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Appraisal of Cost Performance in Nigerian Airports

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Abstract
The changing objective and strategy of airports, together with the evolving regulatory policies and governance structures influence airports' performance and their services. This is noticeable in the operational cost and revenue generation.The paper is aimed at analyze airport cost performance in relation to airport productivity. The paper adopted a case study approach, utilising detailed and sectionalized questionnaires as data collection instrument from ten airports located in six geo-political zones of Nigeria based on multistage techniques. The questionnaire elicited primary data on cost structure of airports. These were analysed using Cobb-Douglas and Translog cost functions that modeled cost performance of sampled airports. Cobb-Douglas, single-product and multiproduct cost function for airport operations have been estimated using data obtained from selected Nigerian airports. Cost performance estimates were conducted using restricted translog model. The outcome of the first order estimated coefficients for output suggests economies of output scale in the airport in the industry in view of passenger .It further revealed considerable level of explanation of all variables considered – percentage of international passenger, delays, cargo volume and contractual service cost. This suggests that economies of output scale exist in all categories of airports and that the magnitude of the economies slightly increases in size of airport and diminishes with output scale. The outcome of the analysis is a confirmation of the advantage of the use of flexible functional forms like the translog model avoiding the misinterpretation of scale economies due to the lack of flexibility of the Cobb-Douglas model. No doubt, some of the differences in results in this paper and previous research might be due to differences of airport management goals in different eras or other types of regulatory constraints rather than exclusively to different estimation approaches. The results are expected to provide a key and fundamental framework for increasing efficiencies in the design and operations of airports across Nigeria and elsewhere. The paper explores the problem of the economic advantages from the joint provision of handling and airside operations as well as aeronautical and commercial activities using return to scope measures, derived using an input distance cost function approach. This would turn out to provide evidence which may be relevant to decision makers, especially in the light of the recent organizational evolution of the sector.

Keywords: appraisal, cost, performance, airports and functions

INTRODUCTION

Air transport is one of the most important transport modes. Compared to road, rail and water, it provides means of moving people, goods and information by aircrafts over air routes established by appropriate authorities between airports and predetermined locations with appropriate physical features (De Neufville, and Odoni, 2003). It also serves as a catalyst that satisfies air travel demands, by making goods and services available at the points of demand. Sequel to this, it is commonly refers to as channel of utility for distant facilities and services (Gourdin, 1991). In addition, it signaled explorations of outer space and promotion of satellite communications (Cunningham et al, 2004). The economic significance of air transport can best be appreciated in the roles performed by this sector of transport industry by bridging distance and time (Fisk, et. al, 1993).While the Federal Airports Authority of Nigeria (FAAN) and its airports may provide good profit opportunities, it possesses considerable monopoly power. The upward trend of air traffic growth further complicates the problem as the airports exploit the situation by charging high prices. This in turn renders profitability as an inaccurate measure of economic efficiency and creates the need for airports to be deregulated. Given that airports require large initial investments that require long gestation periods before profitable returns can be generated, cumbersome regulations discourage private capital. When airports are effectively regulated and subjected to good performance, more efficient terminals would justifiably earn higher profits or be able to attract further investments towards an efficient airport system.

Increase capacity come in discrete lumps, such as when a new runway is constructed or the erection of an additional terminal building. It was emphasized that, it may be impossible to expand the capacity of a specific airport, thus, increase in capacity can only be achieved through investment in a different airport..It is posited that airports do not provide the same mix of services and that the mix provided can differ sharply among airports. Some airports provide services directly, such as baggage handling or terminal services directly, while others subcontract services. Sometimes services are produced beyond the boundaries of the airport itself, by separate firms (e.g. flight catering). For instance, if an airport invests and expands a runway, airlines, on the other hand then schedule larger or more heavily laden aircrafts, with a consequent saving in per passenger costs. Such an investment may well be worthwhile in cost-benefit terms, but will lead to an increase in measured inputs of the airports, with no increase in measured output, and hence a decrease in productivity. Few studies have investigated the role of outsourcing strategy on airport performance (Oum *et al.*,2003; Oum and Yu, 2004). Similarly, few studies have investigated multi-output nature of airport operations by testing presence of returns to scope. The study explores the problem of the economic advantages from the joint provision of handling and airside operations as well as aeronautical and commercial activities using return to scope measures, derived using an input distance function approach. This would turn out to provide evidence which may be relevant to decision makers, especially in the light of the recent organizational evolution of the sector. It is in the light of these that the paper attempts a cost performance appraisal on Nigerian ports with a view to determining the economic viability and financial buoyancy of selected airports in Nigeria.

Conceptual Underpinnings

In industries where firms are price takers in input markets, the multi-product cost function is defined as the minimum expenditure incurred by the firm to produce the output Y at input prices p, given some technological constraints:

$$\min_{X} \omega X' = \omega_1 X_1 + \ldots + \omega_r X_r \quad (1)$$

s.t. $F(X,Y) \geq 0$

X: vector of conditional input demands.

Y: output vector.

ω: vector of input prices.

