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# Analysis of Factors Affecting Indonesia's Cinnamon Export Volume

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**ABSTRACT**

This study aims to analyze the development of Indonesia's cinnamon export volume and identify the factors affecting its export performance in the international market. The variables examined include Indonesia's cinnamon export volume, domestic cinnamon production, China's cinnamon production, Indonesia's cinnamon export price, and the exchange rate of the Indonesian rupiah against the US dollar. The analysis employed the Autoregressive Distributed Lag (ARDL) approach to examine long-run relationships and the Error Correction Model (ECM) to identify short-run dynamics. The results indicate that Indonesia's cinnamon export volume fluctuated over time but showed an increasing trend in the long run. The Bounds Test confirmed the existence of cointegration among the variables. In the long run, the current export price, the exchange rate lagged by one period, and China's cinnamon production lagged by one and two periods have a positive and significant effect on Indonesia's cinnamon export volume. Conversely, the previous period's export volume has a significant negative effect on the current export volume. Domestic cinnamon production was found to have no significant effect.The short-run ECM results reveal a significant adjustment mechanism toward long-run equilibrium. China's cinnamon production lagged by one period, domestic production lagged by one period, and export volume lagged by two periods negatively and significantly affect current export volume, while the current exchange rate has a positive effect.

**Keywords:** Cinnamon Exports, Cinnamon Production, Export Prices, Exchange Rate**.**

## INTRODUCTION

International trade is one of the key aspects that contributes to a country's economic growth through export and import activities. According to Samuelson (2004), exports refer to the sale of domestically produced goods and services purchased by foreign parties. Similarly, Sukirno (2016) defines exports as the activity of selling and delivering domestically produced goods or services to foreign markets in order to generate profits and foreign exchange earnings for the country. Strong export performance can stimulate economic growth, encourage investment, expand employment opportunities, and improve social welfare (Nurjati, 2022). One of the sectors that plays a significant role in Indonesia's export activities is the agricultural sector, particularly the plantation subsector, which produces various high-value commodities. The plantation subsector offers numerous commodities with substantial export potential (Zuhri *et al*., 2016). One such commodity that has considerable potential to generate foreign exchange earnings is cinnamon (*Cinnamomum burmannii*) (Fitriyeni, 2011).

Indonesia is one of the world's leading producers and exporters of cinnamon. According to data from the Food and Agriculture Organization (FAO), Indonesia ranks as the third-largest cinnamon exporter globally, after Vietnam and China. Indonesian cinnamon is exported to various countries, particularly the United States, European countries, and Asian markets, to meet the needs of the food, beverage, pharmaceutical, cosmetic, and herbal health industries. The strong demand for cinnamon indicates that this commodity has significant potential to be further developed as one of Indonesia's leading export commodities. In addition, Indonesian cinnamon is recognized for its distinctive aroma and high quality, enabling it to compete effectively in international markets.

Despite its strong position in the international market, Indonesia's cinnamon export volume has exhibited fluctuations over time. These fluctuations suggest that export performance is influenced not only by domestic production capacity but also by various domestic and international factors. The export volume of a commodity is determined by both domestic supply and foreign demand. From the supply side, export volume can be influenced by

several factors, one of which is production (Marlian *et al.*, 2004). Domestic cinnamon production is particularly important because higher production increases the availability of products for export. High levels of cinnamon production may stimulate export activities due to excess supply that cannot be fully absorbed by the domestic market (Indelman *et al*., 2022). However, Indonesia's cinnamon production has tended to decline in recent years due to shrinking cultivation areas, low productivity, and suboptimal farming practices (Asrini *et al.*, 2021). In addition to domestic production, the production levels of competing countries may also affect the international cinnamon trade. Bardazzi and Ghezzi (2022) argue that changes in the production of exporting countries can influence commodity prices and international trade as a whole. In recent years, China's cinnamon production has continued to increase and has even surpassed Indonesia, making China the world's largest cinnamon producer.

From the demand side, export prices and the exchange rate of the Indonesian rupiah against the US dollar are important determinants of export performance. An increase in export prices may reduce importers' demand for a commodity, leading to a decline in export volume. Conversely, lower export prices tend to increase export demand (Lipsey *et al*., 1997). When prices continue to rise beyond a certain threshold, consumers are likely to seek substitute products (Boediono, 2011). Changes in export prices may affect demand from importing countries, while exchange rate fluctuations influence the competitiveness of Indonesian products in international markets. When the rupiah depreciates against the US dollar, Indonesian products become relatively cheaper for foreign buyers, thereby potentially increasing export demand (Putra & Huda, 2021).

The fluctuations in Indonesia's cinnamon export volume indicate that export performance is influenced by various factors originating from both domestic and international markets. Domestic production, competitor-country production, export prices, and exchange rates are among the factors suspected of affecting changes in Indonesia's cinnamon export volume. Although numerous studies have examined the determinants of exports, previous findings have shown varying effects of these variables across different periods and market conditions. Accordingly, this study investigates the trends in Indonesia's cinnamon export volume and assesses the influence of domestic cinnamon production, China's cinnamon production, export prices, and exchange rates on Indonesia's cinnamon exports from 1989–2023.

## RESEARCH METHOD

This research is based on secondary time-series data collected over a 35-year timeframe, extending from 1989 through 2023. The data were obtained from the official databases of the Food and Agriculture Organization (FAO), UN Comtrade, Bank Indonesia (BI), and other relevant institutions. The variables used in this study include Indonesia's cinnamon export volume (Y), Indonesia's cinnamon production (X1), China's cinnamon production (X2), Indonesia's cinnamon export price (X3), and the exchange rate of the Indonesian rupiah against the US dollar (X4).

