AN EVALUATION OF NIGERIAN PORTS POST-CONCESSION PERFORMANCE

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Introduction

The competition between ports is more intense nowadays than it used to be. Cullinane and Wang (2007) consider that port markets used to be described as monopolistic due to the exclusive and immovable geographical location of the ports and the unavoidable concentration of port traffic. The development of international container and intermodal transportation has changed the market structure from one of monopoly to one where aggressive competition takes place worldwide. Many ports, no longer enjoy the monopoly yielded by handling the cargoes that is from their hinterland rather they compete for cargoes with their neighbouring ports (Cullinane & Wang 2006, 2007, Cullinane, et al. 2004).

Due to intense competition, many studies focus their attention in measuring efficiency in ports. Cullinane and Wang, (2006) are of the view that the analysis of individual ports and terminals are essential for the health of the industry and the survival and competitiveness of its players. These studies not only provide a valuable tool for port managers and operators to use, but also contribute as input for regional port planning and operations.

As a result of this, performance measurement has become a central issue to stakeholders in the port industry globally. Ports in the West African sub region are not left out of the new world order of intense competition and technological changes in the port market. In Nigeria this is experienced in the form of cargo diversion to neighbouring ports of Cotonou, Lome and Tema in Benin Republic, Togo and Ghana respectively. In order to tackle these problems Nigeria undertook a major port reform program which culminated in the concession of all ports to the private operator. Therefore, this study evaluates the post concession performance of Nigerian ports five years after adopting the Landlord model, to understand whether the ports are on the path of efficiency which is the major objective of the concession.

Review of Related Literature

There are contrasting views among authors on the effects of private sector participation on port efficiency. Liu (1995) investigated the impact of different types of port ownership on technical efficiency of ports in the UK. Liu did not find any significant difference provided the policy environment is competitive. Similarly, Notteboom et al. (2000) evaluated different type of ownership and administrative systems in the port sectors and maintained that port performance is not a function of ownership structure. In the same vein, (Pallis and Syriopoulos, 2007) studied the financial performance of Greek's port new governance model; the result of the study indicated that despite profitable results in most of the Greek ports, the financial accounts raised doubt as to the efficiency of the ports organisational structure.

On the other hand, there are many empirical studies supporting institutional reforms based on private sector participation as a veritable tool to achieve higher efficiency in port terminal operations. Notably, Estache et al., (2002) evaluated Mexico's port reform of privatisation and decentralisation using Malmquist productive Index (MPI) the result showed significant short-term improvements in performance. This view is collaborated by Gonzalez and Trujillo (2008) on the study of Spanish port which showed improved productivity due to technological progress after the reform. Barros (2003) study of Portuguese ports identified substantial improvements in efficiency due to the reform. In the same vein, Cullinane et al. (2002) examined the relative efficiency of major Asian container terminals using Stochastic Frontier Analysis (SFA) using both cross-sectional and panel data the result obtained supported view that privatisation improves efficiency. A study by Tongzon and Heng (2005) with terminal level data also suggested that there is improved efficiency. In addition they argued that privatization has become a strategy to gain competitive edge in the global market place. (Haarmeyer and Yorke 1993) investigated the US public port system and concluded that the US public port system is dominated by inefficient operation as a result of political interference and risk aversion. In conclusion they argued that the injection of private capital through privatisation will increase efficiency.

De Monie (1996), was of the view that private investors and operators pursuit of profit maximisation objective may undermine long term investment in facilities and services in a broader social perspective. This is particularly true in regions with limited competition; privatisation will then lead to private monopolies of port facilities. The study of the efficiency of 27 Spanish 1985 to 1989 by Coto-Millan et al. (2000) revealed that the most efficient Spanish ports are those with more centralised management system than those with autonomous management. Baird (2000) identified long pay-back period, high costs in the port industry as factors that make outright sale and complete transfer of operations and regulatory functions counterproductive. He was of the view that complete dependence on the private sector may result in delayed investment in key operational facilities and equipment.

