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Research article

The bitter price of sweet chocolate: cocoa market integration amid global shifts

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Abstract

This study analyses vertical price transmission across the global cocoa, Indonesian export, and Indonesian farm-gate markets using monthly data from January 1994 to December 2024. Econometric diagnostics include Johansen cointegration, the vector error correction model (VECM), Granger causality, and the Chow breakpoint test. Johansen cointegration confirms a stable long-run equilibrium, but normalised estimates indicate a severe margin disparity, with farmers capturing only 48% of price changes, while exporters capture 94%. The VECM estimates reveal severe short-run price stickiness at the farm-gate level despite rapid adjustment behaviour at the export level. Granger causality confirms bidirectional feedback between global and export markets, but a strictly unidirectional flow from the farm-gate to the export level. The Chow breakpoint test confirms the absence of a structural break following the April 2010 progressive export tax policy, proving that domestic market rigidities and oligopsonistic structures were already deeply entrenched. Asymmetric price transmission isolates smallholders as price-takers, hindering United Nations Sustainable Development Goals 1 and 8. Policy interventions must prioritise transparent digital price-tracking systems, farm-gate price-floor mechanisms, and village-level fermentation infrastructure.

Keywords: Agricultural marketing, Cocoa, Indonesia, Global geopolitics, Vertical market integration.
JEL codes: Q11, Q13, Q17.

Highlights:

- Vertical cocoa price transmission exhibits severe short-run asymmetry despite stable long-run cointegration.
- Exporters rapidly adjust to global shocks, while farm-gate prices remain unresponsive.
- The April 2010 progressive export tax did not trigger a structural break.
- Fair value distribution requires tax reforms, transparent pricing, and post-harvest upgrades.

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1. Introduction

Geopolitical changes and global tensions significantly impact international trade and agricultural commodity markets, inducing high price volatility (Prasetyo *et al*., 2024; Sun *et al*., 2024). Global tensions in this study operationally encompass geopolitical conflicts, such as the Russo–Ukrainian war and the Iran–Israel crisis, that directly threaten critical maritime chokepoints like the Strait of Hormuz. Disruptions along these vital trading routes increase international shipping tariffs, restrict physical export supply flows, and trigger immediate surges in global agricultural commodity prices. Price volatility stemming from these geopolitical bottlenecks transmits downward through national borders, altering domestic pricing mechanisms and exposing smallholder farmers in developing nations to extreme market vulnerability.

The law of one price (LOP) serves as the foundational paradigm in spatial and vertical market integration literature, stating that price differences for a homogenous commodity across different levels should equal physical transaction costs (Ravallion, 1986). Competitive supply chains exhibit perfect vertical price integration, ensuring that price signals transmit rapidly and symmetrically between downstream exporters and upstream producers. Real-world agricultural markets frequently violate the LOP due to significant transaction costs, trade policies, and institutional bottlenecks. Asymmetric price transmission occurs when price increases and decreases do not propagate with the same speed, magnitude, or intensity. Downstream processors and exporters often exploit their market power within oligopsonistic structures to rapidly transmit global price decreases to local levels while delaying or withholding the transmission of global price surges. Transaction costs, including localised

transportation bottlenecks and asymmetric market information, further exacerbate this short-run price insulation of local producers, creating severe domestic market segmentation.

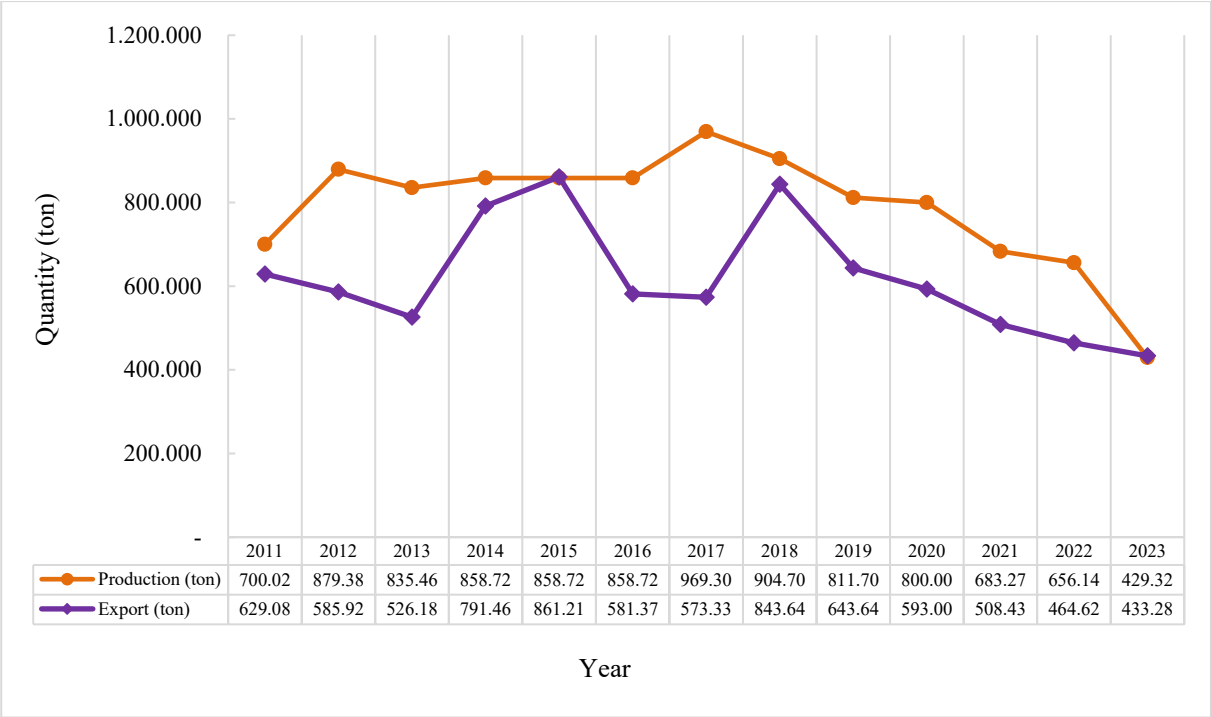
Indonesia represents a vital arena for examining these vertical price transmission dynamics due to its strategic position as the world's third largest cocoa producer (Pusat data dan Sistem informasi Pertanian [Indonesian Agricultural Data Center and Information System], 2022). The domestic cocoa value chain operates under highly vulnerable and multi-layered distribution channels, flowing from isolated smallholders through village collectors and larger intermediate traders to exporters or domestic grinding factories (Shoffiyati *et al*., 2023). Village collectors and local middlemen utilise their geographical dominance to establish localised oligopsonies, capturing the bulk of price premiums during global cocoa booms. Smallholder farmers function as weak price-takers due to severe credit constraints, limited storage facilities, and lack of direct market access.

