

Research Article

Influential Factors of Indonesian Cocoa Export: Evidence from FMOLS and DOLS Approaches

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Abstract

The study investigated the determinants of cocoa exports using both FMOLS and DOLS approaches. The time series data were obtained from FAOSTAT and ICCO websites from the year 1990 to 2022. ADF and PP stationary unit roots were conducted to examine the stationarity of the variables while Johansen cointegration was used to verify the cointegrating among the variables. The outcome of the Johansen cointegration analysis suggests the existence of a cointegration relationship among the eight variables, indicating the presence of long-run relationships among the variables. The estimated results revealed that cocoa productivity, domestic cocoa production, domestic cocoa supply, exchange rates, and world cocoa prices affect Indonesian cocoa exports. Based on the estimated results and discussion, the study draws a conclusion that cocoa productivity, domestic cocoa production, exchange rates, and world cocoa prices positively and statistically significantly influenced cocoa exports while domestic cocoa supply negatively affected Indonesian cocoa exports. The study recommends that the government of Indonesia should stabilize the fluctuating exchange rates and encourage cocoa production via higher productivity by practicing farm rehabilitation practices to increase productivity and cocoa beans for exports. Moreover, the supply of cocoa beans should also be increased by increasing domestic producer prices. These key determinants are crucial for policymakers and industry stakeholders to understand and address to enhance the competitiveness and growth of the cocoa export industry in Indonesia.

Keywords

Cocoa Exports, Domestic Supply, FMOLS, Exchange Rate, Productivity

1. Introduction

Cocoa (*Theobroma cacao*) is an industrial plantation commodity that significantly contributes to Indonesia's economic activities [47, 54]. This primary crop is also recognized as one of the export commodities that generate foreign exchange [9, 57]. Over the last two decades, Indonesia has

been the third-largest producer [23, 55] and exporter of cocoa globally accounting for 15.8% tons of production and 5.5% tons of exports [18]. In addition, export earnings from processed cocoa were over 1 billion United States Dollars in 2021 [34], and cocoa bean exports for 2022 were over 100 million USD

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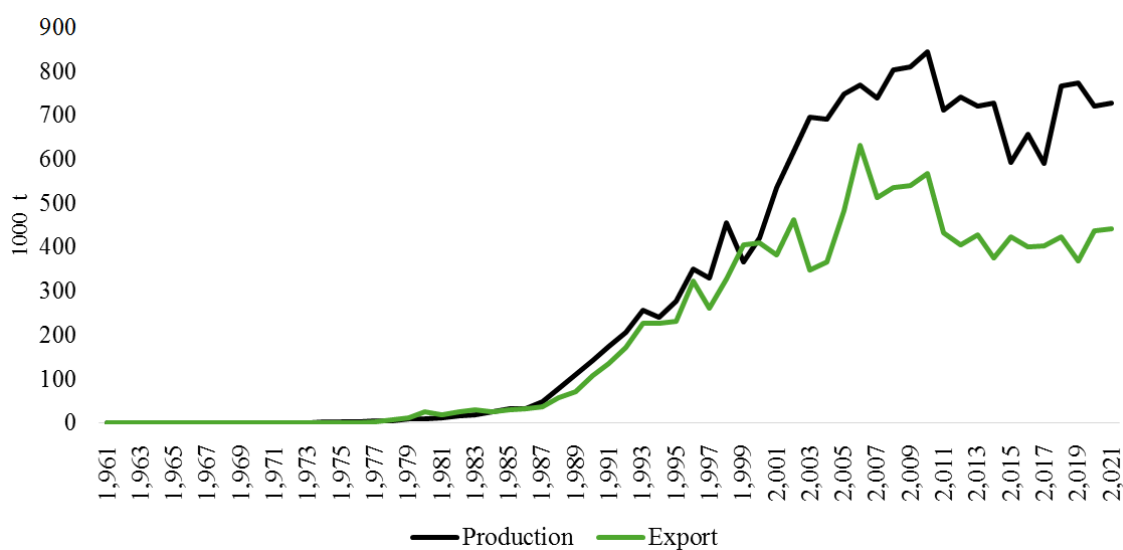
[3] Nonetheless, the cocoa sector offers both direct and indirect employment and sustenance to millions of individuals, especially those residing in rural regions where farming is the principal economic pursuit in Indonesia [23].

Despite its significance, the cocoa industry is faced with challenges ranging from global price fluctuation, exchange rate volatility, and unstable levels of productivity [9]. Hence, an understanding of the determinants of the exports of cocoa is important in the formulation of policies to enhance its competitiveness and sustainability in Indonesia [2]. Previous studies have investigated the determinants of cocoa exports in different countries including Indonesia [21, 25, 40, 48, 50]. In West Africa for instance, studies have shown that productivity, global prices, and exchange rates significantly determine cocoa export performance [2, 10, 12, 40]. Studies about Indonesia have shown that exchange rates, cocoa production, global cocoa price, export duty, and palm oil prices all significantly affect cocoa export [15, 34, 50].

Whilst previous studies have focused on bilateral and regional exports of cocoa, this study contributes to the existing literature by focusing on the general cocoa export performance of Indonesia. The novelty of the study lies in its use of

advanced econometric techniques that control serial correlation, endogeneity, and cointegration. As such, this study provides more accurate and reliable estimates of the determinants of Indonesia's cocoa export performance which is valuable for policymakers and stakeholders in the industry [46].

Given the above, the primary objective of the study was to identify the significant determinants of Indonesian cocoa exports. In addition to that was to examine the long-run relationship between the determinants and cocoa exports and to provide policy recommendations based on the findings to boost the growth of Indonesia's cocoa exports [20]. The introduction concludes with a concise depiction of Indonesian cocoa production and exports. An explanation of exports by destination is also provided. The next section pertains to the materials and methodology employed. This section presents the derivation of the theoretical model and the specification of the econometric model. The data and sources are explained. The unit root and cointegration tests are clearly specified. The estimating methodology and causality are clearly defined. The subsequent section following the materials and methodology is the results and discussions, while the concluding section is the conclusion.



