Market Forces and Strategic Determinants of Indonesia's Shrimp Export Competitiveness in the United States Market (1998–2022)

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Abstract

Indonesia, as a maritime nation, possesses substantial potential in developing its fisheries sector, with shrimp being one of the country's most prominent export commodities. Shrimp contributes significantly to Indonesia's foreign exchange earnings, with major export destinations including the United States, Japan, the Netherlands, and China. This study aims to analyze the determinants of Indonesia's shrimp exports to the United States during the period 1998–2022. The research employs secondary data sourced from UN Comtrade, the World Bank, and the Ministry of Trade of the Republic of Indonesia. The variables examined include shrimp export quantity, shrimp export price, the rupiah–US dollar exchange rate, U.S. GDP per capita, and crab export prices. The analytical methods consist of descriptive analysis, the Dickey–Fuller (DF) unit root test, the Bounds Test for cointegration, classical assumption tests, and the estimation of an Autoregressive Distributed Lag (ARDL) model. The results indicate that shrimp export quantity and crab export prices exert a significant negative effect on Indonesia's shrimp export value in both the short and long run. Conversely, shrimp export prices, the rupiah exchange rate, and U.S. GDP per capita demonstrate a significant positive effect on the value of shrimp exports in both time horizons. These findings highlight the multifaceted economic factors shaping Indonesia's shrimp export performance in the U.S. market and underscore the importance of maintaining competitive prices, stable currency conditions, and responsiveness to demand dynamics in major importing countries.

Keywords: shrimp export value, export quantity, export price, exchange rate, ardl model.

1. INTRODUCTION

Indonesia, as a maritime nation endowed with abundant marine resources, holds substantial potential for developing its fisheries sector, particularly shrimp, which has consistently served as one of the country's leading export commodities. The fisheries subsector has demonstrated strong and sustained growth, with its GDP increasing by an average of 8.20 percent between 2016 and 2021—exceeding the national GDP growth rate and indicating the sector's strategic contribution to the national economy (KKP, 2022). Shrimp plays a dominant role, contributing more than one-third of Indonesia's total fishery export value and positioning the country as the world's second-largest exporter of frozen shrimp after India (Yolandika et al., 2022). Despite this strong potential, Indonesia's competitive position in the United States market has weakened over time, with the country's market share falling to third place behind Ecuador and India and accounting for only about 6 percent of total U.S. shrimp imports (NMFS, 2022). This decline raises

significant concerns considering that the United States remains Indonesia's most valuable shrimp export destination and absorbs a substantial portion of national production.

Existing studies have underscored the importance of economic factors such as price, income, exchange rates, and competitor prices in driving shrimp demand and trade flows (Olorunniwo et al., 2018; Chen et al., 2019; Ridwan et al., 2021). However, the empirical literature on Indonesia's shrimp exports to the United States remains limited in three important ways. First, most prior research has primarily focused on shrimp prices, exchange rates, and income, while overlooking the role of substitute commodities— particularly the price of exported crab—which, according to demand theory, directly influences consumer substitution behavior and export performance. This omission is problematic given that U.S. consumers often shift between shrimp, crab, and other crustaceans in response to price fluctuations. Second, previous studies generally rely on OLS or ECM approaches (Ridwan & Hanafi, 2012; Fadhillah & Amin, 2015), which require long time series and impose assumptions that may not be suitable for datasets affected by structural shocks such as global trade disruptions, pandemics, and exchange rate volatility, especially after 2018. Third, despite the strategic importance of maintaining Indonesia's global competitiveness, there is still limited empirical evidence that integrates both short-run and long-run dynamics of shrimp export determinants within a single robust model capable of addressing small-sample limitations.

Given these empirical and methodological gaps, this study provides two key novelties. The first lies in incorporating the export price of crab as a substitute good—an important variable neglected in the Indonesian context—thereby offering a more realistic representation of U.S. consumer preferences and cross-price effects in the crustacean market. The second novelty is the application of the Autoregressive Distributed Lag (ARDL) approach, which is methodologically superior for estimating mixed-order integration variables, handling small samples, and capturing both short-term adjustments and long-term equilibrium relationships (Pesaran et al., 2001; Setiawan & Yusuf, 2023). This methodological advancement is crucial given the limited availability of annual data from 1998 to 2022 and the need to assess the responsiveness of shrimp exports to macroeconomic fluctuations.

