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Analysis Of The Competitiveness Of Indonesian Wood Pellets Pre Post The Implementation Of The Indonesia-Korea Comprehensive Economic Partnership Agreement (IK-CEPA) 2020-2025 And Recommendations For Increasing Competitiveness Through SWOT Analysis

Rachelia Az-Zahra Zetira

Program Studi Sarjana Terapan Bisnis Internasional Fakultas Ekonomi dan Bisnis Universitas Padjajaran Bandung

Email : razetira@gmail.com

Abstract

Changes in trade policy through the Indonesia-Korea Comprehensive Economic Partnership Agreement (IK-CEPA) provide an important context for evaluating the development of Indonesian wood pellet export competitiveness in the South Korean market. This study aims to analyze the comparative advantage, market position, and changes in the level and trend of Indonesian wood pellet competitiveness before and after the implementation of IK-CEPA, while also formulating recommendations for improving competitiveness. The study uses a mixed methods approach with monthly secondary data of wood pellets HS 440131 from Indonesia to South Korea during January 2020–December 2025. The study population and sample include all 72 available monthly observations during that period. Data are analyzed using Revealed Comparative Advantage (RCA), Export Product Dynamics (EPD), Interrupted Time Series Analysis (ITSA), and Strengths, Weaknesses, Opportunities, and Threats (SWOT). The results showed that RCA was always greater than one and the average increased from 5.1984 in the pre-IK-CEPA period to 14.5824 in the post-IK-CEPA period. EPD showed a Rising Star position in 2024 and 2025. ITSA showed a level change of 4.7289 ($p = 0.027$) and a trend change of 0.3802 ($p < 0.001$). In conclusion, the competitiveness pattern of Indonesian wood pellets increased after the IK-CEPA implementation period, with strategic priorities on production capacity, supply continuity, standardization, efficiency, and market intelligence.

Keywords : Export Competitiveness, Export Product Dynamics, Indonesia-Korea Comprehensive Economic Partnership Agreement, Revealed Comparative Advantage, Wood Pellets

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INTRODUCTION

International trade is an economic activity involving interactions between countries through the exchange of goods and services to meet each country's economic needs and support global economic activity (Purba et al., 2021). International trade is increasingly important because various aspects such as industry, employment, services, and social welfare are interconnected through trade activities between countries (Purba et al., 2021). Furthermore, international trade enables the mutually beneficial exchange of goods and services, encourages production specialization, and increases the efficiency of resource utilization in each country (Wibowo, 2024). One form of international trade activity is export, which is the activity of moving goods from one country to another in accordance with applicable regulations, which also serves as a source of foreign exchange for the national economy (Rohma et al., 2023). In the Indonesian context, non-oil and gas exports are a government focus because they contribute significantly to the economy and need to be continuously encouraged to improve foreign trade performance (Sadiah & Ginting, 2024). The value of Indonesia's non-oil and gas exports increased from US$219,463 million in 2021 to US$276,189 million in 2022, then decreased to US$243,606 million in 2023, before increasing again to US$250,652 million in 2024 and US$269,717 million in 2025 (Satudata Kemendag, 2025). The manufacturing industry sector is the largest contributor to Indonesia's non-oil and gas exports with a value of US$176,833.7 million in 2021 and increasing to US$227,069.0 million in 2025, and has a share of 84.19% of Indonesia's total non-oil and gas exports in 2025 (Satudata Kemendag, 2025). One of the product groups in this sector is wood and wood products and wood charcoal which are included in HS 44 and come from forestry resources that can be processed into value-added products for domestic and international markets (Purwanto, 2024).

One product resulting from the utilization of forestry resources is wood pellets, a biomass product resulting from wood processing, included in the wood and articles of wood group HS 44 with HS code 440131 (ITPC, 2021). Wood pellets are produced through a densification process or high-pressure pressing of wood material and can utilize wood processing waste such as twigs, sawdust, bark, and other wood materials (ITPC, 2021). The Indonesian wood pellet trade showed growth during the 2020–2025 period. The export value increased from US$32,457,714 in 2020 to US$36,322,441 in 2021, then US$62,626,107 in 2022 and US$74,676,074 in 2023, before remaining at the same figure in 2024 and increasing to US$175,337,726 in 2025. Overall, the value shows a significant increase during the study period, although there was stagnation in 2023–2024 before an increase in 2025. South Korea is one of the main destination countries with the value of Indonesian wood pellets exports increasing from US$28.88 million in 2020 to US$115.68 million in 2025 or 65.98% of Indonesia's total wood pellets exports

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(Purwanto, 2024). This potential is also supported by Indonesia's estimated biomass availability of around 146.7 million tons per year, equivalent to an energy potential of around 49,810 MW (Primadanty, 2023). On the other hand, South Korea's need for alternative and low-carbon energy, along with limited domestic production, creates opportunities for supplier countries, including Indonesia (Purwanto, 2024). South Korea also implements a Renewable Portfolio Standard (RPS) policy that encourages the use of new and renewable energy sources, with wood pellets included in the Renewable Energy Certificate (REC) mechanism (Government of the Republic of South Korea, 2012).

Although the Indonesian wood pellet trade is showing improvement, with South Korea becoming a primary destination market, the growth in export value does not directly reflect the competitiveness of Indonesian products in the South Korean market. The overall increase in wood pellet export value is accompanied by a pattern of stagnation in the 2023–2024 period before a sharp increase in 2025. This situation indicates the need for a more in-depth analysis to determine the level of comparative advantage and the development position of Indonesian wood pellet products in the South Korean market. This is increasingly relevant because the South Korean wood pellet market is policy-driven, so changes in policy and institutional conditions can influence market development for this product (ITPC, 2021). Furthermore, the quality of wood pellets is a crucial aspect because the product has technical parameters such as moisture content, ash content, durability, calorific value, and sulfur, chlorine, and nitrogen contents that determine its suitability for specific uses (ITPC, 2021). Wood pellet development is also related to raw material continuity, technological capabilities, funding, pricing, and regulations, which can pose challenges in biomass energy development (Primadanty, 2023).

