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Competitiveness of Indonesia's Paper in Japan's Market

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ABSTRACT

Paper and paperboard consistently contribute to Indonesia's foreign exchange reserves with high export values. Research on demand and other economic analyses related to paper and paperboard products in Indonesia is insufficient. This paper focuses on Indonesian paper and paperboard competitiveness in international markets, especially in strengthening the Indonesian economy and supporting sustainable growth. Paper with Harmonized System Code 480256 is the largest proportion of Indonesia's exported paper and is mostly exported to Japan. The import share of Indonesian paper in Japan's market was approximately 69% from 2010 to 2023. Based on the Quadratic Almost Ideal Demand System (QUAIDS) model, the import demand of Indonesian paper was found to be elastic. Moreover, China and Indonesia papers were substitutes, whereas Indonesia and the United States papers were complementary. Expenditure elasticity analysis further showed that Indonesia's paper was a normal good in Japan's market. These results highlight the policy relevance for policymakers in designing and improving Indonesia's forest products for international trade.

1. Introduction

Indonesia's forests are one of the largest natural tropical forests in the world, boasting a high diversity of flora and fauna, and they have a strategic geographical location. Many forest products and services, such as timber products and non-timber forest products, as well as the forest ecosystem, have been produced simultaneously. Regarding the strengthening of Indonesia's forestry sector, its economic value and demand have been largely studied. Parera et al. (2006) investigated the economic value of eucalyptus forests in Maluku. Simangunsong et al. (2020) determined a tangible economic value of non-timber forest products from the peat swamp forest in Kampar. Ginting et al. (2017) determined the economic value of medicinal plants from a national park in West Kalimantan. Simangunsong et al. (2021) studied Indonesian wooden furniture export demand, indicating that the Indonesian forest industry has been capable of moving beyond exporting raw materials to increase the overall economic contribution of the forestry sector. Moreover, Simangunsong et al. (2019) determined the economic value of wood pellets produced from waste generated by wood processing mills. The manufacture of wood pellets obviously increases the value of forest biomass and contributes to the stability of the energy supply, while reducing CO_2 emissions. Tanjung et al. (2024) studied cinnamon export demand, which showed that these non-timber forest products also support the forestry sector and contribute

to the country's foreign exchange reserves. From the studies mentioned above, it is evident that Indonesia's forestry sector is capable of competing in the international market and offers a diverse range of forest products for trade. Trade Map recorded Indonesia's forest products export value increased from USD 10.67 billion in 2010 to USD 14.61 billion in 2023.

Paper is a preeminent commodity in Indonesia's forest products exports. Its export value accounted for more than 30% of total forest products exports during the period 2010–2023. Hence, its industry plays a pivotal role in the Indonesian economy and possesses substantial potential to expand. Purba et al. (2024) determined that Indonesian paper has high export demand in the global and ASEAN markets, providing significant opportunities to continue increasing its export value. Ahmad et al. (2018) highlighted that Indonesian paper has a significant share in exported paper as a final product. These conditions enable Indonesian paper to continue growing rapidly in gross exports. During the COVID-19 pandemic, an imbalance between supply and demand emerged, with the widespread pandemic leading to a decline in pulp production and an increase in demand for paper products (Liu and Ning 2023). In contrast, Indonesian pulp and paper companies have demonstrated strong financial performance, as evidenced by their net profits and long-term liquidity, which has led the Indonesian government to designate the pulp and paper industry as a strategic sector (Syahran et al. 2016; Utomo et al. 2021).

The Trade Map recorded that in Indonesia, it was mostly dominated by Harmonized System (HS) Code 4802, which is paper, and has enormous potential for export to South Asian countries due to its high competitiveness and favorable market position (Sidiq et al. 2019). Among the 6-digit HS classifications, HS 480256 is the largest contributor to Indonesia's paper exports, accounting for 56% of the total value. This paper has a high RCA value and is considered a rising star, leading to optimistic market development (Paryadi and Choirulina 2023). The primary export destination for HS 480256 paper is Japan, with export value reaching USD 255.25 million in 2023. This export value accounted for 65% of Japan's total imports of HS 480256 paper products in 2023. The export value indicates that Indonesian HS 480256 paper has high sustainability potential for continual export to Japan. This value aligns with research by Sugiharti et al. (2020), which determined Japan as one of Indonesia's five main export markets, and overall, exports to Japan have grown by 35%.

Previous studies have extensively examined the demand and competitiveness of Indonesian forest products in international trade. For example, Simanjuntak and Lin (2017) studied the demand for Indonesian pulpwood exports, finding that income and price elasticities significantly affect key Asian markets. Malau et al. (2022a) analyzed the competitiveness of Indonesian plywood exports in each destination country and found that the importer population, economic distance, and the Revealed Comparative Advantage (RCA) index have a positive effect on Indonesian plywood exports. Similarly, Malau et al. (2022b) analyzed the competitiveness and determinants of Indonesia's paper trade flow, demonstrating that Indonesian paper is competitive and positioned as a "Rising Star" in several markets. Simangunsong and Wulandari (2016) explain that Indonesian paper has a very strong comparative advantage and is currently at the maturation stage. While Nasution (2023) determined the impact of non-tariff measures (NTMs) on Indonesia's pulp and paper exports, found that measures positively affect pulp exports but negatively affect paper exports. In addition, Wiranthi et al. (2019) demonstrated that trade prices and price competition impact the market share of each exporting country. Furthermore, Ramadani et al. (2021) stated that export demand for paper is elastic with respect to price, implying that an increase in export prices will result in a reduction in export value. Collectively, these findings

suggest that various economic factors, including income growth, pricing, trade barriers, and policy interventions, influence Indonesia's forest product competitiveness.

