



Admiralty Journal of Multidisciplinary Research, ISSN 1597–278X

The Effect of Port Efficiency on Maritime Sector Performance: Evidence from Emerging Market

Israel Onokere IMIDE¹, Richard Chinye OSADUME²

¹Department of Economics, University of Delta, Agbor

²Department of Maritime Economics & Finance, Nigeria Maritime University

Authors' Contributions

This work was carried out in collaboration among all authors.
All authors read and approved the final manuscript.

Research Article

ABSTRACT

This study investigated the impact of port efficiency on the performance of the maritime sector in Nigeria, focusing specifically on the effects of berthing capacity and cargo handling equipment. The study employed econometric techniques, including multiple regression analysis and co-integration tests, to examine the relationships between these variables and the maritime sector's contribution to gross domestic product. The findings of the study indicated a significant and positive correlation between cargo handling equipment capacity and maritime sector performance in Nigeria. This suggests that investments in modern and efficient cargo handling equipment can enhance the efficiency of port operations and contribute to the growth of the maritime sector. However, the study did not find a significant relationship between berthing capacity and maritime sector performance, contrary to expectations. The results of this research have important implications for policymakers in Nigeria and other emerging markets. They underscore the need for strategic investments in port infrastructure, particularly in cargo handling equipment, to improve port efficiency and competitiveness. Additionally, the study highlighted the importance of considering other factors beyond berthing capacity when assessing the impact of port infrastructure on maritime sector performance.

Keyword: Berthing cargo equipment, capacity, emerging market, maritime sector performance

Corresponding author: Dr. Richard C. Osadume: dr.rcosadume@gmail.com

INTRODUCTION

The maritime sector, as a critical component of global trade, plays a pivotal role in economic growth and development (Gutiérrez & Rodríguez-Pose, 2013). At the heart of this sector lies the efficiency of ports, which serve as gateways for international commerce. While the significance of port efficiency is universally acknowledged, its impact on the maritime sector's performance in emerging economies, such as Nigeria, remains an area of considerable interest and exploration. Nigeria, endowed with a vast coastline and strategic geographic location, possesses immense potential to harness the maritime sector as a catalyst for economic transformation. However, the country's maritime industry has been grappling with several challenges, including infrastructure deficiencies, bureaucratic bottlenecks, and operational inefficiencies (Olotu & Olotu, 2015). These issues have hindered the sector's performance and negatively impacted the overall economy. This research aims to investigate the intricate relationship between port efficiency and the performance of the maritime sector in Nigeria. By examining the factors influencing port efficiency and their subsequent impact on key maritime sector indicators, this study seeks to contribute to the body of knowledge on port-led development in emerging economies. The findings of this research are expected to provide valuable insights for policymakers, port authorities, and maritime stakeholders in developing strategies to enhance port efficiency and, consequently, bolster the maritime sector's contribution to Nigeria's economic growth.

Despite the recognition of ports as crucial drivers of economic development, the performance of Nigerian ports has been suboptimal. Numerous studies have highlighted the challenges faced by the Nigerian maritime sector, including congestion, delays, high operational costs, and inadequate infrastructure (Olotu & Olotu, 2015; Nwaogbe, Diugwu, Mohammed, & Omoke, 2016). These issues are often attributed to inefficiencies within the port system. Consequently, this research seeks to address the following research question: What is the impact of port efficiency on the performance

of the maritime sector in Nigeria? By delving into this question, the study aims to identify specific factors affecting port efficiency, measure their impact on key maritime sector performance indicators, and propose recommendations for improving port operations and, ultimately, the overall performance of the maritime sector.

The primary objective of this study is to examine the impact of port efficiency on the economic growth of the Nigerian maritime sector. To achieve this, the study will specifically evaluate the effect of berthing capacity on the economic growth of the Nigerian maritime sector; and assess the influence of cargo handling facilities on the economic growth of the maritime sector in Nigeria.

CONCEPTUAL CLARIFICATION

Port Efficiency and Maritime Sector Performance

Port efficiency is a critical determinant of maritime sector performance. It encompasses various factors, including infrastructure, technology, processes, and human resources. Studies have consistently demonstrated a positive correlation between port efficiency and economic growth (Notteboom, 2004). For instance, Lam and Fung (2008) found that efficient ports attract foreign direct investment, leading to increased trade and economic development. In the context of emerging markets, the impact of port efficiency is even more pronounced. These economies heavily rely on maritime trade for economic growth, and efficient ports serve as gateways for international commerce. A study by Wang and Meng (2010) highlighted the role of port efficiency in facilitating trade and industrial development in China. Some specific examples of successful port infrastructure improvements in similar emerging markets are enumerated below.