The competitiveness issue is also related to changes in trade conditions following the implementation of the Indonesia–Korea Comprehensive Economic Partnership Agreement (IK-CEPA). IK-CEPA is a comprehensive economic partnership agreement between Indonesia and South Korea covering trade in goods, trade in services, investment, economic cooperation, transparency, and dispute resolution (Directorate General of International Trade Negotiations, n.d.). The agreement was signed on December 18, 2020, and began to be implemented on January 1, 2023, with regulations on reducing or eliminating import duties on goods in accordance with agreed tariff commitments (Directorate General of International Trade Negotiations, n.d.). In the context of wood pellets with HS code 440131, the MFN tariff is recorded at 2%, while the preferential tariff under IK-CEPA is 0%. IK-CEPA also provides opportunities for increased market access through lower tariffs and simplified trade administration processes (Directorate General of International Trade Negotiations, n.d.). However, the

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utilization of these preferences still requires compliance with the provisions of origin, shipping conditions, and documents proving the origin of goods in accordance with the provisions of the IK-CEPA (Directorate General of International Trade Negotiations, n.d.). Thus, the existence of tariff preferences is not sufficient to indicate changes in the competitiveness of Indonesian wood pellets, so an analysis of the conditions before and after the implementation of the IK-CEPA is necessary.

Another problem lies in the limitations of previous research in describing changes in the overall competitiveness of Indonesian wood pellets in the South Korean market. Based on previous research, most studies used the Revealed Comparative Advantage (RCA) and Export Product Dynamics (EPD) methods to analyze the export competitiveness of various Indonesian agricultural commodities in different destination countries. These studies generally examined different commodities, destination markets, and research periods than this study and focused more on measuring competitiveness using RCA and EPD. However, changes after the implementation of the IK-CEPA need to be viewed not only from the level of comparative advantage and market position, but also from changes in the level and trend of competitiveness. Therefore, RCA analysis was used to determine the level of comparative advantage, while EPD was used to determine the development position of Indonesian wood pellets in the South Korean market. Furthermore, Interrupted Time Series Analysis (ITSA) was used to identify changes in the level and trend of export performance after the implementation of the IK-CEPA, including trends before the intervention, changes in levels after the intervention, and changes in trends between the pre- and post-intervention periods. The RCA, EPD, and ITSA results were then used as the basis for a Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis to formulate recommendations for improving the competitiveness of Indonesian wood pellet exports in the South Korean market. This approach is necessary because optimizing the use of trade agreements is still necessary to ensure the resulting benefits can significantly improve trade performance (Anggraini et al., 2023).

Based on these problems, this study aims to analyze the comparative competitiveness level and competitive position of Indonesian wood pellets exports in the South Korean market in the pre- and post-implementation period of IK-CEPA in 2020–2025 through RCA and EPD analysis, analyze changes in competitiveness levels and trends using ITSA, and formulate recommendations for increasing competitiveness through SWOT analysis. This study is important to provide an overview of the development of Indonesian wood pellets competitiveness in the South Korean market before and after the implementation of IK-CEPA and to provide information for the government, business actors, and exporters regarding the development of Indonesian wood pellets export competitiveness (Ministry of Trade of the Republic of Indonesia,

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2025). The novelty of this study lies in the analysis of Indonesian wood pellets export competitiveness in the South Korean market in the 2020–2025 period which includes the pre-implementation period of IK-CEPA in 2020–2022 and the post-implementation period in 2023–2025 by combining the RCA, EPD, ITSA, and SWOT methods. This combination is used to identify the level of comparative advantage, market position, changes in competitiveness levels and trends, as well as internal and external factors as a basis for recommendations to increase the competitiveness of Indonesian wood pellets exports.

METHOD

This study uses a mixed methods approach, combining quantitative and qualitative approaches in one study. The mixed methods approach was used because the research requires not only numerical data processing but also descriptive analysis to gain a more comprehensive understanding of the competitiveness of Indonesian wood pellet exports in the South Korean market (Tumurang, 2024). The quantitative approach was used because the research data is in numerical form and analyzed through calculations and statistical methods to obtain an overview of the development of export competitiveness (Tumurang, 2024; Veronica et al., 2022). Meanwhile, the qualitative approach was used to identify and analyze internal and external factors related to the competitiveness of Indonesian wood pellet exports to South Korea (Tumurang, 2024).

The type of data used is secondary data in the form of time series data for the period January 2020 to December 2025. Secondary data was obtained through other parties or previously available sources so that researchers did not collect data directly from the research object (Sasono & Syukri, 2026). The research data was obtained from the United Nations Commodity Trade Statistics Database (UN Comtrade) for wood pellets commodities with a six-digit HS Code, namely HS 440131. The research was conducted in 2026 with the research object being Indonesian wood pellets commodities exported to South Korea. The research period is divided into the pre-implementation period of IK-CEPA from 2020 to 2022 and the post-implementation period of IK-CEPA from 2023 to 2025.

The research instrument is secondary trade data of Indonesian wood pellets with HS 440131 obtained from UN Comtrade in the form of export value and volume data as well as data needed to calculate competitiveness. The data is processed using four analytical methods, namely Revealed Comparative Advantage (RCA), Export Product Dynamics (EPD), Interrupted Time Series Analysis (ITSA), and Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis. RCA is used to determine the level of comparative advantage of Indonesian wood pellets in the South Korean market, while EPD is used to determine the competitive position based on the development of export market share. Furthermore, ITSA is used to identify changes in the level and trend of

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competitiveness after the implementation of IK-CEPA by using the RCA value as a competitiveness indicator.