Studies on commodity demand using the Linear Approximation-Almost Ideal Demand System (LA/AIDS) and Quadratic Almost Ideal Demand System (QUAIDS) models emphasize the importance of a deeper understanding of demand and the impact of an economic crisis in the agricultural sector (Atasoy 2019; Suryanty and Matsuda 2023; Türkmen-Ceylan 2019; Türkmen-Ceylan 2025). Although widely used in the food industry, the AIDS model has also been applied in other areas, particularly the forest products sector (Atasoy and Zhang 2025; Cheng et al. 2015; Natalia et al. 2024). However, studies on demand analysis for paper and paperboard, particularly from developing countries such as Indonesia, remain insufficient. This study, therefore, addresses the gap by applying advanced models for demand analysis. Considering that Japan has been Indonesia's main export destination, the Indonesian paper industry has increased its production capacity, as it faces competition from other countries in the paper exports market to the Japanese market. The objective of this study is to analyze the competitiveness of Indonesian paper in the Japanese market using the LA/AIDS and QUAIDS.

2. Materials and Methods

2.1. Theoretical Foundations

The Almost Ideal Demand System (AIDS) model was first introduced by Canadian economists Angus Deaton and John Muellbauer in 1980. The strength of this model is its ability to explain the nature of complementarity and substitution between goods and services. The model enables an understanding of how changes in the price of a commodity can impact both the demand for that commodity and the demand for other commodities. The model has been widely used in various studies to understand consumer behavior, estimate price elasticity, and plan economic policies. The earliest approach to establishing the AIDS model is attributed to the research of Deaton and Muellbauer (1980), who employed a preference model known as the Price-Independent Generalized Logarithmic (PIGLOG) model. These preferences allow appropriate aggregation of consumers and can represent market demand as if it were the result of consumers' rationally represented decisions.

This AIDS model is derived from a utility function using the second-order approximation of a utility function. This AIDS model can be written as Equation 1 as follows.

$$w_i = \alpha_i + \sum_j y_{ij} log p_j + \beta_i \log\left(\frac{x}{p}\right) + \varepsilon_n \quad (1)$$

where i and j are types of goods, w_i is the expenditure share for good i, p_j is the price of good j, x is the total expenditure on all the goods in the system, p is the price index, γ_{ij}, β_i, and α_i are the estimated parameters, and ε_n is the standard error.

For the model to fulfill the theory of demand, it is necessary to impose restrictions with three groups of constraints that must be met for the Linear Approximation-Almost Ideal Demand System (LA/AIDS) demand function to be homogeneous with degree 0 in price and total expenditure according to Slutsky symmetry, which are adding up (Equation 2), homogeneity (Equation 3), and symmetry (Equation 4).

$$\sum_{i=1}^{n} \alpha_i = 1, \sum_{i=1}^{n} y_{ij} = 0, \sum_{i=1}^{n} \beta_i = 0 \quad (2)$$

$$\sum_{i=1}^{n} y_{ij} = 0 \quad (3)$$

$$y_{ij} = y_{ji} \quad (4)$$

In the AIDS model, two approaches can be used to estimate the AIDS demand system model: the LA/AIDS model and the non-linear approach. The LA/AIDS model is derived by calculating the value of *P* (Equation 5). For the linear approach of AIDS (LA/AIDS), p^* is formulated as in (Equation 6).

$$log\ P = \alpha_0 + \sum_k \alpha_k log p_k + \frac{1}{2}\sum_k \sum_j \gamma^*_{kj} \log p_k log p_j \quad (5)$$

$$log\ p^* = \sum_k w_i log p_i \quad (6)$$

where *P* is the price index and p^* is the geometric stone price index.

Furthermore, this study estimates five expenditure share functions, representing the demand functions of Indonesia, China, the United States, Austria, and the rest of the world (ROW) papers in the Japanese market. Equations 7–11 can be formulated as follows:

$$w_1 = \alpha_1 + \gamma_{11} \log p_i + \gamma_{12} log p_c + \gamma_{13} log p_u + \gamma_{14} log p_a + \gamma_{15} log p_r + \beta_1 \log\left(\frac{x}{p^*}\right) + \varepsilon_1 \quad (7)$$

$$w_2 = \alpha_2 + \gamma_{21} \log p_i + \gamma_{22} log p_c + \gamma_{23} log p_u + \gamma_{24} log p_a + \gamma_{25} log p_r + \beta_2 \log\left(\frac{x}{p^*}\right) + \varepsilon_2 \quad (8)$$

$$w_3 = \alpha_3 + \gamma_{31} \log p_i + \gamma_{32} log p_c + \gamma_{33} log p_u + \gamma_{34} log p_a + \gamma_{35} log p_r + \beta_3 \log\left(\frac{x}{p^*}\right) + \varepsilon_3 \quad (9)$$

