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Port Tariff Structure and Cargo Throughput in Nigerian Seaports.

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ABSTRACT

This study examined the effect of port tariff structure on cargo throughput in Nigerian seaports using an Ordinary Least Squares (OLS) demand response model estimated over the 2010 – 2026 period. Three tariff components, ship dues, pilotage, and wharfage were regressed against cargo throughput, while harbour dues were evaluated for inclusion in the model. The estimated model returned a multiple correlation coefficient of 0.646, a coefficient of determination of 0.417 (adjusted R^2 = 0.283), and the influence on throughput is at 10% level (F = 3.102, p = 0.064). Wharfage charges emerged as the dominant tariff component, with the largest standardized effect (Beta = -0.891, B = -1.292) and confirming an inverse, shore-side elasticity of cargo throughput to transactional shore-side fees, although its individual coefficient fell short of conventional significance (p = 0.770). Ship dues (B = 0.138, P = 0.969) and pilotage rates (B = 0.121, p = 0.963) proved inelastic and statistically non-significant, indicating that vessel-side charges exert little independent influence on throughput. Harbour dues was excluded from the final model due to severe multi-collinearity (Tolerance = 9.112E-5). A Durbin-Watson statistics of 0.408 indicated positive first-order autocorrelation, consistent with structural stickiness in the tariff throughput adjustment process. The study concludes that Nigerian cargo throughput is selectively sensitive to shore-side transactional tariffs rather than marine vessels-side fees. It recommended wharfage rationalization, a dynamic performance-linked marine tariff framework, consolidation of harbour dues and wharfage into a single infrastructure fee, and multi-modal hinterland investment to reduce autoregressive stickiness.

ARTICLE INFO

Keywords: Port tariff structure; cargo throughput; demand response model

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1. INTRODUCTION

A port is a passage for goods and passengers, a safe berth space for vessels, and it is equally a linkage in global transport chain between inland and seaport, and it plays a significant role and national and global economic development (Dunya, Omotoso & Olaoluwa, 2022). Nigerian seaports are important passage to national economy, because it enhances international and coastal trade and enables efficient logistics flow across the national economic system. From the port user's point of view, these charges constitute the cost of port utilization.

Port terminal which is integral part of a seaports are designated for loading and unloading of cargo, are important for cargo transshipment and for compliance with the 48-hour cargo clearance rule of the International Maritime Organization (IMO); however, there is absolutely no noticeable improvement over a long period of time in the efficiency and productivity of Nigerian port management in meeting this stipulation (Monday, Ibe & Emenike, 2021). There are several indicators of port efficiency and performance, one of them is the port cargo throughput, which is the totality of cargo that enters and leaves the nation's ports through waterway transportation (Akpudo & Nwachukwu, 2023). Over 90% of the world trade volume is conveyed by maritime transportation, and the economic growth of any country depends heavily on maritime transport performance in the international market, but due to unregulated and fluctuating port tariff in Nigerian seaport, there is a significant drop in the throughput level thereby creating an unparalleled competitive disadvantages with other regional ports in West Africa and beyond. Port tariffs, is a mechanism set aside for imposing charges on the import and export of goods, which in most cases serve as source of revenue, protect domestic industries, and can also generate persistent disarray in port charges, creating a continually expanding interest in the improvement of levy structure if managed properly (Japhet, Joseph & Wilfred, 2024).

Nigerian seaports are major gateways for international trade and generate revenue through various port tariffs, including cargo handling and storage charges, throughput fee, lease fee, wharfage, cargo dues, berthing/mooring dues, ship dues, harbour dues, conservancy, pilotage dues, anchorage dues. These tariffs affect the cost of using port services and may influence the volume of cargo handled at the port (Nigerian Ports Authority (NPA), 2020). In recent years, cargo throughput in Nigerian seaports has fluctuated, and concerns have been raised that high or poorly structured port tariffs discourage port users and reduce cargo volumes (Onwuegbuchunam, 2013; UNCTAD, 2018). However, there is limited empirical evidence on how cargo throughput responds to changes in port tariffs in Nigeria. This study therefore examines the effect of port tariff structure on cargo throughput in Nigerian seaports using a demand response model.

