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DETERMINANTS OF RELATIVE TECHNICAL EFFICIENCY OF HOSPITALS IN NIGERIA: A TWO-STAGE APPROACH

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Abstract

Empirical evidence on the effect of ownership type and size on technical efficiency of hospitals is mixed and still a subject of intense enquiry given market orientations and scale effect of decision making units in developing economies. This study examined the relative technical efficiency of secondary care hospitals based on ownership type, the scale effect and explored the effect of size based on number of beds and volume of patients attended to as determinants of efficiency. Four inputs, four outputs and two determinants of hospital efficiency were used in the analysis. Mean and standard deviation showed there were wide variations in inputs and outputs the hospitals examined. Private hospitals were more scale inefficient than public hospitals while medium sized hospitals were more scale inefficient than small sized hospitals. The average level of technical inefficiency was higher in private hospitals (10.6%) than in public hospitals (8.7%) for the two periods of the study. On the basis of size, the level of inefficiency was higher for medium sized hospitals (10.6%) than for small sized hospitals (9.1%). The determinants of hospital efficiency were the number of patients seen (NPS) and number of beds which had positive and significant impact on the efficiency of hospitals. The study recommended reducing user fees and health safety schemes which could lead to hospital expansion with beneficial effects on the efficiency of hospitals.

Keywords: Technical efficiency, Secondary care hospitals, inputs and outputs, data envelopment analysis, tobit

INTRODUCTION

The economic crunch occasioned by falling international oil prices in oil dependent countries constrained availability of resources to meet the developmental needs of these nations. The situation is dire for an economy such as Nigeria which depends almost entirely on oil revenues to finance up to 90 per cent of public sector budget and meet the high demand for foreign exchange due to the country's dependence on import commodities. Revenue shortfall has given birth to the need to pursue prudence in both public and private sectors, thus an increase in the investigation of efficiency in the use of resources. This increase has been borne out of the desire to reduce wastage of scarce economic resources and improve performance. The investigation of health system efficiency is particularly important due to the poor performance of the health care system and the seeming mismatch between resources ploughed into the system and the output.

Nigeria's health indices are poor and its health system ranking both in Africa and the world is low. For instance the World Health Organisation ranking of the year 2000 placed the country's health system at the third position from the rear out of the 190 countries studied. Though the healthcare system consists of varied components, the hospital is the major player within the system and consumes a large portion of the resources allocated to the sector in developing and developed countries alike. Hospitals consume 58% of health expenditures in United Kingdom, 50% in United States and 59% in Netherlands (OECD, 1985), between 50-80% of government recurrent expenditure in developing countries and over 60% of human and material resources in Nigeria (Nwosu, 2000; Ichoku et al 2011) Given the volume of resources consumed by hospitals, there has been corresponding growth in efficiency investigation of the sector especially at the turn of the millennium with corresponding increase in the application of data envelopment analysis by a number of studies within the African continent (Obafemi, Eke and Eke, 2016; Jehu-Appiah et al, 2014; Kirigia et al, 2008; Zere et al, 2006; Masiye, 2007 and Kirigia et al 2002). Hospitals vary in operational scope, type of services offered and incentive/reward schemes. This indicates that type of ownership and size are factors which may influence their efficiency. Therefore, the question of whether technical efficiency of hospitals is influenced by size and ownership type and the manner in which it does is an important policy issue which has generated renewed interest among researchers. Some recent studies on hospital efficiency which applied DEA and DEA-related indices in investigating the effect of either ownership type and/or size on efficiency include Jehu-Appiah (2014), Masiye (2007), Hollingsworth (2008) and Schreyogg (2011) and these studies have had mixed results.

In Nigeria, three identified studies by Ichoku (2011), Abiodun (2011) and Obafemi, Eke and Eke (2016) which investigated technical and scale efficiencies either did not investigate

second stage determinants of efficiency, excluded private hospitals or did not disaggregate the analysis based on size of the hospitals.

Thus, this study in filling these identified research gaps addressed three questions including: what is the relative mean technical efficiency of public and private, and medium and small sized hospitals; are these hospitals witnessing increasing, decreasing or constant returns to scale; and is there a correlation between hospital ownership and size, and technical efficiency score of these hospitals? The specific questions this paper intended to answer include: (1) what is the relative mean technical efficiencies of secondary care hospitals when categorised into public and private (2) what are the possible scale effect in the efficiency of these hospitals and (3) what is the impact of ownership and size (bed size and number of patients) on technical efficiency of these hospitals.