Source: Author's analysis of [19]

Figure 1. Indonesia's Cocoa Production and Export from 1961 to 2021.

The line graph in Figure 1 above shows Indonesia's cocoa production and exports over the period 1961 and 2021. It illustrates an increase in cocoa production from the 1980s to reaching its peak in the mid-2000s. However, the graph is not smooth, showing some fluctuations in production and exports over the years reflecting the impacts of possible economic events. While production continued to increase during the Asian Financial Crisis of 1997 – 1998, there were fluctuations in exports due to the depreciation of the Indonesian Rupiah, which made exports more competitive but the cost of imported inputs expensive [29]. There was also a

temporary dip in both production and exports during the Global Financial Crisis of 2008 as world demand contracted and cocoa prices were volatile. The recent COVID-19 pandemic also created disruptions in global supply chains and contracted global demand [37, 38]. This led to stagnation in cocoa exports despite production remaining relatively stable [21]. The figure also shows that production continuously exceeded exports which can be attributed to Indonesia's growing domestic cocoa processing industry which absorbs some of the production. This aligns with the observations of [11, 52], noted that local cocoa processing has reduced vol-

umes of cocoa bean exports. Therefore, the interplay of global cocoa prices, demand, exchange rates, and local industry demand continues to shape the dynamics of Indonesia's cocoa production and exports [49].

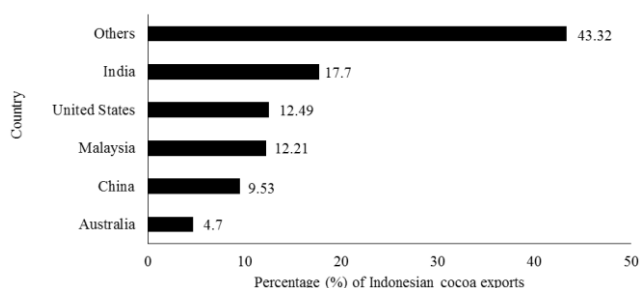


Figure 2. Comparison of Indonesia's Cocoa Export Volume by Destination Countries, 2022. Source: [9].

Figure 2 compares Indonesia's cocoa exports among major destination countries in 2022. India received the largest share of 17.7%, followed by the United States (12.49%), Malaysia (12.21%), China (9.53%), and Australia (4.75%), while the remaining 43.32% was distributed among other countries [9]. India as the top importer could be as a result of bilateral trade relations with Indonesia leveraging its competitive advantage in agricultural products to meet India's growing demand for raw materials [32]. As major players in the global chocolate and confectionery industries, the United States and Malaysia also import substantial amounts of Indonesia's cocoa because of its quality and robust trade relations [39, 57]. There is an increase in consumption among China's rising middle class which also explains its demand for Indonesia's cocoa, while Australia's closer proximity and diplomatic ties with Indonesia secure its place as a major export destination [5]. This is in line with [53] who suggested that spreading export markets reduces the vulnerability to economic downturn in some regions, ensuring more stable export revenue [31].

2. Materials and Methods

2.1. Data and Data Source

This research examines the dynamic influence of cocoa productivity, exchange rates, domestic cocoa production, domestic cocoa supply, world cocoa price, Indonesian population, and foreign direct investment inflows on cocoa exports by employing panel dynamics using data from 1990 to 2022. The time series data was obtained from FAOSTAT and ICCO websites from the year 1990 to 2022. Empirical data

on variables such as cocoa productivity, domestic cocoa production, cocoa exports, domestic cocoa supply, population, foreign direct investment, and exchange rates were obtained from the United Nations Food and Agriculture Organization. In contrast, the world cocoa price was obtained from the International Cocoa Organization website. These key variables were chosen due to their critical roles in determining export performance and fostering economic growth in Indonesia's cocoa industry [3, 21].

2.2. Econometrics Model Specification

Based on the Ricardian Model, crop productivity improves domestic cocoa production which provides a comparative advantage and enables Indonesia to export her cocoa beans to the international market [42, 58]. Hence, Indonesian Cocoa Export (ICX) is a function of cocoa productivity (CPY). Another export determinant based on the Heckscher-Ohlin model is the production [26]. Abundance factors of production like land and labor which are suitable for cocoa production should lead to more domestic cocoa production (DCP) and hence more exports.

In addition, the Balassa-Samuelson Effect notes that as the exchange rate (EXC) depreciates, exports become cheaper [6]. Also, the supply and demand theory holds that export also depends on how much of the supply is consumed domestically. If more cocoa is supplied domestically (DCS) for processing or consumption, exports may reduce leading to a reduction in cocoa exports. And if the domestic cocoa price is low, producers tend to supply less quantity which reduces cocoa exports. Furthermore, based on demand theory, a higher world price (WKH) for cocoa stimulates cocoa exports because of profit motive.

In addition to world price, the Gravity Model of Trade holds that while population (POP) growth may increase domestic demand [26] which in turn reduces export, the net effect on export could be negative when domestic consumption grows faster than production [50]. Another possible determinant of Indonesia's cocoa export performance is FDI. This is in line with the Neo-Classical Growth Theory which suggests that FDI leads to knowledge and technology transfer which in turn improves productivity and production. If a Cobb-Douglas production function type relationship is assumed, the functional form of the above theoretical model of the determinants of Indonesia's cocoa exports can be specified in a multiplicative relationship as:

$$ICX = f(CPY, ICP, EXC, ICS, WKH, POP, FDI) \quad (1)$$

The basic export model is expressed as follows:

$$ICX_t = \alpha_0 + \beta_1 CPY_t + \beta_2 DCP_t + \beta_3 EXC_t + \beta_4 DCS_t + \beta_5 WKH_t + \beta_6 POP_t + \beta_7 FDI_t + \varepsilon_t \quad (2)$$

Where:

α_0 = Intercept or constant

$\beta_1 - \beta_7$ = Coefficient of the explanatory variables

ICX_t =Indonesia's cocoa exports in a year t (ton)

CPY_t = Cocoa productivity in a year t (ha)