The urgency of this study lies in Indonesia's declining competitiveness in its largest export market, the increasing price sensitivity of U.S. consumers, and the intensifying competition from Ecuador, India, and Vietnam, especially after 2020 when global supply chains experienced significant shocks. Without a clear understanding of the determinants driving shrimp exports, Indonesia risks further erosion of market share, reduced foreign exchange earnings, and weakening resilience of its fisheries sector. Therefore, this study not only fills critical empirical gaps but also provides timely and practical insights for policymakers and industry stakeholders to strengthen Indonesia's strategic position in the global shrimp value chain.

2.   LITERATURE REVIEW

Shrimp Export Value

Shrimp export value represents the total monetary earnings obtained from the international sale of shrimp commodities, and it serves as a key indicator of a country's competitiveness in global seafood markets. The export value is influenced not only by production capacity but also by price dynamics, international demand shifts, and global supply chain conditions (FAO, 2021). In emerging economies such as Indonesia, the shrimp export value is highly sensitive to fluctuations in global market prices, logistics congestion, and policy interventions in major importing countries (Putra & Setiawan, 2020). With shrimp remaining one of the most profitable seafood exports globally, understanding changes in export value is essential for evaluating economic performance and assessing trade resilience (UNCTAD, 2022).

Empirical studies emphasize that the shrimp export value is determined by the interaction of supply-side production capabilities and demand-side economic conditions in importing nations (Nguyen et al., 2019). For example, improvements in farming technology, disease control, and certification strategies have been found to significantly increase export revenues in Asian shrimp-producing countries (Hossain et al., 2020). Meanwhile, global events such as the COVID-19 pandemic and geopolitical disruptions have demonstrated that export value can be highly vulnerable to external shocks, especially in countries reliant on limited destination markets (Zhang et al., 2021). Hence, continuous monitoring of structural factors influencing shrimp trade is necessary to maintain stability in export earnings.

In the case of Indonesia, shrimp contributes the largest share of export value within the fisheries sector, yet its global market position has fluctuated due to tightening food safety standards and increasing

competition from India, Ecuador, and Vietnam (KKP, 2022). Previous findings indicate that Indonesia's export value is particularly affected by changes in foreign consumer incomes, substitute products, and international competition (Widodo et al., 2020). Despite its strong production potential, Indonesia's export value remains vulnerable to price volatility, currency movements, and trade barriers imposed by importing countries (Ardita & Nuryanti, 2023). These dynamics underscore the importance of analyzing the drivers that shape Indonesia's shrimp export value in major markets, especially the United States.

Shrimp Export Quantity

Shrimp export quantity refers to the volume of shrimp shipped abroad and plays a pivotal role in determining export earnings and market stability. According to international trade theory, export quantity is influenced by production capacity, cost efficiency, and access to international markets (Krugman et al., 2020). In countries where aquaculture forms a major part of national fisheries activity, fluctuations in export quantity often reflect structural constraints such as disease outbreaks, technological limitations, or supply chain inefficiencies (FAO, 2021). Consequently, export quantity becomes a crucial indicator of the competitiveness and health of the aquaculture sector.

Empirical findings show that export quantity often declines during periods of global supply chain disruption, especially when logistic delays and container shortages increase export costs (Lee & Min, 2022). At the same time, rising global demand tends to boost export quantity, particularly in premium markets such as the United States, Japan, and Europe (Torres et al., 2019). However, export volume growth is not always linear, as it may be hindered by unfavorable domestic production conditions including limited feed supply, water quality instability, or extreme weather events associated with climate change (Rahman et al., 2021). Therefore, export quantity is shaped by both domestic production dynamics and international market conditions.

In the Indonesian context, several studies report a long-term upward trend in shrimp export volume, although yearly fluctuations remain significant (Ridwan et al., 2021). The country's efforts to scale up aquaculture productivity, including the introduction of intensification programs and quality certification, have been associated with increased export volumes in certain years (Sari & Utomo, 2020). Despite these improvements, Indonesia still faces competitive pressure from global producers with larger-scale operations and lower production costs. Understanding how export quantity affects Indonesia's shrimp export performance is therefore critical for strengthening the nation's market share abroad.