Previous studies on cocoa market integration offer fragmented empirical evidence and exhibit critical methodological limitations. They often rely on nominal price series, ignoring inflation and exchange rate fluctuations that distort measured co-movements across different currency environments. In the past, researchers have frequently treated multi-decade timelines as homogeneous blocks, failing to test for structural breaks caused by major policy shifts. This study addresses these empirical gaps by analysing real cocoa prices deflated with agricultural sector and United States producer price indices. This investigation utilises Johansen cointegration, the vector error correction model (VECM), Granger causality, and the Chow breakpoint test to capture both short-run dynamics and long-run vertical integration parameters. Understanding these quantitative price relationships requires a comprehensive analysis of the broader global supply chain and macroeconomic policy shifts, which are detailed in Section 2.

2. Background of the global cocoa supply chain

Understanding vertical price transmission requires contextualising the commodity within the broader global supply chain and macroeconomic policies. The global cocoa supply chain is characteristically buyer driven, leaving smallholder farmers in the Global South with extremely weak bargaining power. Multinational processors and chocolate manufacturers retain the vast majority of value added, whereas smallholder growers often receive a profit share below the poverty line (Marschner *et al*., 2025; Parra-Paitan *et al*., 2023). This unequal value distribution directly challenges the progress towards United Nations Sustainable Development Goals (SDGs), specifically SDG 1 on poverty alleviation and SDG 8 on decent work and economic growth (Martins *et al.*, 2023).

Global cocoa prices are highly sensitive to climate-induced supply shocks in major producing regions. For instance, the decline in production in Ghana due to extreme weather, increased rainfall from La Niña in 2019, and drought from El Niño in 2022, has periodically tightened global supplies (Kosoe, Ahmed, 2022; Nisa' *et al*., 2023). The resulting reduction in Ghana's cocoa bean exports, as shown in Figure 1, serves as a primary catalyst for price surges in the world market, which inevitably transmit to Indonesian export prices.



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Production (ton)	700.02	879.38	835.46	858.72	858.72	858.72	969.30	904.70	811.70	800.00	683.27	656.14	429.32
Export (ton)	629.08	585.92	526.18	791.46	861.21	581.37	573.33	843.64	643.64	593.00	508.43	464.62	433.28

Figure 1. Ghana's total cocoa bean production and exports.
Source: ICCO and Trade Map, 2025.

Global price surges theoretically incentivise farmers to increase productivity, but the transmission of these incentives in Indonesia is heavily distorted by domestic trade policies. The Indonesian government implemented a progressive export tax on raw cocoa beans in April 2010 under the Ministry of Finance Regulation No. 67/PMK.011/2010 to secure domestic raw material supply and stimulate downstream processing industries (Fahmid *et al*., 2022). This policy shift triggered a profound transformation in the structure of the Indonesian cocoa industry. The export value of intermediate processed products, including cocoa butter and powder, demonstrated robust growth over the past decade, occurring concurrently with a drastic decline in raw cocoa bean exports, as shown in Figure 2.

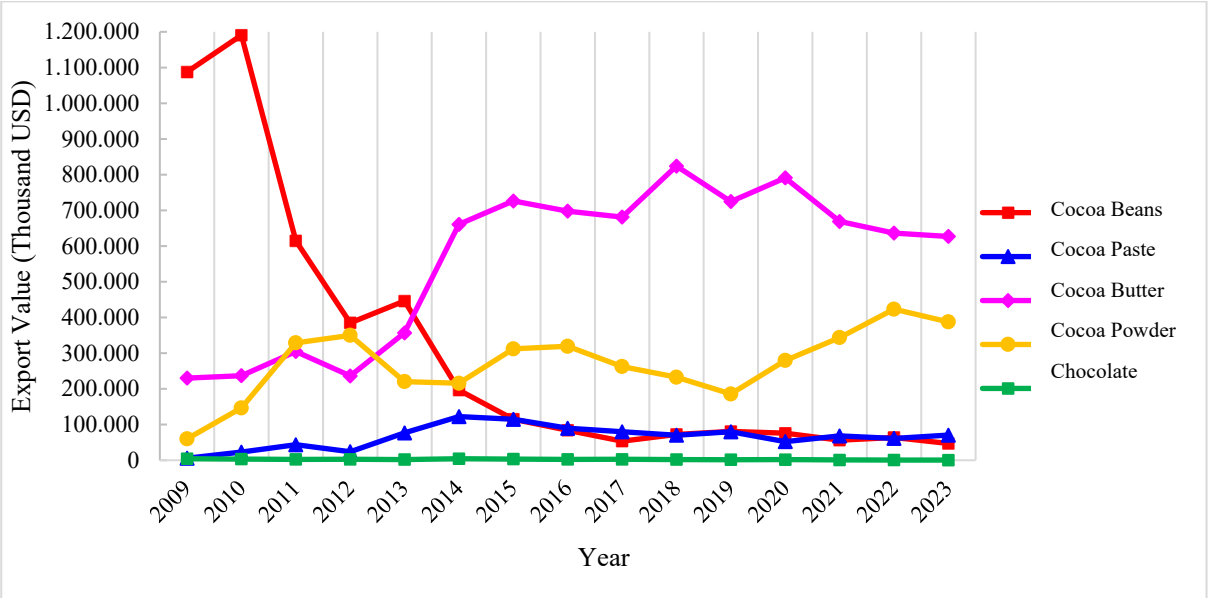


Figure 2. Value of Indonesian cocoa bean and cocoa product exports, 2009-2023.
Source: FAOSTAT, 2025

The progressive export tax successfully stimulated downstream industrialisation but inadvertently created a structural barrier in vertical price transmission. Exporters and processors shifted the tax burden up the supply chain, translating the policy cost into depressed real buying rates at the farm-gate level (Duron *et al.*, 2022). This price suppression widened the real price gap between domestic and global benchmarks, leaving smallholder farmers highly vulnerable (Fatkurrohim *et al*., 2025). Investigating how these macroeconomic policies and global supply shocks alter vertical integration parameters constitutes the core empirical focus of this study.