DCP_t = Domestic cocoa production in a year t (ton)

EXC_t = Exchange rate of Rupiah against USD in a year t (IDR)

DCS_t = Domestic cocoa supply in a year t (ton)

WKH_t = World cocoa price in a year t (USD)

POP_t = Indonesian population a year t (m)

FDI_t = Foreign direct investment inflows in a year t (USD)

ε_t =error term

The natural logarithm of both sides of equation (2) becomes equation (3)

$$\ln ICX_t = \alpha_0 + \beta_1 \ln CPY_t + \beta_2 \ln DCP_t + \beta_3 \ln EXC_t + \beta_4 \ln DCS_t + \beta_5 \ln WKH_t + \beta_6 \ln POP_t + \beta_7 \ln FDI_t + \varepsilon_t \quad (3)$$

2.3. Augmented Dickey-Fuller and Philips-Perron Unit Root Tests

The research employs a three-phase empirical analysis. In the first phase, the study utilized Augmented Dickey-Fuller (ADF) and Philips- Perron (PP) unit root tests to check the stationarity of the economic variables, ensuring their suitability for policy decision-making and preventing unit root issues [13, 14, 45]. The ADF and PP unit root test equations are specified as:

$$\Delta z_t = \delta_0 + \delta_1 Z_{t-1} + \sum_{i=1}^k \alpha_i \Delta Z_{t-i} + \mu_t \quad (4)$$

$$\Delta z_t = \delta_0 + \delta_1 t + \delta_2 Z_{t-1} + \sum_{i=1}^k \alpha_i \Delta Z_{t-i} + \mu_t \quad (5)$$

The ADF and PP tests were performed with intercept and trend in the study. The ADF regression tests the presence of the unit root of Z_t where t and k mean the time and

number of lags included in the unit root testing regression. The ΔZ_{t-1} denotes the first difference of the variable with k lags. The term μ_t adjusts the errors of autocorrelation, while $\alpha_i, \delta_0, \delta_1$ and δ_2 estimated parameters. The null hypothesis of $H_0: \delta_1 = 0$ has a unit root against the alternative hypothesis $H_A: \delta_1 \neq 0$ are stationary in the equations (5) and (6) as postulated by [14]. The results showed that most of the variables were not stationary at their level form, but they became stationary after differencing once, indicating integration by order one I (1).

2.4. Johansen Cointegration Test

The second phase involved using the Johansen cointegration test to determine if the variables were cointegrated. Johansen cointegration is proposed by [27] for testing the number of cointegration vectors or the rank of Π in the vector autoregression model. The Johansen cointegration equation in the vector autoregression model is specified by:

$$\Delta Z_t = \phi + \Gamma_1 \Delta Z_{t-1} + \Gamma_2 \Delta Z_{t-2} + \dots + \Gamma_{p-1} \Delta Z_{t-p+1} + \Pi Z_{t-1} + \mu_t \quad (7)$$

In equation (6) ϕ is the vector of constant terms, Δ is the difference operator, Z_t is the vector of variables in the model, Γ and Π are the coefficient matrices and μ_t is the vector of the disturbance term. The matrix of Π shows the long-run relationship between the Z_t variables while the rank Π means the number of linearly dependent and stationary linear combinations of variables [14].

2.5. Fully Modified Ordinary Least Squares and Dynamic Ordinary Least Squares Approaches

Finally, after establishing the existence of cointegration in the model, the study applied FMOLS and DOLS. These analytical techniques were based on the cointegration regression framework proposed by [43]. This technique of estimation boasts several advantages that make it highly suitable for use in econometric analysis. In contrast to the Engle-Granger two-step method or Johansen method, FMOLS and DOLS are more resistant to serial correlation and heteroscedasticity. This is because, during the estimation phase, FMOLS and

DOLS rectify these issues [1]. Additionally, [43] notes that even if the co-integration relationship in a model is not well stated, FMOLS and DOLS methods still yield reliable estimates due to their more flexible model definition that considers non-linearities and omitted variables bias [35]. The DOLS also has an inherent mechanism that corrects for serial correlation and endogeneity by selecting the appropriate lags and leads. Therefore, the study employs the DOLS to verify the robustness of the FMOLS. The model likewise accounts for potential nonlinearities in the estimated model. The uniqueness of these techniques makes them beneficial and applicable to this present study. [41] has also utilized these econometric models to estimate economic variables in his research. The FMOLS model, which was introduced by [44] provides consistent parameter estimates even when using a small sample size. This model addresses issues of endogeneity, serial correlation, omitted variable bias, and measurement errors, and allows for heterogeneity in the long-run parameters [28]. Unlike traditional EG cointegration techniques, FMOLS estimates a single cointegrating relationship that combines I (1) variables [44]. By transforming both data

and parameters, the FMOLS model provides appropriate corrections to the inference problems associated with traditional EG cointegration techniques. The long-run coefficient estimators in the FMOLS model are defined as follows:

$$\widehat{\theta}_{FME} = (\sum_{t=1}^T Z_t' Z_t)^{-1} (\sum_{t=1}^T Z_t Y_t^+ - T \begin{bmatrix} \lambda_{12}^+ \\ 0 \end{bmatrix}) \quad (8)$$

Where Y_t^+ and λ_{12}^+ terms correct the endogeneity and serial correlation. The FMOLS estimator is asymptotically unbiased and has a fully efficient mixture-normal asymptotic distribution, which allows for standard Wald tests using the asymptotic chi-square statistical inference [5, 14].