Shrimp Export Price

Shrimp export price is a major determinant of international demand and influences the revenue generated from shrimp trade. In global seafood markets, price mechanisms reflect supply and demand interactions, production costs, and international competition (Anderson et al., 2020). For developing countries, the ability to stabilize export prices can significantly enhance their competitiveness, especially when dealing with price-sensitive markets such as the United States (Khan & Ahmed, 2021). Price movements are therefore central to assessing the strength of Indonesia's shrimp export sector.

Studies across multiple shrimp-producing nations have shown that higher export prices often reduce export volume as buyers substitute toward lower-priced suppliers unless compensated by superior quality or branding (Chen et al., 2019). At the same time, export prices are influenced by production constraints, such as disease and environmental shocks, which periodically limit supply and raise global prices (Liu & Gephart, 2022). Moreover, fluctuations in global economic conditions may alter consumer willingness to pay, especially in premium markets where shrimp is considered a semi-luxury good (Olorunniwo et al., 2018). Thus, shrimp export price remains one of the most dynamic factors in global seafood markets.

In Indonesia, shrimp export prices have been subject to volatility due to international supply competition, rising logistics costs, and fluctuations in global demand (Arfiansyah & Prasetyo, 2023). Although higher prices can increase Indonesia's export earnings in the short term, excessively high prices may negatively impact competitiveness in markets dominated by price-sensitive buyers. Previous studies in the Indonesian context have consistently found that export price plays a significant role in determining shrimp export performance, both in the short and long run (Fadhillah & Amin, 2015; Ridwan et al., 2021). Analyzing export price trends is therefore essential for understanding Indonesia's strategic position in the U.S. shrimp market.

Exchange Rate

The exchange rate is a central macroeconomic variable that affects international trade flows, including the competitiveness of shrimp export commodities. According to international finance theory, currency depreciation makes domestic goods cheaper in foreign markets, thereby increasing export competitiveness (Krugman et al., 2020). For developing countries reliant on export sectors, exchange rate volatility can create uncertainty in international transactions and influence exporters' income expectations (Bahmani-Oskooee & Aftab, 2018). Therefore, analyzing exchange rate dynamics is essential for understanding fluctuations in export performance.

Empirical research shows that exchange rate depreciation generally increases export volumes for export-oriented sectors, although the magnitude depends on price elasticity and market conditions (Ibrahim & Sulaiman, 2019). However, excessive exchange rate volatility may discourage exporters due to increased risks associated with uncertain future revenue (Ghosh et al., 2020). In seafood-exporting countries, exchange rate fluctuations also interact with production costs, especially when inputs such as feed, equipment, and energy are partially imported (Tran et al., 2021). Consequently, exchange rate behavior influences both the supply and demand side of shrimp exports.

In Indonesia, several studies have consistently found that exchange rate movements significantly affect shrimp export performance, particularly in major markets such as the United States (Ridwan et al., 2021). Rupiah depreciation tends to increase export competitiveness, although the benefits may be offset by rising import costs for aquaculture inputs. Moreover, exchange rate shocks can influence long-term investment decisions in the fisheries sector, affecting productivity and export potential (Putri & Hakim, 2022). Understanding the exchange rate's role is therefore crucial for assessing Indonesia's ability to maintain stable and competitive shrimp export flows.

U.S. GDP per Capita

GDP per capita in importing countries serves as a key indicator of consumer purchasing power and is a major determinant of demand for seafood products such as shrimp. Economic theory suggests that as income rises, consumers tend to allocate more expenditure toward high-value or luxury food items, including premium seafood products (Deaton & Muellbauer, 2020). Several studies indicate that shrimp is income-elastic in many developed countries, meaning demand increases as income grows (Olorunniwo et al., 2018). Thus, U.S. GDP per capita is expected to influence the import volume of Indonesian shrimp.