$$w_4 = \alpha_4 + \gamma_{41} \log p_i + \gamma_{42} log p_c + \gamma_{43} log p_u + \gamma_{44} log p_a + \gamma_{45} log p_r + \beta_4 \log\left(\frac{x}{p^*}\right) + \varepsilon_4 \quad (10)$$

$$w_5 = \alpha_5 + \gamma_{51} \log p_i + \gamma_{52} log p_c + \gamma_{53} log p_u + \gamma_{54} log p_a + \gamma_{55} log p_r + \beta_5 \log\left(\frac{x}{p^*}\right) + \varepsilon_5 \quad (11)$$

where α_i, β_i, γ_{ij} are the parameters, w_1 is the expenditure share for Indonesian paper in Japan market, w_2 is the expenditure share for China's paper in Japan market, w_3 is the expenditure share for United States paper in Japan market, w_4 is the Austrian paper in Japan market, w_5 is the expenditure share for rest of the world paper in Japan market, p_i is the export price of Indonesian paper in Japan market (USD/ton), p_c is the export price of Chinese paper in Japan market (USD/ton), p_u is the export price of United States paper in Japan market (USD/ton), α,γ,β is the estimated coefficient, x is the total expenditure for all paper imports by Japan (USD), p^* is the geometry stone price index, and ε_n is the standar error.

The obtained parameters are then used to estimate own-price elasticity, cross-price elasticity, and expenditure elasticity using the formulas expressed in Equations 12–14.

Uncompensated elasticity:

$$e_{ij} = -\delta_{ij} + \frac{\hat{\gamma}_{ij}}{\overline{w}_i} - \hat{\beta}_i \frac{\overline{w}_j}{\overline{w}_i} \quad (12)$$

Compensated elasticity:

$$e^*_{ij} = -\delta_{ij} + \frac{\hat{\gamma}_{ij}}{\overline{w}_i} + \overline{w}_j \quad (13)$$

Expenditure elasticity:

$$\eta_i = 1 + \frac{\hat{\beta}_{ij}}{\bar{w}_i} \quad (14)$$

Conventional empirical demand models often struggle to represent consumer behavior across different income levels accurately. Banks et al. (1997) addressed this condition by developing a demand model called the Quadratic Almost Ideal Demand System (QUAIDS). The QUAIDS model is a modified form of the AIDS model, with the assumption of linearity in the expenditure function eliminated. Since empirical research based on the Engel curve is not always linear (Mittal 2010). Bank et al. (1997) incorporated a quadratic expenditure factor into the model, which led to the development of QUAIDS. The QUAIDS model can maintain consistency with the Engel curve and the influence of relative prices in utility maximization. In addition, QUAIDS also allows for more parameters to be predicted compared to previous models, such as LA/AIDS (Kharisma et al. 2020). The QUAIDS model is also in line with the overall pattern of purchasing behavior and in accordance with consumer theory. Using the post-estimation procedure, expenditure elasticity, compensated price elasticity, and uncompensated elasticity can then be calculated (Ojetunde 2023).

The QUAIDS model of Banks et al. (1997) is based on the indirect utility function as shown in Equation 15.

$$\ln v = \left\{ \left[\frac{\ln m - \ln a(p)}{b(p)} \right]^{-1} + \lambda(p) \right\}^{-1} \quad (15)$$

where $ln\, a(p)$ is the transcendental logarithm function (Equation 16) and *b(p)* is the Cobb-Douglass price aggregator (Equation 17).

$$\ln a(p) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln p_j \quad (16)$$

$$b(p) = \prod_{i=1}^{n} p_i^{\beta_i} \quad (17)$$

$$\lambda(p) = \sum_{i=1}^{n} \lambda_i \ln p_i \quad (18)$$

where α_i, p_i, γ_{ij}, and λ_i are the estimated parameters. The QUAIDS command imposes adding up, homogeneity, and Slutsky symmetry restrictions automatically as in Equation 19.

$$\sum_{i=1}^{n} \alpha_i = 1 \; ; \; \sum_{i=1}^{n} \beta_i = 0 \; ; \; \sum_{j=1}^{n} \gamma_{ji} = 0 \; ; \; \sum_{i=1}^{n} \lambda_i = 0 \; ; \; \gamma_{ij} = \gamma_{ji} \quad (19)$$

When λ(p) is independent of price, the indirect utility function is reduced to PIGLOG, which includes the AIDS and translog forms, and by applying Roy's identity in addition to the indirect function, the budget shares for good i are generally obtained from Equation 20.

$$w_i = \frac{\partial \ln a(p)}{\partial \ln p_i} + \frac{\partial \ln b(p)}{\partial \ln p_i} (\ln x) + \frac{\partial \lambda_i}{\partial \ln p_i} \frac{1}{b(p)} (\ln x)^2 \quad (20)$$

Equations 16–18 are QUAIDS functions, then Equation 15 is substituted into Equation 20 to produce the budget shares equation as in Equation 21 for QUAIDS.