LITERATURE REVIEW

In Africa, studies investigating technical efficiency of hospitals and the countries studied in the past decade include; Angola (Kirigia et al, 2008), Benin (Kirigia et al, 2011); Botswana (Tlotlego et al 2010), Burkina Faso (Marschall and Flessa, 2011), Cameroon (Bertrand, 2012); Ethiopia (Sebastian et al 2010), Eritria (Kirigia *et al.,* 2013), Ghana (Osei *et al.,* 2008, Akazili *et al.,* 2008, Alhassan *et al.,* 2015, Jehu-Appiah *et al.,* 2014; Akazili *et al.,* 2008); Kenya (Nzioka *et al.,* 2015, Kinyanju *et al.,* 2015; Kirigia *et al.,* 2013), Malawi (MOH/WHO, 2008), Nigeria (Ichoku *et al.,* 2010; Abiodun, 2010, Obafemi *et al.,* 2016), Njeru-Ncheke, Democratic Republic (Kirigia *et al.,* 2013), Seychelles (Kirigia *et al.,* 2013), Sierra Leone (Kirigia *et al.,* 2011; Renner *et al.,* 2005), South Africa (Kirigia *et al.,* 2013), Tanzania (Saronga *et al.,* 2014; Bwana *et al.,* 2015), Uganda (Yawe & Kavuma, 2008; Mujasi *et al.,* 2016), Zambia (Masiye, 2007) and Zimbabwe (Maredza, 2012). These studies were primarily concerned with efficiency of hospitals or hospital units without comparing efficiency on the basis of pre-determined criteria such as ownership type of the hospital, location or size of hospital. Some other studies across the continent examined aspects of hospital efficiency such as human resources, public expenditure on health and efficiency and productivity change and such studies include Novignon 2015, Kirigia *et al.,* 2011, Kirigia and Emrouznejad 2013 and Kirigia 2013.

However, some of the studies which compared hospitals on the basis of ownership and/or size include Jehu-Appiah et al (2014) which studied 128 district hospitals in Ghana found public hospitals (average efficiency score = 70.4%) to be more efficient than private (efficiency score = 55.8%) and Mission hospitals (efficiency score = 68.6%). Another study by Masiye (2007) which studied 30 primary and secondary care hospitals in Zambia found that private/mission hospitals (eff. score = 73%) were more efficient than public hospitals (eff. Score

= 63%). Outside the continent, studies by Priote and Souza (2004), Hollingsworth (2008) and Tiemann and Schreyogg (2011) found public hospitals were more efficient than private hospitals while Luke and Haksrever (1987) and Ozcan and Luke (1993) found private hospitals were more efficient than public hospitals. Other studies by Register and Bruning (1987) and Kimsey (2009) found no difference in efficiency of public and private hospitals. This study adds to the existing body of knowledge in the area of hospital efficiency by examining the technical and scale efficiencies of secondary care hospitals while investigating the effect of ownership type and size.

RESEARCH METHODS

Data envelopment analysis (DEA)

Data Envelopment Analysis (DEA) is based on the application of the traditional theory of production in Economics to the behavior of firms or decision making units (DMUs) such as hospitals. The production theory regards a firm as using a combination of inputs to produce given levels of output(s). Charnes, Cooper and Rhodes (1978) were the first to name the term data envelopment analysis and proposed an analytical model for efficiency analysis that assumes constant returns to scale (CRS). The model which was so developed had Farrel's (1957) radial measures with multiple inputs and outputs as its backbone and in turn applied the concept of Debreu's (1958) coefficient of resource utilization. Fare, Grosskopf and Lovell (1994) made further extensions to the work by Farrel (1957) and Debreu (1958) in updating the use of operations research and linear programming based data envelopment analysis in measuring efficiency and estimating production. DEA has the following characteristics (i) it measures the efficiency of decision making units (DMUs) relative to other similar DMUs with restriction that all DMUs lie on or below the efficiency frontier (ii)DEA does not specify a parametric functional form for the production function, thus it allows for variable returns to scale (iii) Efficiency is measured as a vertical (output orientation) or horizontal (input orientation) distance of DMUs to the efficiency frontier (iv) DEA defines the efficient DMUs (DMUs on the production possibility set) and inefficient DMU''s level of deviation from the frontier. (v) It is a strictly deterministic technique which ignores the error term and assumes that any deviation from the production frontier is due to inefficiency. (vi) The degree of inefficiency shows the potential output loss due to inability to fully utilize resources or its misallocation, misapplication or wastage and (vii) DEA identifies specific DMUs that serve as benchmark