On the contrary, the DOLS was developed by Peter Philips and Sam Qualis to provide precise and accurate estimates compared to the Ordinary Least Squares (OLS) regression in situations where the long-term relationships between variables involve integration in a different order, but the variables remain cointegrated [36]. This model tackles the challenges of bias and small sample bias by utilizing leads and lags [7, 48]. It addresses the issue of endogeneity in regressors, resulting in more efficient estimates that eliminate the bias in coefficients caused by serial correlations [48]. Additionally, it allows for a better specification of the model's dynamics. The estimators of the DOLS can be obtained from the

least-squares estimates, and these estimates are unbiased and asymptotically efficient, even in the presence of endogenous problems [8]. The parameters also account for any potential autocorrelation and non-normality in residuals [34]. The DOLS long-run coefficient estimators are represented by the following equation:

$$y_t = \alpha_t + \beta_t x_t + \sum_{i=-k}^{i=k} \phi_i \Delta x_{t+i} + \varepsilon_t \quad (9)$$

Where β_t is the long-run elasticity, the term ϕ_i is the coefficient of the leads and lags differences of I (1) regressors. These coefficients are considered nuisance parameters, and they serve to adjust for possible endogeneity, autocorrelation, and non-normal residuals.

3. Results and Discussion

This section presents the major determinants of Indonesian cocoa exports from 1990 to 2022. To start the ball rolling, Table 1 illustrates the estimated descriptive statistic results of all the variables employed in the econometric analysis ranging from the mean to kurtosis.

Table 1. Descriptive Statistics of variables.

	ICX	CPY	DCP	EXC	DCS	WKH	POP	FDI
Mean	211,390	6.37	569,949	8,813	419,192	3,617	2.31E+08	15,720
Maximum	490,778	11.32	844,626	14,850	978,831	5,245	2.76E+08	36,658
Minimum	22,280	3.47	142,347	1,843	37,876	2,278	1.82E+08	1,895
Std. Deviation	142,791	2.17	215,245	4,303	311,700	883	28,838,080	8,678
Skewness	0.14	0.57	-0.67	-0.45	0.33	0.15	-0.08	0.70
Kurtosis	1.88	2.32	1.99	2.06	1.87	1.80	1.77	3.35
Observations	33	33	33	33	33	33	33	33

Source: Authors' computation (2024)

The estimated results in Table 1 indicate that the mean Indonesian cocoa exports were 211,390 tons which occurred in the 1997 and 1998 cocoa production periods. The estimated results of the average cocoa productivity was 6.37 kg/ha and a standard deviation of 2.17 kg/ha. This was experienced between the 2004 and 2005 production seasons. The estimated results indicate that the average domestic cocoa production was 569,949 tons and this was experienced in the 2001 production period. The average exchange rate of the Rupiah against the US dollar was IDR 8,813,

which occurred in 1991. The average domestic quantity of cocoa supplied during the period was 419,192 tons which took place in the 2003 cocoa production season. The average world cocoa price used in the study was USD 3,617 per ton, which started in the 2003 production period. The average Indonesian population under the study was 231,791,427 million people and was experienced in the year 2006. The average foreign direct investment inflow was USD 15,720, which occurred in 2001.

3.1. Estimated Results of Augmented Dickey-Fuller and Philips-Perron Unit Root Test Levels

Table 2 illustrates the estimated results of ADF and PP unit roots at different stationary levels. The intercepts and trends

were used at different levels. The lag length selection criteria test was conducted before performing the ADF and PP unit root tests. The lag section helps in determining the optimal number of lags to include in the FMOLS and DOLS models where lag 2 was selected using the Akaike information criterion for achieving accurate and unbiased estimates.

Table 2. Estimation results of ADF and PP Unit Roots Test at levels.

Variables	ADF		PP		Integration Order
	Levels	1 st Differences	Levels	1 st Differences	
lnICX	-1.8189	-5.7657***	-1.8033	-5.7657***	I (1)
lnCPY	-3.9733**	-5.4600***	-3.6833**	-12.7028***	I (0)
lnDCP	-1.2654	-8.0365***	-1.0565	-8.0306***	I (1)
lnEXC	-2.6727	-6.6356***	-2.7249	-6.6356***	I (1)
LnDCS	-3.4383*	-6.7401***	-3.3674*	-9.3526***	I (0)
LnWKH	-6.9928***	-4.6296***	-7.5225***	-20.7752***	I (0)
lnPOP	-1.2694	-1.1607	12.1069	-1.6214*	I (1)
lnFDI	-2.7873	-6.5282***	-2.7873	-6.9517***	I (1)

Source: Authors' computation (2024), Note: *, **, and *** are significant at 10%, 5% and 1% significance level.

The results in Table 2 from the ADF and PP tests reveal that cocoa productivity, domestic cocoa supply, and world cocoa prices exhibited statistical significance in both the intercept and trend components for the levels at the 1%, 5%, and 10% significance levels, with an integration order of I (0). On the other hand, Indonesia's cocoa exports, domestic cocoa production, exchange rate, population, and foreign direct investment inflows were statistically significant at the first difference at 1% and 10% significance levels, with an integration order of one. Some of the selected variables were found to be stationary at the first difference, as confirmed by [13, 44]. The ADF and PP findings indicate that all the variables surpass their respective p-values, implying a rejection of the null hypothesis of a unit root in favor of the

alternative hypothesis of no unit root [44]. The order of integration results suggests that the variables included in the FMOLS and DOLS models are integrated at the order I (1) as confirmed by [4, 13, 14, 44].

3.2. Johansen Cointegration Test Results

Table 3 presents the Johansen Cointegration test results. The Johansen Cointegration test was used to test cointegrating relationships between Indonesia's cocoa exports, cocoa productivity, Indonesia's cocoa production, Indonesia's cocoa supply, world cocoa prices, population, and foreign direct investment inflows and to determine the cointegrating rank of the FMOLS and DOLS models [27].

Table 3. Johansen Cointegration Analysis.

Hypothesis	Trace statistic	5% Critical value	p-value
None*	220.4802***	159.5297	0.0000
At most 1*	152.1792***	125.6154	0.0004
At most 2*	107.6600***	95.7536	0.0059
At most 3*	75.2273**	69.8188	0.0173
At most 4*	49.1178**	47.8561	0.0379

Hypothesis	Trace statistic	5% Critical value	p-value
At most 5*	31.1779**	29.7970	0.0345
At most 6*	16.6873**	15.4947	0.0329
At most 7	3.4503	3.8414	0.0632
Hypothesis	Max-eigen statistic	5% critical value	p-value
None*	68.3010***	52.3626	0.0006
At most 1	44.5192	46.2314	0.0755
At most 2	32.4326	40.0775	0.2799
At most 3	26.1095	33.8768	0.3141
At most 4	17.9398	27.5843	0.5002
At most 5	14.4905	21.1316	0.3262
At most 6	13.2369	14.2646	0.0722
At most 7	3.4503	3.8414	0.0632

Source: Authors' computation (2024). Trace and Max-eigenvalue tests indicate 7 & 1 cointegrating eqn (s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level. Note: *, **, and *** are significant at 10%, 5% and 1% significance level.