3. Research methods

Adopting a vertical integration approach, this study specifically investigates the cocoa value chain with the central hypothesis that price shocks in the global cocoa market trigger a response in Indonesian export prices, which subsequently affect Indonesian cocoa bean prices at the farm-gate level. This study utilises monthly time-series data of world cocoa prices, Indonesian export prices, and Indonesian farm-gate prices for the period January 1994 to December 2024 (N = 372 monthly observations), sourced from the World Bank, Trade Map, and Statistics Indonesia (BPS).

All price series are transformed from nominal to real terms using specific producer price indices (PPI) with a standardised base year of 2010 = 100 to address the methodological concerns regarding inflationary bias over this long-term horizon: (1) real Indonesian prices (IDR/ton) are obtained by deflating nominal farm-gate prices with the Indonesian producer price index for the agricultural sector sourced from BPS; (2) real Indonesian export prices (IDR/ton) used for the export-to-domestic analysis are deflated using the Indonesian producer price index for the export sector sourced from BPS; and (3) real Indonesian export prices (USD/ton) and real world prices (USD/ton) used for the world to export analysis are deflated using the United States Producer Price Index (US PPI), sourced from the Federal Reserve Economic Data (FRED). To ensure methodological transparency and comparability and to avoid exchange rate volatility bias, the world-to-export market analysis utilises real USD/ton, while the export-to-Indonesian market analysis utilises real IDR/ton, reflecting real transaction practices at the local level. All price series data processing and subsequent econometric estimations in this study are conducted using EViews software.

Following data transformation, the analysis begins with time-series diagnostics. Because time-series data are inherently prone to non-stationarity mean and variance, which can lead to spurious regression results, the augmented Dickey-Fuller (ADF) unit root test is applied to assess whether the price series contains a unit root and to determine its order of integration. If the test results indicate that the data is not stationary at the zero-order level, then the test proceeds by applying differentiation, starting with the first difference ($I(1)$), then moving to higher-order differences ($I(2)$), until the data become stationary. The decision criteria are based on a comparison of the t-statistic from the ADF unit root test with MacKinnon's critical values (at the 1%, 5%, and 10% levels) as follows: if the t-statistic is less than the MacKinnon critical value, then the data are not stationary. If the t-statistic is greater than the MacKinnon critical value, then the data are stationary.

After assessing stationarity, the vertical integration of the cocoa value chain is initially modelled using the classical Ravallion linear regression framework as an empirical baseline. This model comprises two equations: (1) market integration between world cocoa bean prices and export prices, and (2) market integration between export cocoa bean prices and Indonesian farm-gate prices. The vertical integration of the global and Indonesian cocoa bean markets is shown by the following equations.

$$P_{xt} = a_0 + a_1 P_{xt-1} + a_2(P_{wt} - P_{wt-1}) + a_3 P_{wt-1} + \varepsilon_t \quad (1)$$

$$P_{dt} = b_0 + b_1 P_{dt-1} + b_2(P_{xt} - P_{xt-1}) + b_3 P_{xt-1} + \varepsilon_t \quad (2)$$

where P_{xt} is the current export price of Indonesian cocoa beans (USD/ton and IDR/ton); P_{wt} is the current world cocoa beans price (USD/ton); P_{dt} is the current Indonesian cocoa bean price (IDR/ton); P_{xt-1} is the price of cocoa beans exported from Indonesia in the previous month (USD/ton and IDR/ton); P_{wt-1} is the price of cocoa beans at the world level in the previous month (USD/ton); P_{dt-1} is the cocoa bean price at the Indonesian level in the previous month (IDR/ton); a_0 and b_0 are constants; a_1, a_2, and a_3 are the regression coefficients in equation 1; b_1, b_2, and b_3 are the regression coefficients in equation 2; and ε_t is the error term.

The degree to which price changes in the reference market are passed on to the follower market is determined by the value of a_2 or b_2, which is based on the Ravallion model. The strength and/or weakness of market integration is assessed based on the index of market connection (IMC):

$$IMC = \frac{a_1}{a_3} \text{ or } \frac{b_1}{b_3} \quad (3)$$

According to Timmer (1986), the closer the IMC is to zero, the stronger the level of integration. If the IMC is < 1, then the market is strongly integrated. If the IMC is > 1, then the market is not strongly integrated.

Although the Ravallion model effectively serves as a baseline indicator of immediate price transmission, it exhibits critical econometric limitations when applied to non-stationary $I(1)$ time-series data, as it captures short-run correlations without mathematically validating long-run equilibrium pathways. To overcome this limitation and ensure methodological rigor, the analysis transitions into an advanced cointegration framework utilising the VECM. Building on the previously established data stationarity, the empirical execution of this framework is conducted systematically through sequential stages, specifically the determination of the optimal lag length, the Johansen cointegration test, formal estimation of the VECM parameters, and Granger causality.

(a) Optimal lag length and diagnostic tests

Determining the optimal lag length is crucial to avoid residual autocorrelation in the vector autoregression (VAR) system. The optimal lag reflects the time required for a market to respond to price changes in another market. In this study, the lag length is selected based on the minimum values of the Akaike information criterion (AIC), the Schwarz criterion (SC), Quinn criteria (HQ), and the final prediction error (FPE), and the largest likelihood ratio (LR). Lag selection is determined based on a consensus or majority recommendation among these five information criteria.

(b) Johansen cointegration test

The Johansen cointegration test is employed to estimate and confirm the presence of a stable long-term equilibrium relationship between the non-stationary price variables. The presence of cointegration is detected by comparing the trace statistic (TS) and maximum eigenvalue (ME)

against their critical values at the 5% significance level. If the values of TS and ME are greater than their critical values at the 5% significance level, then there is cointegration (Johansen, 1988).

(c) VECM

Upon confirming cointegration, the VECM is estimated to disaggregate the price dynamics into short-run adjustments and long-run equilibrium. The VECM corrects short-term deviations towards the long-term equilibrium path. The equation is formulated as follows:

$$\Delta Y_t = a_0 + \Pi ECT_{t-1} \sum_{i=1}^{p} \Gamma_i \Delta Y_{t-i} + \sum_{i=1}^{p} \Phi_i \Delta X_{t-i} + \varepsilon_t \quad (4)$$

where ΔY_t and ΔX_t are the first-differenced prices of the follower and reference markets of cocoa beans, respectively. The error correction term ECT_{t-1} represents the magnitude of the previous period's disequilibrium. *ECT* is statistically significant when p-value is < 0.05. The adjustment coefficient Π measures the speed and direction of response to deviations from the long-run equilibrium defined by the cointegrating vector, necessitating a statistically significant value with a sign consistent with convergence towards equilibria. The coefficients Γ_i and Φ_i capture the short-term dynamics.