Empirical evidence from various seafood-exporting countries confirms that rising GDP per capita in high-income markets significantly boosts shrimp import demand (Chen et al., 2019; Kim & Lee, 2021). In the United States, where shrimp consumption has consistently grown during the past decade, increasing household income continues to support higher demand for imported shrimp (NOAA, 2021). Higher income levels also correlate with greater consumer preference for quality, sustainability, and traceability—factors that shape purchasing decisions in premium seafood markets (Martins et al., 2022). Consequently, GDP per capita reflects both purchasing power and evolving consumer preferences.

For Indonesia, the United States is one of the most lucrative markets for shrimp exports, making U.S. income trends highly relevant for export performance. Prior studies specifically examining Indonesia-U.S. shrimp trade find that U.S. GDP per capita significantly contributes to increased export volumes from Indonesia (Ridwan et al., 2021). The positive correlation between U.S. income growth and shrimp imports highlights the importance of monitoring macroeconomic conditions in importing countries when forecasting export potential. Thus, U.S. GDP per capita remains a critical factor shaping long-term demand for Indonesian shrimp.

Crab Export Price (Substitute Good)

In microeconomic theory, substitute goods are products that consumers may interchange based on price changes, and their prices significantly influence the demand for the primary commodity (Varian, 2019). In the seafood sector, shrimp and crab are commonly considered partial substitutes due to similarities in consumption patterns, culinary uses, and market positioning (FAO, 2021). As a result, fluctuations in crab prices can shift consumer demand toward or away from shrimp, thereby influencing shrimp import volumes

in major markets. The role of substitute goods is therefore an integral part of demand analysis in crustacean markets.

Empirical studies highlight that the price of substitute seafood products often plays a significant role in shaping import demand, although the magnitude of substitution varies by consumer preference and cultural factors (Liu & Cai, 2022). In some markets, higher crab prices lead consumers to increase shrimp consumption, while in others the substitution effect is limited due to differences in product form and availability (Zhou et al., 2020). Nonetheless, price competition among crustaceans remains an important determinant of trade flows, especially in highly competitive import markets such as the United States (Phong & Rios, 2021). Therefore, analyzing the price of related seafood commodities is essential for understanding export performance.

In the Indonesian context, very few studies have incorporated the price of crab as a substitute variable in analyzing shrimp export performance, creating a significant gap in the literature. Including crab export price allows for a more comprehensive understanding of cross-price elasticity and market competition dynamics. Preliminary evidence suggests that crab prices influence shrimp demand in the United States, although the relationship may differ between the short and long run (Astuti et al., 2023). By integrating crab price into the analysis, this study provides a novel contribution to Indonesian seafood trade research and strengthens the empirical modeling of shrimp export determinants.

3. METHOD

The present study employs a quantitative descriptive research design using a long-term time series dataset to capture structural dynamics in Indonesia's shrimp export performance to the United States. The analysis relies exclusively on secondary data drawn from UN Comtrade, the World Bank, and the Ministry of Trade of the Republic of Indonesia, covering 30 years from 1993 to 2022. The dataset includes shrimp export value, export quantity, shrimp export prices, the rupiah–US dollar exchange rate, U.S. GDP per capita, and crab export prices, all selected to reflect both demand-side and supply-side determinants relevant to international trade behavior. The dependent variable, namely the export value of Indonesian shrimp to the United States, represents the total monetary value of fresh, frozen, or processed shrimp shipments, while the independent variables capture key economic drivers that theoretically influence export performance through price competition, purchasing power, macroeconomic fluctuations, and substitution effects within the seafood market.

To analyze the dynamic interactions among variables, the study applies the Autoregressive Distributed Lag (ARDL) approach, which is appropriate for time series that exhibit mixed levels of stationarity and allows simultaneous examination of short-run adjustments and long-run equilibrium relationships. Prior to estimation, descriptive statistics are generated to understand the basic characteristics of each variable, followed by unit root testing using Dickey–Fuller and Augmented Dickey–Fuller procedures to ensure that the data are stationary at level or first difference. The Bounds Testing procedure is then used to identify whether long-run cointegration exists among the variables, justifying interpreting both short-run coefficients and long-run equilibrium relationships. Once cointegration is confirmed, the ARDL model incorporates an error correction term that reflects the system's ability to converge back to equilibrium after experiencing short-term shocks in export prices, exchange rates, or demand conditions.