Input oriented data envelopment analysis model with variable returns to scale was used to estimate the efficiency score for each of the hospitals. The variable returns to scale (VRS) is based on short run analysis and most suited for non-competitive market situation such as the

hospital set-up. The VRS assumption is also suited for this analysis in view of the fact that hospitals may not always operate at optimal level due to the constraints of time and financial resource availability. The input-orientation reflects the extent to which each hospital can reduce its inputs given a certain level of output and its choice stems from the fact that managers have more flexibility to vary inputs that they have in influencing the number of outputs since hospitals are basically not profit oriented in Nigeria and so do not engage in competitive tendencies and outright canvassing for patronage through advertisement.

The Charne, Cooper and Rhodes (CCR) model which deals with constant returns to scale could not however be applied since hospitals were not operating at optimal scale which necessitates the decomposition of technical efficiency into pure technical efficiency and scale efficiency. In order to disembody scale efficiency from technical efficiency, a DEA model with variable returns to scale was applied. This study applied the Banker Cooper and Rhodes (1984) model which is an extension of the CCR (1978) model. The dual multiplier of this model follows the form:

$$\max z = \sum_{r=1}^{s} u_r q_{ro} - u_0 \qquad (1)$$

subject to

$$\sum_{r=1}^{s} v_i x_{ijo} = 1 \qquad (2)$$

$$\sum_{r=1}^{s} u_r q_{rj} - \sum_{r=1}^{s} v_i x_{ij} + u \leq 0 \quad j = 1....n \qquad (3)$$

$$u_r, v_r \geq 0$$

$$u_0 \geq 0$$

Where,

q_{rj} (r = 1……s) = Output r, for hospital j

x_{ij} (I = 1…...m) = input I for hospital j

u_r = weight of output r

v_i = weight of input i

In this study, x denotes the inputs while q represents the outputs where x_I is the number of doctors, x_2 is number of nurses, X_3 is the number of paramedical and administrative staff and X_4 is the number of beds and q_1 is number of inpatient admissions, q_2 is number of outpatients'

visits, q_3 is the number of surgeries and q_4 is the number of laboratory tests. X_{11} represents the number of doctors in hospital 1, X_{12} the number of doctors in hospital 2, …….X_{1m} represents the number of doctors in the mth hospital. X_{21} is number of nurses in hospital 1, X_{22} the number of nurses in hospital 2, ……X_{2m} is the number of nurses in hospital m, X_{31} refer to total number of Administrative/paramedical staff in hospital 1, X_{32} the number of Administrative/paramedical staff in hospital 2……X_{3m} the number of Administrative/paramedical staff in hospital m, X_{41} refer to total number of beds in hospital1, X_{42} the number of beds in hospital 2……X_{4m} is the total number of beds in hospital m.

The outputs, q, include q_1 is number of inpatients, q_2 is the number of outpatients, q_3 is the number of surgeries and q_4 is the number of laboratory test/scans such that q_{11} represents the number of inpatients in hospital 1,….q_{1m} represents number of inpatients in hospital m, ……q_{41} represents the number of laboratory tests/scans in hospital 1, ……q4m is the number of laboratory tests/scans in hospital m.

The scale efficiency model was also applied to examine the possible scale effects on efficiency of the studies hospitals. Scale efficiency is concerned with whether or not a hospital or decision making unit (DMU) produces at an optimal size. According to Marschall and Flessa (2011), a DMU reaches an optimal size if "a marginal increase in all inputs used in production results in the same increase", in relative terms, of outputs.

The scale efficiency model seeks discover if there is any inefficiency in a firm which is as a result of the size of the firm. Thus the model answers the question; how large or how small are they compared respective level of output. To answer these questions, calculating scale efficiency scores for each of these hospitals using the orientation best suited for the study is required. Following Fare, Grosskopf and Lovell (1994) and Coelli et al (2005), the following model is adopted for measuring the scale efficiency in this study.