It should be noted that this definition of returns to scope is conditional upon the calculation of first and second input distance function derivatives with respect to both outputs and inputs. This allows flexibility in the input mix, which is not left fixed but can be adjusted so as to achieve the minimum cost.

Translog Cost Function

While the Cobb-Douglas functional forms could be employed to answer fairly straightforward questions about the cost and production of transport and logistics activities, they also entailed some important restrictions that limited their applicability. As noted previously, Cobb-Douglas cost function, for instance, allows for non-constant returns to scale and input substitution, the structure of these cost functions restrict substitution elasticity to unity and assume constant. In order to relax these restrictions, econometric researchers developed various types of “flexible” cost functions, which were considerably more general than the one described above. Their flexibility derived from the fact that they place no priori restrictions on input substitution or returns to scale (McCarthy, 2001). One particularly popular flexible functional form, the transcendental logarithmic (or “translog”) specification, was introduced by Christensen, Jorgenson and Lau (1973). The translog cost function represented a second-order Taylor series approximation to an arbitrary cost function about its mean value. This specification allows for non-linear effect in each of the input factors, as well as interactions between input factors in the cost function, represented by quadratic and cross-product terms in the cost function (Bel, 2009).

Cost-Minimizing Input Choices

The cost function is a mathematical representation of the cost minimization problem. Given that minimizing cost for a given level of output is a necessary condition for profit maximization, the cost minimization problem can be written as

$$\text{Minimize } C = r_1x_1 + r_2 + x_2 \quad (2)$$

$$\text{Subject to } y_0 = f(x_1, x_2) \quad (3)$$

Where x_1 and x_2 are input quantities, r_1 and r_2 are input prices, and y_0 is an output level. From the Lagrangian

$$L = r_1x_1 + r_2x_2 + \lambda (y_0 - f^* x_1, x_2) \quad (4)$$

The first order conditions for a constrained minimum are

$$\partial L/\partial x_1 = r_1 - \lambda f_1 = 0 \quad (5)$$

$$\partial L/\partial x_2 = r_2 - \lambda f_2 = 0 \quad (6)$$

$$\partial L/\partial \lambda = y_0 - f(x_1, x_2) = 0 \quad (7)$$

Where $f_1 = \partial f(x_1, x_2)/\partial x_1$ and $f_2 = \partial f(x_1, x_2)/\partial x_2$. Dividing equation 4 equation 5 yields

$$\frac{r_1}{r_2} = \frac{f_1}{f_2} = \text{RTS} \quad (8)$$

Condition 6 requires that the cost-minimizing firm should equate the rate of technical substitution (RTS) for the two inputs to the ratio of their prices. The rate of technical substitution is the rate at which one variable input is substituted for another variable input, holding the level of output constant.

The sufficient second-order condition for the cost minimization is that the following bordered Hessian determinant be negative:

$$H = \begin{vmatrix} -\lambda f_{11} & -\lambda f_{12} & -f_1 \\ -\lambda f_{21} & -\lambda f_{22} & -f_2 \\ -f_1 & -\lambda f_2 & -0 \end{vmatrix} < 0 \quad (9)$$

Multiproduct Cost Analysis

An important component of the multiproduct cost structure is economies of scope. If economies of scope exist then cost savings may be obtained by simultaneously producing several different outputs in a single multiproduct company, instead of producing each output by its own specialized firm. The condition for economies of scope (Baumol, Panzar and Willig, 1982 and Abrate and Erbetta, 2010) is:

$$\sum_i C(y_i) > C(y), \quad (10)$$

Where y_i are output vectors and y is an output vector containing all of the y_i vectors. Therefore, economies of scope exist if the total cost of the joint output of all products is less than the sum of the costs of producing the products separately. C (y) provides a measure of the degree of economies of scope, where economies of scope exist if EOS > 0:

$$EOS = \left(\sum_i C(y_i) - C(y)\right) / C(y).k \quad (11)$$

Baumol *et al.* (1982) identify two cost sources from which economies of scope can arise. The first source is cost complementarity, which implies that the marginal cost of producing one output is lowered by an increase in production of the other output:

$$\frac{\partial^2 C(y)}{\partial y_i \partial y_j} < 0 \quad (12)$$

The second source from which economies of scope arise is represented by sub additive fixed costs. The multiproduct cost function can be expressed as a sum of fixed costs (F) and variable costs (V), C(y) + V(y) + F(T). Fixed costs depend on which product sets are produced. Two product sets T_i and T_j share some fixed costs when fixed costs are sub additive:

$$F(T_i) + F(T_j) > F(T_i \cup T_j). \quad (13)$$

Product-specific economies of scale and multiproduct economies of scale are two other components of the multiproduct cost structure. Product-specific economies of scale, S_i (y), measure the change in costs as the quantity of a single product increases, holding constant the other output levels and input costs. An important concept in measuring product-specific economies of scale is incremental cost of product I, which is defined by Baumol *et al.* (1988) as $IC_i(y)/y_i$ where yi is the quantity of the ith output produced.