To maintain model reliability, several diagnostic tests are performed, including assessments for normality, autocorrelation, and heteroskedasticity, ensuring that the estimated parameters meet classical econometric assumptions. Autocorrelation issues detected in the residuals are addressed using the Heteroscedasticity and Autocorrelation Consistent (HAC) method to obtain robust standard errors, while heteroskedasticity is examined through ARCH-based testing to verify the stability of residual variance. These procedures strengthen the validity of the ARDL estimation and support the interpretation of both short-run and long-run effects of export quantity, export prices, exchange rate movements, U.S. purchasing power, and crab price substitution on Indonesia's shrimp export value. The final model provides a comprehensive account of how macroeconomic dynamics and market structures jointly influence Indonesia's competitiveness in the U.S. shrimp market over three decades.

4. RESULT AND DISCUSSION

Descriptive Analysis

The descriptive analysis presents statistical summaries of the research variables, including mean, median, maximum, minimum, and standard deviation. The export value of Indonesian shrimp to the United States averages USD 492,638 with a median of USD 330,641. The highest export value of USD 1,349,682 occurred in 2022, coinciding with a 4% increase in export quantity, while the lowest value of USD 107,623 occurred in 1999 during the Asian financial crisis, which affected production and exports. The standard deviation of 357,055 indicates that the data are normally distributed since the mean exceeds the standard deviation. The shrimp export quantity averages 49,553,079 kg, with a median of 41,831,647 kg, peaking in 2022 and reaching its lowest of 3,722,562 kg in 1995 due to disease outbreaks like White Spot Syndrome Virus (WSSV). The standard deviation of 37,767,080 confirms the normal distribution of the data.

The export price of shrimp averages USD 7.898 per kg (median USD 7.66), with a maximum of USD 10.97 in 2022 and a minimum of USD 5.70 in 2001, reflecting domestic economic fluctuations. The Rupiah exchange rate shows a mean of IDR 9,784 per USD, with a maximum of IDR 15,731 in 2022 and a minimum of IDR 2,100 in 1993, influenced by global monetary conditions and trade patterns. US GDP per capita averages USD 46,998, ranging from USD 26,387 in 1993 to USD 76,330 in 2022. Meanwhile, the export price of Indonesian crab averages USD 13.27, with a maximum of USD 21 in 2022 and a minimum of USD 4 in 1993. The standard deviations of all variables indicate normal distribution as the mean values exceed their respective standard deviations.

Table 1. Descriptive Statistics of Research Variables

Variable	Mean	Median	Maximum	Minimum	Std. Dev
NEU_Y	492,638.0	330,641.0	1,349,682	107,623.0	357,055.0
VE_X1	49,553,079	41,831,647	1.19E+08	3,722,562	37,767,080
HEU_X2	7.898000	7.660000	10.97000	5.700000	1.266514
NTR_X3	9,784.033	9,632.500	15,731.00	2,100.000	3,825.986
GDPUS_X4	46,998.70	47,622.50	76,330.00	26,387.00	13,366.33
HEK_X5	13.26667	14.00000	21.00000	4.000000	4.748381

Unit Root Test (Stationarity Test)

The Augmented Dickey-Fuller (ADF) test was applied to examine the stationarity of all variables at the level. As shown in Table 2, all variables were non-stationary at the level across 1%, 5%, and 10% significance levels. However, after taking the first difference, Table 3 shows that all variables became stationary, indicating that none of the variables contain a unit root at the first difference. This confirms that the dataset is suitable for further time series analysis.

Table 2. Unit Root Test at Level (ADF Test)

Variable	ADF	1%	5%	10%	Description
NEU_Y	0.9860	-3.679	-2.968	-2.623	Non-stationary
VE_X1	0.9961	-3.679	-2.968	-2.623	Non-stationary
HEU_X2	0.2544	-3.659	-2.966	-2.613	Non-stationary
NTR_X3	0.4473	-3.675	-2.954	-2.623	Non-stationary
GDPUS_X4	0.9996	-3.679	-2.966	-2.623	Non-stationary
HEK_X5	0.2577	-3.689	-2.972	-2.625	Non-stationary

Table 3. Unit Root Test at First Difference (ADF Test)

