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# Effects of Exchange Rate Fluctuations and Interest Rate Dynamics on Maritime Sector Operational Efficiency in Nigeria (ARDL Bounds Test Approach)

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**Abstract**
This study investigated the effects of exchange rate fluctuations and interest rate dynamics on maritime sector operational efficiency in Nigeria, using data spanning 2000 to 2024. Anchored on the Traditional Flow Theory and Systems Theory, the study used secondary data from the World Development Indicator, the Central Bank of Nigeria, and the Nigeria Ports Authority. Cargo Throughput (CTP) and Maritime Trade Volume (MTV) served as proxies for operational efficiency, while Effective Exchange Rate (EXR) and Interest Rate INT) represented macroeconomic dynamics, with Maritime Sector GDP (MGDP) as control variable. The Autoregressive Distributed Lag (ARDL) bounds testing approach was employed for analysis. Findings revealed that MGDP had a positive, statistically significant effect on CTP ($\beta = 10.177$; $p < 0.05$), while exchange and interest rates showed insignificant effects on port productivity. Conversely, a significant long-run relationship was confirmed for MTV, which was highly sensitive to interest rate dynamics ($p < 0.05$), with an error correction term of -0.2246, indicating a 22.5% annual speed of adjustment toward equilibrium. The study concluded that cargo handling is primarily driven by sectoral growth, while trade flows are significantly affected by financial shocks, and recommended exchange rate stability policies and affordable maritime credit facilities.
**Keywords:** Exchange Rate, Interest Rate, Operational Efficiency, Cargo Throughput, Maritime Trade Volume, ARDL Bounds Test

## 1.0 INTRODUCTION

The maritime industry is a fundamental pillar of global economic architecture, as more than 90% of international trade is facilitated through sea transportation and coastal gateways (Okene, Ibenta, & Nwanna, 2023; Oyeduntan, 2022). Nigerian seaports, particularly the Lagos Port Complex, Tin Can Island, and Port Harcourt, act as primary conduits for the movement of essential agricultural goods, manufactured items, and crude oil to international markets (Ndalu & Okene, 2024; Odogu, Orji, & Bereiweriso, 2026). For Nigeria to maintain its competitive edge within the West African sub-region, it is imperative to optimize port operational efficiency, which is directly influenced by the stability of the macroeconomic environment (Irejeh, Sile, & Egelu, 2023).

Operational efficiency within the Nigerian maritime sector is a multifaceted concept traditionally measured through performance indicators such as cargo throughput, ship turnaround time, and total trade volume (Ikeogu et al., 2025; Odogu, Orji, & Bereiweriso, 2026; Seifegha, Ndalu, & Okene, 2023). Cargo throughput serves as a primary metric for evaluating the productivity and utilization of a seaport's

facilities over a specific timeframe (Ikeogu et al., 2025; Kehinde, 2022). Maritime trade volume, encompassing both seaborne exports and imports, reflects the revenue-generating capacity and global integration of the nation's maritime industry (Okene, Ibenta, & Nwanna, 2023; Osadume & Blessing, 2020). However, the operational output of these ports is frequently hindered by adverse macroeconomic dynamics, most notably exchange rate fluctuations and interest rate volatility (Irejeh, 2026; Okene, Ibenta, & Nwanna, 2023).

Exchange rate fluctuations represent a significant source of macroeconomic disequilibrium in Nigeria, as the depreciation of the Naira inflates shipping costs and erodes container throughput revenue (Irejeh, 2026; Okene, Ibenta, & Nwanna, 2023). Unpredictable currency movements create uncertainty that discourages long-term investment in port infrastructure and complicates the financial planning of maritime operators (Aliyu, 2021; Mamman, Ahmed, & Ajidani, 2025). Interest rate dynamics likewise play a pivotal role in the capital-intensive maritime landscape, determining the cost of borrowing for vessel financing and modernization projects (Agunobi, Efionayi, & Akutson, 2024; Osadume & Imide, 2024). High interest rates in Nigeria have historically depressed growth in the real sector, limiting the ability of local shipping firms to compete with international players and hindering the automation of logistics processes (Adewale & Ibitoye, 2024; Osadume & Imide, 2024).