For j^{th} hospital, the Scale efficiency is given as

$$SC_j = \frac{TE_j\ (y_j, xj;\ crs,\ S)}{TE_j\ (yj,\ xj;\ vrs,\ S)} \qquad (4)$$

Where,

"SC_j = Scale efficiency scores for hospital j

TE_j = Technical efficiency scores for hospital j (as derived from DEA model under CRS and VRS assumptions)

Y_j = Outputs (services) produced by hospital j

X_j = Resources (inputs) utilized by hospital j

crs, S = efficiency scores under strong disposability assumptions

vrs, S = efficiency scores under strong disposability assumptions

SC_j = 1 if hospital j is scale efficient

SC_j< 1 if hospital j is scale inefficient"

Tobit model for second stage analysis

The efficiency scores calculated in the first stage with the DEA model have censoring points at zero and one thus using ordinary least square regression which has the assumption of a normal and homoscedastic distribution of the disturbance and thus the dependent variable would likely produce biased and inconsistent parameter estimates because the expected error will not be equal to zero (Maddala, 1988) and this makes the use of a Tobit model necessary. Greene (2003) however suggested a normalization of the Tobin (1958) model which uses a left-censored variable consistent with measures of efficiency using DEA which range between 0 and 1. These scores are normalized by being transformed to a one-sided truncation by applying the formula:

INEFFj = (1/Eff) -1. (5)

The results from applying this formula are interpreted to have a positive association with efficiency score when the coefficient has a negative sign and vice versa. Following Chang (1998), the tobit model for DMUj can be defined as follows:

$T(y_j^*) = \beta_0 + \beta_1 x_{j1} + \varepsilon_j$ (6)

$y_j = y_j^*$ if $y_j^* > 0$, (7)

$y_j = 0$ if $y_j^* \leq 0$ (8)

where

$\varepsilon_j \sim N(0,\sigma^2)$,

y_j^* stands for unobserved latent variable and y_j stands for transformed DEA VRS efficiency scores for hospital j, xj are the explanatory variables which are a set of ownership and size variables for hospital j, βs are the coefficients with relevant signs but values that cannot be explained, ε_j is the normally distributed error term. Chilingerian (1995) noted that as soon as the DEA scores are changed into inefficiency score, the tobit model coefficients can be interpreted in a similar manner as that of ordinary least squares regression.

Bearing in mind the objective of this study which is to investigate the role of ownership and size on hospital efficiency, the estimated empirical tobit model is thus specified as:

$INEFF = \beta_0 + \beta_1 OWN + \beta_2 SIZ + NPS + \varepsilon_i$ (9)

Where, INEFF is transformed inefficiency score of hospitals OWN is ownership dummy which is 1 for public ownership and 0 for private ownership, SIZ is size dummy indicating 1 for medium size (number of beds greater than 37) and 0 for small size (number of beds equal to or below 37) and NPS is a second indicator for size which is the number of patients seen in each

hospitals measured by a summation of all patients attended to by the hospitals. It expected a priori that private ownership and medium size of hospital will have a positive effect on the efficiency

Study variables and Data collection

There are over 25,000 primary health centres, 3275 secondary care hospitals and 66 tertiary hospitals in Nigeria. Secondary level of care in the country is mainly provided by the state governments through general hospitals and private hospitals in which private sector constitute over 70-75% of hospitals which provide secondary care in the country (NBS, 2007). In Cross River State, there are over 133 secondary care providers with 88% privately and 12% publicly owned. The distribution of these hospitals in terms of zones and percentages are presented in table 1.

Table 1 Distribution of secondary care hospitals in Cross River State as at 2014

Senatorial	Private hospitals		Public hospitals	
District	Total in region	Percentage of total	Total in region	Percentage of total
Southern	54	46.2	9	56.2
Central	32	27.4	3	18.8
Northern	31	26.4	4	25
Total	117	100	16	100

Source: Cross River State Ministry of Health, Calabar, 2018

A cross- section of public and private secondary care hospitals were used to investigate the technical and scale efficiencies. The study employs a survey design in which a sample of the study population (secondary care hospitals in Cross River State) was selected and analyzed to find out the relationship between the inputs and outputs. Data was collected initially for thirty -two hospitals but complete data was available for twenty-six (12 public and 14 private) hospitals rendering secondary health care in Cross River State. Four of the sixteen public secondary care hospitals in the state provide specialized services such eye and dental care and treatment of infectious diseases. A method of randomization was applied in selecting private hospitals after excluding hospitals that were either not accredited by the state ministry of health to operate for the two years, hospitals that started operation after 2010, or those which are clinics/delivery homes and those considered small in size (with less than five beds). These hospitals were drawn from a list after being stratified according to senatorial districts in order to ensure representation across the three zones. The distribution per senatorial district

for public hospitals include five in the south, three in the central and four in the north while for private hospitals there were seven in the south, four in central and three in the northern districts.

