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Indonesia's Coffee Export Dynamics: Exploring the Impacts of Climate, Trade, and Productivity

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ABSTRACT: As the fourth-largest coffee exporter worldwide, Indonesia contributes significantly to the global coffee trade while contending with challenges such as export volatility, trade barriers, and the impacts of climate change. This study aims to investigate the determinants of Indonesia's coffee exports, focusing on productivity, trade barriers, and climate variability. This study employed the Error Correction Model (ECM) to analyze time-series data from 1989 to 2022, sourced from the FAO, WITS, and the World Bank. The findings indicate that, in the long run, coffee imports, trade openness, and the extent of harvested land area are positively correlated with export performance, while export taxes and increasing land temperatures exert negative effects. In the short run, productivity is associated with increased exports, whereas land area appears to have a negative relationship. These findings suggest that addressing trade barriers, improving land management, and enhancing trade openness are essential for strengthening export competitiveness.

Keywords: Coffee export, Climate Changes, ECM, Productivity, Trade Barriers

***ABSTRAK**: Indonesia, sebagai pengekspor kopi terbesar keempat di dunia, memberikan kontribusi signifikan terhadap perdagangan kopi global meskipun menghadapi tantangan seperti volatilitas ekspor, hambatan perdagangan, dan dampak perubahan iklim. Penelitian ini bertujuan untuk mengkaji faktor-faktor penentu ekspor kopi Indonesia, dengan fokus pada produktivitas, hambatan perdagangan, dan variabilitas iklim. Penelitian ini menggunakan Error Correction Model (ECM) untuk menganalisis data deret waktu dari tahun 1989 hingga 2022, yang diperoleh dari FAO, WITS, dan World Bank. Hasil penelitian menunjukkan bahwa dalam jangka panjang, impor kopi, keterbukaan perdagangan, dan luas lahan panen berpengaruh positif terhadap kinerja ekspor, sementara pajak ekspor dan peningkatan suhu lahan memberikan dampak negatif. Dalam jangka pendek, produktivitas berpengaruh positif terhadap ekspor, sedangkan luas lahan menunjukkan hubungan negatif. Temuan ini mengindikasikan bahwa mengatasi hambatan perdagangan, meningkatkan pengelolaan lahan, dan memperkuat keterbukaan perdagangan sangat penting untuk memperkuat daya saing ekspor.*

***Kata Kunci:** Ekspor kopi, Perubahan iklim, ECM, Produktivitas, Hambatan perdagangan*

INTRODUCTION

Coffee is one of the most popular beverages worldwide and plays a significant role in culture and consumer preferences as part of lifestyle and social status (Hasanah & Prasetyanto, 2022). The majority of global coffee production occurs in countries located within the tropical regions known as the coffee bean belt, including Indonesia (Putro et al., 2024). According to the International Coffee Organization (ICO), coffee is one of the most widely traded agricultural commodities globally, serving as a crucial source of income for millions of smallholder farmers, particularly in low- and middle-income countries (ICO, 2022). n 2023, the top ten coffee-producing countries included Brazil, Vietnam, Colombia, Indonesia, and Ethiopia, with Brazil, Vietnam, and Colombia leading global production. These five countries accounted for approximately 70% of global coffee output, with Brazil alone contributing a significant share of around 40% in 2023. Coffee trade reached USD 36 billion in 2023, representing approximately 0.14% of global trade (OEC, 2023). The largest coffee importers are the United States, Germany, France, Italy, and Belgium, collectively importing coffee worth USD 13.81 billion in 2023 (ICO). Increasing coffee demand has driven massive production activities across the upstream and downstream sectors (Rahmah et al., 2023).