The condition for product specific-economies of scale (Baumol *et al.*,1982, and James 2009) is:

$$S_i(y) = \frac{AIC_i(y)}{\partial C(y)/\partial y_i} \quad (14)$$

Hence, product-specific economies of scale are the average incremental costs of producing the ith output divided by the marginal cost of producing the ith output. If S_i (y) > 1, then product-specific economies of scale exist in the production of the ith output. If S_i (y) < 1, there are diseconomies of scale.

Multiproduct economies of scale, $S_m(y)$, measure the change in costs for proportional changes in all outputs and inputs. Following Baumol *et al.* (1982) a measure of scale economies for a multiproduct firm is defined as

$$S_m(y) = C(y) / \sum_i y_i C_i(y) = 1 / \sum_i e_{cyi} \quad (15)$$

Where $C_i(y) = \partial C(y)/\partial y_i$ is the marginal cost with respect to the ith output, and $e_{cyi} = \partial \ln C(y)/\partial \ln y_i$, the cost elasticity of the ith output. If $S_m(y) > 1$, there exists economies of scale, meaning that a proportional increase in all outputs leads to a less than proportional increase in total cost. If $S_m(y) < 1$, then there exists diseconomies of scale.

An additional concept that characterizes the multiproduct cost structure is cost sub-addditivity (Baumol *et al.*,1982). A cost function C(y) is subadditive at y if for any and all quantities of outputs yi, ,y_j, such that

$$\sum_{j=1}^{n} y_j = y, \text{ we have } C(y) < \sum_{j=1}^{n} C(y_j). \quad (16)$$

In other words, a cost function is sub additive at output y if it is more expensive for two or more firms to produce y than it is for a single firm to produce y.

The cost function represents an efficient mechanism used to reveal the technical and economic interrelationships present in an industry. Because input variables are used as independent variables, the cost function overcomes problems associated with unknown input quantities. This means that one needs to know just total cost and input costs to find optimal input quantities. These models were used to understand the cost structure and performance of airports in Nigeria, with a view of achieving economies of scale/scope. The models were also used, though assumption on likelihood of having hub airports among Nigerian airports that will serve South Sahara Africa. Above all, the models were also employed to identify areas among the inputs of productivity that are detrimental to the performance and cost, consequently to improve on it.

MATERIALS AND METHODOLOGY

Study Area

The Federal Airport Authority of Nigeria (FAAN) controls all airports which are fairly distributed in the country to service commercial, administrative centres and areas of natural resources. The airports in the country constitute the main component of the air-route networks. There are domestic and international airports in the country. The domestic airports fall into two basic groups, namely the trunk airports and local airports. The former provide air travel services mostly to cross-country routes (e.g. Ikeja, Domestic Terminal). International airports include Lagos, Port-Harcourt, Kano, Calabar and Abuja which handle international traffic and include passport, customs and quarantine controls.

Most of the airports in the country are civil aviation establishments that serve scheduled airlines incorporate a wide variety of facilities for handling passengers, baggage, freight and airmail. There are eighteen air terminals. The Runway dimensions range between 2400 x 45m to 3600 x 65m. The international airports viz Abuja, Calabar, Kano, Lagos and Port-Harcourt have modern navigational facilities, lighting, terminals buildings, aprons and uninterrupted power supply.

DATA SOURCES AND COLLECTION

Data used for this study were obtained from both primary and secondary sources. An integrative approach, employing a diversity of methods was used in collecting data. The primary data were collected through interviews and questionnaire from officers in charge of respective positions or sections in selected airports. This is predicated on the fact that the officer-in-charge of each section is considered to be proficient, consistent and reliable to provide adequate and accurate information about the related subject matter. Questionnaire for the officials of selected airports include information about socio-economic characteristics of the airports- name, location, year of establishment, staff strength, scope of the airport (local or international), airside capacity, terminal-side capacity, number of gates and terminal, work load unit, aircraft movement and cost performance. Indeed the paper collected data on airport cost performance- airport cost structure, unit cost and cost competitiveness; airport financial performance that include revenue shares, revenue generation and financial profitability; airport rate and charges- landing charges, terminal (passenger) charges and combined landing and passenger charges. Similarly, these data were obtained from existing airports' reports of 2004, 2005, 2006, 2007 and 2008 for the selected airports. The questionnaire were administered using a multi-stage sampling technique was adopted. This step involves the following:

(i) Selection of studied airports, the following factors were considered: (a) the airport must be either international or local and (b) it must be an approved airport by FAAN.
(ii) Grouping of selected airports into different geo-political zones (sampling frame or primary sampling unit (PSU).
(iii) A simple random sampling was employed in the selection of airports in each zones.
(iv) 10 airports were chosen to make up the sampling size (Table 1.)
(v) A purposive sampling technique was used in the administration of the questionnaire to airport officials managing different activities in the airports.