Data was collected using data collection form adapted from Jehu-Appiah *et al.,* (2014) and was administered on relevant medical and administrative officers of hospitals. Data from institutional records of State Ministry of Health - Department of Planning Research and Statistics, Directorate of Administration/Accounts as well as from state government publications such as the Statistical Yearbook of the Cross River State Bureau of Statistics, State Planning Commission, Department of Budget Implementation and Monitoring, Offices of State Accountant General and Auditor General and Essential Drug Programme was used to fill gaps experienced at the hospital level. Ethical clearance for the study was obtained from the Cross River State Ethical Committee domiciled in the State Ministry of Health while the consent to participate was signed by the Medical Director or Administrator of each hospital. Data was collected by five trained field assistants for six months (July to December 2015) for eight inputs, four outputs and seven determinants of hospital efficiency. However, for this study, four inputs, four outputs and two determinants of hospital efficiency including human (doctors, nurses and administrative/other staff) and capital (number of beds) resources required for production and the annual number of inpatients, outpatients, surgeries and laboratory tests and scans conducted in each hospital while determinants were type of ownership, number of beds and number of patients seen (both proxies for hospital size). The average number of beds for the hospitals was calculated and hospitals with number of beds above the average were considered medium sized while those with beds equal to or below the average were considered small sized.

This study was carried out in two stages. The first stage involves estimation of DEA models to obtain the technical and scale efficiency scores. These efficiency scores reflect the extent to which each hospital converts inputs in the production process into outputs. Comparison was made between private and public hospitals as well as between medium and small sized hospitals. This is meant to give an overview of efficiency of the healthcare system in the state while also taking into account ownership and size of these institutions. The second stage analysis using tobit, two ownership patterns (public and private) and two measures of size (numbers of beds and patients seen) were regressed as exogenous variables against technical efficiency scores of selected hospitals.

Table 2: Description and measurement of study variables

Variable	Measurement
Inputs	
Beds	Total Number of beds
Doctors	Total Number of medical doctors (physicians, dentists, residents)
Nurses	Total Number of nurses, including professional, enrolled, registered, community nurses, and nursing aids.
Other staff	Total Number of paramedics and assistants, technicians and assistants; administrative and other general staff.
Outputs	
Outpatient	Annual Total Number of outpatient and emergency department attendances
Inpatient care	Annual Total Number of inpatient admissions
Surgeries	Annual Total Number of surgeries in the hospital including Caesarean section
Laboratory tests and Scan	Annual total number of laboratory tests and Scan conducted in the hospitals.
Determinants of efficiency	
Size	Measured by the number of beds in a hospital with small size having number of hospitals less than the average and the medium sized hospital as those with the number of beds above the average.
Ownership	Refers to whether a hospital is government owned or privately owned. Ownership in this study is represented by dummy variables taking value of 1 for public ownership and 0 for private ownership.

Source: Literature review/theoretical evidence

Table 3: Characteristics of hospitals included in the study

S/N	Hospital	Abbreviation	Ownership	Location (Rural/Urban)
1	General hosp., Calabar	GHCalabar	Public	Urban
2	St Joseph Akpabuyo	SJAkpabuyo	Public	Rural
3	General hosp. Akamkp	GHAkamkp	Public	Urban
4	Cottage hospital Oban	CHOban	Public	Rural
5	Cottage hospital Biase	CHBiase	Public	Rural
6	General hospital Ugep	GHUgep	Public	Urban
7	Eja Memorial Itigidi	EM Itigidi	Public	Rural
8	General Hospital Obubra	GHObubra	Public	Rural
9	General Hospital Obanliku	GHObanliku	Public	Rural
10	Lutheran Hospital, Yahe	LH Yahe	Public	Rural

Table 3...