Singapore's Port Transformation

- a. Automation and Technology: Singapore's Port Authority (PSA) has been a pioneer in port automation, implementing advanced technologies

such as automated guided vehicles (AGVs) and automated stacking cranes. This has significantly improved efficiency and reduced operational costs.

- b. **Smart Port Initiatives:** PSA's initiatives to create a smart port ecosystem, including data analytics and IoT applications, have enabled real-time monitoring and optimization of port operations.
- c. **Expansion and Infrastructure:** The expansion of the Pasir Panjang Terminal and the development of the Tuas Terminal have increased Singapore's port capacity and enhanced its connectivity to global trade routes.

Dubai's Port Modernization

- a. **Jebel Ali Port:** Dubai's Jebel Ali Port is one of the largest and busiest ports in the world, known for its world-class facilities and efficient operations.
- b. **Diversification:** Dubai Ports World has successfully diversified its operations, expanding into other regions and investing in various port-related services.
- c. **Technology Adoption:** Jebel Ali Port has embraced technology to improve its efficiency, including automated gate systems and advanced cargo handling equipment.

China's Port Infrastructure Development

- a. **Scale and Investment:** China has invested heavily in port infrastructure, resulting in the development of massive port complexes such as Shanghai's Yangshan Port.
- b. **Hinterland Connectivity:** China's extensive rail and road networks have played a crucial role in connecting its ports to inland regions, facilitating trade and economic growth.
- c. **Government Support:** The Chinese government has provided significant

policy support to the port sector, including tax incentives and infrastructure investments.

India's Port Modernization

- a. **Public Private Partnerships:** India has successfully implemented public-private partnerships (PPPs) to modernize its ports and attract private investment.
- b. **Port-Led Development:** The government has promoted port-led development, focusing on the creation of industrial zones and logistics hubs around major ports.
- c. **Technology Adoption:** Indian ports have been increasingly adopting technology to improve efficiency and competitiveness.

Port Efficiency in Nigeria

Nigeria, as a major African economy, offers a case study for examining the relationship between port efficiency and maritime sector performance in an emerging market context. Several studies have explored this topic. For example, Okoro and Osuagwu (2015) investigated the impact of port congestion on maritime trade in Nigeria, emphasizing the need for improved port infrastructure and efficiency.

Additionally, research by Adewale and Osibanjo (2017) analyzed the challenges facing Nigerian ports, including corruption, inadequate equipment, and inefficient processes. They emphasized the importance of port reform in enhancing the country's maritime sector.

Key Performance Indicators of Port Efficiency

To assess port efficiency, researchers have employed various performance indicators. Common metrics include cargo throughput, ship turnaround time, dwell time, and container productivity (Grewal et al., 2012). These indicators provide insights into port operations and their impact on overall maritime sector performance.

Challenges and Opportunities in Port Efficiency

While the importance of port efficiency is widely recognized, challenges persist in many emerging markets, including Nigeria. These challenges often stem from factors such as inadequate infrastructure, corruption, lack of skilled personnel, and outdated technology (UNCTAD, 2013).

However, emerging markets also present significant opportunities for port development and efficiency improvement. Investments in modern port infrastructure, adoption of advanced technologies, and implementation of efficient port management practices can yield substantial benefits (Jalilvand et al., 2015).

THEORETICAL FRAMEWORK

This section considers the theoretical underpinnings of the relationship between port efficiency and maritime sector performance. It explores relevant theories and models that provide a framework for understanding the complex interplay between these variables.

Porter's Diamond Model

Michael Porter's Diamond Model offers a valuable lens through which to examine the impact of port efficiency on maritime sector performance. By considering the factors of factor conditions, demand conditions, related and supporting industries, and firm strategy, structure, and rivalry, this model highlights how port efficiency can influence the competitiveness of a nation's maritime sector. A highly efficient port can contribute to favourable factor conditions by providing access to skilled labour, infrastructure, and logistics services. Moreover, it can stimulate demand for maritime services by facilitating trade and economic growth. A well-connected port can also foster the development of related and supporting industries, such as shipping, logistics, and warehousing.

Supply Chain Management Theory

Supply chain management (SCM) theory emphasizes the importance of efficient logistics and transportation networks. Ports play a crucial

role in these networks as they serve as critical hubs for the movement of goods. A port's efficiency directly impacts the overall performance of the supply chain, affecting factors such as lead times, inventory levels, and transportation costs. According to Christopher (2011), efficient ports can contribute to reduced supply chain uncertainty, improved customer service, and increased profitability. By minimizing delays and disruptions, efficient ports can enhance the competitiveness of firms operating within the maritime sector.