The ITSA analysis used monthly RCA data from January 2020 to December 2025, consisting of 72 observations: 36 observations before the intervention and 36 observations after the intervention. January 2023 was designated as the intervention point because it marked the beginning of the implementation of the IK-CEPA. The analysis used a single-group ITSA design because the study only used one time series data set without a control group. Testing was conducted to identify changes in the level and trend of RCA after the implementation of the IK-CEPA. Furthermore, the results of the RCA, EPD, and ITSA analyses were compared between the pre- and post-implementation periods of the IK-CEPA. The results of this comparison were then used as the basis for a SWOT analysis to identify strengths, weaknesses, opportunities, and threats, and to develop recommendations for improving the competitiveness of Indonesian wood pellet exports in the South Korean market.

The research population is the trade data of Indonesian wood pellets commodities in the South Korean market during the research period of 2020 to 2025. The research sample uses Indonesian wood pellets export data with HS 440131 to South Korea available in UN Comtrade during the period of January 2020 to December 2025. The data used in the ITSA analysis amounted to 72 monthly observations, consisting of 36 observations of the pre-implementation period of IK-CEPA, namely January 2020 to December 2022, and 36 observations of the post-implementation period of IK-CEPA, namely January 2023 to December 2025. Thus, all monthly data during the research period were used in the analysis.

The research procedure begins with the collection of secondary data on Indonesian wood pellets exports to South Korea with HS 440131 from UN Comtrade for the period January 2020 to December 2025. The data is then arranged based on the periods before and after the implementation of IK-CEPA, with the pre-implementation period covering 2020 to 2022 and the post-implementation period covering 2023 to 2025. Furthermore, the data is processed to obtain the RCA value as an indicator of comparative advantage and EPD to determine the market position of Indonesian wood pellets in South Korea.

The next stage was an ITSA analysis using monthly RCA values, with January 2023 as the intervention point. This analysis was used to identify changes in competitiveness levels and trends before and after the implementation of the IK-CEPA. Because the data used was monthly time series data, a model diagnostic test was conducted to determine the data conditions before testing the ITSA model. Next, the RCA, EPD, and ITSA results were compared between the pre- and post-implementation periods of the IK-CEPA to obtain an overview of changes in competitiveness and the

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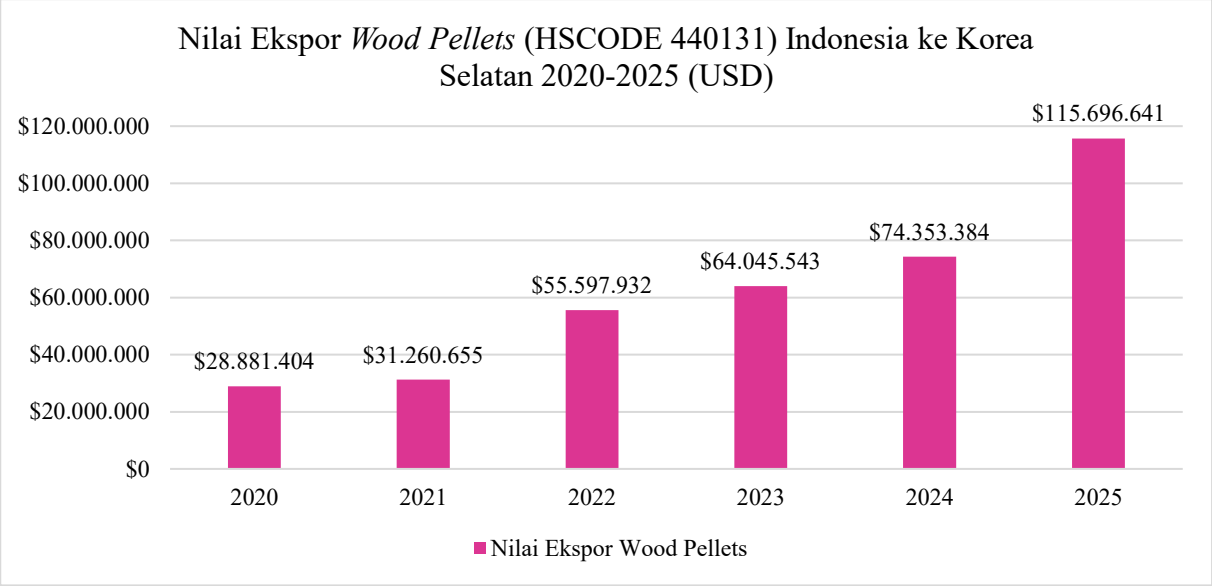
market position of Indonesian wood pellets. The final stage was a SWOT analysis by integrating the results of the quantitative analysis with internal and external factors related to the competitiveness of Indonesian wood pellets. The results of this factor matching were used to formulate alternative SO, WO, ST, and WT strategies as recommendations for increasing the competitiveness of Indonesian wood pellet exports in the South Korean market.

RESULTS AND DISCUSSION

Overview of Indonesian Wood Pellets Commodity (HSCODE 440131)

1. Indonesia-South Korea Wood Pellet Export Value 2020-2025

Chart 1. Value of Indonesian Wood Pellets Exports (HSCODE 440131) to South Korea 2020-2025



