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Keywords: *productivity, shipping industry, performance, liner shipping, port efficiency.*

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Examinining the Productivity of the Nigerian Shipping Industry

Peter Ekeada[α], Uzoma Obioma[σ] & Julius O. Anyanwu[ρ]

Abstract- This study is on investigation of the productivity of Nigerian Shipping Industry, a study of some selected companies. In addressing the specific objectives, four hypotheses were formulated. Data was sourced through primary sources and secondary sources. The collected data were analyzed using Data Envelopment Analysis Model, Principal Component Analysis (PCA), Production Frontier Model (Cobb Douglas Function, Data Envelopment Analysis (DEA) Model, Least Squares Regression–Based Estimation of Frontier. From the analysis Based on the significance of the p value at $\alpha = 0.05$, the researcher reject the null hypothesis in favour of the alternative hypothesis. Therefore, the productivity of shipping companies was positively affected by capital input resources applied during the study period, in hypothesis two it is also significant at $\alpha = 0.05$. Therefore, based on this result we again see a positive contribution of labour input with productivity in the case of these shipping companies. In hypothesis three the coefficient of port efficiency is 0.009 with a "t" statistic of 0.430. This is however not significant. The implication is that port efficiency or crane efficiency at the ports of call does not have a significant impact on the productivity of shipping companies and hypothesis four the result suggests that most shipping companies operating in Nigeria's shipping industry should be encouraged to improve their overall efficiency which will accrue directly to shippers and indirectly to the national economy. The study therefore concludes by recommending that that most shipping companies operating in Nigeria's shipping industry should be encouraged to improve their overall efficiency which will accrue shippers and indirectly to the national economy and many other recommendations.

Keywords: productivity, shipping industry, performance, liner shipping, port efficiency.

I. Introduction

Shipping has multiple meanings. It can be a physical process of transporting goods and cargo, by land, air and sea. It can also describe the movement of objects by ship, land or "ground" shipping can be by train or by truck. In air and sea shipments, ground transportation is often still required to take the product from its origin to be airport or seaport and then to its destination, ground transportation typically more affordable than air shipments but more expensive than shipping by sea (Bird, 1970).

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a) Problem Statement

Inefficiencies at the ports have led shipping companies to be less productive. Such inefficiencies which formed the basis for this research work is as follows; Inadequate infrastructural facilities for efficient and fast services: It is noteworthy that vessels make money when they are on the move and that the time spent on discharging and handling cargo carried by vessels cost the vessels' owners money on the crew, port charges, vessels' running etc and so the less the delay in turnaround time (i.e. time to berth, unload cargo, load any new cargo and leave the port), the better for the vessels since whilst delayed or working at ports, the vessels are accumulating heavy costs depending on the size of the vessel.

b) Objectives of the Study

The main objective of the study is to examine the productivity of the Nigerian shipping industry. However, the research objectives are;

1. To determine the effect of capital resource (proxied by deadweight) on the productivity of Nigeria's shipping companies.
2. To determine the effect of labour resources on the productivity of shipping companies.
3. To ascertain the effect of port efficiency (proxied by crane efficiency) to shipping company productivity.
4. To ascertain the relative efficiencies of Nigeria's shipping companies.

c) Research Hypothesis

1. There is no significant effect of capital resource (proxied by deadweight) on the productivity of shipping companies.
2. There is no significant effect of the labour resources on the productivity of shipping companies.
3. There is no significant effect of port efficiency (proxied by crane efficiency) on shipping company productivity.
4. The relative efficiencies of Nigeria's shipping companies are not significantly different from zero.

II. Literature Review

a) Key Features of the Liner Shipping Industry

The liner shipping industry is one of the most capital intensive industries, given their passive investments in each step of its organizational structure and infrastructure Fusillo, 2006). There are substantial time gaps between taking a decision to invest in or to

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upgrade any asset and the deployment of such assets. During these time gaps the decision factors may have turned dramatically against the earlier decision creating the core of observed supply/demand imbalances in liner shipping (Fusillo, 2004). Shipping lines have to invest heavily on their assets, vessels and equipment fleet to maintain fixed sailing schedule. On the other hand they are facing volatile demand due to seasonality effects and cargo imbalances between trades.