Economic Growth Theory

Economic growth theories provide a broader context for understanding the impact of port efficiency. According to Solow's growth model, technological progress, capital accumulation, and labour force growth are key drivers of economic growth. Port efficiency can indirectly contribute to economic growth by facilitating trade, attracting foreign investment, and supporting industrial development. Moreover, endogenous growth theory emphasizes the role of human capital, innovation, and knowledge creation in driving economic growth (Wahua & Ahlijah, 2020). Efficient ports can contribute to human capital development by creating employment opportunities and fostering the growth of related industries.

The Role of Emerging Markets

Emerging markets, such as Nigeria, present unique challenges and opportunities for port efficiency and maritime sector development. According to the theory of comparative advantage, these countries can benefit from specializing in sectors where they have a competitive advantage, such as natural resource extraction (Tsekpo & Wahua, 2023; Tsekpo, Wahua, Ngwenya, Akpomeyoma, & Brobbey, 2024).). Efficient ports are essential for exporting these resources and importing necessary inputs. However, institutional and infrastructure challenges often hinder port efficiency in emerging markets. According to Williamson's (1985) transaction cost economics, inefficient institutions and governance

structures can increase transaction costs, reducing the efficiency of port operations.

EMPIRICAL REVIEW

Existing research consistently underscores the pivotal role of port infrastructure in driving maritime economic growth. Studies by DeSalvo (1994), Verbeke & Debisschop (1996), and Castro & Coto-Millán (1997) emphasize the multifaceted impact of ports on the economy, encompassing direct, indirect, and induced effects. Key performance indicators commonly used to assess port contributions include port revenue, productivity, integration with inland transportation, and employment (Verbeke & Debisschop, 1996; Lam, Ng & Fu, 2013; Vrakas, Chan & Thai, 2021). Moreover, the strategic nature of port investment decisions has been highlighted (Verbeke & Debisschop, 1996; Lam, Ng & Fu, 2013; Vrakas, Chan & Thai, 2021). Several studies have established a strong correlation between port efficiency and economic growth. Limao and Venables (2001) and Lakshmanan (2011) emphasize the link between infrastructure investment, reduced freight costs, and export-led growth. Lai & Cheng (2003), Bang et al. (2012), Han (2018), and Xu et al. (2021) have employed statistical methods to demonstrate the relationship between port performance indicators and economic drivers.

Clark et al. (2004) highlights the association between efficient ports and superior infrastructure, revenue performance, and foreign direct investment attraction. De Langen, Nijdam, and van der Horst (2007) expanded the scope of port performance indicators beyond throughput volume to include employment and value-added, providing a more comprehensive assessment. Pangihutan (2008) and Sjafrizal (2008) corroborate the positive relationship between transportation infrastructure, including seaports, and economic growth. Wilms and Hoffmann (2008) quantified the impact of liner shipping connectivity and port infrastructure on freight rates in the Caribbean. While port infrastructure is crucial, studies by Panayides & Song (2009)

and Kuo, Lu & Le (2020) emphasize the importance of efficient port operations in maritime logistics. Banerjee (2009) and Fu (2011) further highlight the potential for ports to become bottlenecks if capacity is insufficient, underscoring the need for efficiency improvements to positively impact GDP.

In a study on Blue Ocean Strategy for Sustainable Port Development in Taiwan, Othman et al. (2022), Xiao et al. (2022), and Molina et al (2020)- suggest that the Blue Ocean Strategy can help ports achieve economic, social, and environmental sustainability and improve port efficiency. Also, in a study of Smart Port Initiatives and Performance, Molavi et al (2020)., Zhao et al. (2020), and Lin et al (2022)- assess the performance of smart ports based on various criteria, including operations, environment, energy, safety, and security in China, and discovered a significant relationship between port performance and efficiency. Similarly, Smart Port Maturity Models and efficiency in Hong Kong was studied by Triska et al (2022). and Boullauazan et al (2022), and proposed maturity models to evaluate the progress and efficiency of smart port development across different domains.

In summary, the literature consistently demonstrates a strong positive relationship between port efficiency and economic growth. Efficient ports, characterized by adequate infrastructure, effective operations, and strategic investment, contribute significantly to economic development by reducing costs, attracting investment, and facilitating trade.

Gaps in Literature

Despite the growing body of research on port efficiency and maritime sector performance, several gaps remain. This study explores the long-term impact of port efficiency on economic growth using error correction term approach. The outcome of this research work will engender the development of effective port policies and strategies in an emerging economy like Nigeria. This literature review has demonstrated the critical role of port efficiency in driving maritime sector performance,

particularly in emerging markets like Nigeria. While significant progress has been made, challenges and opportunities persist. Future research should focus on identifying and addressing these issues to enhance the competitiveness of emerging economies in the global maritime trade.