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left[\frac{x}{a(p)}\right] + \left[\frac{\lambda_i}{b(p)}\right]\left\{\ln\left[\frac{x}{a(p)}\right]\right\}^2 \quad (21)$$

Then, differentiate Equation 21 with respect to ln x (Equation 22) and $ln\ p_j$ (Equation 23). These results are then used to calculate price elasticity values based on the QUAIDS model.

$$\mu_i = \frac{\partial w_i}{\partial \ln x} = \beta_i + \frac{2\lambda_i}{b(p)}\left\{\ln\left[\frac{x}{a(p)}\right]\right\} \quad (22)$$

$$\mu_i = \frac{\partial w_i}{\partial \ln p_j} = \gamma_{ij} - \mu_i\left(\alpha_i + \sum_j \gamma_{ij} \ln p_j\right) - \frac{\lambda_i \beta_i}{b(p)}\left\{\ln\left[\frac{x}{a(p)}\right]\right\}^2 \quad (23)$$

The estimated parameter results from the QUAIDS model are then used to calculate the expenditure elasticity (Equation 24) with positive β and negative λi, uncompensated elasticity (Equation 25), where δij is $kronecker\ delt$a, and compensated (Equation 26) calculated using the Slutsky equation. The symmetry and negativity conditions can be determined by looking at the matrix element wi $[e_{ij}^c]$, which should normally be symmetric and negative semi-definite.

$$e_i = \frac{\mu_i}{w_i} + 1 \quad (24)$$

$$e_{ij}^u = \frac{\mu_{ij}}{w_i} - \delta_{ij} \quad (25)$$

$$e_{ij}^c = e_{ij}^u + e_i w_j \quad (26)$$

In other words, using the QUAIDS model, five demand functions estimated in this study representing the demand functions of Indonesia, China, the United States, Austria and the rest of the world (ROW) papers in the Japanese market are shown in Equations 27–31.

$$w_1 = \alpha_1 + \gamma_{11} \log p_i + \gamma_{12} logp_c + \gamma_{13} logp_u + \gamma_{14} logp_a + \gamma_{15} logp_r + \beta_1 \log\left(\frac{x}{p^*}\right) + \left[\frac{\lambda_1}{b(p)}\right]\left\{\ln\left[\frac{x}{a(p)}\right]\right\}^2 + \varepsilon_1 \quad (27)$$

$$w_2 = \alpha_2 + \gamma_{21} \log p_i + \gamma_{22} logp_c + \gamma_{23} logp_u + \gamma_{24} logp_a + \gamma_{25} logp_r + \beta_2 \log\left(\frac{x}{p^*}\right) + \left[\frac{\lambda_2}{b(p)}\right]\left\{\ln\left[\frac{x}{a(p)}\right]\right\}^2 + \varepsilon_2 \quad (28)$$

$$w_3 = \alpha_3 + \gamma_{31} \log p_i + \gamma_{32} logp_c + \gamma_{33} logp_u + \gamma_{34} logp_a + \gamma_{35} logp_r + \beta_3 \log\left(\frac{x}{p^*}\right) + \left[\frac{\lambda_3}{b(p)}\right]\left\{\ln\left[\frac{x}{a(p)}\right]\right\}^2 + \varepsilon_3 \quad (29)$$

$$w_4 = \alpha_4 + \gamma_{41} \log p_i + \gamma_{42} logp_c + \gamma_{43} logp_u + \gamma_{44} logp_a + \gamma_{45} logp_r + \beta_4 \log\left(\frac{x}{p^*}\right) + \left[\frac{\lambda_4}{b(p)}\right]\left\{\ln\left[\frac{x}{a(p)}\right]\right\}^2 + \varepsilon_4 \quad (30)$$

$$w_5 = \alpha_5 + \gamma_{51} \log p_i + \gamma_{52} logp_c + \gamma_{53} logp_u + \gamma_{54} logp_a + \gamma_{55} logp_r + \beta_5 \log\left(\frac{x}{p^*}\right) + \left[\frac{\lambda_5}{b(p)}\right]\left\{\ln\left[\frac{x}{a(p)}\right]\right\}^2 + \varepsilon_5 \quad (31)$$

where the additional parameters for QUAIDS are λ_i.

Based on the AIDS equation system described above, the seemingly unrelated regression (SUR) method is used to analyze the AIDS equation. In contrast, the non-linear seemingly unrelated regression (NLSUR) method is used to analyze the QUAIDS equation.

2.2. The Analysis and Processing of Data

This study uses data on the monthly export value and export quantity of paper (HS 480256) from exporting countries to Japan from 2010 to 2023. There are several limitations to the data in this study, including the fact that the data used in the analysis relies on data obtained from Trade Map, which does not fully reflect the dynamics in each country. In addition, the data used is aggregated at the international level, so these results cannot be generalized directly to all types of paper products. Nevertheless, the data used still makes an important contribution to assessing the competitiveness of Indonesian paper in the international market. The price is proxied by dividing the export value by the export quantity. This price is the nominal export price (in USD/ton). Then, the price (USD/ton) is multiplied by the exchange rate (LCU/USD) and then divided by the GDP deflator of each exporter (base year: 2010) to obtain the price in local currency units (LCU/ton). This captures the economic dynamics of the exporting country. The real price (USD/ton in 2010) is obtained by dividing the price in local currency units (LCU/ton) by the 2010 exchange rate (LCU/USD). Data on monthly export value and quantity are obtained from Trade Map, while data on GDP deflator and exchange rate are obtained from the World Bank and Bank Indonesia.