Table 3 demonstrates that there are at most seven cointegrating vectors that can be established at a 5% significance level among the selected variables, as indicated by the Trace statistic. The Maximum Eigenvalue statistic indicates that only one cointegrating equation is significant at a 5% significance level. The Trace statistic value of 220.4802 exceeds the 0.05 critical value of 159.5297, with a p-value of 0.000, below the 0.05 threshold. Similarly, the Max-eigen statistic of 63.30105 surpasses its critical value of 52.36261, with a p-value of 0.0006. These results suggest rejecting the null hypothesis, indicating a cointegrated equation and cointegration among the variables. The null hypothesis for at most 6* in the trace statistic, with a value of 16.68733, is higher than the 0.05 critical value of 15.49471, and has a p-value of 0.0329, also below 0.05, implying more than six cointegrating equations. However, the null hypothesis for at most 1 eigenvalue is supported, as the maximum eigenvalue (45.51924) is lower than the critical value (46.23142) and has a p-value of 0.0755,

above 0.05. Thus, we cannot reject this null hypothesis, indicating the maximum eigenvalue statistic is insignificant [51]. Ultimately, we reject the hypothesis, as both the trace and maximum eigenvalue statistics exceed the 5% critical value from none to at most 6* in the trace statistic and at none* in the maximum eigenvalue statistic, suggesting cointegration in the equation and among the variables [30].

3.3. Estimated Results of FMOLS and DOLS

Table 4 presents the estimated results of Indonesia's cocoa exports and its explanatory variables in FMOLS and DOLS models. The R^2 of FMOLS estimates was 0.95, meaning that 95% of the variables were well explained by the model only 5% were not explained, while in DOLS, the R^2 value was 0.99, which indicates that only 1% was not explained by the model.

Table 4. Estimated Results of FMOLS and DOLS.

Variables	FMOLS		DOLS	
	Coefficient	Standard Error	Coefficient	Standard Error
lnCPY (kg/ha)	10.4350**	4.978	44.0780*	6.810
lnDCP (ton)	0.7800***	0.053	0.6611**	0.030
lnEXC (IDR)	0.0070*	0.004	0.0290*	0.003
lnDCS (ton)	-0.7240***	0.073	-1.0970**	0.053
lnWKH (USD)	0.0170	0.031	0.2491*	0.034

Variables	FMOLS		DOLS	
	Coefficient	Standard Error	Coefficient	Standard Error
lnPOP (people)	0.0650	1.548	-0.4810	1.338
lnFDI (USD)	0.0010	0.001	0.0010	0.000
Constant	-163.4870	273.767	-2015.690*	257.354
R-squared	0.95		0.99	

Source: Authors' computation (2024). Note: *, **, and *** are significant at 10%, 5% and 1% significance level.

The results in Table 4 show that cocoa productivity has a statistically significant relationship with Indonesia's cocoa exports at 5% significance level in FMOLS and 10% significance level in DOLS. This indicates that a unit increase in cocoa productivity will cause cocoa exports to increase by 10.43% and 44.08% holding other factors constant. Higher productivity can lead to increased cocoa export volume, as more cocoa beans are available for export [17, 50]. This is due to sustainable farm management practices such as cocoa farm rehabilitation and regular farm maintenance contribute to higher productivity leading to an increase in cocoa export volumes and values in Indonesia. A similar finding was reported by [33] who reported that cocoa farm rehabilitation increases cocoa yields which results in increases in Ghanaian cocoa export volume.

In addition, domestic cocoa production also positively and significantly affected Indonesia's cocoa exports at 1% and 5% significance levels in FMOLS and DOLS models, respectively. A unit increase in domestic cocoa production causes Indonesia's cocoa exports to increase by 78% and 66% respectively holding other variables constant. This indicates that Indonesia has a comparative advantage in cocoa production over other countries by allocating scarce resources to produce cocoa beans efficiently and sufficiently [50]. This makes cocoa beans more available for the consumer market internationally due to the sustainable cocoa production at the producer level. This finding is in line with the findings of [3] that cocoa production is one of the main determinants of export in Indonesia. Similarly, [20, 21, 40, 48, 53] found that cocoa production increases cocoa bean export volume in Indonesia.

The exchange rate was positive and had a statistically significant effect on Indonesia's cocoa export volume at a 10% significance level in FMOLS and DOLS. The results show that a unit increase in the exchange rate caused Indonesia's cocoa exports to rise by 0.01% and 3% ceteris paribus. This is because the exchange rate is an important price that is determined by the demand and supply balance in the competitive market, and it is also the basis used to compare world prices of cocoa in the European market. The findings reveal that the Indonesian domestic currency (Rupiah) keeps depreciating against the US dollar which makes the price of Indonesian cocoa beans cheaper and eventually increases the high

demand for Indonesian cocoa beans in the international market. This has led to an increase in cocoa exports confirmed by [21, 48, 56].

Domestic cocoa supply negatively and significantly affected Indonesia's cocoa exports at 1% and 5% significance levels in FMOLS and DOLS, respectively. An increase in one unit of domestic cocoa supply leads to a reduction in Indonesian cocoa exports by 72.4% and 100% all things being equal. Domestic supply is greatly influenced by price in any commodity market, motivating producers to increase production and sales. In this study, the negative relationship between domestic supply and cocoa exports indicates that cocoa producers receive low prices for their cocoa beans in the domestic market. As domestic prices increase, producers tend to prioritize supplying and selling more to the domestic market rather than exporting, leading to a decline in exports. The findings are consistent with the findings of [16, 57] domestic supply decreased due to low domestic prices resulting in a decline in cocoa exports.