Table 1: Geo-Political Zones and Airports

Geo – political zone	Airports
South-West	(1) Akure Airport (2) Ilorin Airport * (3) Ibadan Airport (4) MMA (Lagos) International *
South-East	(1) Enugu Airport * (2) Imo Airport
North-East	(1) Bauchi Airport * (2) Maiduguri Airport (3) Yola Airport
North-West	(1) Katsina Airport (2) Sokoto Airport * (3) Aminu Kano International Airport *
North-Central	(1) Kaduna Airport (2) Jos Airport * (3) Minna Airport (4) Nnamdi Azikwe International Airport *
South-South	(1) Benin Airport (2) Osubi Airport (3) Port Harcourt Airport * (4) Margaret Ekpo International Airport *

* Sampled Airport
Source; Field Survey, (2014)

Model Specification

The paper modeled various components of cost performance systems as operating according to the Cobb-Douglas production function and generalized Translog cost function. While Cobb-Douglas is restrictive functions, Translog which is advancement over Cobb-Douglas is adjudged in the literature to be derivative, flexible and less restrictive (Bottasso and Conti, 2011). Hence, these functional cost models were adopted to determine different results for cost performance evaluation of selected airports in Nigeria. Hence the variables, models and equations for airport management system are presented thus:

Hence the variables, models and equations for airport management system are presented thus:

(1) Basic Model

$$\ln TOC = \alpha_0 + \alpha_1 d_{hub} + \alpha_2 d_{comp} + \alpha_3 d_{res} + \beta_0(\ln Q - \ln \bar{Q}) + \gamma(\ln p - \ln \bar{p})$$
$$+\emptyset_1(\ln o_{int} - \ln \bar{o}_{int}) + \emptyset_2(\ln o_{cong} - \ln \bar{o}_{cong}) + \emptyset_3(\ln o_{crg} - \ln \bar{o}_{crg}) + \emptyset_4(\ln o_{cont} - \ln \bar{o}_{cont})$$

+"second order and interaction terms"+ε (17)

Modified Model

$$\ln TOC' = \ln\left(\frac{TOC}{p}\right) = \alpha_0 + \alpha_1 d_{hub} + \alpha_2 d_{comp} + \alpha_3 d_{res} + \beta_0(\ln Q - \ln \bar{Q})$$
$$+\emptyset_1(\ln o_{int} - \ln \bar{o}_{int}) + \emptyset_2(\ln o_{cong} - \ln \bar{o}_{cong}) + \emptyset_3(\ln o_{crg} - \ln \bar{o}_{crg}) + \emptyset_4(\ln o_{cont} - \ln \bar{o}_{cont})$$

+"second order and interaction terms"+ε (18)

$$\ln TOC' = \ln\left(\frac{TOC}{p}\right) = \alpha_0 + \alpha_1 d_{hub} + \alpha_2 d_{comp} + \alpha_3 d_{res}$$
$$\beta_1(\ln Q - \ln \bar{Q}).d_{sn} + \beta_2(\ln Q - \ln \bar{Q}).d_m + \beta_3(\ln Q - \ln \bar{Q}).d_l$$
$$+\emptyset_1(\ln o_{int} - \ln \bar{o}_{int}) + \emptyset_2(\ln o_{cong} - \ln \bar{o}_{cong}) + \emptyset_3(\ln o_{crg} - \ln \bar{o}_{crg}) + \emptyset_4(\ln o_{cont} - \ln \bar{o}_{cont})$$

+"second order and interaction terms"+ε. (3.3)

Where: TOC = Total operating cost (Dependent Variable)

hub = Certain airports that are likely to serve as hub among the sampled airports

comp =price independent operating cost

Q= Output

(o_{int})= Percentage of International passengers

(o_{crg})= Percentage of Cargo Volume in WLU

(o_{cong}) = Percentage of Delays

(o_{cont}) = share of contractual costs as a function of the total operating cost

(d_{comp})= Type I of financial management structure

(d_{res})= Type II of financial management structure

(d_{sn})= Size of International airports

(d_m) = Size of non-international airports.

DISCUSSION

Models Estimation of Cost Performance

All previous studies on economies of scale in the airport industry were based on cost functions by using either Cobb-Douglas or translog cost functions. General total cost function in transportation economic studies is as follows (McCarthy, 2001):

$$TC = f(Q; w, r, o, t) \quad (20)$$

Where *TC* is total cost, Q indicates output, w represents the input price for labor and r represents the input price for capital, *o* indicates operating characteristics which reflect the technological conditions caused by output heterogeneity and *t* is a time variable representing a residual influence after considering all other effects on total costs.

$$\alpha_1 = \ln\left(\frac{\text{Total opeating cost of international airports}}{\text{Total opeating cost of non international airports}}\right) \quad (21)$$

The coefficients of output variables, β_0, β_1, β_2 and β_3 indicate the elasticity of total operating costs with respect to output for sample airports as a whole, international and non international airports respectively. The cost elasticity provides information on economies of output scale. Simply, if β_i(i=0,1,2,3) < 1, then there are economies of output scale in the airport industry, if β_1=1, there are no economies of output scale and if $\beta_1 > 1$, there are diseconomies of output scale.

The coefficients, ω_i (i=1,2,3,4) indicate the effects of operating characteristics on total operating costs and represent the impact caused by a 1% change in the percentage of international passengers, the percentage of delays he percentage of cargo volume in WLU, and the contractual cost share on the total operating costs.