The analytical models used to analyze the competitiveness of Japanese imported paper products were the LA/AIDS and QUAIDS models. These two models are used to determine own-price elasticity, cross-price elasticity, and expenditure elasticity of demand for HS 480256 paper in the Japanese market (Banks et al. 1997; Deaton and Muellbauer 1980; Ojetunde 2023). The data was processed using MS Office Excel 2021, while the demand function was estimated using the Seemingly Unrelated Regression (SUR) and Non-Linear Seemingly Unrelated Regression (NLSUR) techniques with STATA 18.

3. Results and Discussion

3.1. Indonesian Paper Demand in Japan Market

In international trade, paper and paperboard are classified under the Harmonized System (HS) Code 48. Trade Map listed around 200 countries as exporters of HS 48 paper and paperboard in 2023. The two largest exporters of paper and paperboard in the world were China (15.45%) and Germany (11.79%), while Indonesia holds the 13th position with a share of 2.53%. Over time, the types and quantities of paper requested have continued to increase. Currently, 23 types of paper are produced and exported worldwide, based on the established 4-digit HS Code. Trade Map recorded that paper with HS Code 4819 was the type of paper with the largest export value in the world in 2023 (16.95%), followed by HS 4810 (13.26%), HS 4811 (11.45%), and HS 4802 (9.76%). Regarding Indonesia, it was primarily dominated by HS 4802, which has enormous potential for export to South Asian countries due to its high competitiveness and favorable market position (Sidiq et al. 2019). Further classified under HS Code 4802 is HS 480256, which is the largest contributor to Indonesia's paper exports, accounting for 56% of the total value. The primary export destination for HS 480256 paper is Japan, with export value reaching USD 255.25 million

in 2023. This export value accounted for 65% of Japan's total imports of HS 480256 paper products in 2023.

The estimated results of the HS 480256 paper import demand in the Japanese market using the LA/AIDS and QUAIDS models with three restrictions: adding-up, homogeneity, and Slutsky symmetry, are shown in **Table 1**. Over the period 2010–2023, the average expenditure share (Wi) shows that imports of paper 480256 in the Japanese market were dominated by Indonesia (69.0%), followed by China (29.2%), the United States (0.3%), Austria (0.2%), and the rest of the world (ROW 1.3%). **Table 1** also shows the R-squared values, which indicate whether the regression model using paper prices and expenditure as independent variables effectively explains the variation in expenditure share in the Japanese market (Gujarati and Porter 2009; Khan et al. 2022). The values range from 17.7% to 54.8%, a relatively poor fit of the regression line. Nevertheless, a better overall measure might be a statistic that describes the predictive power of the model in the face of new data. The variance of expenditure share of the two main exporters, Indonesia and China, is slightly better explained by QUAIDS (47% and 52%) than by LA/AIDS (46% and 51%).

Table 1. Estimated coefficients by LA/AIDS and QUAIDS

Variable	*Countries*				
	Indonesia	**China**	**USA**	**Austria**	**ROW**
	Estimated coefficients of the LA/AIDS model				
Wi	0.690	0.292	0.003	0.002	0.013
α	0.903***	0.010	0.007	0.012***	0.069**
β	0.069	-0.094	0.001	0.005**	0.019**
R-sq	0.461	0.512	0.203	0.177	0.548
	Estimated coefficients of the QUAIDS model				
Wi	0.690	0.292	0.003	0.002	0.013
α	3.226***	-2.197***	-0.010	-0.028	0.009
β	2.722***	-2.613***	-0.018	-0.042	-0.048
λ	0.755***	-0.717***	-0.006	-0.013	-0.019
R-sq	0.471	0.521	0.202	0.177	0.546

Notes: Significant at confidence level of: *** 1%, **5% and *10%.

As stated by Bank et al. (1997), the LA/AIDS model is often incapable of accurately representing consumer behavior across various expenditure levels due to its linear limitations. A non-linear parameter (coefficient λ) is then integrated into the QUAIDS model to capture changes in elasticity as expenditure varies. As shown in **Table 1**, the estimated value of the λ coefficient for Indonesia was positive and significant (+0.755). This indicated a quadratic increase in Japan's expenditure share for Indonesian HS 480256 paper as Japan's expenditure increases (**Fig. 1**). Conversely, the negative and significant λ value for China (-0.717) indicated that Japan's expenditure share for China's paper experienced a quadratic decrease as Japan's expenditure increases, leading Japan to shift toward alternative substitute goods. The λ coefficient values for the United States and Austria were negative but not significant (-0.006 and -0.013), indicating no significant effect on Japan's expenditure shares for their papers as Japan's expenditure changes. Estimation results using the QUAIDS model indicate that QUAIDS is more suitable than LA/AIDS for capturing this non-linear relationship. The QUAIDS model introduces complexity for higher-order approximations, making it effective in addressing issues related to consumer responses that change significantly at different income levels, varying elasticities across income

groups, and in better explaining variation in expenditure shares (Türkmen-Ceylan et al. 2025; Vigani and Dudu 2021).