METHODOLOGY

This quantitative research used aggregate secondary data of Nigeria for the period 1990 to 2022. This is supported by Wahua, Tsekpo and Anyamele (2018) and Wahua and Ezeilo (2021). The sources of data used in this research are:

- Nigerian Port Authority (NPA): Data on berthing capacity, cargo throughput, and other relevant port-related statistics.
- National Bureau of Statistics (NBS): Economic growth data, including Gross Domestic Product (GDP), sectoral contributions, and trade statistics.
- Central Bank of Nigeria (CBN): Monetary policy data, exchange rates, and other macroeconomic indicators.
- Academic Journals and Research Publications: Previous studies on port efficiency, maritime economics, and the Nigerian economy.
- International Organizations: Reports and data from organizations such as the World Bank, International Monetary Fund (IMF), and United Nations Conference on Trade and Development (UNCTAD).

Model Specification and Data Analysis

Econometric models were developed to estimate the impact of port efficiency on economic growth; and control variables (such as GDP per capita, inflation, and trade openness) were included in the model to account for other factors influencing economic growth. This agrees with Daganzo and Goodchild (2005). A multiple regression model which adopts the ordinary least square (OLS) method in estimating the parameters was adopted. The functional model is presented below:

$$(1) \text{RGDP} = f(\text{CTP}, \text{STT}, \text{PRT}, \text{GRT})$$

The model is re-written in its econometrics form as:

$$(2) \text{RGDP} = \beta_0 + \beta_1\text{CTP} + \beta_2\text{STT} + \beta_3\text{PRT} + \beta_4\text{GRT} + \mu$$

Modifying equation 2, we have:

$$(3) \text{MSRGDP} = \beta_0 + \beta_1\text{VESTAT} + \beta_2\text{BERCAP} + \beta_3\text{CARHCA} + \beta_4\text{INFRIN} + \mu$$

$$(4) \text{LgMSRGDP} = \beta_0 + \text{Lg}\beta_1\text{VESTAT} + \text{Lg}\beta_2\text{BERCAP} + \text{Lg}\beta_3\text{CARHCA} + \text{Lg}\beta_4\text{INFRIN} + \mu$$

Where: RGDP (real gross domestic product); STT (ship turnaround time); GRT (gross registered tonnage); PRT (port registered tonnage); VESTAT (vessel turnaround time); BERCAP (Berthing capacity); CARHCA (cargo handling capacity); INFRIN (port infrastructure index); MSRGDP (maritime sector contribution to GDP); β_0 (intercept); $\beta_1, \beta_2, \beta_3$ and β_4 (parameters to be estimated); μ (the stochastic); Error Term ($\beta_1, \beta_2, \beta_3$ and $\beta_4 < 0$)

Model Selection

- Equation (3): Uses linear regression to analyze the relationship between variables.
- Equation (4): Uses logarithmic transformations to analyze the percentage changes in variables. This is often used when variables exhibit exponential growth or decay.

The choice of model depends on the specific research question and the nature of the data. Logarithmic transformations can be helpful for analyzing percentage changes and can sometimes improve the model's assumptions. The Models were estimated and evaluated for their goodness of fit, significance of coefficients, and overall model performance. The results of the statistical analyses estimated the coefficients of the independent

and control variables to determine the impact of berthing capacity and cargo handling facilities on economic growth. Final conclusions were drawn based on the empirical findings. This study employed both the multiple regression analysis and co-integration econometric techniques to test the relationship between the dependent and independent variables.

Multiple linear regression analysis is a statistical method used to model the relationship between a dependent variable (response variable) and multiple independent variables (predictor variables). It assumes a linear relationship between the variables. The multiple regression model is based on the following assumptions:

- a. **Linearity:** The relationship between the dependent variable and the independent variables is linear.
- b. **Independence:** The observations are independent of each other.
- c. **Normality:** The error terms are normally distributed.
- d. **Homoscedasticity:** The variance of the error terms is constant across all levels of the independent variables.
- e. **No multicollinearity:** The independent variables are not perfectly correlated

The Co-integration is a statistical technique used to analyze the long-run relationship between non-stationary time series variables. It identifies whether variables share a common trend and can be integrated to the same order. Co-integration analysis is often used to examine relationships between economic variables that may appear to be unrelated in the short run but are connected in the long run. The model assumptions for co-integration analysis are:

1. **Stationarity:** The variables are integrated of the same order (example, I(1)).
2. **Co-integration:** The variables are co-integrated, meaning there exists a linear combination of them that is stationary.