Despite various government-led administrative strategies and port concession programs designed to improve efficiency, Nigerian ports continue to face systemic problems such as chronic congestion, long ship turnaround times, and infrastructure deficits (Ikeogu et al., 2025; Odogu, Orji, & Bereiweriso, 2026). Corruption, price manipulation, and bureaucratic bottlenecks further undermine the sector's contribution to Nigeria's Gross Domestic Product (Ndikom, Buhari, Okeke, & Matthew, 2017). While existing literature has extensively discussed the relationship between maritime trade openness and economic growth, there is a notable scarcity of empirical work that concurrently analyzes the dual impact of currency and interest rate shifts on specific operational metrics such as cargo throughput and trade volume (Okene, Ibenta, & Nwanna, 2023; Osadume & Imide, 2024). Many previous studies have focused on broad economic growth indicators without isolating the day-to-day productivity variations caused by macroeconomic shocks (David, 2021; Ikeogu et al., 2025; Oyeduntan, 2022).

### 1.1 Statement of the Problem

The Nigerian maritime sector, which facilitates over 90% of the nation's international commerce, is currently hampered by persistent operational inefficiencies characterized by prolonged ship turnaround times, suboptimal cargo throughput, and high berth occupancy delays (Ikeogu et al., 2025; Odogu, Orji, & Bereiweriso, 2026; Okene, Ibenta, & Nwanna, 2023). Unpredictable exchange rate fluctuations have introduced severe macroeconomic disequilibrium that inflates vessel shipping costs while eroding container throughput revenue and overall port profitability (Irejeh, 2026; Kanu & Nwadiubu, 2020; Okene, Ibenta, & Nwanna, 2023). Volatile interest rate dynamics further depress the sector's operational capacity by inflating the cost of borrowing for capital-intensive infrastructure and limiting financial market access for local maritime operators (Agunobi, Efionayi, & Akutson, 2024; Mamman, Ahmed, & Ajidani, 2025; Osadume & Imide, 2024). Despite various administrative strategies and port modernization efforts, the industry continues to grapple with systemic bottlenecks and a notable scarcity of comprehensive empirical research utilizing the ARDL bounds testing approach to holistically examine the concurrent effects of these macroeconomic variables on maritime efficiency (Ikeogu et al., 2025; Maccido & Lawali, 2026; Osadume & Porwei, 2020).

### 1.2 Objectives of the Study

The purpose of this study is to fill the existing literature gap by investigating the impact of exchange rate and interest rate dynamics on maritime sector operational efficiency in Nigeria using the ARDL bounds test approach. Specifically, the study aims to:

(a) assess the effects of exchange rate volatility and interest rate dynamics on cargo throughput in Nigeria, to determine how these variables influence port productivity levels; and

(b) ascertain the effects of exchange rate volatility and interest rate dynamics on maritime trade volume in Nigeria, thereby uncovering the vulnerabilities within international trade flows facilitated by Nigerian seaports.

## 1.3 Conceptual Review

### *1.3.1 Concept of Maritime Sector Operational Efficiency in Nigeria*

Maritime sector operational efficiency in Nigeria refers to the effective and productive execution of core port activities, focusing on the quality, timeliness, and cost-effectiveness of service delivery (Ikeogu et al., 2025; Odogu, Orji, & Bereiweriso, 2026; Osadume & Imide, 2024). This concept is fundamentally evaluated through Key Performance Indicators (KPIs) such as cargo throughput, ship turnaround time, and berth occupancy rates, which collectively determine the utilization level of Nigeria's coastal gateways (Ikeogu et al., 2025; Odogu, Orji, & Bereiweriso, 2026; Oyeduntan, 2022). Scholars argue that an efficient maritime sector serves as a primary catalyst for socio-economic development, transforming Nigerian ports into regional hubs that facilitate over 90% of the nation's international trade volume (Edih, Igemohia, & Faghawari, 2022; Osadume & Blessing, 2020).