World cocoa price has positively and significantly affected Indonesia's cocoa exports at a 10% significance level in DOLS. A unit increase in world cocoa price increased Indonesia's cocoa exports by 0.25 USD. International market price is one the main determinants of commodity demand and supply, an increase in the world cocoa price will cause the domestic cocoa exports to increase and vice versa [50]. The finding is affirmed by [22, 24, 34, 53] that world cocoa prices increased Indonesia's cocoa export volume.

4. Conclusion and Recommendation

4.1. Conclusion

Cocoa is an important cash crop for majority of the Indonesian farmers. The crop is produced and exported to other countries, thereby contributing significantly to the GDP of Indonesia. Cocoa production has created jobs, improved the living standards of farmers, among other benefits. The study examined the determinants of cocoa exports through the analysis of FMOLs and DOLS using time series data from 1990 to 2022. From the empirical testing of the variables

with ADF and PP stationary unit roots and Johansen cointegration to check the cointegrating among the selected variables. The results of the Johansen cointegration analysis suggest the existence of a cointegration relationship among the eight variables, indicating the presence of long-run relationships among the variables. The estimated results depicted that cocoa productivity, domestic cocoa production, domestic cocoa supply, exchange rates, and world cocoa prices affect Indonesian cocoa exports.

Based on the estimated results, the study draws a conclusion that cocoa productivity, domestic cocoa production, exchange rates, and world cocoa prices positively and statistically significantly influenced cocoa exports while domestic cocoa supply negatively affected Indonesian cocoa exports.

4.2. Recommendation

The study recommends that the Indonesian government should stabilize exchange rates, to avoid its fluctuation. Cocoa production and productivity should be enhanced through intensification and extensification programs, including input subsidies, farm incentives, and rehabilitation projects, extension service provision, adoption of improved and hybrid varieties, among others. Increasing domestic producer prices can also boost the supply of cocoa beans.

4.3. Study Limitation and Areas for Further Studies

This study focused on cocoa productivity, domestic production, domestic supply, exchange rates, world prices, population, and foreign direct investment, without considering the area under cultivation, which may affect exports, domestic prices, and other macroeconomic indicators like GDP, inflation, and the consumer price index. Data on domestic cocoa prices, demand, and consumption were inaccessible. Future research should examine the impact of cultivation area, productivity, production, domestic price, export volume, exchange rates, international prices, export taxes, economic distance, and GDP per capita on export value.

Abbreviations

USD	United States Dollar
GDP	Gross Domestic Product
IDR	Indonesian Rupiah
FMOLS	Fully Modified Ordinary Least Squares
DOLS	Dynamic Ordinary Least Squares
ADF	Augmented Dickey-Fuller
PP	Philips-Perron
ICCO	International Cocoa Organization
FAOSTAT	Food and Agriculture Organization Statistics
OLS	Ordinary Least Squares

Ethical Clearance

The study used secondary data. Ethical clearance is not applicable

Author Contributions

John Atsu Agbolosoo: Conceptualization, Formal analysis
Dick Chune Midamba: Writing – original draft
Ibrahim Massaquoi: Writing-Review and editing
Ratna Mega Sari: Writing-Review and editing

Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflict of Interest.

References

- [1] Abdlaziz, R. A., Naseem, N. A. M., & Slesman, L. (2018). Dutch Disease Effect of Oil Price on Agriculture Sector: Evidence from Panel Cointegration of Oil Exporting Countries. *International Journal of Energy Economics and Policy*, 8(5), 241–250. <https://www.econjournals.com>
- [2] Abukari, A., & Cunfeng, T. (2021). The Export Competitiveness of Ghana's Cocoa Industry in West Africa. *Journal of Agricultural Science*, 13(3), 80–92. <https://doi.org/10.5539/jas.v13n3p80>
- [3] Andriyani, D., & Septiani, M. (2023). Key factors analysis in optimizing Indonesian cocoa exports. *International Proceeding Journal on Finance, Economics, and Management*, 1(1), 1–10.
- [4] Apergis, N., Filippidis, I., & Economidou, C. (2007). Financing Deepening and Economic Growth Linkages: A Panel Data Analysis. *Review of World Economics*, 179–198.
- [5] Athukorala, P. chandra, & Kohpaiboon, A. (2011). Australian–Thai Trade: Has the Free Trade Agreement Made a Difference? *Australian Economic Review*, 44(4), 457–467. <https://doi.org/10.1111/J.1467-8462.2011.00658.X>
- [6] Balassa, B. (1978). Exports and economic growth: Further evidence. *Journal of Development Economics*, 5(2), 181–189. [https://doi.org/10.1016/0304-3878\(78\)90006-8](https://doi.org/10.1016/0304-3878(78)90006-8)
- [7] Batila, N. K. P. G., & Bongo, K. G. (2021). The Role of the Quality of Institutions in the Financial Development of CEMAC Countries. *Modern Economy*, 12(02), 452–468. <https://doi.org/10.4236/me.2021.122023>
- [8] Bellocchi, A., Sanchez Carrera, E. J., & Travaglini, G. (2021). What drives TFP long-run dynamics in five large European economies? *Economia Politica*, 38(2), 569–595. <https://doi.org/10.1007/s40888-021-00215-x>