(d) Granger causality test

This test is used to empirically identify the relationship between two variables – that is, to determine whether they have a reciprocal relationship. This test can be used to examine whether price developments in a market can cause changes or price movements in other markets by evaluating these prices as exogenous and endogenous variables and vice versa. The bivariate causality equations are specified as (Engle, Granger, 1987):

$$Y_t = a_0 + \sum_{i=1}^{n} a_i Y_{t-i} + \sum_{i=1}^{n} b_i X_{t-i} + \varepsilon_{1t} \quad (5)$$

$$X_t = c_0 + \sum_{i=1}^{n} c_i X_{t-i} + \sum_{i=1}^{n} d_i Y_{t-i} + \varepsilon_{2t} \quad (6)$$

If the p-value is less than the significance level, then the null hypothesis is rejected, indicating that price changes in market X Granger-cause price changes in market Y, or vice versa.

Addressing potential aggregation bias over the extensive 1994-2023 study period, this study explicitly accounts for the structural shift triggered by PMK No. 67/PMK.011/2010 on 1 April 2010. This policy introduced a 10% progressive export tax on cocoa beans based on reference prices, aimed at fostering Indonesian downstreaming and securing local raw material supplies. The Chow breakpoint test is used to investigate whether the price transmission parameters changed significantly before and after the implementation of this policy. A significant F-statistic ($p < 0.05$) confirms a structural break, indicating that the tax policy structurally altered market integration.

4. Results

4.1. Data stationarity test

Table 1 presents the empirical results of the ADF unit root test for all log-transformed real price series. Unit root testing in level form indicates that the null hypothesis of non-stationarity cannot be rejected for all variables. For all price series – namely world price, Indonesian export price in USD, Indonesian export price in IDR, and Indonesian farm-gate price – the level-form p-values are < 0.05.

Table 1. Results of the stationary test of cocoa bean market data.

No	Price variables	Augmented Dickey-Fuller unit root test	
		Intercept without trend	
		Level	First difference
1	World price (USD)	-1.537 [0.514]	-4.082 [0.001]***
2	Indonesian export price (USD)	0.741 [0.993]	-18.275 [0.000]***
3	Indonesian export price (IDR)	0.421 [0.984]	-18.301 [0.000]***
4	Indonesian farm-gate price (IDR)	-1.667 [0.448]	-19.822 [0.000]***

Note: The p-values are presented in square brackets. The asterisks (***), (**), and (*) indicate significance at the 1%, 5%, and 10% levels, respectively.
Source: Author's computation, 2026.

First-difference transformation is subsequently applied to all price series to achieve stationarity. The ADF unit root test statistics for the first-differenced series of world price, export price in USD, export price in IDR, and Indonesian farm-gate price are -4.082, -18.275, -18.301, and -19.822, respectively. All first-differenced variables are highly significant ($p < 0.01$). These statistical diagnostics confirm that all analysed real price series are integrated of order one, or $I(1)$. This uniform integration order satisfies the mathematical prerequisite for the Johansen cointegration test and subsequent VECM estimation.

4.2. Ravallion linear regression and the IMC

The vertical market integration is initially estimated using the classical Ravallion linear regression model to capture immediate price transmission across the supply chain. Tables 2 and 3 present the baseline regression results and the IMC for both market levels.

Table 2. Ravallion regression results of the world and Indonesian export cocoa bean markets.

Variable	Coefficient	T-test	P-value	Significance
a_0	-64.598	-1.130	0.259	Not Significant
P_{xt-1}	0.602	15.713	0.000***	Significant
$P_{wt} - P_{wt-1}$	0.106	1.420	0.156	Not Significant
P_{wt-1}	0.408	10.671	0.000***	Significant
F-Test	560.945		0.000***	Significant
Adjusted R^2	0.819			
Index of market connection = 1.475				

Note: The asterisks (***), (**), and (*) indicate significance at the 1%, 5%, and 10% levels, respectively
Source: Author's computation, 2026.

As shown in Table 2, short-term changes in world prices significantly influence Indonesian export prices ($p < 0.01$). However, the resulting IMC is 1.475, indicating low market integration. This suggests that while a relationship exists, changes in global cocoa prices are only partially and imperfectly

transmitted to the Indonesian export market.

Table 3. Ravallion regression results of the Indonesian export and Indonesian cocoa bean markets.

Variable	Coefficient	T-test	P-value	Significance
b_0	99,323.593	1.020	0.308	Not Significant
P_{dt-1}	0.981	104.919	0.000***	Significant
$P_{xt} - P_{xt-1}$	0.029	4.120	0.006***	Significant
P_{xt-1}	0.005	1.481	0.139	Not Significant
F-Test	3,957.742		0.000***	Significant
Adjusted R^2	0.970			
Index of market connection = 196.2				

Note: The asterisks (***), (**), and (*) indicate significance at the 1%, 5%, and 10% level, respectively.
Source: Author's computation, 2026.

Furthermore, Table 3 illustrates the integration between the export market and the Indonesian farm-gate market. The relationship yields a substantially higher IMC of 196.2. This extremely high IMC value demonstrates that the short-term integration between exporters and Indonesian farmers is exceptionally weak. Indonesian farm-gate prices do not adequately respond to price fluctuations in the export market. Although these baseline IMC values successfully indicate weak vertical integration, this metric primarily evaluates immediate, mechanical price linkages and has critical limitations when handling non-stationary data at the level form. To robustly validate these baseline findings, mathematically confirm long-term equilibrium, and precisely distinguish short-term adjustments, the analysis proceeds to the advanced Johansen cointegration test and VECM.

4.3. Optimal lag length and diagnostic tests

Table 4 presents the empirical results for determining the optimal lag length for both market integration models. The optimal lag length for the world cocoa price and Indonesian export price in USD model is established at lag eight. This selection is supported by the majority of the statistical criteria, namely the LR, FPE, AIC, and HQ. The optimal lag length for the Indonesian export price in IDR and Indonesian farm-gate price model is determined at lag two, based on the LR, FPE, and AIC. These selected optimal lags of eight and two are directly utilised in the subsequent Johansen cointegration tests and VECM estimations to ensure that the empirical systems are free from residual autocorrelation.