Operational performance is increasingly tied to administrative strategies, including the modernization of infrastructure and digitalization of logistics systems to reduce bureaucratic bottlenecks and port congestion (Ndalu & Okene, 2024; Odogu, Orji, & Bereiweriso, 2026). The efficiency of Nigerian seaports like Apapa and Onne is critical for maintaining national competitiveness, as suboptimal performance leads to increased shipping costs and lost revenue to neighboring West African ports (Ikeogu et al., 2025; Irejeh, Sile, & Egelu, 2023; Odogu, Orji, & Bereiweriso, 2026).

### *1.3.2 Exchange Rate Fluctuations, Cargo Throughput and Maritime Trade Volume*

Exchange rate fluctuations introduce significant macroeconomic uncertainty into the Nigerian maritime landscape, directly influencing the financial performance of shipping firms and the volume of trade flows (Irejeh, 2026; Kanu & Nwadiubu, 2020; Okene, Ibenta, & Nwanna, 2023). Unpredictable currency depreciation often results in macroeconomic disequilibrium that inflates vessel shipping costs while eroding container throughput revenue and port profitability (Irejeh, 2026; Mina, 2026; Okene, Ibenta, & Nwanna, 2023). Frequent shifts in the value of the Naira against major benchmarks like the US Dollar create volatility that discourages long-term investment in port facilities and complicates the planning of international shipping contracts (Aliyu, 2021; Mamman, Ahmed, & Ajidani, 2025; Okene, Ibenta, & Nwanna, 2023).

In an import-dependent economy like Nigeria, currency volatility significantly depresses maritime trade volume by increasing the cost of manufacturing inputs and imported finished goods, leading to fluctuations in total cargo throughput (Irejeh, Sile, & Egelu, 2023; Mamman, Ahmed, & Ajidani, 2025; Njoku, Yomi, & Sunday, 2020). Stable exchange rate policies are therefore indispensable for fostering a predictable environment that allows for consistent growth in both seaborne exports and imports (Maccido & Lawali, 2026; Mina, 2026; Okene, Ibenta, & Nwanna, 2023).

### *1.3.3 Interest Rate Dynamics, Cargo Throughput and Maritime Trade Volume*

Interest rate dynamics serve as a primary determinant of capital allocation within the maritime sector, as the cost of borrowing dictates the feasibility of acquiring modern cargo-handling equipment and maintaining merchant fleets (Adewale & Ibitoye, 2024; Osadume & Imide, 2024). High interest rates in Nigeria have historically depressed growth in the real sector, limiting the financial capacity of local maritime operators to compete with international firms and automate logistical processes (Adegoke, Ahmed, & Ajidani, 2025; Osadume & Imide, 2024).

There is an undeniable synergy between financial market access and maritime growth, as affordable credit is essential for funding the large-scale infrastructure projects required to enhance cargo throughput capacity (Chukwunulu & Ibenta, 2021; Osadume & Imide, 2024; Osadume & Porwei, 2020). Volatile interest rates and restrictive monetary policy dynamics further constrain maritime trade volume by inflating logistics costs across the supply chain and reducing liquidity available for trade business expansion (Agunobi, Efionayi, & Akutson, 2024; Mamman, Ahmed, & Ajidani, 2025; Osadume & Imide,

2024). A stable interest rate environment is thus a prerequisite for ensuring that the maritime industry can achieve long-run equilibrium and contribute meaningfully to national GDP (Ikeogu et al., 2025; Maccido & Lawali, 2026; Osadume & Imide, 2024).