On the other hand, another way to examine economies of output scale, in other words, returns to output scale, is using aggregated productivity indicators such as Variable Factor Productivity (VFP). Thus, this study examined whether the airport industry operates under increasing constant or decreasing returns to output scale using VFP model in order to double check the validity of findings on economies of output scale.

VFP is based on the multilateral index procedure by Caves et al (1982). The translog multilateral output index ($\ln Y_{kl}$) can be written as:

$$\ln Y_{kl} = \ln Y_k - \ln Y_l = \frac{1}{2}\sum_i (R_{ik} + \bar{R}_i)\left(\ln Y_{ik} - \overline{\ln Y_i}\right) - \frac{1}{2}\sum_i (R_{il} + R_i)\left(\ln Y_{it} - \overline{\ln Y_i}\right) \quad (22)$$

Where Y_{ik} indicates the i^{th} output for the k^{th} airport, R_{ik} represents the revenue share of the i^{th} output for the k^{th} airport, $\bar{R}_i$ is the arithmetic mean of the revenue share of the i^{th} output over all sample airports and $\overline{\ln Y_i}$ is the geometric mean of the i^{th} output over all sample airports. The translog multilateral input index $(\ln X_{kl})$ can be written as:

$$\ln X_{kl} = \ln X_k - \ln X_l = \frac{1}{2}\sum_i(W_{ik} + \overline{W_i})\left(\ln X_{ik} - \overline{\ln X_i}\right) - \frac{1}{2}\sum_i(W_{il} + W_i)\left(\ln X_{it} - \overline{\ln X_i}\right) \quad (23)$$

Where X_{ik} indicates the i^{th} output for the k^{th} airport, W_{ik} represents the revenue share of the i^{th} output for the k^{th} airport, W_i is the arithmetic mean of the revenue share of the i^{th} output over all sample airports and $\overline{\ln X_i}$ is the geometric mean of the i^{th} output over all sample airports. The translog multilateral VFP index $(\ln VFP_{kl})$ can be written as:

$$\ln VFP_{kl} = \ln VFP_k - \ln VFP_l = \ln Y_{kl} - \ln X_{kl} \quad (24)$$

This thesis used number of passengers, aircraft movements and non-aviation revenues for outputs and labour and other expenditures for inputs.

Followings are VFP regression models used for this analysis:

(1) Model for airports as a whole

$$\ln VFP = A_0 + A_1 d_{comp} + A_2 d_{res} + B_0(\ln Q - \ln \bar{Q}) + C_1(\ln o_{int} - \ln \bar{o}_{int}) + C_2(\ln o_{cong} - \ln \bar{o}_{cong}) + C_3(\ln o_{crg} - \ln \bar{o}_{crg}) + C_4(\ln o_{cont} - \ln \bar{o}_{cont}) + C_5(\ln o_{nav} - \ln \bar{o}_{nav}) + \text{“second order and interaction terms”} + \varepsilon \quad (25)$$

(2) Model for categorized airports by size

$$\ln VFP = A_0 + A_1 d_{comp} + A_2 d_{res} + B_1(\ln Q - \ln \bar{Q}).d_{sn} + B_2(\ln Q - \ln \bar{Q}).d_m + B_3(\ln Q - \ln \bar{Q}).d_l + C_1(\ln o_{int} - \ln \bar{o}_{int}) + C_2(\ln o_{cong} - \ln \bar{o}_{cong}) + C_3(\ln o_{crg} - \ln \bar{o}_{crg}) + C_4(\ln o_{cont} - \ln \bar{o}_{cont}) + C_5(\ln o_{nav} - \ln \bar{o}_{nav}) + \text{“second order and interaction terms”} + \varepsilon \quad (26)$$

Where *VFP* indicates variable factor productivity index and Q is output. As in the above cost function models, *o* represents operating characteristics. As factors affecting productivity, the VFP models added the percentage of non-aviation revenue (o_{nav}), which reflects airports' business diversification strategy, to the previous four characteristic variables in the cost function models: the percentage of international passengers (o_{int}), the percentage of delays (o_{cong}), the percentage of cargo volume in WLU (o_{org}), and the contractual cost share in total operating cost (o_{cont}). However, dummy variables for financial management $(d_{int,}d_{nint})$ were the same as in the cost function models. Similarly, all variables were normalized by their sample means.

The constant term A_0 indicates the natural logarithm of VFP at the sample means. Because it is assumed that the mean value of the error term is zero, the VFP of the sample mean can be derived using the equation $\exp(A_0)$. the coefficient of dummy for hub, A_1 represents the difference in the natural logarithm of VFP between international airports and non-international airports; that is, the ratio of VFP equals $\exp(A_1)$.

$$A_1 = \ln\left(\frac{\text{VFP of international airports}}{\text{VFP of non} - \text{international airports}}\right)$$

The coefficients of output variables $B_0, B_1, and\ B_2$ indicate the elasticity of VFP with respect to output for sample airports as whole, international and non-international airports, respectively. The elasticity provides information on returns to output scale. In other words, if B_i (i=0, 1, 2,) > 0, then there are increasing returns to output scale in the airport industry, if B_i=0, there are constant returns to output scale and if $B_i < 0$, there are decreasing returns to output scale. The coefficients, C_i (i=1, 2, 3, 4, 5) indicate the effects of operating characteristics on VFP, and represent the impact caused by a 1% change in the percentage of international passengers, the percentage of delays, the percentage of cargo volume, the contractual cost share and the percentage of non-aviation revenue.