Table 4. Optimal lag length results.

Lag	LR	FPE	AIC	SC	HQ
A. World and export Indonesian cocoa bean markets					
0	NA	5.89e+09	28.172	28.193	28.180
1	121.417	4.29e+09	27.856	27.921	27.882
2	16.660	4.19e+09	27.832	27.939	27.875
3	19.955	4.05e+09	27.798	27.948	27.858
4	22.812	3.88e+09	27.756	27.949	27.832
5	28.901	3.66e+09	27.695	27.931	27.789
6	31.467	3.42e+09	27.628	27.907*	27.738
7	7.339	3.42e+09	27.629	27.950	27.756
8	30.528*	3.20e+09*	27.562*	27.927	27.707*
Diagnostic validation checks at the selected lag order (lag 8)					
Autocorrelation	5.545 [0.236]				
VAR stability	0.943				
B. Export Indonesian and Indonesian farm-gate cocoa bean markets					
0	NA	1.02e+25	63.261	63.282	63.270
1	86.864	8.20e+24	63.041	63.106*	63.067*
2	12.623*	8.09e+24*	63.029*	63.136	63.071
3	2.197	8.22e+24	63.044	63.195	63.104
4	5.695	8.27e+24	63.050	63.244	63.127
5	2.992	8.38e+24	63.064	63.299	63.158
6	3.116	8.49e+24	63.077	63.356	63.188
7	2.819	8.61e+24	63.091	63.413	63.219
8	1.230	8.77e+24	63.109	63.474	63.254
Diagnostic validation checks at the selected lag order (lag 2)					
Autocorrelation	4.641 [0.326]				
VAR stability	0.433				

Note: (*) indicates the lag order selected by the criterion. AIC, Akaike information criterion; FPE, final prediction error; HQ, Quinn criteria; LR, likelihood ratio; SC, Schwarz criterion (SC); VAR, vector autoregression.
Source: Author's computation, 2026.

Diagnostic validation checks confirm that the estimated pricing models satisfy all necessary econometric assumptions. The Breusch-Godfrey Lagrange multiplier (LM) test for the world to export channel yields an LM statistic of 5.545 ($p = 0.236$), confirming that the null hypothesis of no serial correlation cannot be rejected. The corresponding stability analysis reveals a maximum modulus of 0.943, below the critical limit of 1.000. The domestic pricing model from export-to-Indonesian farm-gate price similarly produces an LM statistic of 4.642 ($p = 0.326$), supporting the complete absence of residual autocorrelation. The inverse roots for this domestic system confirm dynamic stability with a maximum modulus of 0.433.

4.4. Johansen cointegration test

The Johansen cointegration test was conducted to estimate and confirm the presence of a stable long-term equilibrium relationship between the non-stationary price variables.

Table 5. Johansen cointegration test results.

Number of cointegration equations	Trace statistic	Critical value (5%)	Maximum eigenvalue statistic	Critical value (5%)
World and export Indonesian cocoa bean markets				
None*	94.874	15.495	92.420	14.265
At most 1	2.454	3.841	2.454	3.841
Export Indonesian and Indonesian farm-gate cocoa bean markets				
None*	276.797	15.495	169.152	14.265
At most 1*	107.645	3.841	107.645	3.841

Note: (*) indicate significance at the 5% level.
Source: Author's computation, 2026.

Table 5 outlines the empirical results of the Johansen cointegration test under both the TS and ME frameworks. The null hypothesis of no cointegration is rejected for both marketing stages ($p < 0.05$), confirming that a stable long-run equilibrium relationship binds these markets together over time. The world and Indonesian export price linkage exhibits exactly one cointegrating vector.

The Indonesian export price and Indonesian farm-gate price linkage indicates the potential presence of two cointegrating vectors at the 5% significance level. A cointegration rank of two in a bivariate system mathematically implies that both price variables are stationary in their levels, directly contradicting the prior ADF unit root test results. Empirical practice in the agricultural trade literature suggests restricting the cointegrating rank to one under such conditions to maintain theoretical consistency and ensure a valid error correction specification (Napitupulu *et al*., 2021; Wibowo *et al*., 2021). The cointegrating rank for this domestic marketing stage is consequently restricted to one to estimate a theoretically sound VECM.

4.5. VECM estimates

Tables 6 and 7 present the empirical parameters for the long-run and short-run price transmission dynamics along the cocoa supply chain. The long-run cointegrating vectors in Table 6 establish highly significant structural relationships across both marketing stages. World prices and Indonesian export prices in USD exhibit a highly significant long-run equilibrium. Indonesian export prices in IDR and Indonesian farm-gate prices display a similarly robust long-run relationship.

Table 6. Long-term cointegration estimates.

Cointegration equation	Cocoa bean price variables		
	PW_USD	**PX_USD**	**C**
World (PW) and export Indonesian (PX)	1.000	-1.063 (0.082) [-12.905]***	1.685
	PX_IDR	**PD_IDR**	**C**
Export Indonesian (PX) and Indonesian farm-gate (PD)	1.000	-2.077 (0.310) [-6.704]***	-107,571.1

Note: The t-statistics are presented in square brackets. The asterisks (***), (**), and (*) indicate significance at the 1%, 5%, and 10% levels, respectively. t-table value: t(α = 1%) = 2.589; t(α = 5%) = 1.965; t(α = 10%) = 1.649.
Source: Author's computation, 2026.

Normalisation of the long-run parameters indicates that the price transmission from the world market to the export market is nearly perfect. Indonesian exporters capture almost the entire magnitude of global price movements in the long run. The long-run price transmission from the export market to the Indonesian farm-gate level is highly depressed. Smallholder farmers receive less than half of the corresponding price increases over the long-run horizon, indicating a severe long-run margin disparity.

Table 7 details the short-run dynamics and the speed of adjustment parameters represented by the error correction terms. The error correction term for the Indonesian export price in the world-to-export linkage is significant ($p < 0.01$). The export market responds actively to global price deviations, confirming short-run adjustment behaviour. The error correction term for the Indonesian farm-gate price in the export-to-domestic linkage is not statistically significant. The Indonesian farm-gate price fails to perform any significant short-run adjustment when disequilibria occur in the export market. The error correction term for the Indonesian export price in this Indonesian linkage is significant ($p < 0.01$). The export price adjusts rapidly to correct short-run disequilibria along the Indonesian channel, while the Indonesian farm-gate price remains completely rigid in the short run.