**1.4 Theoretical Framework**

The theoretical framework for this study integrates macroeconomic paradigms and systems-oriented organizational perspectives to explain the nexus between financial volatility and maritime productivity (Irejeh, Sile, & Egelu, 2023; Odogu, Orji, & Bereiweriso, 2026; Okene, Ibenta, & Nwanna, 2023).

The Traditional Flow Theory serves as the primary anchor, postulating that exchange rate volatility increases the risk of international trade and creates uncertainty that depresses trade flows and sectoral returns (Irejeh, 2026; Okene, Ibenta, & Nwanna, 2023; Yakub, Sani, Obiezue, & Aliyu, 2019). This theory suggests that, in the absence of perfect hedging, profit-oriented shipping firms will scale back operations in response to unpredictable currency shifts, ultimately reducing cargo handling volumes and port efficiency (Mina, 2026; Okene, Ibenta, & Nwanna, 2023; Yakub, Sani, Obiezue, & Aliyu, 2019).

From an operational standpoint, Systems Theory provides a holistic view of the maritime industry as a complex network of interdependent components, such as infrastructure, management, and labour, that must synergize within a stable macroeconomic environment to achieve optimal efficiency (Ikeogu et al., 2025; Odogu, Orji, & Bereiweriso, 2026). According to this perspective, any failure in the macroeconomic subsystem, such as high borrowing costs or currency disequilibrium, inevitably compromises the performance of the port system, resulting in ship turnaround delays and suboptimal throughput (Ikeogu et al., 2025; Odogu, Orji, & Bereiweriso, 2026).

**1.5 Empirical Review**

***1.5.1 Exchange Rate Volatility and Maritime/Economic Performance***

Mina (2026) examined the effects of exchange rate volatility and the blue economy on the financial performance of Nigeria's shipping industry from 1990 to 2024 using the ARDL framework. The findings revealed that exchange rate volatility significantly reduced container throughput revenue and port earnings while increasing shipping costs, and the study recommended exchange rate stabilization policies and financial risk-hedging instruments.

Maccido and Lawali (2026) investigated the impact of monetary policy on exchange rate dynamics in Nigeria from 2012 to 2025 using the ARDL bounds testing approach. The findings revealed that conventional monetary policy rates exert statistically insignificant effects on exchange rate movements, whereas financial market performance, proxied by the All Share Index, significantly improves real exchange rate stability.

Mamman, Ahmed, and Ajidani (2025) analyzed the long-run impact of exchange rate fluctuations on Nigeria's economic growth from 1987 to 2024 using the GARCH model. The study found that high inflation and interest rates significantly constrain economic growth, while previous exchange rate volatility continues to influence current macroeconomic stability, and recommended targeted reforms to reduce exchange rate risks.

Okene, Ibenta, and Nwanna (2023) assessed the effects of exchange rate volatility on shipping trade performance in Nigeria from 1995 to 2022 using a combined GARCH and ARDL bounds testing approach. The findings indicated that exchange rate volatility has no significant effect on seaborne exports and imports in either the short run or the long run, an outcome attributed to Nigeria's dependence on imports and dominance of crude oil exports.

Irejeh, Sile, and Egelu (2023) examined the relationship between arbitrage in port operations and maritime performance in Nigeria from 1990 to 2022 using the Ordinary Least Squares (OLS) technique. The findings showed that exchange rate and Treasury bill rates positively and significantly influence maritime GDP, whereas inflation risk and money supply negatively affect maritime performance.

Yakub, Sani, Obiezue, and Aliyu (2019) investigated the impact of exchange rate volatility on trade flows in Nigeria using monthly data and the ARDL bounds testing approach. The findings revealed that

exchange rate volatility negatively affected trade flows in the short run but had no significant long-run effect, and recommended that the Central Bank strengthen foreign exchange market interventions.

### *1.5.2 Port Operational Efficiency and Port Performance*

Odogu, Orji, and Bereiweriso (2026) evaluated the impact of administrative strategies on the operational performance of Nigerian ports using a cross-sectional survey design. The findings revealed that improved port infrastructure significantly enhances vessel services and cargo delivery efficiency, and that port modernization improves berthing and cargo productivity, although digitalization exerts only marginal influence on certain port services.