Indonesia's sub-tropical climate is highly suitable for cultivating plantation commodities such as coffee, palm oil, and other crops. Among Indonesia's plantation commodities, coffee and palm oil significantly contribute to national foreign exchange earnings through international trade (Sihotang et al., 2024). Indonesia ranks as the fourth-largest coffee exporter and producer globally, following Brazil, Vietnam, and Colombia. According to the International Coffee Organization (2021), Indonesia produces an average of 653,000 tons of coffee annually, representing approximately 7% of global coffee production. Between 2010 and 2019, Indonesia exported approximately 405,000 tons of coffee each year. The country's coffee production is predominantly robusta, accounting for 72.66% of output, while the remaining 27.34% is arabica (Center of Data and Information Ministry of Agriculture, 2021). Figure 1 illustrates the trends in Indonesia's coffee export and import data.

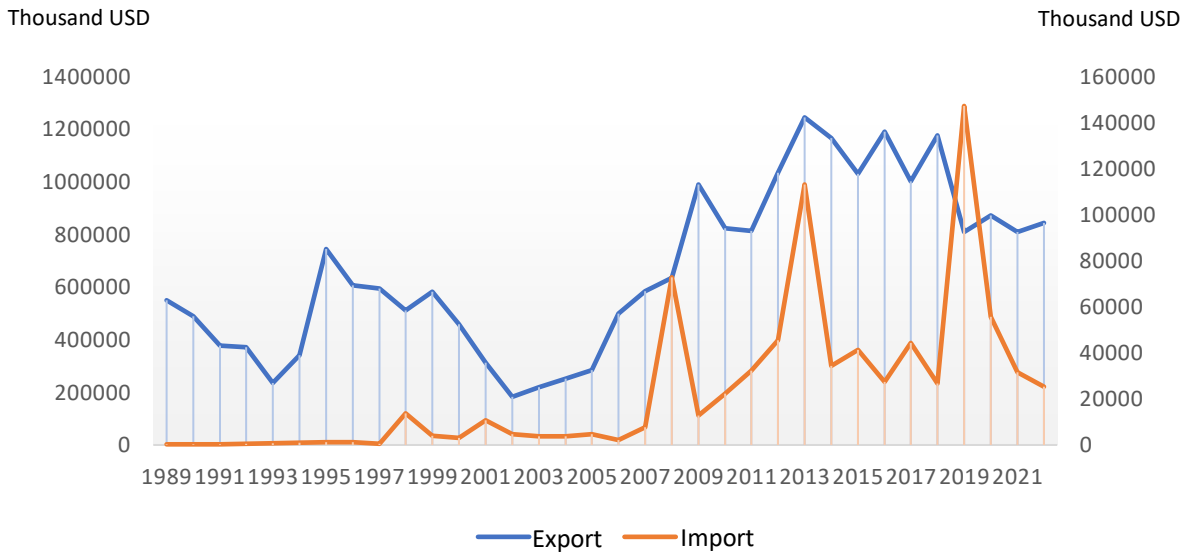

Figure 1. Trends in Indonesia's Coffee Exports and Imports 1989–2022 (in Thousand USD)
Source: *Food and Agriculture Organization* (FAO), 2024 (processed)

Figure 1 illustrates the performance of Indonesia's international coffee trade from 1989 to 2022. Based on empirical data, Indonesia's coffee exports over the past decade have been characterized by considerable fluctuations, driven by economic turbulence, the global pandemic, and heightened political and trade issues. Conversely, coffee imports have remained relatively low but experienced significant surges during certain years due to commodity crises caused by climate change, which disrupted domestic production and supply. These conditions necessitated large-scale imports to meet domestic demand.

Coffee is a crucial agricultural commodity that significantly contributes to Indonesia's foreign exchange earnings (Rahman et al., 2024). The majority of Indonesia's coffee production is exported to countries worldwide, while only a small portion is consumed domestically (Herdira & Hakim, 2021). According to the International Coffee Organization (2021), Indonesian coffee is exported to continents such as Asia, Africa, Australia, the Americas, and Europe. Major importing countries include the United States, Malaysia, Egypt, Spain, and Japan. Moreover, Indonesia's coffee trade balance consistently recorded a surplus for ten consecutive years (2010–2019), with an average annual surplus of USD 977.52 million (Pusdatin Pertanian, 2021). This indicates Indonesia's competitive advantage as a key exporter in the global coffee trade.