- [9] BPS. (2022). Cocoa statistics in Indonesia. <https://go.id/id/publication/2023/11/30/ef4419ba62ec7d4490218e/statistik-kakao-indonesia-2022.html>
- [10] Coulibaly, S. K., & Erbao, C. (2019). An empirical analysis of the determinants of cocoa production in Cote d'Ivoire. *Journal of Economic Structures*, 8(5), 1–19. <https://doi.org/10.1186/s40008-019-0135-5>
- [11] Darhyati, A. T., Suharno, S., & Rifin, A. (2017). Impact of Non-Tariff Measure on Indonesian Cacao Exports. *International Journal of Agriculture System*, 5(2), 175–184. <https://doi.org/10.20956/ijas.v5i2.1191>
- [12] David, B. (2013). Competitiveness and determinants of cocoa exports from Ghana. *International Journal of Agricultural Policy and Research*, 1(9), 236–254.
- [13] Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with unit root. *Journal of the American Statistical Association*, 427–431.
- [14] Dritsakis, N. (2004). Tourism as a long-run economic growth factor: An empirical investigation for Greece using causality analysis. *Tourism Economics*, 10(3), 305–316. <https://doi.org/10.5367/0000000041895094>
- [15] Duron, M. J. J. U., Manalo, M. P. I. S., Reyes, A. M. C., & Rosete, M. L. (2022). Trading Policy Analysis of the Cocoa Industry in Indonesia. *International Journal of Social and Management*, 3(1), 32–62.
- [16] Duron, M., Manalo, M., Reyes, M. C., & Rosete, M. (2022). Trading Policy Analysis of the Cocoa Industry in Indonesia. *International Journal of Social and Management Studies*, 3(1), 32–62.
- [17] Fahmid, I. M., Harun, H., Fahmid, M. M., Saadah, & Busthanul, N. (2018). Competitiveness, production, and productivity of cocoa in Indonesia. *IOP Conference Series: Earth and Environmental Science*, 157(1), 1–6. <https://doi.org/10.1088/1755-1315/157/1/012067>
- [18] FAOSTAT. (2023). World Food and Agriculture – Statistical Yearbook 2023. FAO, Rome-Italy. <https://doi.org/10.4060/cc8166en>
- [19] FAOSTAT. (2024). Crops and Livestock Products. <https://fao.org/faostat/en/#data/QCL>
- [20] Fauzi, F. A., & Islami, S. I. (2022). Analysis of factors affecting the volume of Indonesian cocoa exports to the United States. *Jurnal Ilmiah Mahasiswa Fakultas Pertanian*, 2(2), 195–203. <https://doi.org/10.52045/jimfp.v2i2.348>
- [21] Feni, R., Marwan, E., Kesumawati, N., & Efendi, R. (2022). The Analysis of Factors Affecting Indonesian Cocoa Bean Exports. *International Journal of Multicultural and Multireligious Understanding*, 9(1), 377–384. <https://doi.org/10.18415/ijmmu.v9i1.3349>
- [22] Fisabilillah, L. W. P. (2023). Gorontalo Development Review Pola Kusalitas Harga International dan Ekspor Komoditas Kakao pada Perkebunan Indonesia Quality Trends in Cocoa Commodity Exports and Prices from Indonesia Plantations. *Gorontalo Development Review*, 6(1), 53–60.
- [23] Fudjaja, L., Ryadha, R., Saadah Saadah, Viantika, N. M., Ridwan, M., & Darma, R. (2024). Fostering cocoa industry resilience: A collaborative approach to managing farm gate price fluctuations in West Sulawesi, Indonesia. *Open Agriculture*, 9(1), 1–11. <https://doi.org/10.1515/opag-2022-0312>
- [24] Hadi, A. F., & Setyo, W. A. (2019). Analysis of factors affecting the value of export of Indonesian cocoa beans in 1996-2015. *Jurnal Ilmiah Bidang Ilmu Ekonomi*, 14(1), 16–30.
- [25] Hapsari, T. T., & Yuniasih, A. F. (2020). The determinant factors of Indonesian competitiveness of cocoa exports to Germany. *Jurnal Ekonomi Pembangunan*, 18(1), 75–84. <https://doi.org/10.29259/jep.v18i1.9978>
- [26] Heckscher, E., Ohlin, B., Flam, H., & Flanders, M. (1991). Heckscher-Ohlin Trade Theory.
- [27] Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52(2), 169–210.
- [28] Kao, C., & Chiang, M. H. (2001). On the Estimation and Inference of a Cointegrated Regression in Panel Data. *Advances in Econometrics*, 15, 179–222.
- [29] Krugman, P. (1987). The narrow moving band, the Dutch disease, and the competitive consequences of Mrs. Thatcher. Notes on trade in the presence of dynamic scale economies. *Journal of Development Economics*, 27(1–2), 41–55. [https://doi.org/10.1016/0304-3878\(87\)90005-8](https://doi.org/10.1016/0304-3878(87)90005-8)
- [30] Kulshrestha, D., & Agrawal, K. K. (2019). An econometric analysis of agricultural production and economic growth in India. *Indian Journal of Marketing*, 49(11), 56–65. <https://doi.org/10.17010/ijom/2019/v49/i11/148276>
- [31] Kustiari, R., & Hermanto, N. (2018). Impacts of Indonesia-India Free Trade Agreements on Agricultural Sector of Indonesia: A CGE Analysis. *Jurnal Agro Ekonomi*, 35(1), 33–48. <https://doi.org/10.21082/jae.v35n1.2017.33-48>
- [32] Kwaw-Nimeson, E., & Tian, Z. (2019). Impact Assessment of the Cocoa Rehabilitation Project on Cocoa Exports in Ghana. *Open Journal of Social Sciences*, 07(09), 207–219. <https://doi.org/10.4236/jss.2019.79015>
- [33] Latansha, F., Barokatumnalloh, B., Badriah, L. S., & Suparjito, S. (2023). Analysis Of Factors Affecting Cocoa Bean Exports in Indonesia. *Midyear International Conference (Myic)*, 2(6), 784–808.
- [34] Lustrilanang, P., Suwarno, Darusalam, Rizki, L. T., Omar, N., & Said, J. (2023). The Role of Control of Corruption and Quality of Governance in ASEAN: Evidence from DOLS and FMOLS Test. *Cogent Business and Management*, 10(1), 1–17. <https://doi.org/10.1080/23311975.2022.2154060>
- [35] Maeso-Fernandez, F., Osbat, C., & Schnatz, B. (2004). Towards the Estimation of Equilibrium Exchange Rates for CEE Acceding Countries: Methodological issues and a panel cointegration perspective. papers.ssrn.com/sol3/papers.cfm?abstract_id=533022