Ikeogu, Anyanwu, Ikeogu, Erumaka, and Nwosu (2025) examined the short-run determinants of port performance at the Lagos Port Complex using the ARDL model. The findings showed that cargo throughput and improvements in vessel turnaround time significantly enhance operational efficiency, whereas berth occupancy rate was statistically insignificant, suggesting that vessel clearance delays remain a major bottleneck.

Kehinde (2022) assessed the effect of cargo throughput on maritime GDP in Nigeria between 1996 and 2016 using simple regression analysis. The findings indicated that cargo throughput accounts for approximately 68% of the variations in maritime GDP, concluding that improving cargo handling efficiency is essential for increasing the sector's contribution to the national economy.

Nwaogbe et al. (2020) evaluated the operational performance of the Calabar Free Port using multiple regression analysis. The findings demonstrated a statistically significant relationship between cargo throughput, vessel traffic, and the number of employees, with an R-squared value of 99%.

### *1.5.3 Financial Markets, Maritime Sector Growth, and Trade Development*

Osadume and Imide (2024) evaluated the effect of financial market access on maritime sector growth in Nigeria between 1981 and 2020 using Ordinary Least Squares (OLS) estimation. The study established that the financial institutions access index has a statistically significant positive effect on the maritime sector's contribution to GDP, concluding that expanding financial services and ship financing is essential for improving competitiveness.

Agunobi, Efionayi, and Akutson (2024) investigated the effect of selected macroeconomic variables on stock market performance in Nigeria from 1990 to 2022 using the ARDL bounds testing approach. The findings revealed that lagged broad money supply and financial deepening significantly influence total market capitalization, whereas interest rates do not have a statistically significant effect, though they remain an important determinant of investor decisions.

Osadume and Blessing (2020) investigated the relationship between maritime trade and economic development in Nigeria from 1980 to 2019 using Granger causality and ARDL bounds testing techniques. The findings revealed a strong bi-directional causal relationship between trade openness and economic development, measured by the Human Development Index, concluding that increased trade openness significantly improves national living standards, education, and health outcomes.

## 1.6 Gap in the Literature

Existing research on the Nigerian maritime industry has primarily focused on the broad relationship between maritime trade openness and national economic growth, often neglecting specific day-to-day operational efficiency metrics (Irejeh, Sile, & Egelu, 2023; Okene, Ibenta, & Nwanna, 2023; Osadume & Blessing, 2020). There is a notable scarcity of comprehensive empirical studies that concurrently analyze the dual influence of exchange rate fluctuations and interest rate dynamics on port productivity indicators such as cargo throughput and trade volume (Ikeogu et al., 2025; Maccido & Lawali, 2026; Osadume & Imide, 2024). Furthermore, while various econometric models have been utilized to study trade flows, there remains a deficiency in the application of the ARDL bounds testing approach to investigate both the short-run dynamics and long-run equilibrium relationships between these financial shocks and specific operational output (Agunobi, Efionayi, & Akutson, 2024; Ikeogu et al., 2025; Okene, Ibenta, & Nwanna, 2023). Most extant studies also fail to capture how these variables interact within the context of recent Nigerian policy shifts, leaving a critical knowledge gap regarding the resilience of port operations in a

volatile financial environment (Irejeh, 2026; Maccido & Lawali, 2026; Osadume & Imide, 2024). This study addresses these gaps.

## 2.0 MATERIALS AND METHODS

This study adopted the ex-post facto research design. The Autoregressive Distributed Lag (ARDL) bounds test approach was used to analyse the data. Data for the study were sourced from the World Development Indicator, the Central Bank of Nigeria Annual Statistical Bulletin, and Nigeria Ports Authority Annual Reports, covering the period 1997 to 2024. The dependent variable is proxied by Cargo Throughput (CTP) and Maritime Trade Volume (MTV). The independent variables are the Real Effective Exchange Rate (REER) and Lending Rate (LR), while Maritime Sector GDP (MGDP) serves as a control variable.