The high fixed to variable cost ratio, highly specialized capital, variable demand and fixed supply in the short run means that longer periods of overcapacity are followed by shorter periods of capacity scarcity. In periods of overcapacity shipping lines are driven towards freight rate and capacity competition potentially pushing them to price below marginal costs.

i. *Concentration*

Economies of scale are a key driver in liner shipping. A rather inelastic demand, low freight rates and low return on investment (ROI) force carriers to concentrate on their costs base, partly by exploiting economies of scale in ships and in organizational size. Larger ships along with efficient hub and spoke logistics systems mean a lower cost per transported unit (Cullinane and Khanna, 2000), which is the main concern for liner carriers, providing that demand secures fully loaded ships. Industry concentration comes in various forms.

Operational co-operation ranges from slot-chartering and vessel-sharing agreements to strategic alliances, mergers and acquisitions. Trade agreements in the form liner conferences lost much of their role when the European Commission abolished the block exemption in late 2008. The industry tends to be more and more concentrated to respond to the market challenges posed by demand instability and to take advantage of economies of scale (Notteboom, 2012; Fusillo, 2006).

ii. *Entry and Exit Barriers*

The liner industry is a capital intensive industry. Liner companies have to invest heavily not only on building ships and acquiring a large box fleet, they also need to invest in marketing, information systems, building the customer base and may also invest extensively on the land side. Consequently, the entry barriers are considered as relatively high. The merger and acquisition policy followed by some liner companies can be seen as a way to gain immediate entry to new markets or to expand presence on existing markets.

iii. *Product Differentiation*

The main activity of liner companies is the ocean transportation of containerized cargo. Consequently, they serve mainly the commodity market, giving no room for service differentiation. New supply chain requirements put more pressure on liner companies in terms of service reliability and a more global coverage (Notteboom, 2006). Service frequency and reliability, cargo security and some other qualities only give small room for service differentiation. Vertical integration offers more scope for differentiation.

iv. *Vertical Integration*

The poor financial performance of the liner carriers compared to other players in the shipping and logistics industries gave impetus to some liner companies to extend their services to port terminals, inland transportation and logistics services (Graham, 1998, Cariou, 2001, Frémont and Soppé, 2007). The deployment of larger vessels, the formation of strategic alliances and the waves of Merger and Acquisition have resulted in lower costs at sea, shifting the cost burden to landside operations (Notteboom, 2009). Some shipping lines develop door-to-door services based on the principle of carrier haulage in an attempt to get a stronger grip on the routing of inland container flows. Other shipping lines combine a strategy of selective investments in key supporting activities (e.g. agency services or distribution centers) with sub-contracting of less critical services. Only a few exceptions, the management of pure logistics services is done by subsidiaries that share the same mother company as the shipping line but operate independently of liner shipping operations, and as such also ship cargo on competitor lines (Heaver, 2002). A last group of shipping lines are increasingly active in the management of hinterland flows.

b) The volatility in carriers' revenue streams and their pricing strategies

The container shipping industry has one of the complex pricing strategies. They deal with too many customers with different cargos. Freight of All Kind (FAK) pricing policies are applied on most of the trade lanes, irrespective of cargo quantity loaded inside the container. Carriers' primary target is to maximize and stabilize their revenues flow from freight rates. However, demand inelasticity, trade imbalances and capacity rigidity in the short run do not help shipping lines to achieve the revenue stability they are looking for, which is the core problem for carriers' financial performance. In a market with ships over supply conditions, carriers compete between each other by cutting down rates to maintain their market share. In fact, such reaction has a minor influence on the demand. The only change they produce is just attracting very low value cargos which normally are not shipped in containers (e.g. scrap and waste paper). Accordingly, these cargoes disappear once the freight rates pick up again to normal patterns. Price wars between carriers continue till freight rates reach the lowest acceptable level or the refusal level. Below this threshold level, carriers prefer to lay-up their ships.

Reducing ships oversupply leads to rate restoration above the refusal levels again. As soon as

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demand and freight rates pick up again, the full available capacity will be deployed again in the market. Freight rates will keep going up till the market reaches full utilization of the available capacity. At that point, carriers irrationally start to order new capacity to skim more profits from the market. However, it takes sometime till the new capacity is delivered to the market. By that time the demand conditions are totally different and not in favor of the extra capacity deployed. This pushes freight rates to lower levels and generates a new situation of oversupply conditions. Another aspect of the difficulty facing the carriers when setting up their pricing strategy is the trade imbalance on some of the trade lanes, especially on the major lanes. Carriers' pricing policies focus on charging higher freight rates on the production-consumption direction than on the opposite direction.

i. *Shipping Lines and Strategic Alliances*

Strategic alliances are formed in order to extend economies of scale, scope and network, through strategies such as the integrating of individual service networks, vessel sharing, slot-chartering, joint ownership and/or utilization of equipment and terminals and similar endeavors on better harmonization of operations. Liner carrier alliances are developing at least two different types: (1) core alliances with a set of global partners,

(2) Multi-consortia networks of slot exchanges covering individual traders. Through this kind of global alliance arrangement, a lot of scale benefits can be achieved: more frequent service, shorter transit times, wider port coverage, lower slot costs and a stronger bargaining position in negotiating with terminal operators, container depots and inland/feeder transportation carriers.