- [36] Mark, C. N., & Sul, D. (2003). Cointegration Vector Estimation by Panel DOLS and Long-run Money Demand. *Oxford Bulletin of Economics and Statistics*, 65(5), 655–680. <https://doi.org/10.1111/j.1468-0084.2003.00066.x>
- [37] Miroudot, S. (2020). Reshaping the policy debate on the implications of COVID-19 for global supply chains. *Journal of International Business Policy*, 3(4), 430–442.
- [38] Munshi, S.A., Das, A., Shivaswamy, G., Devi, M.C.A., Subash, S., Jeyakumar, S., & Sivaram, M. (2024). Socio-economic Impact of COVID-19 Pandemic on Dairy Farm Households in West Bengal State. *Indian Journal of Animal Sciences*, 94(2), 179–184. <https://doi.org/10.56093/ijans.v94i2.130041>
- [39] Nisa, D. P. J. I. N., Darsono, & Antriandarti, E. (2023). Determinants of Cocoa Bean Trade in the International Market: Gravity Model Approach. *International Journal of Sustainable Development and Planning*, 18(10), 3347–3356. <https://doi.org/10.18280/ijstdp.181035>
- [40] Nwachukwu, I. N., & Nwaru, J. C. (2015). Competitiveness and determinants of cocoa. *Report and Opinion*, 2(7), 51–54.
- [41] Olaoye, O. (2023). Environmental Quality, Energy Consumption and Economic Growth: Evidence from Selected African Countries. *Green and Low-Carbon Economy*, 2(1), 28–36. <https://doi.org/10.47852/bonviewGLCE3202802>
- [42] Parrinello, S. (1988). On Foreign Trade and the Ricardian Model of Trade. *Journal of Post Keynesian Economics*, 10(4), 585–601. <https://doi.org/10.1080/01603477.1988.11489711>
- [43] Pedroni, P. (2001). Fully Modified OLS for Heterogenous Cointegrated Panels. *Advances in Econometrics*, 15, 93–130.
- [44] Philips, P. C. B., & Hansen, B. E. (1990). Statistical inference in instrumental variable regression with I (1) processes. *The Review of Economic Studies*, 57(1), 99–125.
- [45] Philips, P. C. B., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, 75(2), 335–346.
- [46] Phillips, P. C. B., & Hansen, B. E. (n. d.). Estimation and Inference in Models of Cointegration: A Simulation Study. <https://www.researchgate.net/publication/4744422>
- [47] Prasetyo, A., Suswadi, & Aziez, A. F. (2021). Determinant factors to improve Indonesian cocoa performance. *IOP Conference Series: Earth and Environmental Science*, 892(1), 1–10. <https://doi.org/10.1088/1755-1315/892/1/012073>
- [48] Priyankara, E. (2018). The long-run Effect of Services Exports on Total Factor Productivity Growth in Sri Lanka: Based on ARDL, FMOLS, CCR, and DOLS Approaches. *International Journal of Academic Research in Business and Social Sciences*, 8(6), 74–92. <https://doi.org/10.6007/ijarbss/v8-i6/4180>
- [49] Putri, D., Ivo, J., Nisa, N., & Antriandarti, E. (2023). Determinants of Cocoa Bean Trade in the International Market: Gravity Model Approach. *International Journal of Sustainable Development and Planning*, 18(10), 3347–3356.
- [50] Putro, S. A. C., Yusalina, Y., & Winandi, R. (2023). Factors Affecting Export of Indonesian Cocoa Beans To Malaysia. *Jurnal Manajemen Dan Agribisnis*, 20(1), 90–101. <https://doi.org/10.17358/jma.20.1.90>
- [51] Rasheed, R. A., Emam, A., & Elmuthum, N. (2024). The Nexus between Some Agricultural Products and Economic Growth in Saudi. *Universal Journal of Agricultural Research*, 12(2), 249–261. <https://doi.org/10.13189/ujar.2024.120205>
- [52] Rosyidi, I. M., Irianto, H., & Purnomo, S. H. (2021). An Analysis of Factors Influencing Indonesia's Leading Agricultural Commodities Export to India. *Caraka Tani: Journal of Sustainable Agriculture*, 36(1), 135–143. <https://doi.org/10.20961/carakatani.v36i1.39366>
- [53] Sari, S. D. K., & Imaningsih, N. (2024). Effect of Production, Price, and Rupiah Exchange Rate on the Export Value of Cocoa Beans (HS 1801) in Indonesia. *Journal of Business Management and Economic Development*, 2(02), 501–511. <https://doi.org/10.59653/jbmed.v2i02.591>
- [54] Siagian, A., Supriana, T., & Iskandarini. (2024). Analysis of the Best Forecasting on Cocoa Production and Imports in Indonesia in 2022-2026 using the Triple Holt-Winters and ARIMA Methods Introduction. *Issue I Electronic Research Journal of Social Sciences and Humanities*, 6, 66–82. www.eresearchjournal.com
- [55] Sitepu, I., & Nainggolan, M. L. W. (2024). The Sustainability of Production and The US Dollar Exchange Rate Influence Indonesian Cocoa and Pepper Exports and Their Competitiveness. *IOP Conference Series: Earth and Environmental Science*, 1302(1), 1–7. <https://doi.org/10.1088/1755-1315/1302/1/012142>
- [56] Tsowou, K., & Gayi, S. K. (2019). Trade Reforms and Integration of Cocoa Farmers into World Markets: Evidence from African and non-African Countries. *Journal of African Trade*, 6(1–2), 16–29. <https://doi.org/10.2991/jat.k.190916.001>
- [57] Widayat, D. F., Anindita, R., & Setyowati, P. B. (2019). The Influence of Cocoa Price Volatility (Theobroma cacao L.) to Cocoa Exports in Indonesia. *Agricultural Social Economic Journal*, 19(2), 117–124. <https://doi.org/10.21776/ub.agrise.2019.019.2.6>
- [58] Wulandari, W. A., & Widjojoko, T. (2020). Analysis of Export Competitiveness of Indonesian Cocoa Beans in The International Market. *The 3rd International Conference on Multidisciplinary Approaches for Sustainable Rural Development*, 154–167.