The model formulated for the study was estimated with the ARDL bounds test technique, following Yakub et al. (2019), Maccido and Lawali (2026), and Okene et al. (2023), with modifications. Model 1 equations estimate the relationship between exchange rate, interest rate, and cargo throughput, while Model 2 equations estimate the relationship between exchange rate, interest rate, and maritime trade volume.

***ARDL Model 1***

$CTP = f(REER, LR, MGDP)$ ..... (1.0)

Long-run ARDL Equation: $CTP_t = \beta_0 + \beta_1 REER_t + \beta_2 LR_t + \beta_3 MGDP_t + \varepsilon t$ ..... (1.1)

Short-run ARDL-ECM Equation: $\Delta CTP_t = \alpha_0 + \Sigma\alpha_i \Delta CTP_{t-i} + \Sigma\beta_i \Delta REER_{t-i} + \Sigma\gamma_i \Delta LR_{t-i} + \Sigma\delta_i \Delta MGDP_{t-i} + \lambda ECM_{t-1} + \varepsilon t$ ..... (1.2)

***ARDL Model 2***

$MTV = f(REER, LR, MGDP)$ ..... (2.0)

Long-run ARDL Equation: $MTV_t = \beta_0 + \beta_1 REER_t + \beta_2 LR_t + \beta_3 MGDP_t + \varepsilon t$ ..... (2.1)

Short-run ARDL-ECM Equation: $\Delta MTV_t = \alpha_0 + \Sigma\alpha_i \Delta MTV_{t-i} + \Sigma\beta_i \Delta REER_{t-i} + \Sigma\gamma_i \Delta LR_{t-i} + \Sigma\delta_i \Delta MGDP_{t-i} + \lambda ECM_{t-1} + \varepsilon t$ ..... (2.2)

The ARDL bounds test approach emphasizes both short-term dynamics and long-term adjustments, making it an effective tool for analysing the impact of exchange rate and interest rate dynamics on maritime sector operational efficiency in Nigeria.

Where CTP is Cargo Throughput; MTV is Maritime Trade Volume; REER is Real Effective Exchange Rate; LR is Lending Rate; MGDP is Maritime Sector GDP; $\beta_0$ is the constant; $\beta_1$–$\beta_3$ are regression coefficients; $\Delta$ is the first difference operator; $\varepsilon$ is the error term; and $\lambda$ measures the speed of adjustment.

## 3.0 RESULTS AND DISCUSSION

***Table 1. Descriptive Statistics***

| | CTP | MTV | EXR | INT | MGDP |
|---|---|---|---|---|---|
| Mean | 64.92781 | 3.612361 | 92.27198 | 24.87293 | 4.068442 |
| Median | 70.47600 | 2.892542 | 85.13346 | 24.69180 | 4.010277 |
| Maximum | 103.3369 | 9.538067 | 155.7536 | 31.65000 | 6.100000 |
| Minimum | 28.93288 | 0.567080 | 58.24839 | 18.36250 | 2.838211 |
| Std. Dev. | 18.80261 | 2.357473 | 26.41426 | 4.165929 | 0.857625 |
| Jarque-Bera | 0.916191 | 7.370172 | 5.594880 | 1.679614 | 0.844728 |
| Probability | 0.632487 | 0.025095 | 0.060966 | 0.431794 | 0.655495 |

*Source: Author's computation with E-views, 2026. Note: CTP = Cargo Throughput, MTV = Maritime Trade Volume, EXR = Exchange Rate, INT = Interest Rate, MGDP = Maritime Sector GDP.*

The mean values for Cargo Throughput (CTP) and Maritime Trade Volume (MTV) were 64.92 and 3.61, respectively. Based on the Jarque-Bera probability values, CTP, EXR, INT, and MGDP are normally distributed ($p > 0.05$). However, MTV ($p = 0.025$) rejects the null hypothesis of normality at the 5% level, indicating a slight deviation from a normal distribution.