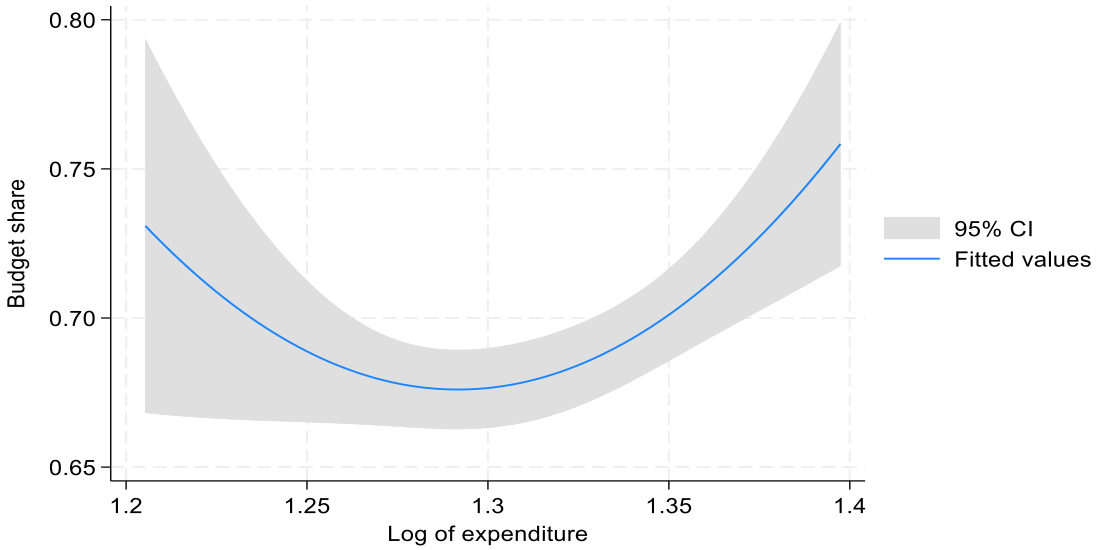

Fig. 1. Non-linear relationship between budget share and log-expenditure of Indonesian paper.

Furthermore, the QUAIDS model is better than the LA/AIDS model in terms of the significance of the parameters α and β. All parameters α and β for Indonesia and China estimated by the QUAID model are significant at the 1% significance level. The coefficient α describes Japan's average expenditure share for HS 480256 paper when prices and expenditures are constant; the coefficient α itself is not affected by changes in prices or expenditures. The β coefficient explains the effect of expenditure on the expenditure share for HS 480256 paper in the Japanese market. The β coefficient is used to measure expenditure elasticity, assuming that the larger the β coefficient, the more significant the impact of Japanese expenditure on changes in the expenditure share for Indonesia, China, the United States, and Austria papers in the Japanese market.

The results of the QUAIDS model estimation show that all uncompensated own-price elasticity values (bolded) were negative and significant, as presented in **Table 2**. These results align with the demand theory, which posits a negative relationship between price and demand (Nicholson and Snyder 2012; Yan et al. 2018). **Table 2** showed that the own-price elasticity for Indonesia was negative (-3.99) and significant. This indicates that Japanese imports of Indonesian paper were elastic; when the price of Indonesian paper increases by 1 percent, the expenditure share for Indonesian paper in the Japanese market decreases by 3.99%. Similar results were observed for papers from China, the United States, and Austria. An increase in their paper prices by 1% may decrease Japan's expenditure share for their paper by 9.58%, 2.63%, and 7.03%, respectively. This condition indicates that the demand for Japanese paper imports was elastic.

As shown in **Table 2**, the cross-price elasticity value for Indonesia-China was positive (+7.99) and significant, indicating that the papers of Indonesia and China were substitutes for each other. This implies that when the price of Indonesian paper increases by 1%, Japan's expenditure share for Chinese paper increases by 7.99%. Meanwhile, the cross-price elasticity value for Indonesia-United States was negative (-6.08) and significant, indicating that Indonesian and the United States papers were complementary. This implies that when the price of Indonesian paper increases by 1%, Japan's expenditure share for the United States paper decreases by 6.08%.

Table 2. Uncompensated own price, compensated cross-price and expenditure elasticities

Variable	Countries				
	Indonesia	**China**	**USA**	**Austria**	**ROW**
Uncompensated Own price					
Price of INA	**-3.990*****	7.545	-6.908	5.042	-15.502
Price of CHN	2.991	**-9.584*****	8.400	7.234	48.087
Price of USA	-0.034	0.107	**-2.627*****	0.563	-0.184
Price of AUT	0.016	0.058	0.303	**-7.033*****	-2.341
Price ROW	-0.142	1.243	-0.365	-9.119	**-33.627*****
Compensated Cross-price					
Price of INA	-3.197	7.996***	-6.077**	7.332	-13.094
Price of CHN	3.337***	-9.419	8.743***	8.196***	49.197***
Price of USA	-0.030**	0.109***	-2.623	0.575	-0.173
Price of AUT	0.018	0.060***	0.306	-7.026	-2.334***
Price ROW	-0.128	1.254	-0.348	-9.077	-33.595
Expenditure	1.151*** (0.9–1.4)	0.559 (-0.1–1.2)	1.217 (-0.3–2.7)	3.173*** (1.0–5.4)	2.389 (-0.1–49)

Notes: Significant at confidence level of: *** 1%, **5%, and *10%.