Table 7. Short-term cointegration estimates.

World (PW) and export Indonesian (PX)		
Error correction	**D(PW_USD,2)**	**D(PX_USD,2)**
CointEq1	-1.074	2.871
	(0.229)	(0.320)
	[-4.686]***	[8.983] ***
D(PW_USD(-1),2)	0.184	-2.486
	(0.228)	(0.318)
	[0.807]	[-7.820] ***
D(PW_USD(-2),2)	0.339	-2.395
	(0.224)	(0.312)
	[1.516]	[-7.682] ***
D(PW_USD(-3),2)	0.205	-2.029
	(0.214)	(0.299)
	[0.959]	[-6.796] ***
D(PW_USD(-4),2)	0.192	-1.574
	(0.199)	(0.278)
	[0.963]	[-5.671] ***
D(PW_USD(-5),2)	0.083	-1.106
	(0.178)	(0.249)
	[0.465]	[-4.446] ***
D(PW_USD(-6),2)	-0.068	-0.795
	(0.147)	(0.205)
	[-0.460]	[-3.872] ***
D(PW_USD(-7),2)	-0.127	-0.831
	(0.116)	(0.162)
	[-1.099]	[-5.136] ***
D(PW_USD(-8),2)	-0.093	-0.304
	(0.093)	(0.130)
	[-0.996]	[-2.335]**
D(PX_USD(-1),2)	-1.170	1.353
	(0.229)	(0.319)
	[-5.112] ***	[4.237] ***
D(PX_USD(-2),2)	-1.145	0.955
	(0.209)	(0.291)
	[-5.482] ***	[3.277] ***
D(PX_USD(-3),2)	-1.074	0.685
	(0.186)	(0.260)
	[-5.775] ***	[2.641] ***
D(PX_USD(-4),2)	-0.958	0.450
	(0.161)	(0.224)
	[-5.958] ***	[2.007]**
D(PX_USD(-5),2)	-0.732	0.335
	(0.134)	(0.186)
	[-5.475] ***	[1.796]*
D(PX_USD(-6),2)	-0.474	0.247
	(0.105)	(0.146)
	[-4.513] ***	[1.684]*

World (PW) and export Indonesian (PX)		
D(PX_USD(-7),2)	-0.322	0.114
	(0.073)	(0.101)
	[-4.442] ***	[1.124]
D(PX_USD(-8),2)	-0.154	0.026
	(0.037)	(0.052)
	[-4.136] ***	[0.506]
C	7.502	2.419
	(10.269)	(14.326)
	[0.730]	[0.169]
Export Indonesian (PX) and Indonesian farm-gate (PD)		
Error correction	**D(PX_IDR,2)**	**D(PD_IDR,2)**
CointEq1	-1.837	0.021
	(0.135)	(0.024)
	[-13.583]***	[0.864]
D(PX_IDR(-1),2)	0.283	-0.013
	(0.103)	(0.018)
	[2.747]***	[-0.682]
D(PX_IDR(-2),2)	0.066	-0.007
	(0.056)	(0.010)
	[1.178]	[-0.675]
D(PD_IDR(-1),2)	-2.040	-0.661
	(0.346)	(0.062)
	[-5.892]***	[-10.705]***
D(PD_IDR(-2),2)	-0.780	-0.342
	(0.295)	(0.053)
	[-2.643]***	[-6.510]***
C	47305.85	3563.624
	(226267.)	(40324.2)
	[0.209]	[0.088]

Note: The t-statistics are presented in square brackets. The asterisks (***), (**), and (*) indicate significance at the 1%, 5%, and 10% levels, respectively. t-table value: t(α = 1%) = 2.589; t(α = 5%) = 1.965' t(α = 10%) = 1.649.
Source: Author's computation, 2026.

Short-run lagged price changes show distinct transmission patterns across the two systems. Lagged changes in world prices significantly affect the Indonesian export price across multiple periods. Lagged changes in the Indonesian export price do not significantly affect the Indonesian farm-gate price. Lagged changes in the Indonesian farm-gate price exert a highly significant influence on the Indonesian export price. This asymmetry confirms that the Indonesian farm-gate price is insulated from short-run export price changes, whereas the export price is highly sensitive to domestic supply variations.

4.6. Granger causality test

Table 8 presents the empirical findings of the Granger causality test to identify the direction of short-run price transmission along the cocoa supply chain. The international-to-export market

interface exhibits highly significant bidirectional Granger causality. World market price fluctuations cause changes in the Indonesian export price, while export price movements concurrently influence global valuations. This bidirectional feedback demonstrates that the exporter node is closely integrated with global price discovery mechanisms.

Table 8. Granger causality test results.

Hypothesis	F-statistic	P-value
World affects export	15.653	0.000***
Export affects world	5.028	0.000***
Export affects Indonesian	0.520	0.595
Indonesian affects export	3.491	0.032**

Note: The asterisks (***), (**), and (*) indicate significance at the 1%, 5%, and 10% levels, respectively
Source: Author's computation, 2026.

The export-to-domestic market interface displays a strictly unidirectional causal flow. Indonesian export prices do not Granger-cause the Indonesian farm-gate price. Changes in the Indonesian farm-gate price significantly Granger-cause the Indonesian export price. This unidirectional causal pattern confirms that downward short-run price transmission is completely obstructed. Smallholder farmers remain isolated as price-takers, unable to receive immediate price signals from the downstream export market.

4.7. Chow breakpoint test

Table 9 presents the empirical results of the Chow breakpoint test assessing the structural stability of the cocoa price transmission channels. April 2010 represents the specified breakpoint to capture the potential structural shift triggered by the implementation of the progressive export tax policy. The estimated F-statistics for both marketing channels fail to reject the null hypothesis of parameter stability at all standard significance levels.

Table 9. Chow breakpoint test results.

Market linkage	F-statistic	P-value
World and export Indonesian cocoa bean markets	0.412	0.663
Export Indonesian and Indonesian farm-gate cocoa bean markets	0.794	0.453

Note: The asterisks (***), (**), and (*) indicate significance at the 1%, 5%, and 10% levels, respectively
Source: Author's computation, 2026.

The test of the world-to-export price linkage is not significant ($p = 0.6628$). The test of the export-to-domestic linkage is also not significant ($p = 0.4526$). These results indicate the absence of a structural break across both segments of the value chain. The implementation of the progressive export tax has not structurally altered the vertical integration parameters of the Indonesian cocoa market.