***Table 2. ADF Unit Root Test***

| Variable | ADF (Level) | 5% Critical (Level) | Prob. (Level) | ADF (1st Diff.) | 5% Critical (1st Diff.) | Prob. (1st Diff.) | Order |
|---|---|---|---|---|---|---|---|
| CTP | 1.452832 | -1.956406 | 0.9592 | -2.875312 | -1.957204 | 0.0062 | I(1) |
| MTV | -2.855726 | -1.956406 | 0.0064 | – | – | – | I(0) |
| EXR | -0.129549 | -1.956406 | 0.6282 | -2.487249 | -1.957204 | 0.0155 | I(1) |
| INT | 0.737213 | -1.956406 | 0.8668 | -4.878312 | -1.957204 | 0.0000 | I(1) |
| MGDP | 1.457093 | -1.956406 | 0.9595 | -2.432306 | -1.957204 | 0.0176 | I(1) |

*Source: Author's computation with E-views, 2026.*

The Augmented Dickey-Fuller (ADF) unit root test results demonstrate a mixture of integration orders: MTV is stationary at level [I(0)], while CTP, EXR, INT, and MGDP are stationary at first difference [I(1)]. This mixture of integration orders confirms that the ARDL Bounds Test is the most appropriate econometric technique, as it remains robust in the presence of varied integration orders.

***Table 3. ARDL Estimates – Model 1 (Dependent Variable: Cargo Throughput)***

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| CTP(-1) | 0.483400 | 0.190584 | 2.536419 | 0.0201 |
| EXR | 0.014702 | 0.097284 | 0.151129 | 0.8815 |
| INT | -0.052750 | 0.671941 | -0.078505 | 0.9382 |
| MGDP | 10.17758 | 4.087339 | 2.490026 | 0.0222 |
| C | -6.091065 | 20.49608 | -0.297182 | 0.7696 |

R-squared = 0.7975; Adjusted R-squared = 0.7549; F-statistic = 18.7101 (Prob. = 0.000002); Durbin-Watson stat = 2.0232.

*Source: Author's computation with E-views, 2026.*

The ARDL results indicate that the model is statistically significant ($F = 18.71$, $p < 0.01$), explaining about 79.8% of the variation in cargo throughput (CTP). The lagged value of CTP and Maritime GDP (MGDP) have positive and statistically significant effects on CTP. Exchange rate (EXR) has a positive but statistically insignificant effect on CTP ($p = 0.8815$), while interest rate (INT) exerts a negative but statistically insignificant effect ($p = 0.9382$), indicating that neither variable significantly influences cargo throughput during the study period.

***Table 4. ARDL Estimates – Model 2 (Dependent Variable: Maritime Trade Volume)***

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| MTV(-1) | 0.775361 | 0.086902 | 8.922299 | 0.0000 |
| EXR | -0.009621 | 0.005433 | -1.770968 | 0.0935 |
| INT | 0.179342 | 0.050986 | 3.517494 | 0.0025 |
| INT(-1) | -0.188843 | 0.043599 | -4.331358 | 0.0004 |
| MGDP | -0.522496 | 0.301015 | -1.735781 | 0.0997 |
| C | 3.710010 | 1.421769 | 2.609432 | 0.0177 |

R-squared = 0.9497; Adjusted R-squared = 0.9358; F-statistic = 68.0148 (Prob. = 0.000000); Durbin-Watson stat = 2.4803.
*Source: Author's computation with E-views, 2026.*

The ARDL results show that the model is statistically significant ($F = 68.01$, $p < 0.01$), explaining approximately 95.0% of the variation in maritime trade volume (MTV). The lagged value of MTV has a positive and highly significant effect. Exchange rate (EXR) has a negative but statistically insignificant effect ($p = 0.0935$). Current interest rate (INT) positively and significantly affects MTV ($p = 0.0025$), while its lagged value has a significant negative effect ($p = 0.0004$). Maritime GDP (MGDP) negatively but insignificantly influences MTV.