Furthermore, cross-price elasticity values for China-Indonesia, China-United States, and China-Austria are all positive (+3.34, +8.74, +8.19) and significant. This suggests that the papers of Indonesia, the United States, and Austria serve as substitutes for China's paper. With regard to Indonesian paper, when the price of China's paper increases by 1%, Japan's expenditure share for Indonesian paper increases by 3.34%. The substitute relationship between Indonesia and China reflects price sensitivity in the Japanese market through direct price competition. Even slight price changes can affect Japanese demand for Indonesian paper because both Indonesia and China compete with each other in the Japanese market. In addition, a complementary relationship implies a negative impact on Japanese demand for United States paper when there is a disruption in paper prices in Indonesia, vice versa. This complementary relationship allows Indonesia to establish partnerships and expand its supply chain to Japan. Therefore, Indonesia must ensure a stable supply of paper at competitive prices so that Japan continues to choose Indonesia as its source of HS 480256 paper imports.

Based on the cross-price elasticities explained above, Japanese consumers were highly responsive to fluctuations in the price of HS 480256 paper. This dependency is exemplified by Japan's reliance on paper products for daily activities, including the use of paper for wrapping waribashi (disposable chopsticks), paper umbrellas, tissues, toilet paper, and as a writing, drawing, or printing instrument (ITPC 2013). Cross-price elasticity in this study reflects the level of competition between Indonesian HS 480256 paper and competing HS 480256 paper from other countries in the Japanese market. Aung et al. (2022) further explain that compensated cross-price elasticity is used to measure the change in demand for a product resulting from a change in the price of another product. In addition, Hicksian demand theory posits that the pure substitution effect is a response to changes in the price of a good. According to this theory, price changes sufficiently compensate consumers to maintain the same level of utility they experienced before the price change (Paradisi 2016).

The expenditure elasticity value for Indonesian paper was +1.15, which is significant, as shown in **Table 2.** This indicates that a 1% increase in HS 480256 paper import expenditures in the Japanese market would result in a 1.15% increase in Japan's expenditure share for Indonesian paper. The same applies to Austria: a 1% increase in HS 480256 paper import expenditures in Japan would result in a 3.17% increase in Japan's expenditure share for Austria's paper. These

results demonstrate that Japan tends to be sensitive to expenditure elasticity, a key economic factor that can influence a country's financial decisions and economic policies. This finding aligns with research by Lopez et al. (2022), which states that if the expenditure value is greater than or close to one, consumers tend to be highly dependent on a country's exports. Furthermore, although Indonesia's and Austria's expenditure elasticity values appear to be different, at +1.15 and +3.17, respectively, their confidence intervals (CI) overlap, at 0.9–1.4 and 1.0–5.4, respectively. This implies that the expenditure elasticity of Indonesian and Austrian papers was statistically not different and was considered a normal good (Sadiq et al. 2021).

Japan has a 7.60% share of world imports of HS 480256 paper valued at approximately USD 413.7 million and representing more than 409 thousand tons in 2023 (World Trade Map 2025). According to the value, Japan is the third-largest importer of this product. On the other hand, Japan imported at an average value of USD 1,011 per ton. Japan's market experienced a 1% decrease in value terms on average per year over the last five years, accompanied by a 2% decrease in quantity terms, indicating a trend of increasing unit value. The World Trade Map (2025) records a 3% decline in Japanese import value from 2023, while the global decline was slightly less, at 2%. This implies that Japan's expenditure on the Indonesian paper would decrease.

3.2. Policy Impacts

Between 2010 and 2023, several significant global economic events occurred. At the beginning of the period, the world was recovering from the global economic crisis that occurred in 2008. In 2018, tariff escalation from the United States disrupted international trade, necessitating adjustments (Amiti et al. 2019). Then, in 2020, the world was affected by the COVID-19 pandemic, which led to restrictions on activities and inflation (Suryanty and Matsuda 2023). The United States, the world's largest paper producer, is currently experiencing a decline in its production capacity. This is because paper consumption in the United States tends to decline due to massive digitalization (Chaucan and Meena 2021; Vivas et al. 2024; Zhang and Nguyen 2018). In addition, the United States has shifted its focus by converting and further closing inefficient factories that contribute to emissions and excess waste, with factories that produce recycled paper (Chang et al. 2019) and other types of packaging paper. On the other hand, people's behavior has begun to shift in line with increasing global awareness of sustainability, health, and environmental concerns, resulting in a growing demand for environmentally friendly products. Further, Palmer and Cohen (2020) highlight that pulp and paper companies in the United States and the European Union have to diversify their paper production into other business lines, including forest land management, packaging materials such as boxboard, linerboard, and corrugating medium, tissue and hygiene products, pulp products, and pulp by-products such as lignin and bio-energy. Meanwhile, global demand has now shifted to Asian countries, especially Indonesia and China. The advantage of Asian countries as paper producers lies in their abundant natural resources, which can provide sustainable raw materials; their large populations, which increase domestic demand; and their production costs, which are much cheaper than those in the United States.