This study employs the Autoregressive Distributed Lag (ARDL) approach within a dynamic multiple regression framework. The ARDL technique integrates the Autoregressive (AR) and Distributed Lag (DL) models. While the AR component utilizes lagged values of the dependent variable as predictors, the DL component incorporates both current and lagged values of the explanatory variables. According to Pesaran *et al.* (1996), the ARDL approach provides consistent estimates of both short-run and long-run relationships, even when the sample size is relatively small. In its application, the ARDL framework incorporates lagged terms of both the dependent and independent variables to account for dynamic interactions among the variables. A key strength of this approach is its flexibility in handling variables integrated at level, I(0), first difference, I(1), or a mixture of both. Nevertheless, the ARDL technique is not suitable when any variable is integrated of order two, I(2) (Ridha *et al*., 2021).

The analytical procedures consisted of: (1) stationarity testing using the Augmented Dickey-Fuller (ADF) test; (2) Johansen cointegration testing to identify the existence of an initial long-run relationship; (3) ARDL model estimation based on the Akaike Information Criterion (AIC); (4) the Bounds Test to examine cointegration within the ARDL framework; (5) Error Correction Model (ECM) estimation to investigate short-run dynamics; (6) classical assumption tests and; (7) model stability tests using CUSUM and CUSUM of Squares. All variables were transformed into natural logarithms (ln). The natural logarithm transformation was applied to reduce heteroscedasticity problems and stabilize the data. The transformed model equation is expressed as follows:

$$LnY_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i LnY_{t-i} + \sum_{j=0}^{q1} \beta_j LnX_{1,t-j} + \sum_{k=0}^{q2} \gamma_k LnX_{2,t-k} + \sum_{l=0}^{q3} \delta_l LnX_{3,t-l} + \sum_{m=0}^{q4} \theta_m LnX_{4,t-m} + \varepsilon t$$

Information :

$Y_t$ = Indonesia's cinnamon export volume in year t
$X_{1t}$ = Indonesia's cinnamon production in year t
$X_{2t}$ = China's cinnamon production in year t
$X_{3t}$ = Indonesia's cinnamon export price in year t
$X_{4t}$ = Exchange rate of the Indonesian rupiah against the US dollar in year t
$\alpha_0$ = Constant (intercept)
$\beta, \gamma, \delta, \theta$ = Coefficients of the independent variables
$\varepsilon t$ = Error term (residual)
Ln = Natural logarithm

## RESULT AND DISCUSSION

### Development of Indonesia's Cinnamon Export Volume During the Period 1989–2023 and Its Determining Factors

Indonesia's cinnamon export volume is the primary variable examined in this study. The development of Indonesia's cinnamon export volume during the period 1989–2023 is presented in Figure 1.

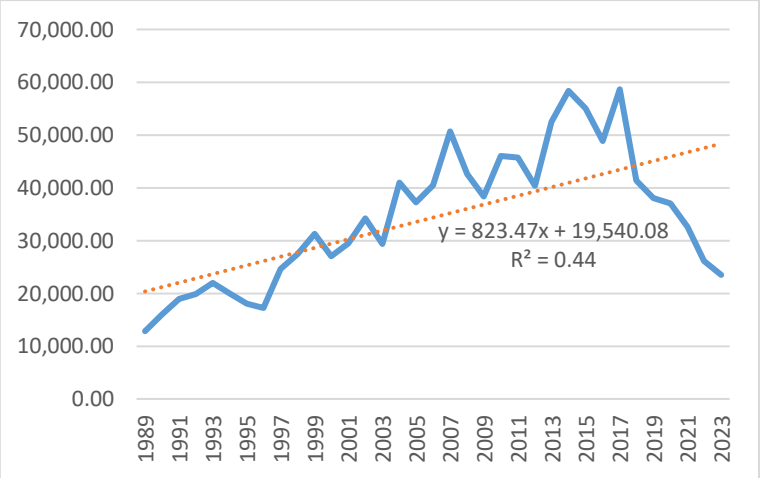


**Figure 1. Development of Indonesia's Cinnamon Export Volume During the Period 1989–2023**

*Source: Food and Agriculture Organization (2026), processed*

Indonesia's cinnamon export volume during the period 1989–2023 exhibited a fluctuating but generally increasing trend. The trend line equation, y = 823.47x + 19,540.08, indicates that export volume increased by an average of 823.47 tons per year. An $R^2$ value of 0.44 suggests that the time trend accounts for 44% of the fluctuations in export volume, whereas the other 56% is influenced by variables outside the model framework. During the study period, Indonesia's cinnamon export volume fluctuated but generally increased, with an average annual growth rate of 3.22%. The highest export volume was recorded in 2017, reaching 58,660.81 tons, driven by strong global demand. However, since 2018, export volume has declined due to intensified market competition, changes in international demand, and the impact of the COVID-19 pandemic. Overall, the development of cinnamon exports has been influenced by global economic conditions, exchange rate fluctuations, and international demand. In addition, the availability of domestic supply or production plays an important role in determining export volume. The development of Indonesia's cinnamon production during the study period is presented in Figure 2.