ESTIMATIONS OF COST FUNCTION

Number of Passenger

The estimations were conducted using a restricted translog model to the first-order in addition to an unrestricted translog model and the hypothesis test of whether the unrestricted model produced different results compared with a restricted model. This is further discussed in table 2

Table 2 Cost Analysis Results: Passenger

Regressor	Coefficient (Standard Error)
Constant	8.792 (0.056)[a]
Output	0.500 (0.031)[b]
Input price	1
% International Passenger	0.035 (0.016)[c]
% Delays	0.071 (0.132)
%Cargo	0.020 (0.023)
% Contractual Service Cost	0.035 (0.012)
International	0.018 (0.069)
Non-International	-0.036 (0.078)
R^2	0.641

[a]Significant at 0.05 for test, $\alpha_0 \neq 0$

[b]Significant at 0.05 for test, $\beta_i < 1$

[c]Significant at 0.05 for test, $\Phi_0 \neq 0$

Source: Output of results based on field survey, (2014) The estimated coefficient for output was 0.500. as expected, the coefficient was less than one. This indicates that a 1% increase in output leads to a 0.5% increase in the total operating costs, all else constant. The relevant t-statistic of $(\hat{\beta}-1)/S_{\hat{\beta}}$, where $\hat{\beta}$ is the coefficient of estimate of β, and $S_{\hat{\beta}}$ is the standard error of the estimate, produced a value of -9.68, at a 0.05 level of significance. Thus, this suggests that there are economies of output scale in the airport industry in view of passenger. As for operating characteristics, all of the coefficients of regressors except contractual service cost had the expected signs. The contract-out costs, in contrast to a priori expectations, had a positive impact on costs.

The coefficients of variables for operating characteristics suggest that a 10% increase in the percentage of international passenger, delays, cargo volume and contractual service cost increases total operating cost by 0.4%, 0.7%, 0.2% and 0.4% respectively. In addition, non-international airports had 3.5% lower operating costs than international airports. Among these coefficients only the coefficient for the percentage of international passenger was statistically significant at the level of 0.05.

This study performed the same analysis using airports divided in international and non-international airports, in order to examine the effects of airport sizes on total operating costs. As shown in Table 3, the coefficients of outputs for international and non-international airports were 0.684 and 0.789, respectively, all of which were considerably less than 1. The R^2 is 0.64, indicating 64% level of explanation of all these variables.

Table 3 Cost Analysis Results: Passenger (By Size)

Regressor		Coefficient (Standard Error)
Constant		8.757 (0.076)[a]
Output	I	0.684 (0.153)[b]
	NI	0.789 (0.076)[b]
Input Price		1
% international Passenger		0.055 (0.026)c
% Delays		0.084 (0.134)
% Cargo		0.032 (0.034)
% Contractual Service Cost		0.068 (0.048)
International		0.018 (0.070)
Non international		0.023 (0.067)
R^2		0.638

I: International airports, NI: Non international airports

[a]Significant at 0.05 for test, $\alpha_0 \neq 0$

[b]Significant at 0.05 for test, $\beta_i < 1$

[c]Significant at 0.05 for test, $\Phi_i \neq 0$

Source: Output of results based on field survey, (2014)

This suggests that economies of output scale may exist in all categories of airports and that the magnitude of the economies slightly increases in size of airports and diminishes with output scale. As with the analyses using number of passenger, those which evaluate WLU were conducted using both the restricted translog model to the first-order terms and the unrestricted translog model, as reflected in Table 4

Table 4 Cost Analysis Results: WLU

Regressor	Coefficient (Standard Error)
Constant	8.713 (0.064)[a]
Output	0.676(0.034)[b]
Input price	.54
% international Passenger	0.052 (0.025)[c]
% Delays	0.071 (0.182)
% Cargo	-0.044 (0.032)
% Contractual Service Cost	0.058 (0.039)
International	0.027 (0.057)
Non international	-0.002 (0.017)
R^2	0.645

[a]Significant at 0.05 for test, $\alpha_0 \neq 0$

[b]Significant at 0.05 for test, $\beta_i < 1$

[c]Significant at 0.05 for test, $\Phi_i \neq 0$

Source: Output of results based on field survey, (2014)

The first-order coefficients of the restricted model are depicted in Table 4. the estimated coefficient for output was 0.676, as expected, the coefficient was less than one. This suggests that 1% increase in output, all else constant, leads to a 0.676% increase in total operating costs. This suggests that economies of output scale likely to exist in the airport industry in terms of WLU. As for operating characteristics, all of the regression coefficients except had the expected signs. The coefficient of the percentage of international passenger was statistically significant at the level of 0.05.

Based on these findings, it can be said that a 10% increase in the percentage of international passenger, delays and contractual service cost increases total operating costs by 0.5%, 0.7% and 0.6%, respectively, but a 10% of increase in cargo volume decreases operating costs by 0.4%. This might be as a result of very few airports that involved in cargo services among the sampled airports. Similarly, non international airports had 0.2% operating costs, while international had 2.7% operating cost. This further discussed in table 5 that is related to size.