Alliances, acquisitions and mergers have been seen as elements of an industry-wide strategy to return to profitability via cost cutting and rationalization. While intense competition and low profitability have encouraged rationalization, the preferred method of achieving the objective has changed over time. Strategic alliances were preferred in the late 1980s and early 1990s, culminating in the formation of the Grand and Global Alliance. More recently the emphasis has switched to merger and acquisition. Co-operative ventures in container shipping began with the formation of consortia in the late 1960s and 1970s in order to raise the capital required to mount container services.

ii. *Productivity Measurement in Shipping*

According to David (1994) Productivity is concerned with the efficient utilization of resources (inputs) in producing goods aid or services. Shipping is a highly competitive capital-intensive transportation services industry where ship owners compete by their ability to undercut their competitors and by record of efficiency and performance as a profit earning reputed carriers of fleets. Productivity is one of the most important variables in determining the overall cargo carrying performance of the fleets measured in terms of ton-miles of cargo transportation provided.

In productivity measurement for the shipping companies, which constitute the maritime fleets of a country, are necessary in order to know at what productivity level they should be operating and at what level they are operating now. Productivity can help the shipping companies to assess the efficiency of conversion of their resources (Dead Weight Tonnage) to produce more service. (Ton miles carried) for a given amount of expended resources. Resource planning, such as scheduling of ships through different available routes and maximum utilization of ships capacity etc, can be facilitated through productivity measurement. Future target of productivity can be fixed considering the present value. Necessary strategies for improving productivity can be determined based on the gap between planned level and the measured level of productivity.

Economic and non-economic objectives of the company can be recognized in the light of production results can be utilized for planning the profit level of the company because higher productivity means higher profit. The conceptual approaches for measuring production includes the estimation of production functions and the estimation of cost functions. In production functions approach, (Groiroos, C. and Ojasalo, K. (2004) formula for the productivity of a fleet is given by:

$$\text{Productivity} = \frac{\text{Total Ton miles of Cargo Shipment in the year}}{\text{Total Deadweight the fleet actively employed in carrying the cargo in the year}}$$

And it depends upon three main factors:

Mean operating speed, which determines the time a vessel takes on a voyage. The mean operating speed is important because it determines the amount of cargo that can be delivered during a fixed period and hence the revenue is earned. Sometimes is it better to operate the ship at full speed in a high freight rate market whereas in low freight rates a reduced speed may be more economic because the cost of fuel saving may be greater than the loss of revenue.

Deadweight utilization, which refers to the extent to which a vessel travels with a full load of cargo. It is the ton mileage of cargo carried divided by ton mileage of cargo that the ship could actually have carried if it had always obtained a full payload. In practice, the deadweight cargo capacity of a ship represents a physical maximum and its commercial decision whether this capacity is fully utilized. The ship owner has always the option to accept a part cargo depending on the market condition.

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Loaded Days at sea which is vessels time divided between loaded at sea (Steaming days) and the unproductive days (in ports, off line, in loaded days at sea by optimizing of each of these components, the productivity of the fleet can be increased. Probably the most useful ways to tackle and increased the productivity of a fleet are to bring changes in its actual operating performance in response to the market condition. Cargo handling is also important since this determines the port-time.

In cost function approach concept of productivity measurement, one has to deal with the total shipping cost and total revenues earned. The costs of shipping (Everett, 1994, Stafford, 1997) are classified into four main following categories.

Operating cost, Cargo Handling costs, Voyage Cost, Capital Costs.

III. Methodology

a) Research Design

The study adopted a survey research approach in analyzing the productivity of some selected shipping companies in Nigeria. Descriptive research is used to describe characteristics of a population or phenomenon being studied.

b) Population of Study

The population of the study consists of some selected shipping companies operating in Nigeria's freight market. The list of those companies was obtained from Nigeria's Shipping Company Association and Nigeria's Shippers Council. There are total of thirty five that own and operate in Nigerian's freight market according to validated list from the relevant records. Out of this number, only thirty of them were willing to participate in the survey. Based on this population, a sample frame of thirty was drawn for sampling purposes.