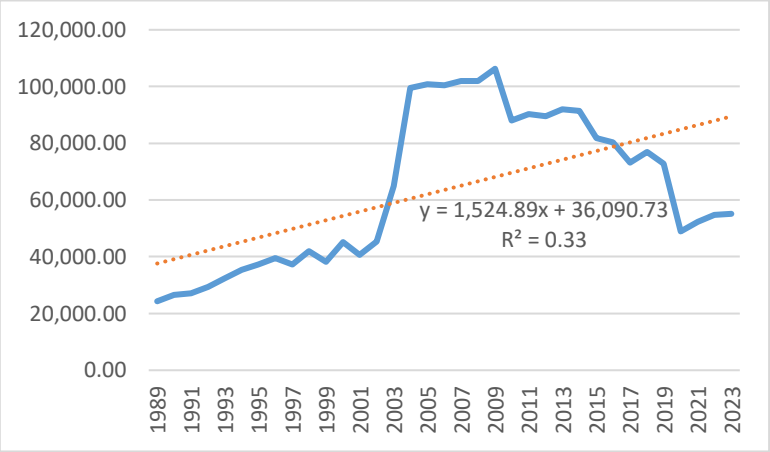


**Figure 2. Development of Indonesia's Cinnamon Production During the Period 1989–2023**

*Source: Food and Agriculture Organization (2026), processed*

Indonesia's cinnamon production during the period 1989–2023 exhibited an increasing trend despite experiencing fluctuations. The trend line equation, y = 1,524.89x + 36,090.73, indicates that production increased by an average of 1,524.89 tons per year. Based on the $R^2$ statistic of 0.33, about 33% of the changes in production can be attributed to the time trend, while the remaining 67% is influenced by other factors. During the study period, Indonesia's cinnamon production showed an upward trend with an average annual growth rate of 3.42%, although fluctuations were observed. Production reached its peak in 2009 at 106,270 tons and subsequently tended to decline until 2020 due to the COVID-19 pandemic, decreasing cultivation area, and low productivity. Thereafter, production increased again during the 2021–2023 period. In general, the development of cinnamon production is influenced by cultivated land area, productivity, climatic conditions, and the harvest cycle of cinnamon plants. In addition to domestic production, the production performance of competing countries may also affect the dynamics of cinnamon trade in the international market. One of the countries that plays a significant role in the global cinnamon trade is China. The development of China's cinnamon production during the study period is presented in Figure 3.

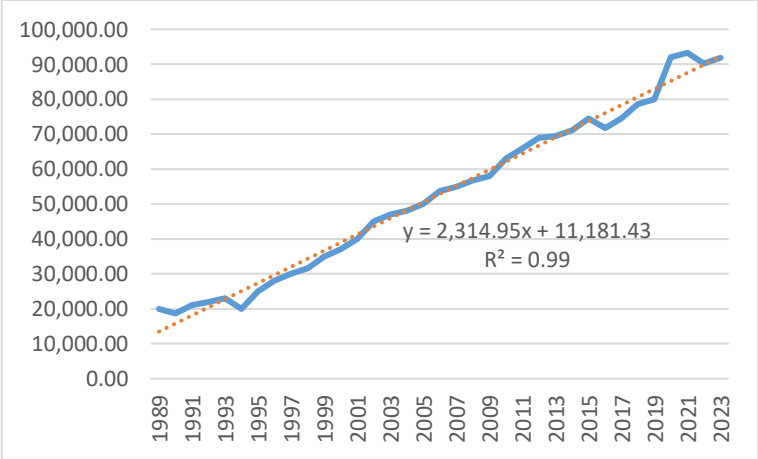


**Figure 3. Development of China's Cinnamon Production During the Period 1989–2023**

*Source: Food and Agriculture Organization (2026), processed*

The trend line equation shows a coefficient of 2,314.95, indicating that China's cinnamon production increased by an average of 2,314.95 tons per year, with an estimated initial production level of 11,181.43 tons. An $R^2$ value of 0.99 indicates that almost all variation in production is accounted for by the time trend. China's cinnamon production during the period 1989–2023 maintained a stable positive trend throughout the study period, with an average yearly growth rate of 4.79%. Production increased from 20,000 tons in 1989 and reached its peak at 93,287.99 tons in 2021. This increase was supported by advances in cultivation technology, agricultural policies, and enhanced production capacity. Overall, China's cinnamon production demonstrated more consistent and stable growth compared to Indonesia. Changes in production levels in both Indonesia and China may affect supply

conditions and cinnamon prices in the international market. The development of Indonesia's cinnamon export price during the study period is presented in Figure 4.

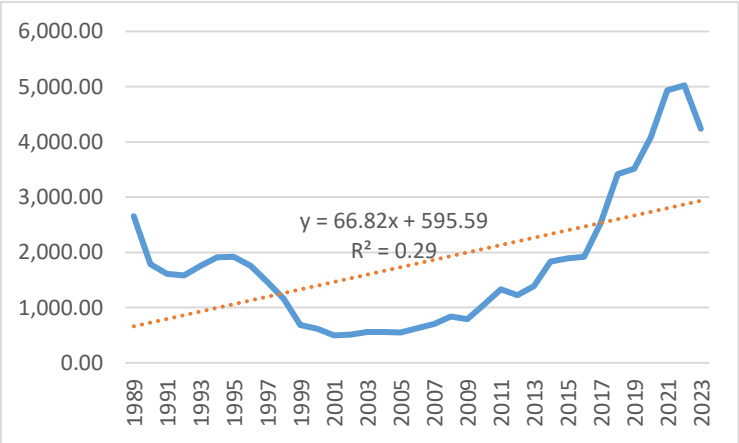


**Figure 4. Development of Indonesia's Cinnamon Export Price During the Period 1989–2023**

*Source: Food and Agriculture Organization (2026), processed*

Indonesia's cinnamon export price during the period 1989–2023 exhibited a fluctuating but generally increasing trend. The trend line equation, y = 66.82x + 595.59, indicates that the export price increased by an average of USD 66.82 per ton annually. The $R^2$ statistic of 0.29 shows that the time trend contributes to explaining 29% of the variation in export prices. Meanwhile, the average annual growth rate of Indonesia's cinnamon export prices reached 3.07% during 1989–2023. Export prices experienced a sharp decline and reached their lowest level in 2001 at USD 498.22 per ton, mainly due to the Asian financial crisis and weak global demand. Subsequently, export prices continued to increase and reached their peak in 2022 at USD 5,023.41 per ton, driven by rising global demand for spices and limited world supply. In general, the development of export prices is influenced by international demand, exchange rate fluctuations, and global trade conditions. In addition to production and price factors, macroeconomic conditions also play an important role in international trade activities. One of the indicators frequently associated with export performance is the exchange rate. The development of the Indonesian rupiah exchange rate against the US dollar during the study period can be observed in Figure 5.