Indonesia has become one of the key countries in the global trade of pulp and paper products. Writing, printing, or other graphic purposes paper (HS 480256) from Indonesia is currently the commodity with the highest export value, with Indonesia ranking first in the export of HS 480256 paper for the past five years. This indicates that the global demand for HS 480256 paper can be

fulfilled by paper from Indonesia. The structure of Indonesia's paper trade market, in particular, is significantly affected by the policies and trade conditions of competing countries. In this context, Indonesia's main competitors for HS 480256 paper in the Japanese market are China, the United States, and Austria. Indonesia is one of Japan's primary exporters across various sectors (Direktorat Perundingan Bilateral Kementerian Perdagangan 2023). Indonesian HS 480256 paper, in particular, holds a strong competitive edge in the Japanese market. The domination and competitiveness of Indonesian HS 480256 paper in the Japanese market tend to be stable, allowing Indonesia to continue fulfilling Japan's demand for HS 480256 paper with its advantages in pulp and paper raw material production. Additionally, the significant increase in paper exports is also influenced by the Japan-Indonesia Economic Partnership Agreement (JIEPA), which facilitates international trade transactions between Indonesia and Japan, such as an agreement on import tariff reduction.

Developing other types of paper is a crucial consideration, as the current unstable economic conditions—such as the COVID-19 pandemic, which has impacted all aspects of life—have led to increased demand and shortages of hygienic tissue products, changes in lifestyle and consumer behavior, and a rise in electronic purchases. As a result, there has been a surge in the e-commerce industry, driving up demand for eco-friendly packaging paper (Vivas et al. 2024). The current trade wars and geopolitical conditions worldwide present an opportunity for Indonesia's pulp and paper industry to address the growing international demand for pulp and paper.

Considering that China and Indonesia are substitute countries for HS 480256 paper commodities in the Japanese market, changes in the price of Chinese HS 480256 paper are very sensitive to Indonesia's market share. This means that if there is an increase in the price of Indonesian paper exports, it will create opportunities for China, in particular, to meet Japan's paper demand. Although China's forest is currently expanding rapidly (Zhang 2018), it leads in production volume and types of paper. Indonesia's paper industry is simultaneously improving its technology to increase energy and raw material efficiency, supported by a commitment to sustainable practices as part of its responsibility to achieve zero deforestation. Meanwhile, the complementary relationship between Indonesia and the United States provides more opportunities for Indonesia to establish partnerships or expand its supply chain to Japan.

Therefore, it is necessary to consider the impact of various factors on the structure of Indonesia's paper product market and policies to maintain the stability of Indonesia's paper export prices. A strategy for policymakers to consider in maintaining the market structure and competitiveness of the Indonesian paper industry is to stabilize paper export prices and uphold trade agreements with export destination countries. Further, several strategies that papers industries can implement to maintain the competitiveness of Indonesian paper include: ensuring the forest certification and maintaning sustainable paper production (Chen et al. 2020; Silva et al. 2016), to increase the added value and uniqueness of paper exported by Indonesia; and periodically reviewing international trade barriers, tariff changes, production cost efficiency, and prices from competitor countries, along with increasing the capacity and technology of Indonesia's paper products. These considerations are necessary to enable Indonesia's paper industry to adapt to the new international trade environment, promote industrial development, foster sustainable global forestry development, and provide a reference for forestry industry decision-making.

4. Conclusions

Indonesia's market share of HS 480256 paper in the Japanese market was around 69% over the period 2020–2023. The QUAIDS model was more effective than the LA/AIDS model in representing consumer behavior across various expenditure levels. The estimated value of uncompensated own-price elasticity from the QUAIDS model shows that Indonesian HS 480256 paper was elastic. Furthermore, the estimated value of the compensated cross-price elasticity indicates that Indonesian and Chinese papers were substitutes, while Indonesian and United States papers were complements. The resulting expenditure elasticity value (+1.15) shows that Indonesian HS 480256 paper was a normal good. This research suggests that to enhance the sustainability of Indonesian paper exports to the Japanese market, a comprehensive strategy integrating government policy and sustainable technology is urgently needed, given the competition from China, the United States, and Austria. Cooperative pricing policies are not recommended, especially with China, to prevent Indonesia from losing one of its primary paper export markets. Further research is necessary to consider the impact of tariffs and other economic factors on the demand for Indonesian paper. Also, the development of LA/AIDS and QUAIDS models is highly recommended for other forest products. This is necessary to gain a more comprehensive view of the competitiveness of Indonesian forest products in the international market, thereby ensuring the continued development of the forestry sector's contribution.

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Author Contributions

M.A.: Conceptualization, Methodology, Software, Validation, Formal Analysis, Investigation, Resources, Data Curation, Writing – Original Draft Preparation, Writing – Review and Editing, Visualization; B.C.H.S. and E.G.T.M.: Conceptualization, Methodology, Software, Validation, Formal Analysis, Investigation, Resources, Writing – Original Draft Preparation, Writing – Review and Editing, Supervision.

Conflict of Interest

The authors declare that they have no conflict of interest regarding the publication of this manuscript.

Declaration of Generative AI And AI-Assisted Technologies in the Manuscript Preparation

Not applicable.

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