Sample Size

The sample size for this study was calculated as follows using Yamane's (1967) formulae:

$$n = \frac{N}{1+N(e)^2}$$

$$n = \frac{30}{1+30(0.0025)}$$

$$n = \frac{30}{1.075}$$

$$n = 28$$

Types of Data

A. Primary data

B. Secondary data

c) Instrument of data collection

The researcher used survey questionnaire to collect data from the shipping companies' sampled. Out of the twenty eight (28) questionnaires sent out to the shipping companies, only twenty four (24) were correctly filled with data and this were the ones used for the statistical analysis.

d) Method of data analysis

Production Frontier Model (Cobb Douglas Function).

Generally shipping operation in a shipping company involves carriage of cargo, involves use of the following capital inputs: vessel or tonnage capacity, terminals, cargo handling facilities (both ship based and shore based). However, in a single output production frontier framework a single most representative variable is chosen as proxy. In this study, we will use deadweight tonnage as the most representative since it reflects the cargo carrying capacity of shipping companies. In terms of labour input we use number of operational staff in the shipping companies whose activities directly impact on the output of production. Researchers argue that certain factors outside the control of shipping managers affect shipping production. To account for this environmental factor, we include crane efficiency which can be taken as a proxy for port efficiency(All hypotheses are tested at $\infty = 0.05$ level of significance)

e) Least Squares Regression–Based Estimation of Frontier Functions

In most applications, the production model, , is linear in the logs of the inputs or functions of them, and the log of the output variable appears on the left-hand side of the estimating equation. It is convenient to maintain that formulation and write:

$$\ln y_i = \alpha + \boldsymbol{\beta}^T \mathbf{x}_i + \varepsilon_i,$$

Where $\varepsilon_i = -u_i$, and $\mathbf{x_i}$ is the set of whatever functions of the inputs enter the empirical model. We assume that ε_i is randomly distributed across shipping firms.

Data Envelopment Analysis (DEA) Model

The Data Envelopment Analysis (DEA) is a relatively new "data oriented approach for evaluating the performance of a set of peer entities called Decision Making Units (DMUs) which convert multiple inputs into multiple output.

IV. Data Presentation and Analysis

a) Frequency Distribution of Data

Table 4.1 indicates the descriptive summary of the data employed for analysis in this study. In this table we note that in the sample of twenty four shipping companies studied, the mean deadweight tonnage of vessels in their fleet is 5,416 tons, and average number of personnel in these companies is twenty seven (27). Within the sample period, these companies covered an average of fourteen (14) shipping routes while lifting and average tonnage of four hundred and seventy seven thousand tons of cargo. Furthermore, average crane

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efficiency at the port was 18.55 tons/hour while average freight rate stood at N4, 429.88 per ton of cargo. The full data set employed in this study is attached in appendix 1. In the subsequent sections, we address the hypotheses that govern this study.

Table 4.1: Descriptive Statistics of Sample Data

Variable	Obs.	Mean	Std. Dev.	Min	Max
Deadweight(Tons)	24	5,416.44	5,724.71	91.47	20,720.20
personnel (number)	24	27	5	17	40
Cargo Throughputs (Tons) (000)	24	477.83	543.71	3.76	1,860.05
Shipping Routes	24	14	5	8	24
Port Efficiency (tons/hour)	24	18.55	10.80	6.06	47.77
Freight Rates (N)	24	4,429.88	1,574.52	2,050.00	7,600.00

b) Tests of Hypotheses

Results obtained from estimation of production function and efficiency using Data Envelopment Analysis shall be used to test the hypotheses.

Test for Hypothesis one: There is no significant effect of capital resource on the productivity of shipping companies.

In table 4.2, we have the result of productivity analysis of shipping companies. The dependent variable is volume of cargo lifted by the shipping companies under study. This variable is also referred to as vessel throughput since cargo vessels were the transport units. To achieve output, various input variables namely: capital (proxied by deadweight capacity of vessel employed) and labour (proxied by the number of operational personnel in the employ of the shipping companies). To account for a variable outside the control of shipping company managers but which impact on their productivity, port efficiency (proxied by crane efficiency at the port of call) is included. Thus we note that the capital (or deadweight) input factor has a coefficient of 0.001 in table 4.2. The associated 't" statistic is 31.410 with a "p" value of 0.000. Based on the significance of the p value at $\alpha = 0.05$, we reject the null hypothesis in favour of the alternative hypothesis. Therefore, the productivity of shipping companies was positively affected by capital input resources applied during the study period.