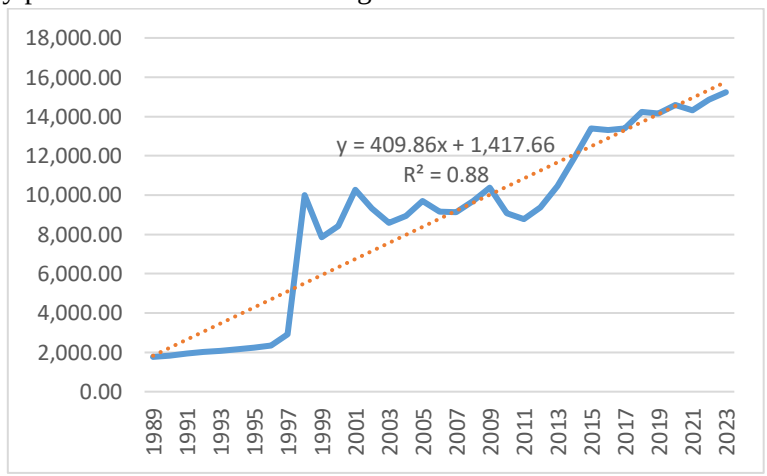


**Figure 5. Development of the Rupiah Exchange Rate Against the US Dollar During the Period 1989–2023**

*Source: Bank Indonesia (2026), processed*

The exchange rate of the Indonesian rupiah against the US dollar during the period 1989–2023 exhibited an increasing trend, reflecting the long-term depreciation of the rupiah. The trend line equation shows a coefficient of 409.86, indicating that the exchange rate increased by an average of IDR 409.86 per US dollar annually. The $R^2$ statistic of 0.88 shows that 88% of exchange rate movements can be attributed to the time trend. The exchange rate remained relatively stable prior to 1997 but experienced a sharp increase during the 1997–1998 Asian financial crisis, which marked a major turning point in the movement of the rupiah exchange rate. Following the crisis, the exchange rate continued to fluctuate and did not return to its pre-crisis level, reflecting the influence of various domestic and

global economic factors. Overall, the average exchange rate during the study period was IDR 8,795.09 per US dollar, with an average annual growth rate of 10.28%. These findings indicate that the Indonesian rupiah generally depreciated against the US dollar throughout the study period.

**Estimation Results of the Factors Affecting Indonesia's Cinnamon Export Volume During the Period 1989–2023**

**1. Stationarity Test**

The Augmented Dickey–Fuller (ADF) test was employed to assess the stationarity of the variables and identify their respective orders of integration.

**Table 1. Augmented Dickey-Fuller (ADF) Stationarity Test Results**

| Variabel | *Augmented Dickey-Fuller Test* | | | | Keterangan |
|---|---|---|---|---|---|
| | Level | | First Difference | | |
| | t-Statistic | Prob. | t-Statistic | Prob. | |
| LN_Y | -2.297471 | 0.1785 | -6.134827 | 0.0000 | I(1) |
| LN_X1 | -1.923218 | 0.3181 | -4.588238 | 0.0009 | I(1) |
| LN_X2 | -1.150948 | 0.6838 | -7.112596 | 0.0000 | I(1) |
| LN_X3 | -0.748599 | 0.8203 | -3.752983 | 0.0077 | I(1) |
| LN_X4 | -1.631662 | 0.4559 | -6.045037 | 0.0000 | I(1) |

*Source: Authors' calculations (2026)*

The results of the stationarity test indicate that all research variables were found to be non-stationary in levels but turned stationary following first-order differencing. Therefore, all variables were identified as being integrated of order one, I(1). These findings suggest that the data satisfy the requirements for analysis using the ARDL approach, as no variable is integrated of order two, I(2).

**2. Johansen Cointegration Test**

The Johansen cointegration approach was utilized to assess the presence of long-run equilibrium relationships among the variables. As a preliminary diagnostic procedure, the test also helped determine the suitability of the econometric model adopted in this study.

**Table 2. Johansen Cointegration Test Results**

| Unrestricted Cointegration Rank Test (Trace) | | | | |
|---|---|---|---|---|
| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** Critical Value |
| None | 0.570114 | 67.63493 | 69.81889 | 0.0738 |
| At most 1 | 0.451242 | 39.77518 | 47.85613 | 0.2307 |
| At most 2 | 0.352902 | 19.97196 | 29.79707 | 0.4247 |
| At most 3 | 0.142436 | 5.608438 | 15.49471 | 0.7412 |
| At most 4 | 0.016161 | 0.537681 | 3.841465 | 0.4634 |
| Trace test indicates no cointegration at the 0.05 level | | | | |
| Unrestricted Cointegration Rank Test (Max-eigenvalue) | | | | |
| Hypothesized No. of CE(s) | Eigenvalue | Max-Eigen Statistic | 0.05 Critical Value | Prob.** Critical Value |
| None | 0.570114 | 27.85975 | 33.87687 | 0.2200 |
| At most 1 | 0.451242 | 19.80322 | 27.58434 | 0.3549 |
| At most 2 | 0.352902 | 14.36352 | 21.13162 | 0.3359 |
| At most 3 | 0.142436 | 5.070757 | 14.26460 | 0.7329 |
| At most 4 | 0.016161 | 0.537681 | 3.841465 | 0.4634 |
| Max-eigenvalue test indicates no cointegration at the 0.05 level | | | | |