Source: UNComtrade

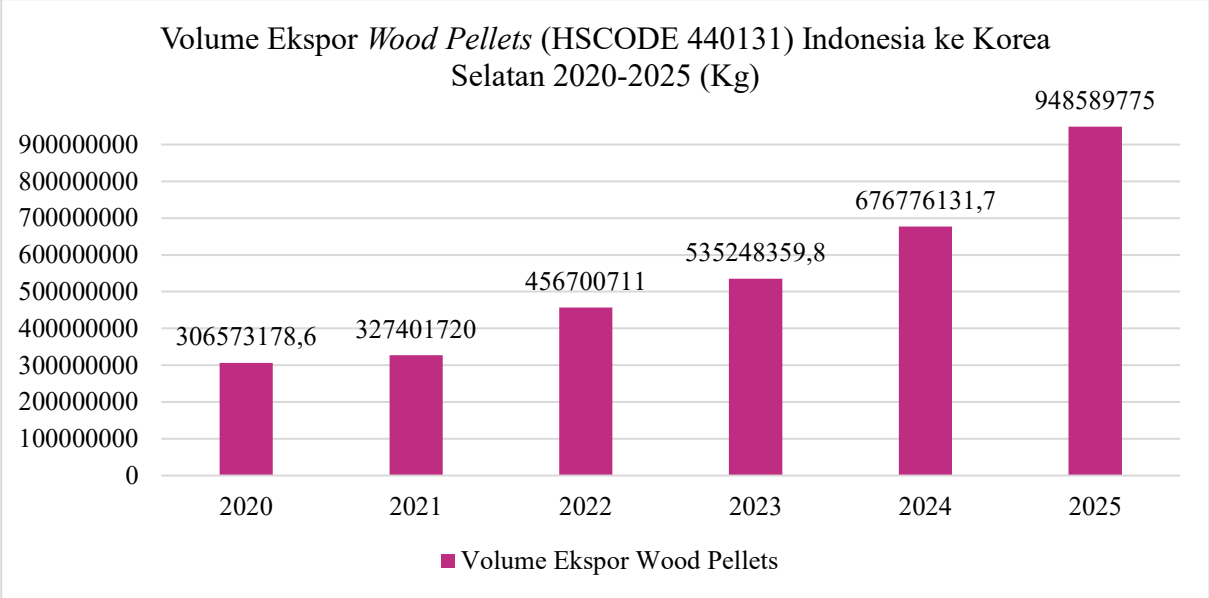
Indonesian wood pellet exports to South Korea increased during 2020–2025, from USD 28,881,404 in 2020 to USD 115,696,641 in 2025, an approximately fourfold increase. Following the implementation of the IK-CEPA in January 2023, export value continued to increase from USD 64,045,543 in 2023 to USD 74,353,384 in 2024 and USD 115,696,641 in 2025. The highest growth in the post-implementation period occurred in 2025, at approximately 55.60% compared to the previous year.

2. Wood Pellet Export Volume between Indonesia and South Korea 2020-2025

Chart 2. Export Volume of Wood Pellets (HSCODE 440131) from Indonesia to South Korea in 2020-2025

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Source: UNcomtrade

The volume of Indonesian wood pellet exports to South Korea increased from 306,573,178.6 kg in 2020 to 948,589,775 kg in 2025, an increase of approximately 209.42%. Following the implementation of the IK-CEPA, export volumes continued to rise, reaching 40.16% in 2025 compared to 2024. This development indicates an increase in the quantity of Indonesian wood pellets entering the South Korean market.

Revealed Comparative Advantage (RCA) Analysis of Indonesia's Wood Pellets (HSCODE 440131) in South Korea 2020-2025

Table 1. Revealed Comparative Advantage (RCA) Value of Indonesia's Wood Pellets (HSCODE 440131) in South Korea 2020-2025

RCA Wood Pellets (HSCODE 440131) Indonesia in South Korea						
Year	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
January	4.968422948	8.022523856	4.461251086	5.914372216	14.15306235	7.285695028
February	3.792955676	5.404225342	4.855357841	7.030012063	27.74376717	21.80383611
March	6.850619037	6.783528521	1.657136386	7,309632148	26,101351	17.34182828
April	7.451922689	3.390154612	2.647653735	8.876898133	8.878813646	15.11409673
May	3.43368809	4.58608006	2,206520003	5.589784948	11.64317942	11.73392624
June	9.242192134	2,164128209	5.778372865	10.40528161	26.21654688	14.98505463
July	8.780843754	3.703325678	4.868549123	5.864939979	16.63533228	24.69200206
August	5.481705656	4.321962911	4.885384358	9.631969887	15.46928436	13.47000213
September	7.248340323	7.454761161	4.564418072	10.54504812	13.68043176	25.06436054
October	5.736069735	5.136090731	6.174831966	11.24929782	33.34290938	16.96336108

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November	6.964780923	6.304761683	4.076585175	6.66509772	16.1165598	10.67364944
December	2,1210164	5.504001165	6.11687355	8.491934464	22.54342076	15.73906273
Average	**6.00604645**	**5.23129533**	**4.35774451**	**8,13118909**	**19.3770549**	**16.2389063**

Source: Data Processing Results

Based on the data processing results in Table 1, the RCA value of Indonesian wood pellets fluctuated during 2020–2025, but all monthly RCA values remained above one. The lowest value occurred in March 2022 at 1.6571, while the highest value was in October 2024 at 33.3429. This condition indicates that Indonesian wood pellets consistently have a comparative advantage in the South Korean market, although the level of superiority varies between periods.

In the pre-IK-CEPA period, the average RCA decreased from 6.0060 in 2020 to 5.2313 in 2021 and 4.3577 in 2022, with a periodic average of 5.1984. Despite the decline, all RCA values remained above one, thus maintaining comparative advantage. Conversely, after the implementation of IK-CEPA, the average RCA increased to 8.1312 in 2023 and reached 19.3771 in 2024, before declining to 16.2389 in 2025. Overall, the average RCA in the post-IK-CEPA period reached 14.5824, or approximately 2.81 times the pre-IK-CEPA period.

Thus, descriptively, there is a difference in the level of comparative advantage between the pre- and post-IK-CEPA periods. However, this difference cannot yet be interpreted as a causal impact of IK-CEPA implementation. Therefore, further analysis uses Interrupted Time Series Analysis (ITSA) to examine changes in RCA levels and trends following IK-CEPA implementation in January 2023.