International trade, particularly exports, is inherently multidimensional and highly sensitive to various factors. According to Yoga et al., (2023) agricultural productivity is a critical factor that directly influences production volume and agricultural effectiveness. Lower agricultural productivity results in reduced domestic coffee supply, ultimately affecting the volume available for international markets. Widjaya et al., (2017) identified several factors impacting coffee farming efficiency and productivity, including land area, labor, fertilizer, seeds, and pesticides. Additionally, agricultural productivity is heavily influenced by climatic factors. Ebisa (2017) emphasized that air temperature, land temperature, and rainfall significantly affect agricultural commodity production.

Trade accession represents one of the primary efforts to normalize trade (Putro et al., 2024) and is largely influenced by national economic policies, such as trade openness. Fitriani et al. (2021), highlighted that trade openness encourages capital inflows into the country, representing a nation's heightened participation in international trade activities like exports and imports. Greater trade openness provides broader access to global markets, increasing demand for agricultural commodities and driving higher production and exports. However, international trade is also influenced by export taxes. Although designed to control domestic prices and protect local consumers, export taxes often reduce the competitiveness of Indonesian agricultural products in international markets by increasing prices, limiting their ability to compete with other producing countries (Gizaw et al., 2022). Such policies also diminish incentives for producers to improve efficiency or output, ultimately affecting overall export performance (Gebreyesus, 2015).

This study aims to analyze the determinants of Indonesia's coffee exports by examining three key aspects: productivity, trade barriers, and climate change. It also seeks to provide empirical insights into the inconsistencies in previous research findings on the impact of imports on exports across countries. Furthermore, the study explores the influence of climate change, specifically, land temperature variations and agricultural productivity on coffee export levels in both the short and long term, a topic that remains underexplored in prior research.

METHODS

This study aims to conduct a comprehensive analysis of the factors influencing coffee commodity exports in Indonesia. It seeks to examine the determinants of Indonesia’s coffee exports through three primary dimensions: productivity, trade barriers, and climate change. The study employs a quantitative approach, utilizing secondary data obtained from various sources such as the Food and Agriculture Organization (FAO), the World Integrated Trade Solution (WITS), and the World Bank, as detailed in the previous table. The data used in this research comprises time-series data at the national level for Indonesia, spanning the period from 1989 to 2022. Table 1 provides a detailed representation of the notations, variables, and data sources employed in this study.

Tabel 1. Notation, Description and Source of Data

Notation	Description	Unit	Source
EXP_t	Coffee export value at year t	USD	FAO (2024)
IMP_t	Coffee import value at year t	USD	FAO (2024)
TO_t	Trade openness at year t	Percentage	WDI (2024)
$LAND_t$	Harvested land area of coffee plantations at year t	Hectare	FAO (2024)
$PROD_t$	Coffee agricultural productivity at year t	Ton/hectare	FAO (2024)
TAX_t	Tax export at year t	% export value	WITS (2024)
$TEMP_t$	Changes in agricultural land temperature at year t	°Celcius	FAO (2024)

Note: FAO is Food and Agriculture Organization, WDI is World Development Indicators, and WITS is World Integrated Trade Solution.
Source: Data processed 2024

To explain the relationship between trade openness, productivity, trade barriers and coffee export in Indonesia, this study uses a quantitative approach using one of the econometric methods, namely the Engle-Granger Error Correction Model. The Engle-Granger Error Correction Model is used to carry out the analysis process because this model is able to provide complete information about the dynamic short-term and long-term relationships between variables integrated with the research model (Salmon, 1988). The basic model, or long-term capital of Engle-Granger ECM, is formulated as follows.

$$Log(EXP_t)= \alpha + \beta_1 Log(IMP_t) + \beta_2 Log(TO_t) + \beta_3 Log(LAND_t)+ \beta_4 Log(PROD_t) + \beta_5 Log(TAX_t) + \beta_6 Log(TEMP_t) + \varepsilon_t \quad (1)$$