*Source: Authors' calculations (2026)*

At the preliminary testing stage, the Johansen cointegration test did not identify any long-run equilibrium relationship among the variables. Based on both the Trace Test and Max-Eigenvalue Test results, all probability

values are greater than 0.05, implying that the results fail to reject the null hypothesis of no cointegration. These findings suggest that the preliminary Johansen cointegration test did not provide evidence of a long-run equilibrium relationship. Since all research variables are integrated of order one, I(1), and no cointegration was identified at the preliminary testing stage, the ARDL approach remains appropriate for further analysis. The presence of a long-run relationship among the variables will be further assessed through the Bounds Test under the ARDL approach.

### 3. ARDL Estimation Results

The Autoregressive Distributed Lag (ARDL) model assumes that a variable is influenced by its own past values as well as by the past values of other variables. The ARDL approach is used to examine the effect of the dependent variable over time and the impact of independent variables, which may not occur in the same period but may emerge in subsequent periods. This assumption reflects real-world conditions, where the effect of one variable on another often requires time before its impact becomes observable.

**Table 3. ARDL Estimation Results**

Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 2500
Selected model: ARDL(3,2,2,0,1)

| Variable | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|
| D(LN_Y(-1)) | -0.522469 | 0.177198 | -2.948501 | 0.0086 |
| D(LN_Y(-2)) | -0.106785 | 0.183333 | -0.582464 | 0.5675 |
| D(LN_Y(-3)) | 0.329266 | 0.160087 | 2.056797 | 0.0545 |
| D(LN_X1) | 0.154941 | 0.207597 | 0.746357 | 0.4651 |
| D(LN_X1(-1)) | 0.137470 | 0.206240 | 0.666551 | 0.5135 |
| D(LN_X1(-2)) | 0.399999 | 0.190463 | 2.100142 | 0.0501 |
| D(LN_X2) | 0.486090 | 0.440476 | 1.103556 | 0.2843 |
| D(LN_X2(-1)) | 1.076413 | 0.475395 | 2.264250 | 0.0361 |
| D(LN_X2(-2)) | 1.802898 | 0.464932 | 3.877770 | 0.0011 |
| D(LN_X3) | 0.608012 | 0.226166 | 2.688348 | 0.0150 |
| D(LN_X4) | 0.234401 | 0.129446 | 1.810807 | 0.0869 |
| D(LN_X4(-1)) | 0.520677 | 0.157034 | 3.315696 | 0.0038 |
| C | -0.248215 | 0.061271 | -4.051137 | 0.0007 |
| R-squared 0.651769 | | | | |
| Prob(F-statistic) 0.023522 | | | | |

*Source: Authors' calculations (2026)*

The ARDL estimation process commenced with the determination of the optimal lag length using the Akaike Information Criterion (AIC). The specification associated with the lowest AIC value was considered the most appropriate model. The estimation results identified ARDL (3,2,2,0,1) as the optimal specification. The model produced an $R^2$ value of 0.6517, indicating that approximately 65.17% of the variation in Indonesia's cinnamon export volume is explained by the explanatory variables included in the model. In addition, the Prob(F-statistic) value of 0.0235 confirms the overall statistical significance of the model.

The estimation results reveal that the first lag of Indonesia's cinnamon export volume exerts a significant negative influence on the current export volume, as indicated by a coefficient of -0.522469. The coefficient implies that a 1% rise in the previous period's export volume is associated with a decrease of about 0.52% in current export volume. This finding suggests the presence of cyclical export patterns associated with inventory availability, production cycles, and trade contract arrangements. A surge in exports during one period may reduce available stocks in the subsequent period, leading to lower export volumes.

Indonesia's cinnamon production does not significantly affect export volume in either the current or lagged periods. This result suggests that increases in domestic production do not necessarily translate into higher exports. A portion of domestic output may be absorbed by the domestic market, while export performance is also influenced by import demand, international prices, exchange rates, and global market conditions.

China's cinnamon production exerts a positive and statistically significant influence on Indonesia's cinnamon export volume at both the first and second lag periods, with coefficients of 1.076413 and 1.802898, respectively. These results imply that a 1% increase in China's cinnamon production one and two periods earlier

increases Indonesia's cinnamon export volume by approximately 1.07% and 1.80%, respectively. This finding reflects the close linkage between Indonesia and China within the global cinnamon supply chain. As one of the world's largest cinnamon producers and importers, China's growing production may signal expanding trade activities and stronger demand within the global market, thereby supporting Indonesia's cinnamon exports.

Indonesia's cinnamon export price exerts a positive and statistically significant influence on Indonesia's cinnamon export volume, with an estimated coefficient of 0.608012. This implies that a 1% increase in export prices leads to an approximately 0.61% rise in export volume. This result indicates that higher export prices reflect stronger global demand for cinnamon and encourage exporters to increase shipments. The finding is consistent with export supply theory, which suggests that higher international prices stimulate export supply (Krugman *et al*., 2017). It also supports the argument that domestic and international markets are interconnected, whereby changes in global prices influence Indonesia's export performance. This finding is consistent with the results of Asbiliyah *et al*. (2014), who reported the existence of market integration between the Kuala Tungkal areca nut market and the Singapore market in both the short and long run.