Cheon et al. (2010) pointed out the need to critically look at the conceptual and methodological aspects of each reform in order to gain a global view of the influence of institutional reforms on national ports efficiency. For instance, most researchers base port efficiency benchmarking studies on data collected from world major container ports. In some cases most of the sampled ports have been adjudged successful. They further argued that as most of the studies are biased and skewed towards ports with available data, the result obtained from such studies makes it difficult to clearly examine the issues. The primary issue is, whether the efficiency gap in a nation's port industry can be explained by the difference of port ownership and institutional structure and whether private sector participation and reforms of port institutions have allowed inefficient ports to become more efficient.

This study aims to address these issues by analysing a sample of six ports based in a particular country Nigeria and a developing country. The analysis is based on ranking and comparing the pre- and post-concession efficiency gains of the following Apapa, TinCan, Warri, PH, Onne and Calabar ports in Nigeria. The most efficient port is used to benchmark the others. This could encourage intra and inter- port competition.

Data Envelopment Analysis (DEA)

DEA is a non-parametric efficiency evaluation model based on mathematical programming theory, Charnes et al (1978). It is used in operations research and econometrics for multi-variant frontier estimation and ranking which can be used in calculating efficiency levels within a group of organisations. This is accomplished by calculating the relative performance of the units under investigation to the group's best practice. Panayides et al. (2009) asserted that efficiency is a relative term that can be measured by the process of benchmarking. There are two types of efficiency, Technical and Scale efficiency. Wang et al. (2005) defined technical efficiency as relative productivity over time or space or both and scale efficiency as possible divergence between actual and ideal production size.

The concept of DEA is developed around the basic idea that efficiency of a DMU is determined by its ability to transform inputs into desired outputs. This concept of efficiency was adopted from engineering which defines efficiency of a machine/process as output /input ≤ 1. In this approach, efficiency is always less than or equal to unity as some energy loss will always occur during transformation process.

Formally, if inputs are considered to be $x_k = (x_{1k}, x_{2k} \ldots x_{Mk}) \in R^{M}_{+}$ to produce outputs represented with the following notation $y_k = (y_{1k}, y_{2k} \ldots y_{Nk}) \in R_{+}^{N}$. The row vectors x_k and y_k form the *k*th rows of the data matrices X and Y, respectively. Let $\propto_k = (\propto_1, \propto_2, \ldots \propto_k) \in R_{+}^{k}$ be a non-negative vector, which forms the linear combinations of the *k* firms. Finally let *e*= (1, 1..., 1) be a suitably dimensioned vector of unity values.

The out-oriented DEA model seeks to maximize the proportional increase in output while remaining within the production possibility set. An output-oriented efficiency measurement problem can be written as a series of *K* linear programming envelopment problems, with the constraints differentiating between DEA-CCR introduced by Charnes et al. (1978) and DEA-BCC by Banker et al. (1984). Models, as shown in equations (1) through (5)

$$\text{Max } U \qquad (1)$$

Subject to

$$U y_k' - Y' \propto \leq 0 \qquad (2)$$

$$X' \propto - x_k' \leq 0 \qquad (3)$$

$$\propto \geq 0 \ (DEA-CCR) \qquad (4)$$

$$e \propto' = 1 \ (\text{DEA-BCC}) \qquad (5)$$

The combinations of equations (1) to (4) and (1) to (5), respectively form the DEA-CCR and DEA-BCC models. The output-oriented measure of technical efficiency of the *k*th DMU, denoted by $TE_{k'}$, can be computed by equation (6).

$$\text{T}E_k = {}^{1}/_{U_k} \quad (6)$$

The technical efficiency derived from DEA-CCR and DEA-BCC model is then used to obtain a measure of scale efficiency, as shown in Equation (7) (Cooper et al., 2000),

$$\text{S}E_k = U_{CCR_k}/U_{BCC\_k} \quad (7)$$

Let SE_K represent the scale efficiency of the kth DMU, while U_{CCR_k} and U_{BCC_k} are the technical efficiency measures for DMU K derived from applying the DEA-CCR and DEA-BCC models, respectively. SE_k =1 connotes scale efficiency whereas $\text{S}E_k < 1$ denotes scale inefficiency.

A look at equations 1-7 shows that time is not considered as a component in the above model.