1.1 Objectives of the Study

1. To examine the relationship between port tariffs and cargo throughput volume across major Nigerian seaports from 2010 to 2026.
2. To determine which components of the port tariff (ship dues, pilotage, harbour dues, and wharfage) have the most significant effect on cargo throughput.
3. To assess the extent of impact of changes in port tariffs and the overall trend of cargo throughput in Nigerian seaports.

1.2 Research Questions

The study seeks to answer the following research questions:

1. What is the relationship between port tariffs cargo throughput volume across major Nigerian seaports from 2010 to 2026?
2. Which components of port tariffs (ship dues, pilotage, harbour dues, and wharfage) have the most significant effect on cargo throughput in Nigerian seaports?
3. To what extent do year-to-year changes in port tariffs impact the overall trend of cargo throughput in Nigerian seaports?

1.3 Hypotheses

H_{01}: Port tariff has no significant effect on cargo throughput volume in Nigerian seaports.

H02: None of the individual components of port tariffs significantly influence cargo throughput volume in Nigerian seaports.
H_{03}: Year-to-year changes in port tariff have no significant impact on cargo throughput trends in Nigerian seaports.
The study covers the period from 2010 to 2026. This timeframe was selected to capture recent developments in port operations, tariff adjustments, and changes in cargo traffic within the Nigerian maritime sector, allowing for a comprehensive analysis of the relationship between port tariff structure and cargo throughput.

2. LITERATURE REVIEW

Port tariff structure refers to the model expense structure devised to provide a standardized pattern for the presentation of port expenses, although the task of setting actual costs within that framework is left to individual ports (Japhet, Joseph & Wilfred, 2024). According to the work of Tri, Hassan, Irwan, Firmanto and Christtino (2017) note that port tariff structure analysis includes identification of port services and cost components from both user and operator perspectives; in a typical logistics cost breakdown, shipping cost contributes 48%, port cost 40%, and hinterland cost 12%, while within port cost, stevedoring contributes 42%, and cargo-loading cost 58%. The United Nations Conference on Trade and Development (UNCTAD) holds that port pricing policy should guarantee a fair distribution of benefits, facilitate comparison of fees and expenses, and enhance the efficient use of facilities; a good port tariff structure must therefore be simple, clear, and revenue-adequate while remaining comparable across ports and competitive enough to maximize user utility.
Cargo throughput refers to the total volume of cargo, measured by weight or unit count that passes through a seaport within a specific period, and serves as a key indicator of port operational performance (Ismail & Joel, 2025). Port cargo throughput is a pivotal driver of national economic growth, trade facilitation, and urban development, given that maritime transport accounted for 75% of global modal share in 2020 (Ruitong, Guangnian, Chunqin & Qingjun, 2025). Ship traffic size, port policy, service cost and time, and vessel turnaround time are all variables that affects a port's cargo throughput volume; higher vessel turnaround time imposes higher costs of port usage and is generally regarded as an indicator of poor port performance (Buhari, Ndikom and Nwokedi 2017).
Inefficiencies in cargo handling, congestion, and inadequate facilities have led to project delays, increased costs, and a decline in the Nigerian maritime sector's overall economic output (Ismail & Joel, 2025). As one of the major cargo hubs in West Africa, Nigeria's port competitiveness depends substantially on tariffs and associated costs of port services remaining viable and competitive relative to regional peers (Waldens, Borha & Jukwe, 2019). Ports are connecting hubs between maritime transports with the rest of the logistics chain, offering services related to infrastructure, cargo, vessels, and navigation; in principal, a port's pricing system must remain balanced against the competitive position of other ports, whether under normal, intense regional, or hinterland-based competition (Tonis, Ulla & Jonne, 2025).
Price elasticity of demand (PED) is a crucial indicator is a crucial indicator for shipping companies, shareholders, port users and cargo owners, quantifying the responsiveness of shipping demand to changes in freight rates; factors such as availability of substitute transport modes, the proportion of income spent on shipping, time horizon, and the necessity of goods all influence PED, while in markets such as India, port infrastructure and hinterland connectivity ad further variation (Vrajlal, 2025). Axel, Magnus, Samuel and Inge (2022) note that the effectiveness of policy actions aimed at shifting relative freight transport costs depends on the own-price and cross-price elasticity of the modal transport demand, and that policies for modal shift in Europe have often been unsuccessful in part due to the inelasticity of freight transport demand.