Operational Measurement

To measure port efficiency and its impact on economic growth, this study will employ the following key indicators:

- a. **Berthing Capacity:** Berthing capacity refers to the total length of berths available for ships to moor and load or unload cargo. It was measured in linear meters.
- b. **Cargo Handling Facilities:** Cargo handling facilities encompass the equipment and infrastructure used to transfer cargo between ships and the landside. Cargo handling facilities was assessed based on factors such as: the type and capacity of cargo handling equipment (cranes, forklifts, etcetera), the availability and efficiency of storage facilities (warehouses, container yards), and the level of automation and technology employed in cargo handling operations

By examining these two key indicators, this study aims to provide a comprehensive assessment of the relationship between port efficiency and economic growth in the Nigerian maritime sector. The key variables used in the study are operationalised thus:

- a. **MSRGDP:** Maritime sector contribution to GDP. This is the dependent variable.
- b. **VESTAT:** Vessel turnaround time. A shorter turnaround time indicates more efficient port operations.
- c. **BERCAP:** Berthing capacity. A higher berthing capacity allows for more ships to be handled simultaneously.
- d. **CARHCA:** Cargo handling capacity. A higher cargo handling capacity improves the efficiency of cargo operations.
- e. **INFRIN:** Port infrastructure index. A higher infrastructure index suggests better port facilities and equipment.

DATA ANALYSIS AND INTERPRETATION

Data Presentation

The raw data used in this study are captured in Appendix A. Table 1 (Descriptive Statistics) reveals that the mean, mode and media are well clustered or dispersed the data in the series are. The mean

values of CARHCA, INFRIN, MSRGGDP, VESTAT and BERCAP are closely clustered together. While two of the variables (CARHCA and BERCAP) in the series show a kurtosis greater than 3, being leptokurtic, while the others exhibit Platykurtic characteristics. The probabilities of the parameters in the series have mixed significance, either below or above the chosen 5% level of significance.

Table 1:
Descriptive statistics

Variable	CARHCA	INFRIN	MSRGGDP	VESTAT	BERCAP
Mean	630182	1.546562	3.478125	5.935938	42.21156
Median	505694.5	2	3.14	6.24	44.855
Maximum	1815163	3.55	4.91	11.34	56.58
Minimum	72500	0	2.54	3.75	26
Std. Dev.	393005.6	1.459654	0.755477	1.607197	9.286001
Skewness	1.158138	-0.0329	0.581767	1.001511	-0.55405
Kurtosis	4.368476	1.15314	1.947831	5.000546	2.080301
Jarque-Bera	9.650475	4.553631	3.281164	10.6857	2.764968
Probability	0.008025	0.10261	0.193867	0.004782	0.250954
Sum	20165825	49.49	111.3	189.95	1350.77
Sum Sq. Dev.	4.7912	66.04832	17.69309	80.07557	2673.124
Observations	32	32	32	32	32

Sources: Authors (2024)

Unit Root Tests

See Appendix 2A. All the variables (CARHCA, BERCAP, INFRIN, VESTAT, and MSRGGDP) displayed statistically significant probabilities below the 5% chosen level of significance and all were integrated at the first level of difference. This indicates that the variables in the series are stationary at the first level of difference.

Serial Autocorrelation Test

See Appendix 2B. The probabilities for F-Statistics (0.2404) and Chi-Square (0.1603) were both insignificant above the 0.05 chosen level of significance, indicating

the absence of autocorrelation in the series. Hence, we say that the model is well specified. We thus accept the null hypothesis that there is no autocorrelation in the series.

Heteroskedasticity Test

See Appendix 2C. The probabilities for F-Statistics (0.0575) and Chi-Square (0.4517) were both insignificant above the 0.05 chosen level of significance, indicating the absence of autocorrelation in the series. Hence, we say that the model is well specified. We thus accept the null hypothesis that there is no autocorrelation in the series.

Table 2:
OLS multiple regression results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.001332	0.695008	5.757244	0.001
CARHCA(-4)	1.007906	3.292107	3.047556	0.0064
INFRIN(3)	0.220488	0.050971	4.325772	0.0003
VESTAT(-2)	-0.215286	0.038702	-5.562598	0.001
BERCAP(2)	-0.001025	0.013006	-0.078804	0.938

Dependent Variable: MSRGGDP
Method: Least Squares
Sources: Authors (2024)

The outcome in Table 2 for the ordinary least square result shows a R^2 of 87.22% and 84.66% of the adjusted R^2 indicating a goodness of fit of the selected model and its capacity to accept more variables. A Durbin

Watson of 1.7728 for this series is considered very adequate, being approximately 2, showing least or no autocorrelation. The vessel turn around (VESTAT) has been included in the model as a test variable.

Table 3:
Cointegration tests result 1 - trace test

Hypothesized	Trace		0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.906738	112.6617	69.81889	0.0001
At most 1 *	0.768107	58.09771	47.85613	0.0041
At most 2	0.481741	24.48371	29.79707	0.1807
At most 3	0.226939	9.366284	15.49471	0.3326
At most 4	0.139147	3.446135	3.841465	0.0634

Trace test indicates 2 cointegrating equations at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
Series: CARHCA INFRIN MSRGGDP BERCAP VESTAT
Lags interval (in first differences): 1 to 1
Unrestricted Cointegration Rank Test (Trace)

Sources: Authors (2024)

Table 3 shows the existence of two co-integration equations at the 5% chosen level

of significance through the Johansen trace tests with probabilities of 0.0000 and 0.0041.