DEA Applications to Seaport Efficiency Measurement

In the last 10 years, measurement of port efficiency using Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis has been symbolic. For instance, Tongzon (2001) investigated port efficiency of selected Australian ports and benchmarked them with other international ports based on DEA estimates. Lee et al. (2005) examined efficiency of ports in the Asia Pacific region applying Recursive DEA, while Cullinane and Wang (2006) studied the efficiency of European container ports by using DEA and Ablanedo-Rosas et al. (2010) evaluated the relative efficiency of 11 major Chinese ports using adopted version of DEA. Song and Yeo (2004) investigated the competitiveness and efficiency of container ports in China using the Analytic Hierarchy Process (AHP) framework. Pang (2006) analysed and evaluated 50 major ports in China by using DEA and dynamically evaluated their efficiency based on 3 years of consecutive data. A related study is developed by Zhou et al. (2008), who evaluated the comparative efficiency of Chinese third-party logistics providers by means of DEA.
Roll and Hayuth (1993) were probably the first attempt to apply DEA to investigate the port efficiency. However, their study was not truly involved with the real data analysis. Martinez-Budria et al. (1999) divided 26 ports into three groups: high-complexity ports, medium- complexity ports, and low-complexity ports. The results of Martinez-Budria et al. (1999) showed that the high-complexity ports were more efficient than the medium- and low complexity ports by using DEA–BCC (Banker et al., 1984). Others like Tongzon (2001) used DEA–CCR (Charnes et al., 1978) and DEA–additive variation models to measure the efficiency of selected Australian and other international ports.

Valentine and Gray (2001) analysed 31 out of 100 world's top container ports by using DEA–CCR. Park and De (2004) used a four-stage DEA to investigate the efficiency the North American seaport infrastructure productivity from 1984 to 1997. Dı'az-Herna'ndez et al. (2008b) studied the cargo handling productivity in Spanish ports. Min and Park (2008) proposed a hybrid DEA-simulation model to evaluate the relative efficiency of major container terminals in South Korea. Wu and Lin (2008) performed an international comparison of logistic port operations with a focus on India. Ablanedo-Rosas and Ruiz-Torres (2009) used DEA to evaluate the efficiency of cargo and cruise operations in major Mexican ports.

Some researchers have measured the impact of these reforms; a specific case is the relationship between privatization and the relative efficiency within the container port industry that has been studied by Estache et al. (2004), Tongzon and Heng (2005), Cullinane et al. (2005a), Pallis and Syriopoulos (2007). Furthermore, after the reforms, ports' performance has been investigated based on financial factors such as Park and De (2004). While Ablanedo-Rosas et al (2010) used a financial ratio-based data envelopment analysis to examine the relative efficiency of 11 major Chinese ports. Pang (2006) analysed 50 ports in Mainland China by using DEA and dynamically evaluated their efficiency based on 3 years of consecutive data. Danijela et al. (2011), evaluated efficiencies of River ports in Serbia using Window-based DEA the result showed variability and very low efficiency scores among the ports.

In the same vein, this paper is also employing Window- based DEA to examine the operational performance of 6 major Nigerian ports from 2004-2010. This approach is useful because different ports perform differently at different times. Therefore, the estimation of efficiency using this approach gets more robust by repeated moving the window term.

Research Methodology
The paper employed the quantitative technique to evaluate the pre- and post-concession Nigerian ports performance. This is because a port's productivity is usually measured by comparing its actual production volume with a production frontier. According to Wang et al (2005), productivity measurement can be classified either as parametric or non-parametric. The most employed non-parametric approach is DEA; there are variants of the DEA methodology as discussed previously. However DEA Window Analysis model is used in this paper to calculate the average efficiency using CCR and BCC model. This version of DEA was first used by Charnes et al (1985), window analysis is a time-dependent version of DEA which is applied with panel data. The basic idea is to treat each port as if it was a different port in each of the years under review. Each port performance is not only compared against the performance of other ports but also against its own performance at different times. This approach is necessary because we are comparing the performance of Nigerian ports at different times and with different ownership structure.