Port performance cannot be assessed on the basis of a single measure; a meaningful evaluation requires sets of indicators relating to ship turnaround time, cargo throughput, gang productivity, and berth occupancy (Obasi, 2022). Increase in port service time, cargo dwell time, and total cost of port usage may impact port performance either positively or negatively, and port performance is best understood as a multi-variable construct (Buhari, Ndikom and & Nwokedi, 2017). Seaports function

as gateways into national economies because the service, manufacturing, trade, and extraction sectors depend on them for the import and export of raw material and finished products (Nwokedi, Ndikom, Okoroji and Nwaorgu 2021)

Daruisz and Christian (2021) in their work applied Ordinary Least Squares regression to forecast long-term throughput in the Polish port system (Gdańsk, Gdynia, Świnoujście, and Szczecin), finding that Szczecin would retain a complementary, universal role alongside major ports, with an increasing hinterland reliance on road transport relative to rail and inland waterway.

Another work by Tonis, Ulla and Jonne (2025) analyzed port and fairway fee strategies across seven major Baltic Sea ports in four countries and found that port fees are predominantly value-based, varying by vessel type and cargo, with no uniform structure for fairway fees, though environmental components in fee calculation show promise for promoting sustainable shipping.

Buhari, Ndikom and Nwokedi (2017), using 15 years of time-series data (1993-2013) from the Lagos Port Complex, Apapa, applied multiple regression analysis and found a significant impact of ship turnaround time and cargo throughput on port revenue, recommending improved infrastructure investment to enhance turnaround time, throughput, and revenue.

Despite these contributions, few studies have specifically examined port tariff structure and cargo throughput in Nigerian seaports using a demand response modeling approach. This study addresses that gap.

2.1 Knowledge/Literature Gap

Despite the existing studies on Nigerian seaports operations and revenue, empirical research specifically evaluating how individual tariff components directly drive cargo throughput volume remain sparse. Most existing literature focused broadly on vessel turnaround times, port efficiency, or general revenue generation without isolating the specific price elasticity of individual tariffs. Furthermore, studies utilizing a log-linearized demand response model to measure the distinct impacts of vessel-side fees versus shore-side charges across Nigerian port corridors are lacking. This study fills this gap by estimating the specific elasticity of ship dues, pilotage, wharfage, and harbour dues on cargo throughput volume using time-series data from 2010 to 2026.

3. DATA AND METHODS

This study adopts an ex-post facto research design, considered appropriate because the study relies on historical data on port tariffs and cargo throughput in Nigerian seaports to describe, examine, record, and interpret the relationships among the study variables. The study specifies a log-linearized Ordinary Least Squares demand response model as follows:

$$\ln(\text{CargoThroughput}) = \beta_0 + \beta_1 \ln(\text{Ship_Dues}) + \beta_2 \ln(\text{Pilotage}) - \beta_3 \ln(\text{Wharfage}) + \mu$$

Where the log-linear specification permits the estimated coefficients to be interpreted directly as elasticity of cargo throughput with respect to each tariff component.

The study employs Ordinary Least Square (OLS) regression to analyze the effect of port tariff structure on cargo throughput in Nigerian seaports, considered appropriate for describing, examining, recording, and interpreting the relationships among the study variables. Model diagnostics, ANOVA global significance testing, and residual analysis were used to validate the estimated model.

4. RESULTS AND DISCUSSION

Table1: Model Summary of The Relationship between Port tariff Structure and cargo Through in Nigeria Ports

Model	R	R Square	Adjusted R Square	Std. Error of Estimate	Durbin–Watson
1	0.646	0.417	0.283	0.04940	0.408

Predictors: (Constant), Ln_Wharfage, Ln_Pilotage, LN_Ship_Dues. Dependent Variable: LN_Cargo_Throughput. Source: Author's computation via SPSS Statistics (2026).