Table 4:
Unrestricted cointegration tests result 2- maximum eigenvalue test

Hypothesized	Max-Eigen		0.05	
No. of CE(s)	Eigen value	Statistic	Critical Value	Prob.**
None *	0.906738	54.56397	33.87687	0.0001
At most 1 *	0.768107	33.61400	27.58434	0.0074
At most 2	0.481741	15.11743	21.13162	0.2808
At most 3	0.226939	5.920149	14.26460	0.6235
At most 4	0.139147	3.446135	3.841465	0.0634

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

Sources: Authors (2024)

Similarly, Table 4, also, shows the existence of two co-integration equations at the 5% chosen level of significance through the

Johansen maximum eigenvalue tests with probabilities of 0.0001 and 0.0074.

Test of Hypotheses

- H₀₁:** There is no significant impact of Berthing capacity on the Maritime sector performance of Nigeria
- H_{i1}:** There is significant impact of Berthing capacity on the Maritime sector performance of Nigeria
- H₀₂:** There is no significant relationship between investment in cargo handling equipment/occupancy and the Maritime sector performance of Nigeria
- H_{i2}:** There is significant relationship between investment in cargo handling equipment/occupancy and the Maritime sector performance of Nigeria

Interpretation of Hypothesis One Results

Table 2, reveals at a lead of 2, berthing capacity (BERCAP) displayed a probability of 0.9380, indicating a negatively insignificant impact on maritime sector performance of Nigeria at the 5% chosen level of significance. Table 3, indicates that there is no co-integration between the dependent and independent variables, that is no long run correlation exists between berthing capacity and maritime sector performance.

The Decision: From the foregoing, we conclude that berthing capacity of Nigerian ports show a negatively insignificant impact on Maritime sector performance of Nigeria in the short run; hence, We accept the null hypothesis that there is no significant impact of berthing capacity on the maritime sector performance of Nigeria and reject the alternative hypothesis.

Interpretation of Hypothesis Two Results

Table 2, reveals at a lag of 4, cargo handling capacity (CARHCA) displayed a probability of 0.0064, indicating a positively significant impact on maritime sector performance of Nigeria at the 5% chosen level of significance. Table 3, indicates the

existence of co-integration at a p-value of 0.0000 (trace test) and 0.0001 (maximum eigenvalue test) suggestive of a long run relationship between cargo handling capacity and maritime sector performance.

The Decision: The outcome above, indicates that cargo handling capacity of Nigerian ports show a positively significant relationship with Maritime sector performance of Nigeria in the short and long runs; hence, we reject the null hypothesis to accept the alternative hypothesis that there is a significant relationship between cargo handling capacity of Nigerian ports and the maritime sector performance of Nigeria.

DISCUSSION AND SUMMARY

Discussions of Findings

The objective of this study was to assess the impact of Port infrastructure investments on maritime sector performance of Nigeria. The study investigated the impact of berthing capacity/occupancy on maritime sector performance of Nigeria. It also evaluated the relationship between cargo handling capacity on Nigeria maritime sector performance. After conducting preliminary tests of descriptive statistics, unit root tests etc, the variables were all stationary at first level of difference and found suitable for our study.

The ordinary regression tests and the co-integration tests that were conducted indicate a negative and insignificant impact of berthing capacity (BERCAP) on Nigeria maritime sector performance with a probability value of 0.9380. This result disagrees with the theory of this study, which expects that there should be a significant correlation between BERCAP and maritime sector performance of Nigeria.[This outcome contradicts the findings of Lakshmanan (2011); Limao and Venables (2001); and Lai and Cheng (2003), who discovered a positively significant impact of port infrastructure investments on maritime sector performance]. The co-integration however, showed no correlation. However, the results of the assessments of the relationships between Cargo handling capacity, Port

infrastructure quality with the maritime sector performance of Nigeria showed a positive and significant correlation in consonance with the theory of the study and findings of scholars such as Lakshmanan (2011); Limao and Venables (2001); and Lai and Cheng (2003). The co-integration test similarly confirmed this status. This result implies that a 1% increase in Cargo handling capacity would lead to increase in the maritime sector performance of Nigeria by 1.007906%. The discrepancy between the findings on cargo handling equipment and berthing capacity in this research study could be due to several factors:

- a. Confounding Variables: varieties of these causes may include:
 - i. Port Congestion: Even with increased berthing capacity, if a port is congested due to other factors (e.g., inefficient customs procedures, inadequate hinterland infrastructure), the full impact of the additional berths might not be realized.
 - ii. Economic Conditions: A weak economy or reduced trade volume could limit the demand for port services, even if there is excess berthing capacity.
 - iii. Technological Advancements: Improvements in cargo handling equipment might have made it possible to handle more cargo with fewer berths, reducing the perceived need for additional berthing capacity.
- b. Data Limitations: this could result from:
 - i. Measurement Errors: Inaccuracies in the measurement of berthing capacity or cargo handling equipment could lead to misleading results.
 - ii. Sample Size: A small sample size might not provide sufficient statistical power to detect the true relationship between berthing capacity and maritime sector performance.
- c. Nonlinear Relationship: some of which will include:
 - i. Threshold Effects: There might be a threshold effect where increasing berthing capacity beyond a certain point has diminishing returns.
 - ii. Interaction Effects: The impact of berthing capacity might be influenced by other factors (e.g., port infrastructure, vessel size) in a non-linear way.
- d. Model Misspecification: this could be caused by:
 - i. Omitted Variables: The model might be missing important variables that are correlated with both berthing capacity and maritime sector performance, leading to biased estimates.
 - ii. Functional Form: The linear functional form of the model might not adequately capture the relationship between the variables.

To better understand the discrepancy, researcher could consider the following:

- a. Conduct Sensitivity Analyses: explore how the results change when you vary the assumptions about the model or data.
- b. Use Alternative Estimation Techniques: try different econometric techniques (e.g., panel data models, instrumental variable estimation) to address potential endogeneity issues.
- c. Collect Additional Data: gather more data on relevant variables to improve the model's explanatory power.

- d. Consider Qualitative Research: conduct interviews or case studies to gain insights into the factors that might be influencing the relationship between berthing capacity and maritime sector performance.

By carefully examining the above explanations, we could gain a deeper understanding of the factors driving the performance of the maritime sector in Nigeria and identify effective strategies for improving port efficiency.

Summary of Findings

The empirical analysis focused on the impact of berthing capacity, cargo handling capacity, and port infrastructure quality on the maritime sector performance of Nigeria. The key findings are that there is no significant impact of berthing capacity on maritime sector performance in the short run. Moreover, there is no long-run relationship between the two variables; and that Cargo handling capacity significantly and positively impacts maritime sector performance in the short run. Additionally, there is a long-run relationship between these two variables.

Policy Implications

The findings of this study suggest several policy implications to enhance the performance of the Nigerian maritime sector:

- a. Investment Prioritization: The government and port authorities should prioritize investments in modern cargo handling equipment, port infrastructure upgrades, and maintenance; and the government should also consider developing a long-term investment plan for port infrastructure and equipment, considering factors such as trade growth, technological advancements, and environmental sustainability.
- b. Regulatory Framework: Creating conducive regulatory environment

to encourage private sector investment in port operations and infrastructure development through public-private partnerships (PPPs) and tax incentives; establishing clear and measurable port efficiency standards to drive performance improvement and facilitate benchmarking; and implementing policies and procedures to streamline customs clearance processes, reduce documentation requirements, and enhance port efficiency.

- c. Capacity Building: Investing in training and capacity building for port workers to improve their skills and productivity; and encourage the adoption of advanced technologies such as port community systems, automation, and data analytics to enhance port operations.
- d. Maritime Sector Development: Developing integrated transportation systems to connect ports with inland transportation networks; improving logistics efficiency and reducing costs; promoting the development of port-city linkages to maximize the economic benefits of port activities; and fostering the growth of maritime-related industries and services to create jobs and increase the sector's contribution to the economy.

By implementing these policies, Nigeria can enhance its port infrastructure, improve maritime sector performance, and contribute to the country's economic growth and development.

Conclusion

Based on the findings, it can be concluded that while berthing capacity is not a significant determinant of maritime sector performance in Nigeria, both cargo handling

capacity and port infrastructure quality play crucial roles in driving sector performance. Also, the positive and significant impact of cargo handling capacity and port infrastructure quality on maritime sector performance underscores the importance of investing in these areas to enhance the sector's contribution to the Nigerian economy. This also, highlights the need for sustained investments in these areas to achieve long-term economic benefits.

Recommendations

Given the findings, the following recommendations are made:

- a. There is need to prioritize investment in cargo handling capacity and port infrastructure quality in order to enhance maritime sector performance. Policymakers and port authorities should focus on increasing investment in modern cargo handling equipment and improving port infrastructure facilities.
- b. Higher level researches should be conducted on berthing capacity of Ports. Although this study did not find a significant impact of berthing capacity on maritime sector performance, further research with different methodologies or data periods could be conducted to explore this relationship in more detail.
- c. Monitoring and evaluation of Ports' performance should be robust and scientific. Regular monitoring and evaluation of port performance indicators are essential to assess the impact of investments and identify areas for improvement.
- d. Ports' stakeholders should improve collaborative and common-good synergy at all levels. Effective collaboration between government, port authorities, private sector, and other stakeholders is crucial for the successful implementation of port development initiatives.
- e. Government and private sector should allocate sufficient resources for the

construction and modernization of port facilities.