Next, the basic model is converted into an error correction model, or a short-term model, as follows:

$$D(Log(EXP_t))= \alpha + \alpha_1 D(Log(IMP_t)) + \alpha_2 D(Log(TO_t)) + \alpha_3 D(Log(LAND_t)) + \alpha_4 D(Log(PROD_t)) + \alpha_5 D(Log(TAX_t)) + \alpha_6 D(Log(TEMP_t)) + \varepsilon_t \quad (2)$$

Where Log represents the natural logarithmic transformation, α denotes the constant, EXP refers to the value of Indonesia's coffee exports, IMP is the value of coffee imports, TO indicates trade openness, LAND represents the area of coffee plantations, PROD is the productivity of coffee commodities, TAX corresponds to export taxes, and TEMP captures changes in agricultural land temperature. The variable t denotes the time period, ε represents the error term,, β_1,β_2,β_3, β_4, β_5, are parameters for the long-term model, α_1, α_2, α_3, α_4, α_5, are parameters for ECM, D adalah the difference between observations N_t to observation N_{t-1}.

The conditions of the Engle-Granger Error Correction model are (1) all variables are notstationary at the level, I (0); (2) all variables are stationary at the first difference, I(1); (3) all variables must be integrated together (cointegration), (4) and in the short-term estimation model the value of ECT(-1) must be negative and significant (Gujarati. D. N., 2004). The stationary test was performed using the Augmented Dickey-Fuller Unit Root Test (ADF) and the cointegration test was performed using the Engle-Granger Cointegration test for residues. The Engle and Granger cointegration test is carried out by running the basic model using OLS, and then testing whether the residuals in the estimated equation are stationary at the level or first difference using the Augmented Dickey Fuller test (Dickey & Fuller, 2012). If the residual is stationary at the level, I(0), it indicates that the variables in the integrated model or all variables in the model have a long-term relationship or long-term equilibrium relationship between the variables in the model. If these three conditions are met, ECM analysis can be used. Specifically, in estimating the relationship of economic variables there are often shock conditions, especially in the short term, which can cause disequilibrium, the Engle-Granger ECM model is used to detect how much and quickly the adjustment of the short-term relationship of cointegrated variables to return to equilibrium conditions (Studentmund, 2016).

According to Wooldridge (2013), ensuring the validity of an econometric model requires it to be free from violations of classical assumptions. Classical assumption testing is essential to confirm the

validity and reliability of coefficient estimates. As outlined by Gujarati et al., (2010), these tests include evaluations for normality, multicollinearity, heteroskedasticity, and autocorrelation.

RESULTS AND DISCUSSIONS

Indonesia occupies a pivotal role in the global coffee trade as the fourth-largest exporter and producer, following Brazil, Vietnam, and Colombia. Nevertheless, in recent years, the value of Indonesian coffee exports has demonstrated considerable volatility, characterized by a declining trend alongside significant surges in import levels during specific periods. This empirical observation underscores a critical paradox: despite its status as one of the world's leading coffee exporters and producers, Indonesia remains constrained by persistent challenges related to the instability and unpredictability of its annual export performance.

Table 2 provides descriptive statistics, including mean, median, maximum, minimum, and standard deviation (Std. Dev). Mean and Std. Dev are presented for determining the range and coverage of the data. EXP_t, IMP_t, TO_t, $LAND_t$, $PROD_t$, TAX_t, and $TEMP_t$ have a higher value of Std. Dev than mean, which implies that data for these variables are variance.

Tabel 2. Descriptive Statistics.

Variable	Mean	Median	Maximum	Minimum	Std. Dev
$Log(EXP_t)$	13.280	13.305	14.034	12.117	0.541
$Log(IMP_t)$	8.872	9.110	11.899	5.677	1.835
$Log(TO_t)$	3.943	3.953	4.566	3.496	0.209
$Log(LAND_t)$	13.893	14.031	14.139	13.482	0.232
$Log(PROD_t)$	8.588	8.595	8.723	8.374	0.083
$Log(TAX_t)$	-1.174	-1.252	1.195	-4.056	1.427
$Log(TEMP_t)$	-0.778	-0.634	0.326	-3.411	0.793

Source: Data Processed, 2024

Furthermore, Table 3 reveals a correlation matrix where all variable values remain below the critical thresholds of 0.8 or 0.9. This suggests that multicollinearity is not a concern among the independent variables, as such thresholds are commonly cited in the literature as indicators of problematic multicollinearity. The absence of excessively high correlations ensures the stability and reliability of the regression coefficients, thereby preserving the robustness and interpretability of the model. Consequently, the variables are deemed appropriate for inclusion in subsequent regression analyses.