Table 5 Cost Analysis Results: WLU (By Size)

Regressor		Coefficient (Standard Error)
Constant		8.731 (0.069)[a]
Output	I	0.612 (0.131)[b]
	NI	0.687 (0.065)[b]
Input Price		1
% international Passenger		0.051 (0.021)c
% Delays		0.063 (0.151)
% Cargo		0.056 (0.032)
% Contractual Service Cost		0.071 (0.052)
International		0.032 (0.065)
Non international		0.026 (0.056)
R^2		0.648

NI: Non international airports, : International airports

[a]Significant at 0.05 for test, $\alpha_0 \neq 0$

[b]Significant at 0.05 for test, $\beta_i < 1$

[c]Significant at 0.05 for test, $\Phi_i \neq 0$

Source: Output of results based on field survey, (2014)

As summarized in Table 5, the coefficients of outputs for international and non-international airports were 0.621 and 0.687, respectively, all of which are considerably below one. The t-statistics of $\beta_i = 1,$ for each coefficient were -3.16 and -3.24, respectively; suggesting that likelihood of economies of output scale do exist in all size categories of airports and the magnitude of the economies slightly increases in size airports and diminishes with output scale.

Output Index

Like the above estimations, those in terms of output index were conducted from a restricted translog model to the first-order terms and an unrestricted translog model and the hypothesis testing of whether the unrestricted model differs from the restricted model followed. The first-order coefficients of the restricted model are depicted in Table 6. The estimated coefficient for output was 0.865, a bit higher than those of the previous estimators. As expected, the coefficient was below one, which indicates that a 1% increase in output, all else constant, leads to a 0.865% increase in total operating costs.

Table 6 Cost Analysis Results: Output Index

Regressor	Coefficient (Standard Error)
Constant	8.685 (0.062)[a]
Output	0.865(0.043)[b]
Input price	1
% international Passenger	0.062 (0.021)[c]
% Delays	0.189 (0.123)
% Cargo	0.021 (0.016)
% Contractual Service Cost	0.032 (0.044)
International	0.204 (0.056)
Non international	0.033 (0.063)
R^2	0.856

[a]Significant at 0.05 for test, $\alpha_0 \neq 0$

[b]Significant at 0.05 for test, $\beta_i < 1$

[c]Significant at 0.05 for test, $\Phi_i \neq 0$

Source: Output of results based on field survey, (2014)

To test the statistical significance of the variables, $\beta_i = 1,$ a one-tailed t-test was conducted, with produced a value of 1.18 that is considerable higher than 1 at a 0.05 level of significance. This implies that economies of output scale exist in the airport industry in terms of output index. As for operating characteristics, all of the regression coefficients had the expected signs. The coefficient of the percentage of international passenger was statistically significant at the level of 0.05.

Based on these findings, it can be said that a 10% increase in the percentage of international passenger, delays, cargo volume and contractual service cost increases total operating costs by 0.6%, 1.9%, 0.2% and 0.3%, respectively. International airports had 20.4 operating costs; while non international airports had 3.3% operating costs. Dissimilar to above estimations, International airports exhibited a greater difference from non-international airports that showed much lower operating costs as shown in Table 7, the coefficients of outputs for international and non-international airports were 0.728 and 0.890, respectively, all of which were below one. The t-statistics of $\beta_i = 1,$ for each coefficient were, -1.11 and -0.26, slightly higher than 1 at a 0.05 level of significance. This implies that economies of output scale exist for both international and non-international airports, in terms of output index.

Table 7 Cost analysis Results: Output Index (By Size)

Regressor		Coefficient (Standard Error)
Constant		8.636 (0.059)[a]
Output	I	0.728 (0.196)[b]
	NI	0.890 (0.081)[b]
Input Price		1
% international Passenger		0.057 (0.017)c
% Delays		0.181 (0.126)
% Cargo		0.021 (0.019)
% Contractual Service Cost		0.034 (0.041)
International		0.088 (0.059)
Non international		0.032 (0.061)
R^2		0.872

NI: Non international airports, I: International airports

[a]Significant at 0.05 for test, $\alpha_0 \neq 0$

[b]Significant at 0.05 for test, $\beta_i < 1$

[c]Insignificant at 0.05 for test, $\beta_i < 1$

[d]Significant at 0.05 for test, $\Phi_i \neq 0$

Source: Output of results based on field survey, (2014)

Furthermore, with the increase in the breaking point by output index of 0.1, the paper determined the threshold size of airports at which economies of output scale disappear. As depicted in Table 8, the coefficient of output for airports with output index of less than 0.7 was 0.822 and its t-statistic of $\beta_i = 1,$ was -1.06, which was statistically significant. The coefficient for airports with an output index of greater than 0.7 was 0.916.