Table 4.2: Regression output on Shipping Company Productivity

Vsl_thruput	Coef.	Std. Err.	T	P>t	[95% Conf.	Interval]
Deadweight	0.001	0.000	31.410	0.000	0.001	0.001
Personel	0.261	0.043	6.140	0.000	0.173	0.350
port_eff	0.009	0.020	0.430	0.672	0.051	0.034
_cons	1.172	1.074	1.090	0.288	3.413	1.068
F(3, 20)	=	378.5				
Prob> F	=	0.000				
R-squared	=	0.983				
Adj R-squared	=	0.980				
Root MSE	=	0.945				
No. of Obs	=	24				

i. *Test for Hypothesis two*

There is no significant effect of the labour resources on the productivity of shipping companies.

Again, we note that in table 4.2, the coefficient of labour (or operational personnel) is 0.261 with associated "t" statistic of 6.140. The "p" value of this input variable is 0.000. This is also significant at $\alpha = 0.05$. Therefore, based on this result we again see a positive contribution of labour input with productivity in the case of these shipping companies.

ii. *Test for Hypothesis three*

There is no significant effect of port efficiency (proxied by crane efficiency) on shipping company productivity.

In table 4.2, we also note that the coefficient of port efficiency is 0.009 with a "t" statistic of 0.430. This is however not significant. The implication is that port efficiency or crane efficiency at the ports of call does not have a significant impact on the productivity of shipping companies. This result may be connected to complaints

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port users make about some terminal operators who are yet to invest in modern cranes (facilities) since the concession process.

The model fitting information of table 4.2 indicated significant "f" statistic (p = 0.000) and an adjusted "R" value 98%. This implies that the model has explanatory power and hence is appropriate for addressing hypotheses one to three which govern this study.

iii. *Hypothesis four*

The relative efficiencies of Nigeria's shipping companies are not significantly different from zero.

Table 4.4 reports the efficiency score and ranking of the shipping companies under study. The mean efficiency score of the companies is 0.74 or 74% approximately. However, a closer look reveals that only eight (8) out of the twenty-four (24) companies sampled have 100% efficiency score with rank of 1st position. Seven (7) other companies have recorded efficiency score of between 60 and 95%. While the remaining nine (9) recorded between 39 and 57% efficiency. This result suggests that most shipping companies operating in Nigeria's shipping industry should be encouraged to improve their overall efficiency which will accrue directly to shippers and indirectly to the national economy.

Table 4.4: Efficiency Results of DEA Model

Shipping Company	Rank (position)	Eff_Score (θ)	Shipping Company	Rank (position)	Eff_Score (θ)
Cross_traders	1	1	Cosco	13	0.75
Maersk	1	1	JNAK	14	0.72
Delmas	1	1	Dully_shipping	15	0.62
Safmarine	1	1	NAI_COMMET	16	0.57
China_shipping	1	1	P&O_NED	17	0.51
SDV	1	1	Brawal	18	0.47
East_Atlantic	1	1	Japaul	19	0.46
Grimaldi	1	1	Wal	20	0.44
Gasop	9	0.95	Gold_Star	21	0.43
Torm	10	0.89	Wolid	22	0.43
Fleming	11	0.84	Gulf	23	0.40
MGM	12	0.78	Green_WA	24	0.39

c) Result of Findings

From the results, for hypothesis one, the associated t-statistic is 31.410 with a p value of 0.000 at 95% confidence level, therefore, the productivity of shipping companies was positively affected by capital input resources applied during the study period.

Based on hypothesis two with t- statistic of 6.140 and p value of 0.000, it was concluded that there was a positive contribution of labour input with productivity.

In addition, hypothesis three indicate that the coefficient of port efficiency is 0.009 with a t-statistic of 0.430, it implies that port efficiency or crane efficiency at the port of call does not have a significant impact on the productivity of shipping companies.

In conclusion, for hypothesis four, it was found out from the DEA output that eight (8) out of the twenty four (24) shipping companies sampled were on the efficient frontier with 100% and seven (7) other companies have the efficient score between 60% and 95%, while the remaining nine (9) recorded between 39% and 57% efficiency.

V. Conclusion

This result suggests that most shipping companies operating in Nigeria's shipping industry should be encouraged to improve their overall efficiency which will accrue shippers and indirectly to the national economy.

VI. Recommendations

Based on the findings of the study it is advised that the shipping companies operating in Nigeria shipping industry should be encouraged to improve their overall efficiency which will accrue directly to shippers and indirectly to the National economy.

In addition, the shipping companies should improve on their labour and capital to increase the productivity of the shipping companies.

Finally, the type of technology employed as well as the capacity utilization will determine the effectiveness, efficiency and productivity of shipping companies, so effort should be made at employing current technologies and modern cranes and facilities.

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