Analysis of Export Product Dynamics (EPD) of Wood Pellets (HSCODE 440131) of Indonesia in South Korea 2020-2025

Table 2 Export Product Dynamics (EPD) Value of Wood Pellets (HSCODE 440131) of Indonesia in South Korea 2020-2025

EPD Wood Pellets (HSCODE 440131) Indonesia in South Korea			
Year	**X-axis**	**Y axis**	**Market Position**
2020	1.096662729	-0.036408762	Falling Star
2021	-0.812542959	0.136534927	Lost Opportunity
2022	0.983959186	0.587441308	Rising Star
2023	7.345387074	-0.190100167	Falling Star
2024	25.40578501	0.220024494	Rising Star
2025	7.055864148	0.919074591	Rising Star

Source: Data processing results

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Based on the EPD calculation results in Table 2, Indonesia's wood pellets market position in South Korea changed during 2020–2025. Indonesia was in the Falling Star position in 2020 and 2023, Lost Opportunity in 2021, and Rising Star in 2022, 2024, and 2025. This condition shows that comparative advantage based on RCA is not always followed by a positive market position based on EPD.

In the pre-IK-CEPA period, the market position changed from a Falling Star in 2020, with an X-axis of 1.0967 and a Y-axis of -0.0364, to a Lost Opportunity in 2021 with an X-axis of -0.8125 and a Y-axis of 0.1365, then a Rising Star in 2022 with an X-axis of 0.9840 and a Y-axis of 0.5874. Meanwhile, the post-IK-CEPA period showed a Falling Star–Rising Star–Rising Star pattern. In 2023, the X-axis value of 7.3454 and the Y-axis of -0.1901 placed Indonesia in a Falling Star position. This position changed to a Rising Star in 2024 with an X-axis of 25.4058 and a Y-axis of 0.2200, and remained in 2025 with an X-axis of 7.0559 and a Y-axis of 0.9191.

Overall, the EPD results indicate that Indonesia's wood pellets market position is becoming more positive towards the end of the study period, particularly in 2024 and 2025. Compared to the RCA, Indonesia's wood pellets have a comparative advantage throughout 2020–2025, but this advantage is not always accompanied by a Rising Star position. Thus, the EPD complements the RCA results by demonstrating the dynamics of Indonesia's ability to increase its export share amidst the development of the South Korean market.

Interrupted Time Series Analysis (ITSA) of Wood Pellets (HSCODE 440131) of Indonesia in South Korea 2020-2025

1. Model Diagnostic Test

A. Autocorrelation Test

Table 3. Autocorrelation test results

Lag	Chi-square	Prob>Chi-square
1	20,869	0.0000
2	18,073	0.0000
3	18,716	0.0000
4	6,951	0.0084
5	0.885	0.3472
6	1,512	0.2189
7	0.077	0.7809
8	0.015	0.9013
9	0.024	0.8775
10	0.234	0.6288

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11	0.354	0.5510
12	1,210	0.2713

Source: Data processing results

Based on the results of the autocorrelation test, the Prob > Chi-square values at lag 1 to lag 4 were 0.0000, 0.0000, 0.0000, and 0.0084, respectively, all of which were less than 0.05. Thus, H_0rejected and $H_1$is accepted, indicating significant autocorrelation in the ITSA model residuals up to the fourth lag. Meanwhile, at lags 5 to 12, the probability value is greater than 0.05, indicating no significant autocorrelation.

These findings indicate that residual autocorrelation is concentrated up to the fourth lag. Therefore, the Newey-West standard errors estimation with a maximum lag of 4 was used to obtain a statistical test appropriate to the residual characteristics. This autocorrelation test serves as a model diagnostic test and not to assess the impact of IK-CEPA on competitiveness, but rather as a basis for determining the estimation method before testing changes in RCA levels and trends.

B. Newey-West Estimates

Table 4. Results of Interrupted Time Series Analysis (ITSA) analysis

Variables	Coefficient	Newey-West Std. Error	*t*-statistics	*p*-value	95% Confidence Interval
Trend (T)	-0.0555	0.0305	-1.82	0.073	-0.1164 – 0.0054
Dummy	4,7289	2,0889	2.26	0.027	0.5604 – 8.8973
Timeafter	0.3802	0.0849	4.48	0,000	0.2108 – 0.5495
Constant	6,2249	0.7308	8.52	0,000	4.7665 – 7.6833
Number of observations = 72					
Maximum lag = 4					
F(3,68) = 26.97					
Prob>F = 0.0000					

Source: Data processing results

The estimation results yield a trend coefficient of −0.0555, a dummy of +4.7289, a timeafter of +0.3802, and a constant of 6.2249. The Newey-West standard errors are 0.0305, 2.0889, 0.0849, and 0.7308, respectively.

*Confidence interval*also provides important information regarding the certainty of the coefficient's direction. The trend coefficient has a 95% confidence interval of -0.1164 to 0.0054. This interval passes through zero, so the negative trend in the pre-intervention period cannot be declared significantly different from zero at the 95%

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confidence level. Conversely, the confidence interval for the level change is 0.5604 to 8.8973, and the confidence interval for the trend change is 0.2108 to 0.5495. Both intervals are entirely above zero. Thus, the estimation results provide statistical evidence that both the level change and the trend change after the January 2023 point are positive.

These results reveal an important initial pattern. Prior to January 2023, the RCA trend was trending downward, but the trend was not yet statistically strong. After entering January 2023, the model showed two changes simultaneously: a shift in the RCA level toward higher levels and a change in the trend slope toward more positive levels. The significance of these changes was further analyzed using the ITSA model test.