Variable	ADF	1%	5%	10%	Description
NEU_Y	0.0001	-3.689	-2.972	-2.625	Stationary
VE_X1	0.0001	-3.689	-2.972	-2.625	Stationary
HEU_X2	0.0003	-3.700	-2.976	-2.627	Stationary
NTR_X3	0.0000	-3.689	-2.972	-2.625	Stationary

GDPUS_X4	0.0170	-3.689	-2.972	-2.625	Stationary
HEK_X5	0.0000	-3.689	-2.972	-2.625	Stationary

Lag Selection and Cointegration Test

The lag length criteria for the VAR model were examined to determine the optimal lag. Table 4 shows that lag 3 is optimal, indicated by the lowest values in AIC, SC, HQ, and FPE. The ARDL model using lag 3 ensures the best estimation performance. The Bound Test for cointegration, presented in Table 5, shows an F-statistic of 10.73666, which is higher than the upper critical bound at 1% significance. This confirms the existence of a long-term relationship among the variables, making the ARDL approach appropriate for further analysis.

Table 4. Lag Length Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1434.55	NA	8.86e+38	106.707	106.995	106.793
1	-1321.78	167.065	3.23e+36	101.021	103.036	101.620
2	-1284.41	38.757	4.57e+36	100.919	104.663	102.032
3	-1171.85	66.702*	7.27e+34*	95.248*	100.719*	96.875*

Table 5. Bound Test for Cointegration

Significance	I0 Bound	I1 Bound
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96	4.18
1%	3.41	4.68
F-statistic	10.73666	k = 5

Normality Test

The normality of residuals is a fundamental assumption for regression models because it guarantees the validity of t-tests and F-tests for hypothesis evaluation. In this study, the Jarque-Bera (JB) test was applied to examine whether the residuals from the ARDL model are normally distributed. The results indicate that the residuals are normally distributed, which confirms that the model does not violate the normality assumption. This ensures that the standard errors are reliable and that the subsequent inference regarding the relationship between shrimp export value and its determinants is valid.

Table 6. Normality Test Results

Test Statistic	Value	Probability
JB	1.336105	0.512706

Since the p-value (0.512706) exceeds the 5% significance level, the null hypothesis of normality is not rejected. Therefore, the residuals can be assumed to follow a normal distribution.

Autocorrelation Test

Autocorrelation occurs when the residuals are correlated across time, potentially biasing standard errors and affecting the reliability of coefficient estimates. The model was tested using both the F-statistic and the Obs*R-squared test.

Table 7. Autocorrelation Test Results

Test Type	Statistic	Probability
F-statistic	0.4045	0.6990
Obs*R-squared	5.5218	0.0632

The p-value for Obs*R-squared (0.0632) exceeds the 5% threshold, indicating no evidence of autocorrelation. This confirms that residuals are independent over time and that the ARDL model is correctly specified with respect to lagged relationships.

Heteroskedasticity Test
Heteroskedasticity refers to non-constant variance of residuals, which can lead to inefficient estimates and invalid hypothesis testing. In this study, the Breusch-Pagan-Godfrey test was employed to detect heteroskedasticity.

Table 8. Heteroskedasticity Test Results

Test Type	Statistic	Prob.
F-statistic	0.434544	0.9166
Obs*R-squared	16.50463	0.6849
Scaled explained SS	0.888518	1.0000

The p-value (0.6849) exceeds the 0.1 level, confirming homoscedasticity. This implies that the variance of residuals is constant across observations, validating the efficiency of the ARDL estimates.

Short-Run ARDL Estimation

The short-run ARDL results capture immediate effects of independent variables and their lags on shrimp export value. Significant coefficients in the short run indicate how past values of exports, quantity, prices, exchange rates, and macroeconomic factors affect current export performance. The error correction term (CointEq(-1)) shows how quickly the system adjusts toward long-run equilibrium.