Table 3. Correlation Matrix

	$Log(EXP_t)$	$Log(IMP_t)$	$Log(TO_t)$	$Log(LAND_t)$	$Log(PROD_t)$	$Log(TAX_t)$	$Log(TEMP_t)$
$Log(EXP_t)$	1.000						
$Log(IMP_t)$	0.608	1.000					
$Log(TO_t)$	-0.573	-0.404	1.000				
$Log(LAND_t)$	0.238	0.771	-0.320	1.000			
$Log(PROD_t)$	0.476	0.109	-0.416	-0.274	1.000		
$Log(TAX_t)$	0.582	0.595	-0.067	0.300	0.196	1.000	
$Log(TEMP_t)$	0.324	0.703	-0.294	0.664	-0.021	0.184	1.000

Source: Data Processed, 2024

The significant role of Indonesia as the fourth largest coffee exporter highlights its crucial position in global agricultural trade. Indonesia faces multifaceted challenges in sustaining its export performance, particularly due to the impacts of climate change, trade barriers, and agricultural productivity limitations. The increasing variability in land temperatures and rainfall patterns poses significant risks to coffee yields and long-term agricultural stability, even if their immediate statistical effects appear negligible. Trade barriers, notably export taxes, exacerbate production costs and undermine the international competitiveness of Indonesian coffee, thereby restricting access to global markets and discouraging innovation among producers. While trade openness facilitates greater market integration, inefficiencies in infrastructure and supply chain management significantly hinder Indonesia’s ability to optimize its export potential. Furthermore, the limited adoption of advanced

agricultural technologies constrains productivity growth, despite the relatively stable availability of arable land. Addressing these challenges requires a comprehensive approach that prioritizes climate adaptation strategies, reforms in trade policies to alleviate fiscal burdens, investments in modern farming techniques, and improvements in trade infrastructure to enhance efficiency and competitiveness. Such measures are critical for ensuring the resilience, sustainability, and long-term stability of Indonesia's agricultural export sector

Table 4. Estimation of Error Correction Model

Variable	Long-run Model	Short-run Model
Constant	12.1651	0.5368
	(8.4819)	(0.7205)
Log(IMP_t)	0.1608**	-0.0349
	(0.0737)	(0.0437)
Log(TO_t)	0.0204***	-0.0049
	(0.0060)	(0.0055)
Log($LAND_t$)	1.0676**	-1.3146***
	(4.7707)	(0.4244)
Log($PROD_t$)	0.2367	1.1583***
	(0.9501)	(0.1789)
Log(TAX_t)	-0.1361**	0.0773
	(0.0542)	(0.0873)
Log($TEMP_t$)	-0.0215***	-0.0058*
	(0.0065)	(0.0447)
ECT (-1)		-0.5260***
		(0.1763)
R-square	0.7195	0.4641
Adjusted R-square	0.6571	0.3141
F-statistics	11.5407***	3.0931***
	Classical Assumption	
Reset Test	5.0970 (0.0326)	
Normality	3.0959 (0.2126)	
Heteroskedasticity test	3.7907 (0.8035)	
Breusch–Godfrey LM test	3.6716 (0.0299)	

Notes: *, **, and *** = significant at 10%, 5%, and 1%.
Source: Data Processed, 2024

The results of the error correction model estimation, as presented in Table 4, provide significant insights into the long-run and short-run dynamics influencing coffee exports in Indonesia. In the long-run model, several variables exhibit statistically significant effects at varying levels of significance. The coffee import, trade openness, dan harvested land area, positively influence coffee exports, with coefficients of 0.1608, 0.0204, and 1.0676, respectively, indicating that increases in imports, trade openness, land area, and export taxes contribute positively to export performance. Among these, trade openness is the most significant variable, highlighting its critical role in fostering market integration and enhancing export growth. Conversely, land temperature and tax as proxy of trade barrier negatively affects coffee exports, with a coefficient of -0.0215, and -0.1361 respectively, reflecting the detrimental effects of rising land temperatures on agricultural stability and productivity.