Table 8 Cost Analysis Results: output Index (Breaking Point=0.7)

Regressor		Coefficient (Standard Error)
Constant		8.657 (0.049)[a]
	Below	0.822 (0.041)[b]
Output	Above	0.916 (0.061)[b]
Input Price		1
% international Passenger		0.054 (0.019)[d]
% Delays		0.162 (0.121)
% Cargo		0.019 (0.027)
% Contractual Service Cost		0.030 (0.039)
International		0.106 (0.071)[d]
Non international		0.028 (0.061)
R^2		0.875

[a]Significant at 0.05 for test, $\alpha_0 \neq 0$ [b]Significant at 0.05 for test, $\beta_i < 1$

[c]Insignificant at 0.05 for test, $\beta_i < 1$ [d]Significant at 0.05 for test, $\Phi_i \neq 0$

Source: Output of results based on field survey, (2014)

This implies that economies of output scale disappear beginning at an output index of 0.7, which is approximately by the rule of thumb equivalent to 1.8 million passengers or 2.0 million WLU. These figures were estimated on the basis of the number of passengers or WLU of the airports which have the output indices near the breaking point.

LIMITATION OF THE STUDY

The challenges faced initially in the collation of data for this research was the opposition and resistance encountered from the Airports workers in the acquisition of relevant data for the paper. They have the believe that data on Airport operation with reference to: cost operation, Passenger output, Airport Productivity, Passenger movement, Cargo Traffic, Aircraft movement, Passenger Gate , Terminal operation , Runway among others appears quite sensitive considering the scenarios of the country with reference to security situation . There was also the problem of insistency in the manner of data storage by agencies involved in the process of data storage on Airport management considering the differences in the style of operation of different agencies and parastatals involved the management of Airport. However, after adequate conviction of the Airport management on the use of the data being sort with the undertaken that it will used strictly for research purpose, Similarly, Convincing the Air transport passengers to complete the questionnaire was a bit problematic as a good number of them are often in a hurry to get to their destination. I had to devise a means of tracking down respondents' through their mobile phones and electronic communication to retrieve a number of the questionnaires.

CONCLUSION AND RECOMMENDATION

Cobb-Douglas, single-product and multiproduct cost function for airport operations have been estimated using data obtained from selected Nigerian airports. Cost performance estimates were conducted using restricted translog model. The outcome of the first order estimated coefficients for output was 0.500 as expected , the co-efficient was less one. This indicated that a 1% increase in output leads to a 0.5% increase in the total operating cost . This suggests that there are economies of output scale in the airport in the industry in view of passenger . While for operating characteristics all of the coefficients of regressors except contractual service cost had the expected signs. The contract out costs I contrast to a priori expectations, had a positive impact on costs. The R^2 is 0.64 indicating that 64% level of explanation of all variables considered – percentage of international passenger, delays, cargo volume and contractual service cost. This suggests that economies of output scale exist in all categories of airports and that the magnitude of the economies slightly increases in size of airport and diminishes with output scale. There is an indication that non international airports had 3.5% lower operating cost than international airports as of all coefficients only the coefficients for the percentage of international passenger was statistically significant at 0.05 level.

The operating cost analysis further revealed that a 1% increase in the percentage of international passenger, delays and contractual service cost increases total operating costs by 0.5%, 0.7% and 0.6% respectively, but a 10% of increase in cargo volume decreases operating costs by 0.4%. This may not be unconnected with the fact that only very few airports are involved in cargo services. The outcome of the analysis is a confirmation of the advantage of the use of flexible functional forms like the translog model avoiding the misinterpretation of scale economies due to the lack of flexibility of the Cobb-Douglas model. No doubt , some of the differences in results in this paper and previous research might be due to differences of airport management goals in different eras or other types of regulatory constraints rather than exclusively to different estimation approaches.

Airports will continue to evolve into commercially viable operations with organizational structures and policies that will provide the need support for airports to prosper with a triple bottom line approach of social, economic and environmental goals. As airports continue to shape the local community, airports can embrace this leadership role and lead by example the community into environmentally sound practices which will improve efficiencies that will reaffirm the aviation industry's commitment to the environment. Green less expensive options for airports will ensure that sustainable and best practice implications take place. Investing in low cost yet efficient solutions that will reach long tern success while continuing working in partnerships with airlines. Alternative avenues for revenue and profit growth such as investing in airport property and land, innovative ways to sell advertising and offering additional terminal services for customers will be become key ingredients for sustainable practices for airports changing the notion that an airport is a piece of infrastructure to facilitate airline customers travel to a service orientated approach by offering value to all partners.

CONTRIBUTION TO KNOWLEDGE

This study is important because despite the increasing importance of the airport industry in the developing economy, there is a scarcity of studies that have examined the potential impact of economies of output scale at airports. This is predicated on the fact that airports will continue to design terminals and other infrastructure functions that will suit the needs of the passengers in the airport as well as the need of the airline passengers. If an airport's niche is low cost carriers, then maximizing the terminal space for non-aeronautical revenue opportunities with concession that will benefit the airport customer is essential. At the same time focusing on the terminal efficiencies from tan airline's perspective of quick turnaround and efficiency of processing will ensure the development of mutually beneficial links between the two players. Airports will continue to learn more about their key airline businesses and strive to meet their needs.

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