5. Discussion

Vertical price transmission along the Indonesian cocoa value chain reveals a highly integrated long-run marketing system paired with severe short-run friction and structural disintegration. The VECM presents the empirical coefficients for both marketing linkages, allowing a systematic evaluation of long-run and short-run price dynamics. The Johansen cointegration tests confirm that a stable long-run equilibrium binds the world, export, and Indonesian farm-gate prices over the period of 1994-2024. This long-run integration suggests that price signals eventually transmit across all market nodes, preventing prices from drifting apart indefinitely (Faizah *et al*., 2023).

Indonesian exporters capture approximately 94% of global price movements in the long run, reflecting a highly efficient external market linkage. Smallholder farmers, by contrast, capture only 48% of export price increases over the same period, indicating a major disparity in value distribution. This long-run margin compression means that farmers are unable to benefit fully from international price booms, a finding consistent with research by Abubakar (2019).

Short-run dynamics from the VECM explain how this vertical imbalance is maintained over time. The error correction term for the Indonesian export price in the world-to-export linkage is significant, confirming rapid adjustment towards long-run equilibrium. The error correction term for the Indonesian farm-gate price in the export-to-domestic linkage is not significant, demonstrating severe price stickiness. This farm-gate price stickiness is further corroborated by the IMC, which reaches an extreme in the domestic linkage. High transaction costs, localised transport bottlenecks, and geographical isolation prevent immediate price transmission from exporters to farmers, mirroring the vertical inefficiencies discussed by Staritz *et al*. (2023).

These physical and spatial inefficiencies require a deeper examination of the causal direction of price discovery along the value chain. Granger causality diagnostics clarify the direction of short-run price discovery and bargaining dynamics along the value chain. The international-to-export interface exhibits bidirectional Granger causality, indicating that Indonesian exporters are active participants in global price formation (Faizah *et al*., 2023). The export-to-domestic interface displays a strictly unidirectional causal flow, where domestic farm-gate prices Granger-cause export prices, but export prices fail to Granger-cause farm-gate prices. This unidirectional causality represents a critical economic puzzle: why do downstream price increases fail to cause farm-gate price adjustments, while local supply shocks affect export pricing?

The answer lies in the highly oligopsonistic structure of the local cocoa marketing system, where village collectors and intermediate traders dominate local transactions (Shoffiyati *et al*., 2023). Intermediary traders exploit their market power and information advantages to absorb global price increases, refusing to transmit higher buying rates to the farm-gate level (Staritz *et al*., 2023). Farmers act as passive price-takers due to their subsistence nature, limited storage capacity, and lack of direct export channel access, accepting whatever price collectors offer (Wibowo *et al*., 2021). This asymmetric power distribution concentrates the economic value of cocoa in the hands of multinational processors and domestic intermediaries, leaving local farmers trapped in persistent poverty (Marschner *et al*., 2025; Parra-Paitan *et al*., 2023). These structural inequalities directly undermine SDG 1 on poverty reduction and SDG 8 on decent work and economic growth (Martins *et al*., 2023).

Market inequalities of this magnitude often prompt state interventions designed to restructure domestic supply chains. The Chow breakpoint test evaluates the structural stability of price

transmission before and after the implementation of the progressive export tax policy. The Indonesian government introduced a progressive export tax on raw cocoa beans in April 2010 under the Ministry of Finance Regulation No. 67/PMK.011/2010 to secure domestic raw material supply and stimulate downstream processing industries (Fahmid *et al*., 2022). The Chow breakpoint test results fail to reject the null hypothesis of parameter stability across both the world-to-export and export-to-domestic linkages.

The non-significant Chow breakpoint test parameters reveal a critical trade-off in the governance of the Indonesian cocoa agroindustry. The progressive export tax implemented under PMK No. 67/PMK.011/2010 successfully accelerated domestic downstreaming by securing raw material supplies for multinational processing plants located in industrial centres. Domestic processing capacity expanded rapidly, but this national industrial success was directly funded at the expense of smallholder welfare. Downstream processors and exporters simply shifted the tax burden up the supply chain, translating the policy cost into depressed real buying rates at the farm-gate level. This structural shift widened the real price gap between domestic and global benchmarks, penalising the very producers responsible for raw material cultivation (Duron *et al*., 2022; Yudyanto, Hastiadi, 2019). Future trade policies must integrate rigid price-floor regulations at the farm-gate level to prevent downstream corporations from shifting policy-induced tax burdens onto vulnerable smallholder farmers (Wibowo *et al*., 2021).

Empirical price trends over time provide a historical record of how these policy trade-offs and structural rigidities play out during real world crises. Figure 3 illustrates the historical movement of real cocoa bean prices across the world, export, and domestic farm-gate markets, revealing a widening price gap during external macroeconomic shocks. The 1998 Asian financial crisis triggered severe depreciation of the Indonesian rupiah, raising local inflation and suppressing domestic purchasing power (Meyn, Kennan, 2009). Real farm-gate cocoa prices remained extremely low during this crisis, while world cocoa prices rose as commodity exports gained international competitiveness. The 2009 global financial recovery introduced high volatility as international investors shifted capital to commodity futures as safe-haven assets, driving world cocoa prices up (Ojong *et al*., 2016). Indonesian export prices rose in tandem with this global spike, but local farm-gate prices lagged significantly due to exchange rate adjustments and domestic marketing rigidities.