In the short-run model, the Error Correction Term (ECT) is highly significant, with a coefficient of -0.5260, indicating the model's stability and showing that deviations from the long-run equilibrium are corrected by approximately 52.6% in each period. Harvested land area and productivity are particularly influential in the short term, with coefficients of -1.3146 and 1.1583, respectively, revealing that land

area negatively impacts exports in the short term, while productivity has a significant positive effect. The consistent short-run and long-run influence of key variables underscores the importance of addressing both structural and immediate challenges in the coffee export sector. The coefficient of ECT_{t-1} shows the speed of adjustment toward equilibrium and negative sign and statistically significant implies a convergence from short run to long run. The speed is 0.5260 means that 52.60% of this disequilibrium is corrected within 1 year.

The models demonstrate strong explanatory power, with R-square values of 0.7195 for the long-run model and 0.4641 for the short-run model, confirming the robustness of the findings. The empirical results confirm that the model satisfies the classical assumptions, as evidenced by passing the tests for normality, heteroskedasticity, autocorrelation (Breusch-Godfrey LM test), and functional form validity (RESET test), ensuring the reliability and robustness of the regression estimates for research modelling. These findings collectively emphasize the critical role of trade openness, environmental factors, and land productivity in shaping the performance of Indonesia's coffee exports both in the short and long run.

This study provides a comprehensive analysis of the factors influencing Indonesia's coffee exports, highlighting both consistencies with existing theoretical frameworks and new perspectives that challenge established assumptions. The significant and positive effect of imports on exports underscores the interconnected nature of domestic and international trade. Tekaligne (2009) emphasizes that imports can enhance export capabilities by addressing domestic consumption needs, enabling the production of value-added goods that cater to international markets. In Ethiopia, for instance, the export of coffee was found to be influenced not only by the availability of imports but also by institutional quality, infrastructure efficiency, domestic income levels, and external market accessibility. These findings align with the theory of trade complementarity, which posits that strategic imports can facilitate the growth of export-oriented industries through resource optimization and technological integration.

The positive and significant impact of trade openness on coffee exports reflects the fundamental principles of trade liberalization. Greater openness enables economies to integrate more effectively into global markets, enhancing their export performance by reducing barriers and fostering competitive advantages. (Prilliadi & Birinci, 2023) supported this finding in their analysis of Indonesian coffee exports to the United States, identifying trade openness as a key determinant of export growth. Usman (2014) further supports this perspective by illustrating how the reduction of tariff and non-tariff barriers through trade liberalization improves market access, increases competitiveness, and drives export expansion. These findings are consistent with the endogenous growth theory, which highlights the role of openness in fostering innovation, efficiency, and economic diversification, thereby strengthening the export sector

. In the short run, import levels and trade openness may not significantly affect coffee exports due to the structural nature of coffee production and export contracts. Coffee is typically cultivated under long-term cycles and bound by pre-negotiated export agreements, limiting its immediate responsiveness to changes in import flows or trade policy liberalization. Moreover, short-run export performance is more influenced by factors such as harvest yield, global coffee prices, and supply-side capacity rather than macroeconomic openness. Thus, while trade openness can facilitate long-term market integration, its impact on coffee exports tends to be delayed and less observable in the short term.

Conversely, the study reveals a negative and significant relationship between export taxes and coffee export While export taxes are often implemented to stabilize domestic prices and protect local consumers, their unintended consequence is a reduction in the competitiveness of agricultural products in international markets. Gizaw et al., (2022) argue that export taxes elevate production costs, leading to higher prices for exported goods, which in turn reduces demand and weakens competitiveness. Beckman et al., (2019) highlight that such policies also discourage innovation and efficiency among producers, further constraining export performance. For Indonesia’s coffee sector, the imposition of export taxes places additional financial burdens on producers and exporters, limiting their ability to compete with dominant global exporters such as Brazil and Vietnam.