The results indicate that the rupiah exchange rate against the US dollar at lag 1 has a positive and significant effect, as reflected by a coefficient value of 0.520677. This suggests that a 1% increase in the exchange rate during the previous period leads to an approximately 0.52% increase in export volume in the current period. The lagged effect suggests that exporters require time to adjust contracts, pricing decisions, and marketing strategies following exchange rate movements. Economically, rupiah depreciation improves the price competitiveness of Indonesian products in international markets, thereby increasing export demand and export volume. This finding is consistent with international trade theory, which argues that currency depreciation can stimulate exports when demand is sufficiently elastic (Krugman *et al*., 2017).

**4. Bounds Test**

The Bounds Testing approach within the ARDL framework was utilized to examine the presence of a long-run cointegration relationship among the variables. This test is essential for determining whether Indonesia's cinnamon export volume and its explanatory variables maintain a long-run equilibrium relationship.

**Table 4. Bounds Test Results**

| Test Statistic | | | | | Value | |
|---|---|---|---|---|---|---|
| F-statistic | | | | | 6.153416 | |
| | 10% | | 5% | | 1% | |
| Sample Size | I(0) | I(1) | I(0) | I(1) | I(0) | I(1) |
| 30 | 2.525 | 3.560 | 3.058 | 4.223 | 4.280 | 5.840 |
| 35 | 2.460 | 3.460 | 2.947 | 4.088 | 4.093 | 5.532 |
| Asymptotic | 2.200 | 3.090 | 2.560 | 3.490 | 3.290 | 4.370 |

*Source: Authors' calculations (2026)*

The results of the Bounds Test show that the F-statistic of 6.1534 is higher than the upper critical bound value [I(1)] at the 10%, 5%, and 1% significance levels, based on both sample-size critical values and asymptotic critical values. Because the estimated F-statistic is higher than the corresponding upper bound values, the hypothesis of no cointegration is rejected. These findings indicate the existence of a long-run equilibrium relationship among the variables incorporated in the ARDL model. Therefore, Indonesia's cinnamon export volume, domestic cinnamon production, China's cinnamon production, export prices, and the exchange rate move together in the long run, indicating that changes in one variable are associated with adjustments in the others toward a long-run equilibrium.

**5. Error Correction Model (ECM) Estimation Results**

Following the establishment of a long-run relationship, the Error Correction Model (ECM) is estimated by incorporating the Error Correction Term (ECT) into the ARDL framework. The ECT represents the speed of adjustment through which short-run disequilibrium is corrected to restore long-run equilibrium.

**Table 5. Error Correction Model (ECM) Estimation Results**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| COINTEQ* | -1.299988 | 0.189268 | -6.868492 | 0.0000 |
| D(LN_Y(-1),2) | -0.222481 | 0.135540 | -1.641440 | 0.1143 |
| D(LN_Y(-2),2) | -0.329266 | 0.107538 | -3.061854 | 0.0055 |
| D(LN_X1,2) | 0.154941 | 0.154754 | 1.001208 | 0.3271 |
| D(LN_X1(-1),2) | -0.399999 | 0.147009 | -2.720912 | 0.0122 |
| D(LN_X2,2) | 0.486090 | 0.321311 | 1.512836 | 0.1439 |
| D(LN_X2(-1),2) | -1.802898 | 0.355199 | -5.075747 | 0.0000 |
| D(LN_X4,2) | 0.234401 | 0.077693 | 3.017021 | 0.0061 |
| R-squared 0.845146 | | | | |
| Prob(F-statistic) 0.000000 | | | | |

*Source: Authors' calculations (2026)*

The ECM estimation produced an $R^2$ value of 0.845, indicating that the independent variables explain about 84.5% of the variation in the dependent variable. In addition, the Prob(F-statistic) value of 0.0000 suggests that the model is statistically significant and suitable for examining short-run dynamics. The coefficient of the error correction term (COINTEQ) is -1.299988 and is significant at the 5% level. These findings support the existence of a long-run equilibrium relationship and imply that disequilibrium is corrected at a speed of approximately 129.9% per period.

The second lag of Indonesia's cinnamon export volume exerts a significant negative influence on the current export volume, as indicated by a coefficient of -0.329266. This finding suggests that export performance in previous periods continues to influence current export dynamics. The negative relationship indicates an adjustment pattern in export activities, whereby an increase in exports in earlier periods tends to be followed by a decline in subsequent periods. This pattern may be associated with inventory constraints, production cycles, trade contracts, and fluctuations in international demand.

The first lag of Indonesia's cinnamon production has a significant negative impact on export volume, with an estimated coefficient of -0.399999. This result indicates that an increase in production in the previous period is associated with a decline in export volume in the current period. The finding suggests that higher production does not automatically translate into higher exports. When production increases without a corresponding increase in export demand, excess domestic supply may arise, leading exporters to postpone shipments while waiting for more favorable market conditions.

The first lag of China's cinnamon production has a significant negative impact on Indonesia's cinnamon export volume, with an estimated coefficient of -1.802898. This coefficient represents the strongest short-run effect among the explanatory variables included in the model. An increase in China's cinnamon production may expand global supply and intensify competition in international markets, thereby reducing Indonesia's export volume. Although China is an important trading partner, its dominant production capacity may also pose challenges through stronger market competition and downward pressure on prices, particularly in shared export destinations.

Indonesia's cinnamon export price does not appear in the ECM estimation results because the selected ARDL model assigns an optimal lag length of zero to this variable. Consequently, the effect of export prices is captured only in the contemporaneous period. Since the ECM specification focuses on short-run dynamic adjustments across periods, variables without lagged effects are not included in the short-run equation.