***Table 5. Bounds Test for ARDL Models 1 and 2***

| Test Statistic | Significance | F-statistic | I(0) | I(1) |
|---|---|---|---|---|
| ARDL Model 1 | 5% | 2.777562 | 2.79 | 3.67 |
| ARDL Model 2 | 5% | 5.210604 | 2.79 | 3.67 |

*Source: Author's computation with E-views, 2026.*

The Bounds test results show mixed evidence of long-run relationships. For ARDL Model 1, the F-statistic (2.7776) is below the 5% upper bound critical value (3.67) and close to the lower bound (2.79), indicating no long-run cointegrating relationship among the variables. In contrast, ARDL Model 2 has an F-statistic (5.2106) exceeding the upper bound critical value, confirming the existence of a long-run cointegrating relationship among the variables.

***Table 6. Error Correction Regression – ARDL Model 2 (Dependent Variable: D(MTV))***

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(LR) | 0.179342 | 0.034645 | 5.176598 | 0.0001 |
| CointEq(-1)* | -0.224639 | 0.039809 | -5.642923 | 0.0000 |

R-squared = 0.6800; Adjusted R-squared = 0.6655; Durbin-Watson stat = 2.4803.
*Source: Author's computation with E-views, 2026.*
The Error Correction Model (ECM) results confirm a stable long-run relationship among the variables in ARDL Model 2 (MTV, EXR, INT and MGDP). The error correction term, CointEq(-1), is negative and highly significant ($-0.2246$, $p < 0.01$), indicating that approximately 22.5% of short-run disequilibrium is corrected each period toward long-run equilibrium. The short-run effect of the interest rate (INT) is positive and statistically significant, while the model explains about 68.0% of the variation in maritime trade volume (MTV).

### *3.1 Diagnostic Tests*

| Test | ARDL Model 1 (CTP) Prob. | ARDL Model 2 (MTV) Prob. |
|---|---|---|
| Serial Correlation LM Test (F-stat) | 0.7149 | 0.4466 |
| Heteroskedasticity Test (F-stat) | 0.3746 | 0.8117 |

For both models, the p-values for the F-statistics exceed 0.05, confirming the absence of serial correlation and heteroskedasticity. These diagnostic outcomes confirm the econometric reliability of both models.

## 4.0 CONCLUSION

The study was anchored on the Traditional Flow Theory, which explains that exchange rate instability creates uncertainty that can weaken international trade flows, and Systems Theory, which views maritime operations as an interconnected system in which macroeconomic instability can affect overall port performance. The study investigated the effects of exchange rate and interest rate dynamics on maritime sector operational efficiency in Nigeria using the ARDL bounds testing approach. The findings revealed that exchange rate fluctuations and interest rate movements have varying effects on cargo throughput and maritime trade volume. Specifically, exchange rate exhibited a positive but insignificant effect on cargo throughput, while interest rate showed a negative and insignificant influence, suggesting that short-term macroeconomic shocks may not substantially alter port cargo handling activities. However, interest rate dynamics significantly influenced maritime trade volume, with evidence of long-run equilibrium adjustment among the variables.

### 4.1 Recommendations

**1. Strengthen Exchange Rate Stability Policies:** The Central Bank of Nigeria should implement effective foreign exchange management strategies that reduce excessive currency volatility, thereby improving financial predictability for shipping operators and supporting sustainable maritime trade activities.

**2. Promote Affordable Maritime Financing:** Government and financial institutions should develop sector-specific credit facilities with lower lending rates to enable shipping firms to invest in modern vessels, port equipment, and logistics infrastructure required for improved operational efficiency.

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