Table 9. Short-Run ARDL Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.	Note
D(NEU_Y(-1))	-1.593795	0.449944	-3.542206	0.0165	Significant
D(NEU_Y(-2))	-0.36254	0.18499	-1.959784	0.1073	Not Significant
D(NEU_Y(-3))	-0.466651	0.199593	-2.338008	0.0665	*Significant*
D(VE_X1)	-0.008772	0.004576	-1.917092	0.1134	Not Significant
D(VE_X1(-1))	-0.02057	0.004613	-4.459664	0.0066	Significant
D(HEU_X2)	41925.1	13982.56	2.998386	0.0302	Significant
D(HEU_X2(-1))	254423.3	54060.68	4.706254	0.0053	Significant
D(HEU_X2(-2))	78038.71	17456.4	4.470492	0.0066	Significant
D(HEU_X2(-3))	214810.8	39345.31	5.459628	0.0028	Significant
D(NTR_X3)	62.35442	13.79654	4.519568	0.0063	Significant
D(NTR_X3(-1))	45.34714	13.46782	3.367072	0.02	Significant
D(NTR_X3(-2))	-11.55144	8.257128	-1.398966	0.2207	Not Significant
D(GDPUS_X4)	144.1691	30.13886	4.783495	0.005	Significant
D(GDPUS_X4(-1))	-42.42886	19.97231	-2.124384	0.087	*Significant*
D(GDPUS_X4(-2))	107.184	25.265	4.24239	0.0082	Significant
D(GDPUS_X4(-3))	-42.03855	17.71209	-2.373437	0.0637	*Significant*
D(HEK_X5)	-9389.796	4517.267	-2.078645	0.0922	*Significant*
D(HEK_X5(-1))	17651.05	8242.536	2.141458	0.0852	*Significant*
D(HEK_X5(-2))	-23454.66	8338.382	-2.812855	0.0374	Significant
D(HEK_X5(-3))	19206.68	7289.943	2.634681	0.0463	Significant
CointEq(-1)	-0.1892312	0.287343	-2.578015	0.0730	*Significant*

The error correction coefficient indicates that approximately 18.92% of deviations from long-run equilibrium are corrected each period. Export value is negatively affected by its own past values at lags 1 and 3, demonstrating a mean-reverting adjustment. Export quantity negatively impacts export value at lag 1, suggesting a short-run trade-off between volume and revenue. Export prices positively affect current values across multiple lags, highlighting the pricing power in export markets. The exchange rate and US GDP per capita show mixed lagged effects, reflecting sensitivity to both macroeconomic and market demand factors.

Long-Run ARDL Estimation

Long-run estimation reveals persistent relationships and the overall effect of each determinant on Indonesian shrimp export value.

Table 10. Long-Run ARDL Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
VE_X1	-0.008572	0.00196	-4.372490	0.0072
HEU_X2	172129.776589	14611.039686	11.780803	0.0001
NTR_X3	28.08954	4.551252	6.171828	0.0016
GDPUS_X4	48.7544	7.626336	6.3929	0.0014
HEK_X5	1172.444294	4436.196398	0.26429	0.8021
C	-939732.4557	9647.008213	-0.974118	0.3747

In the long run, export quantity exerts a significant negative effect on export value, confirming that higher supply reduces prices. Export prices have a strong positive effect, while macroeconomic factors, including exchange rates and US GDP per capita, significantly enhance export revenue. Crab export prices are not statistically significant, suggesting no substantial long-term interaction with shrimp exports.

Discussion

The discussion elaborates the empirical results obtained from the ARDL estimation, connecting them to theoretical frameworks, prior studies, and practical implications. The discussion is divided into short-run and long-run effects, highlighting the dynamics of Indonesian shrimp exports to the US market.

Short-Run Dynamics

In the short run, shrimp export value (*NEU_Y*) is significantly influenced by its own lagged values, confirming a mean-reverting pattern. Specifically, lag 1 and lag 3 of export value show significant negative effects, indicating that a decrease in shrimp export value in one period tends to trigger further declines in subsequent periods before returning to equilibrium. This aligns with market adjustment theory, which posits that export markets react to price shocks with delayed effects, reflecting contracts, supply chain delays, and production cycles (Gujarati & Porter, 2021).

The export quantity (*VE_X1*) exhibits a significant negative impact on export value at lag 1, suggesting a short-run trade-off between volume and revenue. When more shrimp is exported in the previous period, the market experiences supply saturation, reducing unit prices and overall revenue. This is consistent with classical supply-demand theory, where an increase in supply, holding demand constant, depresses prices (Mankiw, 2020).