2. ITSA Model Test.

A. Model Significance Test

Table 5. Results of the model significance test

F-statistic	Prob>F	α
26.97	0.0000	0.05

Source: Data processing results

The Newey-West estimation results yield an F-statistic of 26.97 with a Prob>F of 0.0000. Since the probability value is less than α = 0.05, the overall ITSA model is statistically significant. This means that the time trend, intervention dummy, and timeafter variables together provide significant information in explaining variations in the RCA of Indonesian wood pellets during the period January 2020–December 2025.

The significance of the model indicates that the temporal structure built into the ITSA is relevant to explaining the development of RCA. In other words, the development of RCA over the six years of the study cannot simply be viewed as random monthly variations. Rather, there are temporal patterns and differences in patterns before and after the January 2023 point that can be identified through the model.

However, the F-statistic only indicates that the model is jointly significant. It does not explain whether the change is an increase or a decrease, whether the change is at a level or a trend, or which parameters are significant. Therefore, the significance of changes in competitiveness must be determined based on the coefficients of each ITSA parameter.

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B. Significance Test of ITSA Coefficient

Table 6. Results of the ITSA coefficient significance test

ITSA Parameters	Coefficient	*p-value*
Pre-intervention trends(β_1)	-0.0555	0.073
Level changes(β_2)	+4,7289	0.027
Change in trends(β_3)	+0.3802	<0.001
Post-intervention trends($\beta_1 + \beta_3$)	+0.3247	0.001

Source: Data processing results

Based on the Interrupted Time Series Analysis (ITSA) estimation results with Newey-West standard errors, the RCA trend before the intervention had a coefficient of -0.0555 with a p-value of 0.073. This indicates a downward trend in RCA of approximately 0.0555 points per month during January 2020–December 2022, but is not statistically significant at α = 0.05. Thus, the pre-intervention period shows a negative trend, but it is not strong enough to indicate a significant decline in RCA.

The level change after the implementation of IK-CEPA has a coefficient of +4.7289 with a p-value of 0.027. This result indicates a significant positive level shift, namely a shift in the RCA level to a higher level at the intervention point in January 2023 compared to the projected level based on the pre-intervention pattern. Furthermore, the trend change has a coefficient of +0.3802 with a p-value <0.001, indicating that the RCA slope after the intervention became more positive by 0.3802 points per month compared to the pre-intervention period.

The linear combination results show a post-intervention slope of +0.3247 with a p-value of 0.001. This means that after January 2023, the RCA experienced an increasing trend of approximately 0.3247 points per month, a statistically significant increase. Therefore, the ITSA results indicate a change in the RCA trend from an insignificant negative trend to a significant positive trend, accompanied by a shift to a higher level after the implementation of the IK-CEPA.

Overall, both research hypotheses were accepted. There was a positive and significant change in the level and trend of RCA after the IK-CEPA implementation point in January 2023. However, these results indicate a statistically significant change in RCA patterns after the intervention and do not necessarily prove that all of these changes are causally attributable to IK-CEPA.

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SWOT Analysis

Table 7. Internal and External Factors of Indonesian Wood Pellets (HSCODE 440131) in South Korea

Internal Factors	**Strength** 1. *Wood pellets*Indonesia maintains a consistent comparative advantage in the South Korean market. The RCA analysis shows that all monthly RCA values for Indonesian wood pellets during the 2020–2025 period were above one. This indicates that Indonesia had a comparative advantage in the pre-IK-CEPA period and has maintained this comparative advantage in the post-IK-CEPA period. 2. The comparative advantage of Indonesian wood pellets strengthened in the post-IK-CEPA period. The ITSA results showed an immediate level change of +4.7289 with a p-value of 0.027 and a trend change of +0.3802 with a p-value <0.001 after the IK-CEPA implementation point. The post-intervention slope estimation results also showed an RCA trend of +0.3247 per month with a p-value of 0.001, in contrast to the trend of -0.0555 per month in the pre-intervention period. These findings indicate that the pattern of comparative advantage of Indonesian wood pellets strengthened in the period after January 2023. 3. Indonesia's wood pellets market position developed into a Rising Star by the end of the study period. The EPD results show that in the post-IK-CEPA period, Indonesia's wood pellets position shifted from a Falling Star in 2023 to a Rising Star in 2024 and remained in the Rising Star position in 2025. This development indicates that the strengthening of comparative advantage at the end of the study period was also followed by a more positive development in the market position. 4. Indonesia has abundant natural resources that support the development of the wood pellet industry. Its tropical climate, fertile soil, and extensive industrial forest and plantation areas can support the development of the wood pellet industry.(Sari & Sitorus, 2021)The availability of wood waste from plantation and industrial activities also has the potential to be used as raw material for wood pellet production.(Sari & Sitorus, 2021)Thus, the availability of these resources constitutes internal capital that can support Indonesia's ability to increase wood pellet production and exports.
	Weakness 1. Indonesia's wood pellet production capacity is not yet commensurate with its resource potential. Despite its vast resources, Indonesia's wood