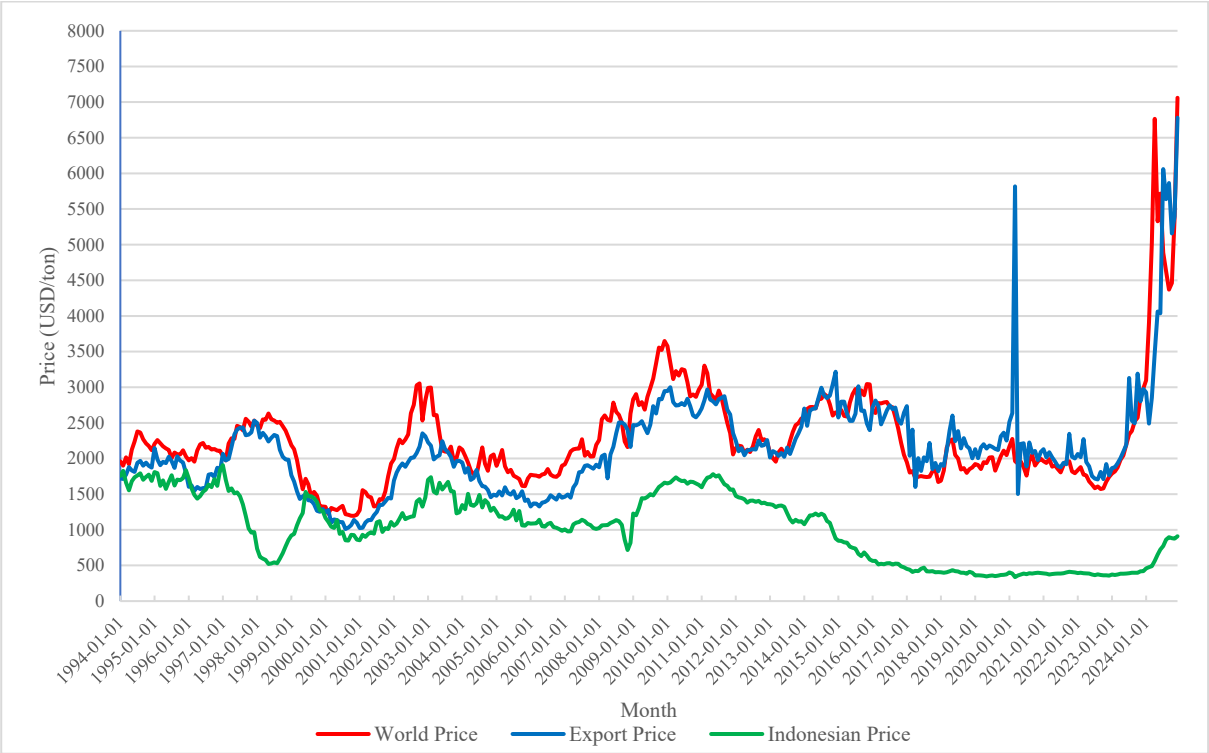


Figure 3. Movements in world cocoa bean prices, Indonesian export prices, and domestic cocoa bean prices in Indonesia.
Source: World Bank, Trade Map, and BPS, 2025.

Exchange rate fluctuations from 2014 to 2016 further disrupted transmission, as a sharp Rupiah depreciation prevented domestic prices from fully reflecting international price peaks. The 2017 global oversupply caused by bumper harvests in Côte d'Ivoire and Ghana triggered an 18% crash in world cocoa prices, which immediately depressed Indonesian export prices (Oussou *et al*., 2022). West African oversupply continued to depress global benchmarks from 2018 to 2019, yet Indonesian export prices temporarily exceeded world prices due to the unique high-melting-point quality of Indonesian beans (Gyan, Bajan, 2022). The coronavirus disease 2019 (COVID-19) pandemic in 2020 severely disrupted international shipping logistics, causing world prices to spike, while local farm-gate prices fell due to restricted domestic trading activity (Asante-Poku, Van Huellen, 2021).

The escalation of the Russo–Ukrainian war in 2022 drove international shipping and energy costs to historic highs, pushing global cocoa prices upward (Babar *et al*., 2024). Extreme weather events and El Niño shocks in major West African producing nations in 2023 caused a historic global supply shortage, pushing world cocoa prices to record highs (Olwig *et al*., 2023; Qin *et al*., 2023; Zelingher, Makowski, 2023). Indonesian farm-gate prices responded positively to this global surge but still failed to capture the full magnitude of the spike, confirming the presence of persistent transaction barriers.

These transaction barriers are closely intertwined with critical non-price factors, particularly the physical quality of the agricultural commodity itself. The lower physical quality of Indonesian smallholder cocoa beans represents a critical non-price barrier that explains this persistent price gap (Ariningsih *et al.*, 2021). Most Indonesian smallholders sell unfermented cocoa beans, which do not

meet international quality standards and are heavily discounted by exporters. Future developmental initiatives must prioritise post-harvest fermentation infrastructure at the village level to elevate bean quality and bridge the persistent domestic to global price gap (Martins *et al*., 2023).

Developing these local infrastructure solutions requires recognising the empirical boundaries of the quantitative analysis presented in this study. The empirical framework relies on macro-level monthly time series data, which cannot capture micro-level transaction costs, real-time freight charges, or regional marketing margins. Spatial transport bottlenecks and local infrastructure deficits are not directly incorporated into the econometric models. The analysis does not explicitly control for quality disparities, such as the unfermented nature of domestic smallholder cocoa beans. These analytical limitations represent important areas for future research, which should employ spatial autoregressive models or primary household-level survey data to directly test these micro-level transmission barriers.

6. Conclusion

This study demonstrates that national industrial downstreaming achievements in the Indonesian cocoa sector coexist with severe economic suppression at the farm-gate level. Market price transmission dynamics confirm a highly rigid, oligopsonistic domestic marketing structure that isolates smallholder growers as passive price-takers. The implementation of the progressive export tax has succeeded in shifting export flows towards processed products but has failed to structurally alter the underlying vertical integration parameters. Downstream processors and intermediate traders have seamlessly absorbed the trade policy shock and passed the financial burden directly to vulnerable growers by depressing farm-gate buying rates. This persistent price decoupling directly undermines the progress towards the SDGs, specifically poverty reduction and decent livelihoods.

Correcting these systemic imbalances requires a fundamental shift in agricultural policy from simple export tariffs to active market restructuring. State authorities must establish transparent, digital market intelligence systems to deliver real-time global price indices directly to local village cooperatives, effectively dismantling the information monopoly of intermediary collectors. The government should also implement dynamic minimum price-floor protections at the farm-gate level to shield smallholders from corporate tax-shifting practices. National development strategies must allocate progressive export tax revenues to build village-level post-harvest fermentation facilities and modern drying infrastructure. These integrated structural interventions will elevate Indonesian bean quality to international standards, strengthen smallholder bargaining power, and secure an equitable distribution of wealth along the agricultural supply chain.

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Author Contributions

V.Y.R: Conceptualization, Methodology, Software, Formal Analysis, Investigation, Writing-Original Draft. Y.H.: Conceptualization, Methodology, Data Curation, Writing-Original Draft, Supervision, Funding Acquisition. J.M.M.A.: Validation, Resources, Writing-Review & Editing. R.Y.R.: Writing-Review & Editing, Visualization, Project Administration.

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