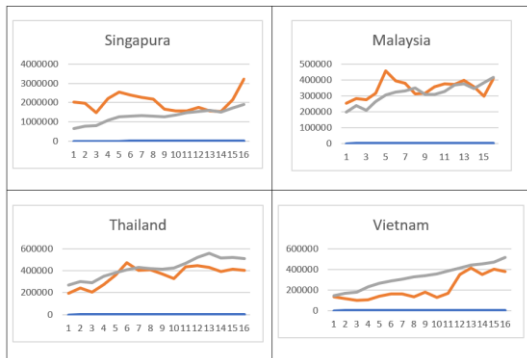| Dependent variable	FE with robust		PPML	
GDPR	.3162058	(0.160)	1.09	(0.000)
gdprt	.0152972	(0.045)	1.03	(0.000)
distance	187044.2	(0.047)	-.0000636	(0.000)
nt	4.595.969	(0.008)	3.68	(0.623)
open	-17402.63	(0.003)	.0298829	(0.000)
expdfta	31650.78	(0.527)	-.0046078	(0.968)
_cons	-1.26E+09	(0.047)	10.85016	0.000

For economic openness, FE shows a significant negative impact on Indonesia's electronics exports, while PPML shows that economic openness statistically has a significant positive impact. The results of research using the PPML method are in line with and where the economic openness of importing countries has a significant positive impact on Indonesian exports. The economic impact of electronic exports on Indonesia, for the FE method, is reflected in Indonesia's GDP which has a positive but not significant impact, while PPML has a significant but very small economic impact [24][25]. This means that an increase in Indonesia's GDP will increase electrical exports, assuming other factors are constant.

4.2. Estimated Trade Potential

The estimated coefficient from the gravity model equation (Equation 4) with the PPML regression coefficient is used to calculate Indonesia's predicted electronics exports, and then these predicted exports are compared with actual exports to see whether Indonesia's electronic export potential exists or not. Figure 2 presents the potential of electronic exports with 4 countries from ASEAN. Based on the results of statistical estimates, Indonesia's electronic export potential to ASEAN countries has reached a saturation point. However, for Vietnam there is still a slight gap to increase the value of Indonesia's electronics exports. Figure 3 presents a comparison between actual exports and statistical estimates to assess export potential in countries 10 countries outside ASEAN.

Figure 2. Export Comparison of Estimates and Actual Exports of 4 ASEAN Countries

In figure 4, the estimation results for markets outside ASEAN show that Indonesia still has the potential to increase electronics exports in major importing countries except Hong Kong. Export potential lies in America, Japan, Korea, Mexico, UAE, China, Australia, France and Poland. For Hong Kong, actual electronics exports have exceeded its estimated export output. Actually, the estimation results for exports to Singapore, Malaysia, Thailand and Hong Kong show that Indonesian electronics no longer have export potential. The Indonesian government can focus more on export opportunities to countries that still have enormous potential, although the Vietnamese market is statistically close to saturation point but the opportunity to utilize exports still exists. The export approach through free trade agreements, based on statistical estimates carried out does not provide significant results for electronic exports. Economic openness that provides significant positive statistical results shows that Indonesia can maximize and focus on increasing its exports to countries that based on estimates have export potential.

Assuming distance has a negative influence on exports, then based on the results of PPML estimation, a great opportunity to increase electronic exports can be shown to countries that have a distance not too far from Indonesia such as Japan, Korea, Australia, China, and the UAE. So that logistics costs do not burden the value of Indonesia's electronics exports too much.

Figure 3. Export Comparison of Estimates and Actual Exports of 10 Countries Outside ASEAN
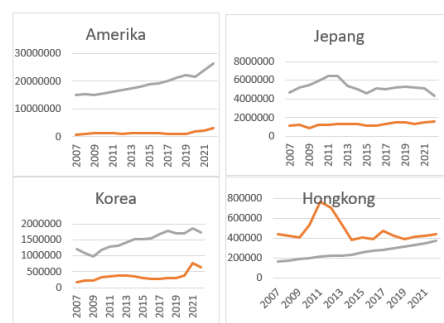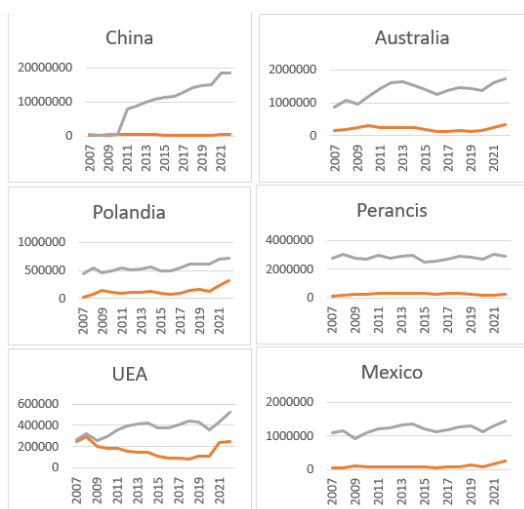
Source: Estimated Results
Remarks: Actual Exotor, Export Estimates

5. CONCLUSION

This study uses FE robust and PPML methods to overcome bias from zero-value trading data, resulting in heteroscedasticity. However, based on the regression results, the PPML method is more suitable to measure the potential of Indonesia's electronic exports, which are the mainstay priority sector to encourage Indonesia's economic growth. The panel data set was taken from 2007-2022. This paper shows that Indonesia's GDP and trading partners, as well as economic openness have a significant positive impact on Indonesia's electronics exports. The role of Indonesia's GDP has significant positive results in the PPML model, but less significant when measured by the 5% significance level in the FE model.

The results of potential estimates show that Indonesia still has the potential to increase electronics exports with 9 major importing countries of electronic products. The potential of electronic exports, which are considered to be a driver of Indonesia's economic growth, is very bright because Indonesia still has opportunities to increase income and reduce the trade deficit. Distance can be a factor that has a negative impact on exports, but countries such as Japan, Korea, China, Australia and the UAE that have not too far distance and still have export potential can be increased exports.

Factors affecting Indonesia's electronics industry including technological developments, market demand, and government policies related to investment and industry regulation should be the government's priority. In addition, the government must make improvements to overcome problems that exist in this industry such as dependence on imports of key components for the electronics industry, lack of skills and labor qualifications related to high technology that can be an obstacle, limited research and development, and infrastructure and logistics systems.

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