The Indonesian rupiah–US dollar exchange rate exerts a positive and statistically significant influence on Indonesia’s cinnamon export volume, as indicated by a coefficient estimate of 0.234401. This shows that a 1% increase in the exchange rate increases export volume by approximately 0.23%. The result suggests that rupiah depreciation enhances the price competitiveness of Indonesian products in international markets by making them relatively cheaper for foreign buyers, thereby stimulating export demand. Furthermore, the findings indicate that the exchange rate is an important determinant of export performance in both the short run and the long run. These findings are consistent with those reported by Setiani *et al*. (2026), who reported that exchange rate fluctuations play an important role in shaping agricultural export performance.

## 6. Classical Assumption Tests

### a. Normality Test

The normality test was performed to assess whether the residuals follow a normal distribution. This test is important for ensuring the validity of statistical inference derived from the regression model (Widarjono, 2017). Residuals are assumed to be normally distributed if the probability value is higher than the 5% significance threshold.

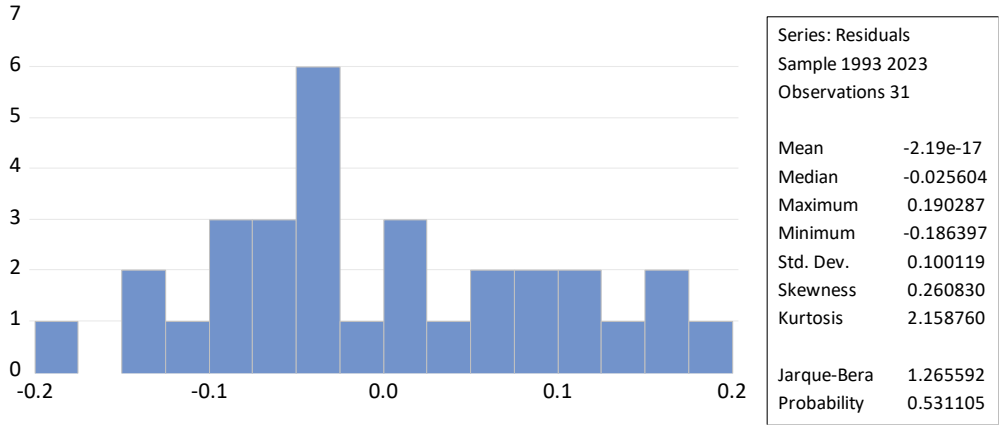


**Figure 6. Normality Test Result**

*Source: Authors' calculations (2026)*

Based on the Jarque–Bera test results, the probability value reached 0.5311, which is greater than the 5% level of significance. Therefore, the test fails to reject the null hypothesis, indicating that the residuals are normally distributed. These results confirm that the normality assumption of the model has been satisfied.

### b. Autocorrelation Test

A Breusch–Godfrey Serial Correlation LM Test was performed to examine whether serial dependence is present in the residuals. The null hypothesis states that the residuals do not suffer from serial correlation.

**Table 6. Autocorrelation Test Results**

| Breusch-Godfrey Serial Correlation LM Test: | | | |
|---|---|---|---|
| F-statistic | 1.234932 | Prob. F(2,16) | 0.3171 |
| Obs*R-squared | 4.145444 | Prob. Chi-Square(2) | 0.1258 |

*Source: Authors' calculations (2026)*

The test findings reveal that the probability values for both the F-statistic and the Chi-square statistic are 0.3171 and 0.1258, respectively. Since both values exceed the 5% significance level, the test fails to reject the null hypothesis that no serial correlation exists. These findings indicate that no serial correlation is present in the residuals. Therefore, the model satisfies the classical assumption of residual independence and can be considered reliable for further analysis.

### c. Heterokedasticity Test

An appropriate regression model is expected to meet the homoskedasticity assumption, whereby the residuals exhibit constant variance. Heteroskedasticity occurs when this assumption is violated and the residual variance is not constant (Widarjono, 2017). A Breusch–Pagan–Godfrey test was performed to determine whether the model suffered from heteroskedasticity. The null hypothesis of this test states that the residuals are homoskedastic.

**Table 7. Heteroskedasticity Test Results**

| Heteroskedasticity Test: Breusch-Pagan-Godfrey | | | |
|---|---|---|---|
| Null hypothesis: Homoskedasticity | | | |
| F-statistic | 0.975578 | Prob. F(12,18) | 0.5042 |
| Obs*R-squared | 12.21651 | Prob. Chi-Square(12) | 0.4285 |
| Scaled explained SS | 2.386339 | Prob. Chi-Square(12) | 0.9985 |

*Source: Authors' calculations (2026)*

The test results indicate that the probability value of the F-statistic is 0.5042, while the probability value of the Chi-square statistic (Obs*R-squared) is 0.4285. The probability values of both test statistics exceed the 5%

significance level, indicating that the null hypothesis of homoskedasticity should be retained. Therefore, The findings confirm the absence of heteroskedasticity in the model, suggesting that the residual variance remains constant and that the homoskedasticity assumption has been satisfied.

**d. Multicollinearity Test**

Multicollinearity refers to the existence of a strong linear relationship among two or more explanatory variables in a multiple regression framework (Widarjono, 2017). The Variance Inflation Factor (VIF) was employed to evaluate the presence of multicollinearity among the independent variables. As a general rule, a Centered VIF value greater than 10 indicates potential multicollinearity problems, whereas values below 10, particularly below 5, suggest that multicollinearity is not a concern.