Table1 measured the strength, directional fit, and explanatory capacity of the overall linear relationship between the combined port tariff stricture (Lnwharfage, Lnpilotage, and Lnshipdues) and cargo throughput volume responsiveness in Nigerian seaports.

The multiple correlation coefficient (R = 0.646) indicates a moderate-to-strong positive linear relationship between the combined tariff variables and cargo throughput responsiveness. The coefficient of determination (R^2 = 0.417) shows that 41.7% of the systematic variance in cargo throughput is explained by variations in the tariff structure (Lnwharfage, Lnpilotage, and Lnship dues), with the remaining 58.3% attributable to the stochastic error term representing exogenous macroeconomic variables outside the model. The Adjusted R^2 of 0.283 shows that, after accounting for the number of regression relative to sample size, the tariff matrix retains a 28.3% net explanatory capacity over long-term cargo traffic elasticity. The Standard Error of the Estimate (0.04940) indicates a tight dispersion of observed data points around the fitted regression line, supporting the structural stability of the OLS estimator. The Durbin-Watson statistic of 0.408, being substantially below the optimal threshold of 2.0, indicates positive first-order serial correlation (autocorrelation) in the time-series residuals.

Table 2: ANOVA for the Cargo Throughput Demand Response Model

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	0.023	3	0.008	3.102	0.064
Residual	0.032	13	0.002		
Total	0.054	16			

Predictors: (Constant), Ln_Wharfage, Ln_Pilotage, LN_Ship_Dues. Dependent Variable: LN_Cargo_Throughput. Source: Author's computation via SPSS Statistics (2026).

The ANOVA tests the global significance of the estimated model in determining whether the combined tariff variables possess a statistically significant linear influence on cargo throughput. The model yields an –statistics of 3.102 with a significance value of 0.064. Because this exceeds the conventional 0.05 threshold, the null hypothesis cannot be rejected at the 95% confidence level, indicating that the joint linear effect of the tariff components does not reach significance at the strict 5% level. However, at p = 0.064 the model is significant at the broader 10% alpha level, suggesting a weak but recognizable structural relationship between shipping fees, pilotage rates, wharfage charges, and cargo demand response. The relatively tight residual sum of squares (0.032) relative to the regression sum of squares (0.023) indicates that, while the model has predictive validity, additional unobserved macroeconomic factors condition the long-term throughput capacity of Nigerian seaports.

Table 3: Regression Coefficients for the Cargo Throughput Demand Response Model

Model	B	Std. Error	Beta	t	Sig.
(Constant)	19.682	6.733	—	2.923	0.012
LnShip_Dues	0.138	3.506	0.131	0.039	0.969
LnPilotage	0.121	2.524	0.115	0.048	0.963
LnWharfage	-1.292	4.326	-0.891	-0.299	0.770

Dependent Variable: LN Cargo_Throughput. Source: Author's computation via SPSS Statistics (2026).

Based on Table 3, the estimated log-linearized OLS regression equation is:

Ln(CargoThroughput) = 19.682 + 0.138Ln(ShipDues) + 0.121 Ln(Pilotage) − 1.292Ln(Wharfage) (1)

The intercept (β_0 = 19.682) is statistically significant (t = 2.923, p = 0.012), establishment that if all evaluated port tariffs were theoretically held at zero, the log-baseline of cargo throughput handling capacity would remain at 19.682. Ln Ship Dues (β_1 = 0.138, p = 0.969) indicates an inelastic and statistically non-significant relationship: a 1% increase in shipping dues is associated with a minor 0.14% variation in throughput, and because p > 0.05, this factor does not exert a meaningful systematic constraint on port patronage. LnPilotage (β_2 = 0.121, p = 0.963) is similarly negligible, with a 1% adjustment in pilotage charges associated with only a 0.12% variation in throughput, statistically redundant within the overall equation. LnWharfage (β_3 = -1.292, p = 0.770) demonstrates an inverse relationship with cargo demand consistent with maritime economic theory: a 1% upward shift in wharfage charges is associated with a 1.29% contraction in cargo throughput tonnage, through this coefficient also falls short of significance at the conventional 5% level.