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	pellet production is still considered relatively small, at around 80,000 tons per year.(Sari & Sitorus, 2021)During the research period, Indonesia's production was still below Malaysia's, which was reported to have reached more than 180,000 tons per year.(Sari & Sitorus, 2021)This situation indicates that Indonesia's vast resource potential has not been fully converted into comparable industrial capacity. 2. Product standardization remains an internal aspect that needs strengthening. Standardized products are a crucial factor in the development of wood pellets in Indonesia.(Rimantho et al., 2023)These findings indicate that the development of Indonesia's wood pellet industry depends not only on the availability of resources but also on the ability to consistently produce products that meet the required standards. (Rimantho et al., 2023). 3. Raw material management remains a critical factor in the development of the wood pellet industry. Raw materials are a vital factor in the development of wood pellets as a renewable energy source in Indonesia.(Rimantho et al., 2023)These findings indicate that ownership of large resource potential needs to be accompanied by effective raw material management capabilities in order to support sustainable industrial development.(Rimantho et al., 2023). 4. The industry's ability to meet international market competition still needs to be strengthened. Supply certainty, product quality, financial reliability and strength, and competitive pricing are crucial factors that producing countries must consider to achieve a greater role in the wood pellets market.(Sari & Sitorus, 2021)Therefore, the development of the Indonesian wood pellet industry cannot simply rely on the availability of resources; it also needs to be accompanied by strengthening the industry's ability to consistently meet these competitive factors.
External Factors	**Opportunities** 1. South Korea's dependence on wood pellet imports creates a significant market opportunity for Indonesia. South Korea's wood pellet self-sufficiency rate is only around 15.9% in 2022, leaving the country heavily reliant on foreign sources.(Oh & Suh, 2024)More than 95% of the wood pellets used in electricity generation in South Korea are imported.(Oh & Suh, 2024)This dependency creates opportunities for supplier countries, including Indonesia, to maintain and increase their export penetration in the South Korean market.(Oh & Suh, 2024).

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	2. South Korea's Renewable Portfolio Standard (RPS) policy supports Indonesia's demand for wood pellet imports. The South Korean government has implemented the Renewable Portfolio Standard (RPS), which encourages power plants to use renewable energy sources alongside fossil fuels in their electricity production processes.(Oh & Suh, 2024). The increase in the mandated share in the RPS was found to increase the demand for imported South Korean wood pellets originating from Vietnam and Indonesia.(Oh & Suh, 2024)This energy policy presents an external opportunity for Indonesia to strengthen its wood pellets position in the South Korean market.(Oh & Suh, 2024). 3. The growing transition to renewable energy is increasing the potential demand for wood pellets. The growth of the global wood pellets market is linked to the increasing use of wood pellets as a renewable energy source in the transition to cleaner energy.(Oh & Suh, 2024)Wood pellets also have the potential to be used as a coal substitute to meet the need for more environmentally friendly energy in South Korea.(Purwanto, 2024). This development provides an opportunity for Indonesia to expand its role as a supplier of wood pellets for South Korea's energy needs. 4. The limited domestic supply of South Korean forestry products opens up opportunities for Indonesian products. South Korea still relies on imports to meet its forestry product needs due to limited domestic supply.(Purwanto, 2024).The potential for Indonesian wood products to enter the South Korean market is considered large if Indonesia is able to provide adequate supply, good quality, competitive prices, and the required legal documents.(Purwanto, 2024).This situation provides an opportunity for Indonesia to utilize the competitive base that has been formed to increase market penetration of wood pellets in South Korea.
	Threats 1. Indonesia faces strong competition from other wood pellet suppliers, particularly Vietnam. Vietnam is a major supplier of wood pellets to South Korea, and its exports to South Korea increased from approximately 30,300 tons to 2.1 million tons between 2012 and 2021.(Oh & Suh, 2024)During the same period, Indonesian wood pellet exports to South Korea reached approximately 314.8 thousand tons in 2021, making Vietnam's supply to the South Korean market much larger than Indonesia's.(Oh & Suh, 2024)This situation indicates that Indonesia

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	faces strong competitive pressure to maintain and expand its market share for wood pellets in South Korea. 2. South Korea's wood pellet import demand is influenced by changes in domestic energy policy. Policy-induced import allocation, i.e., changes in the RPS policy, can influence the allocation of South Korea's wood pellet import demand based on the supplier country.(Oh & Suh, 2024). Because some demand for wood pellets is related to renewable energy policies, changes in the direction and magnitude of RPS obligations could impact future developments in import demand.(Oh & Suh, 2024)This dependence poses an external threat because changes in South Korea's energy policy are beyond the control of Indonesian exporters. 3. Changes in relative prices between supplier countries can alter South Korea's import allocation. South Korea's demand for wood pellet imports is influenced not only by energy policies but also by pricing factors from various supplier countries.(Oh & Suh, 2024)The substitution relationship between wood pellets from different supplying countries suggests that changes in relative prices could lead to a shift in South Korean import sources. This situation poses a threat to Indonesia because increased price competitiveness from competing countries could impact South Korea's import allocation. 4. Product quality and legality requirements are external barriers that must be met to maintain access to the South Korean market. Indonesian wood products have the opportunity to enter the South Korean market if they can offer competitive quality and prices and guarantee compliance with the required legal documentation.(Purwanto, 2024).These requirements show that market access is not only determined by the size of demand, but also by the exporter's ability to meet the product requirements set by the destination market.(Purwanto, 2024).Thus, the inability to meet quality standards and legal requirements could pose a threat to the sustainability of Indonesian wood pellets' access to the South Korean market.

Based on the identification of internal and external factors, the strategy to increase the competitiveness of Indonesian wood pellets exports in the South Korean market is formulated through a combination of Strength–Opportunity (SO), Weakness–Opportunity (WO), Strength–Threat (ST), and Weakness–Threat (WT). The SO strategy is directed at utilizing internal strengths in capturing market opportunities, the WO strategy is directed

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at improving internal weaknesses by utilizing external opportunities, the ST strategy uses existing strengths to face external threats, while the WT strategy is directed at minimizing weaknesses while reducing risks originating from the external environment.