Data source and presentation
The data for this study sourced from NPA consists of panel data on ship and cargo traffic from six major Nigerian ports (2004-2010). The identification of variables is the first step in non-parametric analysis (DEA) because the accuracy of estimation and analysis depends on it. The paper investigated Nigerian ports based on the basic function of port that is receiving ships and cargo handling and the speed with which this activity is carried. To fulfil this function a port needs infrastructure, equipment and human resources. Those facilities are regarded as inputs to a port production. Measures of infrastructure include berth length (quay length), berth depth, terminal area, yard space, storage area, whereas equipment measures include number of handling equipment and handling capacity. Labour input is measured as stevedore labour or number of employees. The output measure of a port is the quantity of cargo (container, RORO, general cargo and bulk) and the number of ships that called at the port/ terminal to discharge cargo.
There is no consensus on the type of data to be used in estimating seaport efficiency by different authors who have written on the subject because of the multi-activity nature of seaports. The indicators or variables used to calculate efficiency using DEA is based on the activity being studied and data availability. Data in use in a DEA is classified as output or input data. The paper used cargo throughput and number of ship calls as output data while berth length, number of berths, number of equipments and number of staff as input.

Efficiency of Nigerian Ports
The paper analysed the efficiency of six ports in Nigeria: Apapa, Tin can Island, Warri, Port Harcourt, Onne and Calabar two years before concession and five years after i.e. 2004-2010 using the DEA Window analysis technique to capture the trend of efficiency changes over the period under review.

		OUTPUTS		**INPUTS**			
Ports	**Year**	**Throughput (Tons)**	**No. of Ship calls**	**Berth length**	**No. of Berths**	**Total No. of Equip.**	**Total No. of Staff**
Apapa	2004	12,294,640	891	2500	15	122	3782
	2005	13,432,106	955	2500	15	114	2996
	2006	16,469,320	1128	2500	15	120	760
	2007	23,139,112	1359	2500	15	100	959
	2008	25,784,118	1452	2500	15	80	717
	2009	28,111,564	1545	2500	15	80	726
	2010	29,258,335	1588	2500	15	80	712
Tin can	2004	4,075,386	504	1045	5	127	1362
	2005	4,743,741	495	1045	5	110	1131
	2006	10,788,867	903	1045	5	137	850
	2007	23,139,112	1185	1045	5	145	799
	2008	21,123,705	1367	1045	5	150	668
	2009	24,243,688	1583	1045	5	168	637
	2010	29,047,925	1666	1045	5	188	604
Warri	2004	1,296,050	229	1790	11	97	388
	2005	1,922,245	295	1790	11	74	942
	2006	1,951,432	193	1790	11	80	836

	2007	1,936,970	205	1790	11	88	480
	2008	1,950,120	246	1790	11	82	426
	2009	1,897,402	231	1790	11	60	424
	2010	2,972,223	341	1790	11	60	422
PH	2004	3,210,907	261	1117	8	67	1,096
	2005	3,516,188	239	1117	8	56	929
	2006	3,488,853	270	1117	8	59	868
	2007	3,854,715	317	1117	8	58	506
	2008	4,595,253	378	1117	8	65	424
	2009	4,879,478	399	1117	8	60	415
	2010	6,595,696	482	1117	8	68	407
Onne	2004	2,158,548	390	2063	8	35	1185
	2005	2,554,328	423	2063	8	35	362
	2006	4,937,758	444	2063	8	40	336
	2007	4,500,291	394	2063	8	45	206
	2008	4,399,202	379	2063	8	48	572
	2009	5,208,247	424	2063	8	48	499
	2010	36,485,617	769	2063	8	55	459
Calabar	2004	480,889	213	1037	8	26	264
	2005	857,726	276	1037	8	28	590
	2006	1,600,989	321	1037	8	32	459
	2007	2,210,989	897	1037	8	38	274
	2008	1,914,120	351	1037	8	44	254
	2009	2,591,241	321	1037	8	51	262
	2010	2,329,757	197	1037	8	56	265

Table 1: Input and Output Variables Source: NPA Annual reports and Abstract of port statistics 2004-2010.