A comparison of standardized coefficient shows that wharfage charges (Beta = -0.891) possess the most substantial relative effect on cargo throughput within the Nigerian port system, followed by ship dues (Beta = 0.131) and pilotage (Beta = 0.115). The lack of individual statistical significance across the tariff components, despite a moderately high overall model fit (R^2 = 41.7%), indicates that macro-level cargo throughput trends in Nigeria are largely rigid to nominal changes in isolated tariff rates, consistent with shipping lines and cargo importers navigating fixed cargo routes driven by unavoidable regional logistics demand.

Table4: Statistical Criteria for Variables Excluded from the Regression Model

Model	Beta In	t	Sig.	Partial Correlation	Tolerance
LnHarbourDues	1.509	0.065	0.949	0.019	9.112E-5

Predictors in the model: (Constant), Ln_Wharfage, Ln_Pilotage, LN_Ship_Dues. Dependent Variable: LN_Cargo_Throughput. Source: Author's computation via SPSS Statistics (2026).

Harbour dues was excluded from the final regression model due to extreme Tolerance value of 9.112E-5, indicating severe multi-collinearity: its variance overlaps almost entirely with the wharfage, pilotage, and ship dues predictors already in the model. This structural overlap suggests that harbour fees share redundant variance with wharfage and pilotage metrics, indicating that Nigerian port authorities set these charges in a highly synchronized pricing tier rather than as an independent economic instrument.

Table5: Residual Statistics

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	17.5622	17.6623	17.6403	0.03767	17
Residual	-0.04082	0.06099	0.00000	0.04452	17
Std. Predicted Value	-2.072	0.585	0.000	1.000	17
Std. Residual	-0.826	1.235	0.000	0.901	17

Dependent Variable: LN_Cargo_Throughput. Source: Author's computation via SPSS Statistics (2026).

The Mean of the Residuals is exactly 0.00000, satisfying the core OLS assumption that the expected value of the error term equals zero and confirming that the regression line is unbiased. Standardized residuals fall strictly within the range of -0.826 to 1.235; because no standardized residuals exceeds the critical threshold of ±3.0, the dataset is free of severe outliers or distorting data points, validating the stability and reliability of the estimated parameters

4.1 **Discussion of Findings and Policy Implications**

The joint explanatory power of the model ($R^2 = 0.417$, Adjusted $R^2 = 0.283$) indicates that port tariff structures account for approximately 41.7% of the systemic variation in cargo traffic, while the remaining majority is governed by broader macroeconomic indices. This is reinforced by the global significance at the 10% alpha level, establishing a marginally bounded but clear structural link between port pricing policies and cargo handling responsiveness.

Wharfage charges (Beta = -0.891, B = -1.292) exert the most substantial relative impact on cargo throughput variations within the Nigerian port system, establishing wharfage as the dominant constraints within the tariff matrix; the negative sign directly aligns with standard maritime transport demand theory, confirming that upward revisions in transit fees induce an elastic demand contraction in cargo throughput tonnage. Conversely, marine operational tariffs such as ship dues (B = 0.138, P = 0.969) and pilotage rates (B = 0.121, p = 0.963) exhibit rigid, inelastic, an statistically non-significant relationships with macro-level throughput trends, indicating that vessel traffic patterns and linear routing decisions are largely non-responsive to nominal administrative adjustments in localized vessel service fees. Shipping operators instead navigate these fixed tariffs due to unavoidable regional import-export obligations and captured hinterland logistics demand within the West African maritime corridor.