In the short run, export taxes do not significantly affect coffee exports primarily because of the inelastic supply response and the prevalence of forward contracts in the coffee trade. Exporters often operate under fixed delivery obligations and predetermined prices, which buffer short-term fluctuations in policy such as tax adjustments. Additionally, coffee production involves long gestation periods and substantial sunk costs, making producers less responsive to marginal changes in export profitability in the immediate term. Consequently, the imposition of export taxes may not lead to a measurable decline in export volumes in the short run, as producers prioritize fulfilling existing contracts and maintaining market relationships over reacting to transient policy shifts.

The positive and significant effect of land area on coffee exports underscores the importance of agricultural resources in shaping export performance. Nugroho & Lakner (2022) emphasize that the expansion of plantation areas directly contributes to increased production volumes, which in turn enhance export capacity. Furthermore, Amrulloh et al., (2020) note that the quality of agricultural land significantly influences the competitiveness of coffee exports, as fertile land allows for the production of higher-quality coffee that meets international standards. This finding aligns with the resource-based view, which posits that the abundance and quality of natural resources provide a competitive edge in international markets. In Indonesia, the substantial allocation of land for coffee cultivation serves as a critical driver of export success, particularly for robusta coffee, which dominates production.

Interestingly, the study finds that agricultural productivity does not significantly affect coffee exports in the long run, suggesting that Indonesia's competitiveness in global coffee markets is more reliant on quality than on quantity. However, in the short run, agricultural productivity shows a negative relationship with coffee exports, indicating that fluctuations in productivity levels may temporarily disrupt export performance. This finding aligns with the argument that short-term variations in productivity can create instability in supply chains, leading to challenges in meeting export demand. Lestari and Anindita (2018) argue that Indonesia’s coffee exports are driven primarily by competitive and comparative advantages rooted in quality differentiation, which are less sensitive to short-term productivity shifts. Similarly, Purwawangsa et al., (2024) found that the revealed comparative advantage (RCA) of Indonesian coffee lies in its inherent quality characteristics rather than in production scale, further underscoring the limited long-term role of productivity in export performance.

The study also highlights that changes in land temperature have no significant effect on coffee exports in the long run, suggesting a degree of resilience in Indonesia’s coffee sector to climate variability. However, in the short run, the results indicate a negative relationship between land temperature changes and exports. This finding suggests that short-term climatic fluctuations, such as sudden increases in temperature, may adversely impact coffee production and, consequently, export volumes. These effects are consistent with studies such as Purbantoro et al., (2024) which found that climate variability, including temperature and rainfall changes, disrupts agricultural productivity and export potential in the short term, Setiawan et al., (2023) further argue that sudden climatic shifts can exacerbate production risks, particularly for crops sensitive to environmental changes. In the case of Indonesia, while the dominant robusta variety exhibits a higher tolerance to temperature changes, short-term climatic disturbances may still affect harvesting cycles, bean quality, and supply chain stability, thus temporarily reducing export capacity. This short-term impact highlights the importance of adaptive agricultural practices and climate-resilient strategies to mitigate these negative effects and sustain export performance.

Building on these findings, it is crucial to emphasize the role of institutional support and policy coherence in addressing both short-term and long-term challenges to coffee export performance. The interplay between institutional frameworks and policy coherence plays a crucial role in addressing both short-term and long-term challenges in Indonesia’s coffee export sector while enhancing the competitiveness of Indonesian coffee in international markets. Strengthening cooperatives and trade associations can facilitate better coordination among stakeholders, including farmers, exporters, and policymakers, integrating smallholder farmers into global value chains and providing critical services such as capacity building, access to financial resources, and market intelligence. These institutions are vital for disseminating advanced climate-resilient technologies and improving productivity and quality, which are essential for competing with leading exporters such as Vietnam. Vietnam’s success in the

global coffee market is attributed to its consistent government support in mechanization, infrastructure development, and streamlined supply chains, areas where Indonesia can further improve. Beckman et al., (2019) highlight that robust institutional infrastructure not only fosters innovation but also reduces barriers to market entry, enhancing export volumes and quality.