	2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Mean***
Apapa	65.3%	68.3% 70.2	75.8% 82.5 90.2	80.3% 86.2 95.3 88.5	88.3 95.5 98.5	97.3 85.5	98.0	**85.4%**
Warri	32.5%	38.9% 36.5	45.8% 44.8 30.5	42.6% 46.7 38.2 23.8	48.4 46.2 38.9	40.1 37.4	48.2	**39.97%**
PH	51.2%	60.1% 55.8	56.2% 58.9 64.2	48.3% 62.7 57.3 51.9	62.5 54.5 57.2	58.6 49.5	50.8	**56.23%**
Onne	68.2	75.6 62.5	83.2 66.9 88.2	90.3 80.2 79.2 68.3	77.5 84.5 64.9	73.5 66.6	61.3	**74.43%**
Calabar	23.2	18.5 22.5	16.4 14.2 21.4	17.2 15.5 16.6 30.5	15.2 13.8 28.9	17.8 18.9	24.5	**19.7%**

Table 2: Nigerian ports 2004-2010 using DEA window Analysis

Mean* efficiency is the arithmetic mean of the efficiency scores for each port

Data Analysis

The window analysis is specified by the time length, i.e., the number of years in this study, of a window, *p*, and the number of windows, *w.* Denoting the number of ports i.e., ports in this study, by, *n* there are *np* units in each window. The total number of DMUs amounts to *npw.* It is a common practice in the window analysis that each port is scored once in every window, or, in other words, scored as many times as the number of windows. Since a port is regarded as a different unit in a new window, each unit is evaluated only once in a set of window applications. For this study, a port will be evaluated based on average scores in the windows.

Table1 gives an overview of the output and input data used for the analysis. Although the ports were not all handed over at the same time, the Lagos ports Apapa, Tin can were taken over by the terminal operators in 2006. The Warri and PH were taken over in 2007 while Calabar came on stream in 2008. Despite this, there are significant changes in ship and cargo traffic in the various ports. Table 1 shows stable increase in cargo throughput and the number of ship calls during the period under review in all the ports except Warri port which experienced a drop between 2007and 2008.This was due to youth restiveness in the Niger Delta region of Nigeria which resulted in kidnappings and other maritime crimes which scared shippers away from using the port. The period also witnessed a drastic drop in the staff strength of the respective ports which is used in this paper as a proxy for labour input after the concession. In fact it was the labour reform and payment of severance package that set the tune for the concession proper. As the concessionaires took over the terminal operations most of them brought modern cargo handling equipments in addition to ones inherited from NPA which boosted the number already in terminals as can be seen in Table 1.

Ports	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Average**
Apapa	65.3	69.25	82.83	87.57	94.10	91.4	98.00	84.06
Tin can	60.4	71.35	92.60	85.87	72.63	81.05	84.30	78.31
Warri	32.5	37.70	40.37	37.83	44.50	38.75	48.2	38.27
PH	51.2	57.95	59.76	55.05	58.06	54.05	50.80	55.27
Onne	68.2	69.05	79.43	79.50	75.63	70.50	61.30	71.90
Calabar	23.2	20.50	17.30	19.95	19.30	18.35	24.50	20.44

Table 3: Average efficiencies

Conclusion

The study evaluated the performance of Nigerian ports two years before concession (2004-2005) and five years after concession (2006-2010) to determine the influence of concession on efficiency. Although the study is still ongoing the paper presented preliminary results based on the investigation so far on the subject. The efficiencies of six Nigerian ports were evaluated using the DEA Window Analysis in combination with panel data for a seven year period and a window length of four. The result revealed a fluctuation in efficiencies over the period with a remarkable increase in efficiency in 2006 the year the terminal operators took over the operation of the ports. This may be attributable to the drastic reduction of the ports labour force than the activities of the private operators. It is also observed that none of the investigated ports achieved a hundred percent efficiency for the period under review though Apapa port with an average of 84% is the most efficient while Calabar was the least with 20.44% efficiency level. It is significant to note that cargo throughput and ship traffic has increased considerably after the concession. That is an indication that Nigerian ports are regaining the traffic lost to neighbouring countries ports in the pre-concession era. Finally, to fully appreciate the gains of the reform the policy makers should conclude all aspects of the reform.

The data presented is a result of an initial investigation where a more complex analysis will be presented into a further publication.

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