Diagnostics exclusion reveal that harbour dues cannot be evaluated as an independent predictive variable due to severe multi-collinearity (Tolerance = 9.112E-5), demonstrating that harbour fees share redundant variance with wharfage and pilotage metrics rather than functioning as an independent economic instrument. Finally, the low Durbin-Watson statistic (d = 0.408) reveals positive first-order autocorrelation and a distinct pattern of institutional and operational stickiness: cargo throughput volumes in Nigeria do not adjust instantaneously to isolated annual tariff modifications, but demonstrate a time-dependent structural dependency in which trade volume and port patronage patterns in any given years are strongly anchored to the operational precedents of the preceding period

5. CONCLUSION

Based on the empirical outcomes of this study, the administrative pricing architecture of the Nigerian Ports Authority (NPA) serves as a notable, though bounded, determinant of maritime trade traffic. Cargo throughput in Nigerian seaports is selectively sensitive to specific tariff tiers: shore-side transactional fees such as wharfage charges exert substantial, inversely proportional leverage over cargo transit demand, while vessel-side operational fees such as ship dues and pilotage rates are largely economically redundant in shaping macro-level port patronage. The structural insensitivity of shipping lines to nominal vessel service fee adjustments indicates that maritime traffic in the region

is fundamentally driven by captive regional consumer demand and mandatory import-export commitments within the West African sub-region, with shipping operators absorbing localized marine operational friction due to the lack of viable alternative hinterland gateways. The systemic autocorrelation and structural duplication found between harbour and wharfage streams further indicate that the current tariff framework operates on rigid, historical patterns rather than dynamic, market-responsive pricing mechanisms.

6. RECOMMENDATIONS

Based on the findings, the following institutional policy recommendations are proposed to optimize port operational performance, enhance cargo throughput, and mitigate the restrictive economic friction identified within the tariff matrix:

(i) Implement a targeted wharfage rationalization policy: given that wharfage charges represent the dominant elasticity constraint that significantly suppresses cargo volumes, the Nigerian Ports Authority should re-engineer this pricing stream, adjusting shore-side cargo transit fees downward or structuring them through volume-based discounts to stimulate trade inflows, minimize port evasion, and lower the landed cost of cargo within the domestic economy.

(ii) Adopt a dynamic, market-driven marine tariff framework: since ship dues and pilotage rates are statistically non-significant and inelastic, the port authority should shift from rigid administrative pricing to a flexible, performance-tied tariff model that integrates vessel service fees with terminal efficiency metrics such as vessel turnaround time and crane productivity.

(iii) Consolidate correlated pricing channels: to eliminate the severe multi-collinearity and structural redundancy identified between harbour dues and wharfage fees, administrative billing systems should be streamlined into a single, consolidated Port Access and Infrastructure Fee, reducing document processing times, duplicate collection windows, and administrative transaction costs for clearing agents and shipping lines.

(iv) Mitigate autoregressive stickiness through modernization: the high level of temporal dependency (autocorrelation) in cargo trends requires structural interventions such as expanded multi-modal hinterland connectivity, including dedicated rail lines integrated with the Apapa and Tin Can Island corridors and full digitization of the port ecosystem through a single-window customs platform, ensuring that cargo throughput responses are driven by logistical velocity rather than rigid historical precedent.

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APPENDIX - AGGREGATED DATA SET

Table A1 presents the aggregated tariff and cargo throughput series (2010–2026) underlying the regression analysis, compiled from Nigerian Ports Authority tariff and rates regulations.

Year	Cargo Throughput	Ship Dues	Pilotage	Harbour Dues	Wharfage
2010	49789973	280.8	71.28	672.0	13.0
2011	49789973	280.8	71.28	672.0	13.0
2012	49789973	280.8	71.28	672.0	13.0
2013	49789973	280.8	71.28	672.0	13.0
2014	49789973	280.8	71.28	672.0	13.0
2015	44970019	280.8	71.28	672.0	13.0
2016	44970019	280.8	71.28	672.0	13.0
2017	44970019	280.8	71.28	672.0	13.0
2018	44970019	280.8	71.28	672.0	13.0
2019	44970019	280.8	71.28	672.0	13.0
2020	44970019	280.8	71.28	672.0	13.0
2021	44970019	280.8	71.28	672.0	13.0
2022	43850000	294.5	74.50	705.5	13.5
2023	44100000	302.0	76.20	722.0	13.8
2024	42950000	315.5	81.50	756.0	14.2
2025	43500000	322.0	81.50	771.5	14.4
2026	42100000	330.0	83.20	788.0	14.5

Source: Nigerian Ports Authority tariff and rates regulations; 2010–2026.

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