Export price (*HEU_X2*) shows a consistently positive effect across multiple lags, indicating that price increases in prior periods enhance current export value. This highlights pricing power in international markets, where higher-quality shrimp or market-demand-induced price increases directly contribute to revenue. Empirical studies on seafood exports in Southeast Asia also confirm that price elasticity plays a dominant role in short-term export revenue (Wijaya et al., 2022).

Similarly, the exchange rate (*NTR_X3*) and US GDP per capita (*GDPUS_X4*) display mixed but significant effects. The positive influence of lagged exchange rates suggests that appreciation of the Rupiah against the US Dollar strengthens the competitiveness of Indonesian shrimp, boosting revenues in the short run. Conversely, the US GDP per capita exhibits both positive and negative lagged effects, reflecting market demand volatility: while higher past income in the US increases demand, past economic fluctuations can temporarily reduce spending on imported seafood. Crab export price (*HEK_X5*) shows mixed short-run significance. Certain lags indicate a negative effect, suggesting substitution or competitive dynamics between seafood products in export portfolios. These dynamics underscore the importance of multi-product interactions in export strategies, especially when markets like the US evaluate product mix and price fluctuations.

Long-Run Relationships

In the long run, the ARDL model reveals persistent relationships between shrimp export value and its determinants. Export quantity retains a negative long-run effect, confirming that increasing volume without

proportional price adjustments depresses revenue. This supports the notion of market saturation and price-volume trade-offs in international trade (Krugman et al., 2021).

Export price exerts a strong positive long-run effect, highlighting that revenue growth is primarily driven by pricing strategies and global demand. In other words, improving shrimp quality or targeting premium markets can sustainably increase export revenue. This finding resonates with prior empirical studies on Indonesian seafood exports, where price competitiveness consistently drives export performance (Suryanto & Nugroho, 2023).

The exchange rate (NTR_X3) positively influences long-run export value, reflecting the importance of currency stability and favorable monetary conditions. Fluctuations in the Rupiah can either enhance or reduce export competitiveness, emphasizing the need for macroeconomic policy alignment with trade objectives. US GDP per capita continues to have a significant positive effect, indicating that economic growth in importing countries consistently boosts demand for Indonesian shrimp. This aligns with income elasticity of demand theory, where higher consumer income in the destination market drives greater consumption of imported goods (Samuelson & Nordhaus, 2021). Interestingly, crab export price (HEK_X5) is not significant in the long run, implying limited interaction with shrimp export revenue over time. This suggests that strategic focus should remain on shrimp market dynamics, while crab exports may serve as a complementary or hedging product rather than a primary revenue driver.

Theoretical and Practical Implications

The findings have several theoretical and practical implications. Theoretically, the results confirm the applicability of ARDL modeling in capturing both short-term dynamics and long-run equilibrium relationships in export markets. The significant error correction coefficient (CointEq(-1)) of -0.189 indicates a moderate speed of adjustment toward equilibrium, consistent with international trade adjustment models (Pesaran et al., 2001).

Practically, the study emphasizes strategic management of export quantity and pricing. Policymakers and exporters must balance production volume with market demand to avoid negative revenue effects. Maintaining competitive pricing, improving shrimp quality, and monitoring macroeconomic indicators like exchange rates and target country GDP are essential for sustainable export growth. Furthermore, diversifying products strategically, considering interactions between shrimp and crab exports, can optimize overall export portfolio performance.

CONCLUSION

Based on the ARDL analysis results, it can be concluded that the value of Indonesian shrimp exports to the United States is significantly influenced by export prices, export quantities, the rupiah exchange rate, and U.S. economic growth in both the short and long term. In the short term, previous declines in export value tend to affect current exports, while increases in export prices and the exchange rate enhance export value. Export quantity shows a negative short-term effect, indicating a trade-off between volume and revenue. In the long term, export prices, exchange rates, and U.S. GDP per capita are the main determinants of increased export value, whereas export quantity continues to exhibit a negative effect. These findings highlight the importance of pricing strategies, export volume management, and attention to macroeconomic conditions in sustaining the growth of Indonesian shrimp exports.

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