Based on the short-run findings, it is advisable that policy interventions related to import regulation and trade openness be oriented toward long-term structural improvements rather than expecting immediate gains in coffee exports. Policymakers should focus on enhancing trade infrastructure, reducing non-tariff barriers, and strengthening international trade agreements to ensure that the benefits of openness are realized gradually through better market access and increased competitiveness. In the short run, efforts may be more effectively directed toward supporting productivity, quality improvement, and post-harvest handling, which have a more immediate impact on export performance than trade liberalization alone.

Policy coherence further bridges the gap between economic volatility and long-term sustainability by aligning trade liberalization measures with infrastructural investments, such as modernizing ports, establishing cold storage facilities, and improving transportation networks, which are critical for reducing logistical bottlenecks and maintaining product quality during export Gizaw et al., (2022) emphasize that reducing trade barriers, such as export taxes, should be complemented by fiscal incentives to encourage quality enhancement, technological upgrades, and compliance with international certifications, such as fair trade or organic labelling, which appeal to premium markets. Additionally, fostering public-private partnerships (PPPs) can mobilize resources for supply chain modernization and support the adoption of digital tools for precision agriculture and market analytics. By adopting these integrated strategies, Indonesia can strengthen its position in the global coffee market, leveraging its comparative advantages while addressing structural vulnerabilities and drawing lessons from other successful exporters like Vietnam to ensure stability and sustainable growth amidst evolving trade dynamics and environmental uncertainties.

CONCLUSIONS

This study comprehensively analyses the determinants of Indonesia's coffee exports using the Error Correction Model (ECM), providing insights into both long-run and short-run dynamics. In the long run, coffee imports, trade openness, and harvested land area positively influence exports, with trade openness emerging as the most critical factor in fostering market integration and export growth. Conversely, land temperature and export taxes negatively impact coffee exports, highlighting the detrimental effects of environmental and trade barriers. In the short run, harvested land area shows a negative effect, while productivity has a positive influence on export performance, reflecting the immediate structural and supply chain dynamics of the coffee sector. The study's findings, supported by robust statistical testing and satisfying classical assumptions, underscore the multidimensional nature of factors influencing coffee exports in Indonesia.

The findings offer nuanced theoretical and empirical contributions by distinguishing the short-run and long-run dynamics influencing coffee export performance. In the short run, the limited effect of trade openness and export taxes reflects the rigidity of agricultural supply, the role of fixed export contracts, and the time-bound nature of production cycles, suggesting that immediate policy shifts may have minimal impact. However, in the long run, the study confirms that trade openness enhances market access and competitiveness, aligning with theories of trade liberalization and comparative advantage. Meanwhile, environmental factors such as rising land temperature, alongside burdensome export taxes, pose significant structural challenges to sustained export growth. Therefore, policymakers should focus on long-term strategies such as reducing trade barriers, improving infrastructure, and investing in climate-resilient agricultural practices. These efforts must be accompanied by continuous productivity improvements and quality assurance measures to secure Indonesia's long-term competitiveness and sustainability in the global coffee market.

While the study provides valuable insights, it is limited by its reliance on secondary time-series data, which may not capture micro-level variables, such as farmer-level practices or regional disparities in coffee production. Furthermore, the model does not explicitly account for non-economic factors such as political stability or global market shocks, which could influence export performance. Future

research should consider integrating panel data analysis to explore regional variations and the role of institutional quality in shaping export outcomes. Additionally, more granular data on climate resilience strategies and their impact on productivity and exports would provide a deeper understanding of how the coffee sector can adapt to environmental challenges. Expanding the analysis to include comparative studies across other major coffee-exporting countries would also enrich the understanding of global trade dynamics.

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