Table 8. SWOT Matrix of Indonesian Wood Pellets (HSCODE 440131) in South Korea

SO Strategy	WO Strategy
1. Increasing the penetration of Indonesian wood pellets exports in the South Korean market by utilizing the established comparative advantages and the increasingly strong competitiveness trend to meet South Korea's high import needs. 2. Maintaining and expanding Indonesia's wood pellets market position by leveraging its Rising Star position in 2024–2025 and the increasing demand for wood pellets supported by South Korea's renewable energy policy. 3. Optimizing the potential of natural resources and the availability of Indonesian biomass to increase supply capacity to meet South Korea's domestic supply constraints.	1. Increasing Indonesia's wood pellet production capacity to convert its vast resource potential into higher supply capacity to meet South Korea's dependence on imports. 2. Strengthening product standardization and raw material management to produce consistent wood pellets that meet evolving market needs in line with South Korea's renewable energy transition. 3. Improving the industry's ability to maintain quality, supply continuity, and price competitiveness to capitalize on the growing demand for wood pellets in South Korea.
ST Strategy	**WT Strategy**
1. Leveraging comparative advantages and strengthening the RCA trend to maintain Indonesia's position amidst competition with other wood pellet supplier countries, especially Vietnam. 2. Maintaining the Rising Star position by improving the consistency of export performance and monitoring changes in South Korea's energy prices and policies that may affect import allocations between supplier countries.	1. Increasing production efficiency and capacity to reduce the industrial capacity gap and improve Indonesia's ability to face the scale and price of competing countries' offers. 2. Strengthening product standardization, raw material management, quality control, and legal compliance to reduce the risk of barriers to South Korean market access. 3. Reducing industry vulnerability to changes in energy policy and market

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3. Utilizing Indonesia's resource potential to produce wood pellets that meet the quality and legality requirements of the South Korean market so that resource advantages can be converted into sustainable competitiveness.	competition dynamics by increasing production flexibility, cost efficiency, and the ability to respond to changing market needs.

Recommendations for Increasing the Competitiveness of Indonesian Wood Pellets Exports (HSCODE 440131)

1. Increase the capacity and continuity of wood pellet supply

Indonesia has significant natural resources and biomass potential, but production capacity still needs to be strengthened. South Korea's high dependence on imports, with over 95% of wood pellets for electricity generation coming from imports (Oh & Suh, 2024), indicates an opportunity to increase Indonesia's supply. Strategies can include optimizing wood and biomass residues, increasing production facility capacity, and strengthening coordination between raw material suppliers and producers to ensure supply continuity.

2. Strengthening the standardization, quality, and legality of wood pellet products

Increased production requires strengthening standardization, quality, raw material management, and product legality. Raw materials and product standards are crucial factors in the development of Indonesian wood pellets (Rimantho et al., 2023), while access to the South Korean market requires good quality, competitive pricing, and compliance with legal documentation (Purwanto, 2024). Therefore, quality control is essential, from raw material selection to the final product, to maintain competitiveness and market access.

3. Strengthen penetration and maintain market position in South Korea

The EPD results show that Indonesia's wood pellets position has shifted from a Falling Star in 2023 to a Rising Star in 2024 and 2025. In line with the strengthening RCA levels and trends after January 2023 based on the ITSA, export strategies need to be directed to maintain this development. Efforts can be made through strengthening relationships with importers and industrial users, B2B promotions, participation in forums and trade exhibitions, and developing medium- and long-term supply contracts.

4. Increase price competitiveness and industrial efficiency

Competition with supplier countries, including Vietnam, requires Indonesia to increase production efficiency and maintain competitive prices. Changes in relative prices between supplier countries can impact the allocation of South Korean wood pellet imports (Oh & Suh, 2024). Therefore, raw material, energy, production, and logistics efficiency need to be strengthened, along with monitoring prices in competing countries so exporters can respond more quickly to market changes.

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5. Develop market intelligence on changes in policy and demand

South Korea's energy policies, including the Renewable Portfolio Standard (RPS), may impact demand for wood pellet imports from Indonesia and Vietnam (Oh & Suh, 2024). Indonesia needs to develop market intelligence to monitor changes in the RPS, demand, import prices, procurement policies, competing countries, and quality and legality requirements. This information can serve as an early warning system for the government and industry players in adjusting their export strategies.

Overall, enhancing the competitiveness of Indonesian wood pellets is directed at five priorities: increasing capacity and supply continuity, strengthening standardization and quality, increasing market penetration, improving efficiency and price competitiveness, and developing market intelligence. These five strategies consolidate the SWOT results and should be directed at maintaining comparative advantage based on RCA and ITSA and the Rising Star position based on the EPD in 2024–2025.

CONCLUSION

This study found that Indonesian wood pellets (HS 440131) maintained a comparative advantage in the South Korean market throughout 2020–2025, as indicated by monthly RCA values consistently above one. The average RCA increased from 5.1984 during the pre-IK-CEPA period to 14.5824 after implementation. The EPD analysis also showed an improvement in market position, with wood pellets moving from Falling Star in 2023 to Rising Star in 2024 and 2025. The ITSA results further indicated a statistically significant positive level change of 4.7289 ($p = .027$) and a positive change in trend of 0.3802 ($p < .001$) after January 2023, while the post-intervention slope increased to 0.3247 ($p = .001$). These findings indicate that the competitiveness pattern of Indonesian wood pellets became stronger after the implementation period of IK-CEPA. However, the study is limited by its use of a single-group time series without a control group, a relatively short post-intervention period, and secondary trade data that cannot fully isolate the effects of IK-CEPA from other market, policy, price, and supply factors. Future research should consider longer observation periods, control-group or comparative-country designs, and additional variables that may explain changes in export competitiveness.

From a practical perspective, the findings indicate that improving competitiveness requires more than utilizing preferential market access under IK-CEPA. Policy and industry efforts should focus on increasing production capacity and supply continuity, strengthening product standardization and quality assurance, improving raw-material management and legal compliance, maintaining competitive production and logistics costs, and strengthening market intelligence regarding South Korean energy policies, prices, import demand, and competing suppliers. The SWOT analysis further suggests that Indonesia can utilize its comparative advantage, biomass potential, and improving

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market position while addressing production capacity, standardization, supply reliability, and competitive pressure from other exporting countries. These measures can support the sustainability of Indonesia's wood pellet exports and strengthen its ability to respond to changes in the South Korean market.

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