- f. The promotion of public private partnerships would encourage private sector participation in port development to leverage their expertise and capital.
- g. Adopting advanced technologies would increase investment in automation and digitalization to improve port efficiency and competitiveness.
- h. Strengthening hinterland connectivity would help in developing robust transportation networks to connect ports to inland regions; and
- i. Implementing regulatory reforms would help in streamlining procedures and reducing bureaucratic hurdles to facilitate trade.

Limitations of the Study

It is essential to acknowledge the limitations of secondary data analysis. Data availability, quality, and timeliness may pose challenges. Additionally, the inability to control for unobserved variables can affect the causal interpretation of the results. By employing a rigorous secondary data analysis approach, this study aims to contribute to the understanding of the relationship between port efficiency and economic growth in the Nigerian maritime sector. Future studies should consider balancing the secondary data with rich primary data using survey instrument or any other primary data collection method.

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APPENDICES

Appendix 1A
Tabular Presentation of Selected Variable

Year	VESTAT	BERCAP	CARHCA	INFRIN	MSRGDP
1990	6.5	26	345,900.00	0	2.78
1991	6.6	26	348,620.00	0	2.79
1992	6.9	26	358,245.00	0	2.54
1993	7.2	27	358,666.00	0	2.87
1994	6.5	27.76	218,749.00	0	2.59
1995	6.17	27.76	264,780.00	0	2.72
1996	6.34	36.68	299,653.00	0	2.8
1997	6.71	36.73	344,505.00	0	2.87
1998	7.31	41.39	385,472.00	0	2.91
1999	6.31	47.07	432,488.00	0	2.96
2000	7.01	44.76	443,992.00	0	3.03
2001	7.91	51.78	475,433.00	0	3.1
2002	11.34	56.58	588,478.00	0	2.85
2003	7.89	52.75	498,779.00	0	2.84
2004	6.44	50.93	512,610.00	1	3.01
2005	7.4	49.7	72,500.00	1.5	3.18
2006	5.31	48.49	87,000.00	3.05	3.37
2007	3.75	44.95	440,950.00	2.69	3.58
2008	4.59	48.49	612,982.00	2.62	3.8
2009	6.55	47.21	653,584.00	2.8	4.01
2010	5.38	48.81	685,937.00	2.98	4.23
2011	5.48	52.32	839,977.00	3.31	3.81
2012	5.75	50.85	880,597.00	3.55	3.75
2013	4.9	51.9	992,666.00	3.44	3.92
2014	4.3	49.2	1,063,486.00	3.16	4.26
2015	4.2	45.25	939,379.00	2.98	4.62
2016	3.9	42.54	808,587.00	2.8	4.69
2017	4.7	38.97	822,706.00	2.8	4.75
2018	4.3	38.78	987,321.00	2.5	4.88
2019	4.3	32.58	1,815,163.00	2.7	4.91
2020	4	40.54	1,566,109.00	2.81	4.1
2021	4.01	41	1,020,511.00	2.8	2.78

Source: CBN, NBS and NPA, 2023

Comment:

The results of the variables in above table shows unsteady cyclical patterns for all the datasets except cargo handling capacity that displayed growing trends between the period under considerations (1990 - 2021).

Appendix 2A

Unit root test results

Variable	T- Statistics	ADF statistics @5%	Probability	Integration
Carhca	-3.5742	-5.1546	0.0013	I(1)
Bercap	-3.5684	-5.9402	0.0002	I(1)
Infrin	-3.5684	-4.3936	0.0080	I(1)
Vestat	-3.5742	-5.5556	0.0005	I(1)
Msrcdp	-3.5742	-6.5614	0.0000	I(1)

Sources: Authors' (2024)

Appendix 2B

Serial autocorrelation results

Breusch-Godfrey Serial Correlation LM Test:			
Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	1.544325	Prob. F(2,18)	0.2404
Obs*R-squared	3.661508	Prob. Chi-Square(2)	0.1603

Sources: Authors' (2024)

Appendix 2C

Heteroskedasticity test result

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
Null hypothesis: Homoskedasticity			
F-statistic	2.739700	Prob. F(4,20)	0.0575
Obs*R-squared	8.849503	Prob. Chi-Square(4)	0.0650
Scaled explained SS	3.675330	Prob. Chi-Square(4)	0.4517

Sources: Authors' (2024)