**Table 8. Multicollinearity Test Results**

| Variance Inflation Factors | | | |
|---|---|---|---|
| Variable | Coefficient Variance | Uncentered VIF | Centered VIF |
| D(LN_Y(-1)) | 0.031399 | 1.606953 | 1.600742 |
| D(LN_Y(-2)) | 0.033611 | 1.681978 | 1.649452 |
| D(LN_Y(-3)) | 0.025628 | 1.333075 | 1.277545 |
| D(LN_X1) | 0.043096 | 1.659800 | 1.626622 |
| D(LN_X1(-1)) | 0.042535 | 1.655170 | 1.614339 |
| D(LN_X1(-2)) | 0.036276 | 1.407809 | 1.375532 |
| D(LN_X2) | 0.194019 | 2.062967 | 1.297339 |
| D(LN_X2(-1)) | 0.226000 | 2.427677 | 1.500505 |
| D(LN_X2(-2)) | 0.216162 | 2.486020 | 1.405923 |
| D(LN_X3) | 0.051151 | 3.106874 | 3.010716 |
| D(LN_X4) | 0.016756 | 1.797575 | 1.666114 |
| D(LN_X4(-1)) | 0.024660 | 2.646832 | 2.450614 |
| C | 0.003754 | 6.966052 | NA |

*Source: Authors' calculations (2026)*

The VIF results indicate that the Centered VIF values for all variables are below the threshold of 5, with most values ranging between 1 and 2. The results provide evidence that the model is free from severe multicollinearity among its explanatory variables. Therefore, it can be concluded that no multicollinearity problem is detected in the ARDL model, suggesting that the estimated coefficients are reliable and can be interpreted without concern for excessive correlation among the independent variables.

**7. Model Stability Test**

**a. CUSUM Test**

The CUSUM (Cumulative Sum) test was employed to verify the stability of the model coefficients over time. A stable model is characterized by a CUSUM plot that remains within the 5% critical boundaries throughout the sample period.

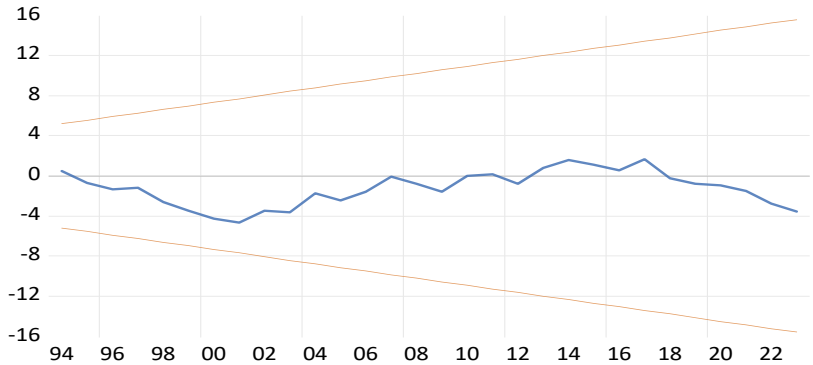


**Figure 7. CUSUM Test Results**

*Source: Authors' calculations (2026).*

The CUSUM test results indicate that the CUSUM plot remains within the 5% significance boundaries over the entire observation period. This suggests that the model is stable and free from significant structural shifts during the study period.

**b. CUSUM of Squares (CUSUMSQ) Test**

The stability of the residual variance was assessed using the CUSUM of Squares (CUSUMSQ) test. The model is deemed stable provided that the CUSUMSQ statistic remains within the 5% confidence bands over the sample period.

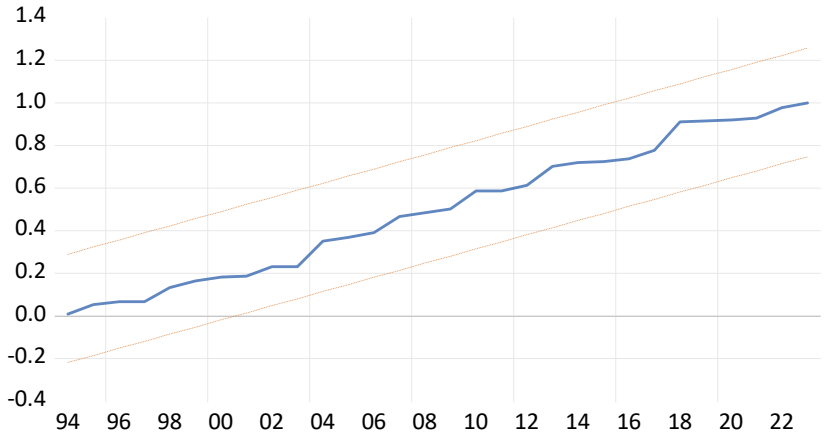


**Figure 8. CUSUM of Squares Test Results**

*Source: Authors' calculations (2026).*

The results show that the CUSUMSQ curve stays within the 5% critical bounds during the entire observation period. This indicates that no substantial changes occurred in the variance of the residuals, implying that the model remained stable throughout the study period.

## CONCLUSION

Indonesia's cinnamon export volume during the period 1989–2023 exhibited a fluctuating pattern but generally followed an upward trend in the long run. The long-run estimation results indicate that export prices, the first lag of the rupiah exchange rate against the US dollar, and the first and second lags of China's cinnamon production have positive and significant effects on Indonesia's cinnamon export volume. In contrast, the first lag of Indonesia's cinnamon export volume has a negative and significant effect, while domestic cinnamon production does not significantly affect export volume. In the short run, the first lag of domestic cinnamon production, the first lag of China's cinnamon production, and the second lag of export volume have significant negative effects on Indonesia's cinnamon export volume. Meanwhile, the exchange rate has a positive and significant effect on export volume.

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