11	General Hospital, Ogoja	GHOgoja	Public	Urban
12	General Hosp Okpoma	GHOkpoma	Public	Rural
13	Amanda Jarvis hospital	AJCalabar	Private	Urban
14	Amazing Grace Specia,	AGCalabar,	Private	Urban
15	Mambo Clinic, Calabar	MCCalabar	Private	Urban
16	Mevom Specialist Clinic	MSCalabar	Private	Urban
17	Mission Hill Clinic, Cal	MHCalabar	Private	Urban
18	Ogbani Clinic, Calabar	OCCalabar	Private	Urban
19	Awukam Hospital, Ikom	AH Ikom	Private	Urban
20	Benson Clinic, Ikom	BC Ikom	Private	Urban
21	Citizens Clinic/Maternity,	CC Ikom	Private	Urban
22	Obim Medical Centre,	OMC Ikom	Private	Urban
23	Joy Med. Centre Ogoja	JMed Ogoja	Private	Urban
24	Luksana Found. Med.	LukMed Ogoja	Private	Urban
25	Santa Maria Clinic Ogoja	Smaria Ogoja	Private	Urban

RESULTS

Data envelopment analysis software programme version 2.1 developed by Tim Coelli of the Centre for efficiency and productivity analysis (CEPA) in Australia was used to calculate the efficiency scores while the tobit model determinants of efficiency was analysed using E-views programme version 7.0

Descriptive statistics

The summary descriptive statistics for the sample of twenty-five secondary care hospitals in Cross River State for 2010 and 2011 is shown in Table 2. It reveals that there are marked variations in the mean input and output variables when classified by ownership as well as size. The mean number of nurses in 2010 for instance ranged between 59 for public hospitals and five for private hospitals; and from 73 for medium sized hospitals to eight for small sized hospitals in 2010. The outputs for 2010 show that public hospitals saw about sixteen times more outpatients than private hospitals while medium sized hospitals saw about 14 times more outpatients than small sized hospitals. The public hospitals in 2011 had about four times more administrative/paramedical staff and saw four times more inpatients than private hospitals. Medium sized hospitals had four times and six times more administrative/paramedical staff and inpatients respectively than small sized hospitals for 2010. The other variables (inputs and outputs alike) also revealed wide variations for the two years of the analysis.

Table 4: Summary descriptive statistics of inputs and outputs

Classification		Input variables (means, std dev)			
2010		Doctors	Nurses	Admin. staff	Bed
Ownership	Public	4 (4.6)	59 (53.2)	34(38.8)	63 (33.1)
	Private	2 (1.3)	5 (4.3)	11(5.3)	14(7.7)
2011					
Ownership	Public	4 (4.6)	61 (58.0)	41(32.2)	63 (36.5)
	Private	2 (1.3)	5 (4.2)	11(5.2)	14 (7.60
		Output variables (means, std dev)			
		Outpatient	Inpatient	Surgeries	Lab. tests
2010					
	Public	6894 (13550.1)	639 (786.3)	147 (177.1)	2759(4291.5)
Ownership	Private	432 (367.9)	161(125.9)	96 (119.2)	416(487.2)
2011					
	Public	6734 (11036.8)	710 (748.6)	159 (183.8)	7427(11841.4)
Ownership	Private	474 (395.2)	193 (159)	80 (78.5)	444 (499.2)

Technical efficiency result of individual hospitals

The technical efficiency score of individual hospitals is shown in Figure 1. Twenty-five hospitals in all were used in the analysis out of which thirteen hospitals (52 per cent) which comprised of six public hospitals (General hospitals in Calabar, Akamkpa, Ugep, Itigidi, Okpoma and Cottage hospital, Oban) and seven private hospitals (Mevom Specialist Clinic, Mission Hill Clinic, Awukam Clinic, Benson Clinic, Joy Medical Centre, Luksana Foundation and Santa Maria Clinic) were consistently efficient for the two periods of analysis. Conversely, four hospitals (16 per cent) including two public (General hospital Obubra, Lutheran hospital Yahe) and two private (Mambo Clinic and Ogbani Clinic) were inefficient for the two years of analysis. In terms of efficiency change, General Hospital, Ogoja was the most improved for the period moving from efficiency score of 22 per cent in 2010 to 100% in 2011 while Amanda Jarvis witnessed the sharpest efficiency decline from 100 per cent in 2010 to 57.1 per cent in 2011. Overall, seven (28%) hospitals witnessed efficiency decline while five (20%) hospitals experienced improvements of various magnitudes.

Of the hospitals included in the analysis in 2010, 17 (68%) had efficiency score of 1 or 100% and were found to lie on the efficiency frontier, 5 (20%) had efficiency score ranging between 70% and 99.9% while 3 (12%) scored between 20% and 69.9%. In 2011, 17 (68%) of the hospitals were efficient but 3 (12%) hospitals had efficiency score ranging between 70% and 99.9% while 5 (20%) hospitals had efficiency score below 70%.

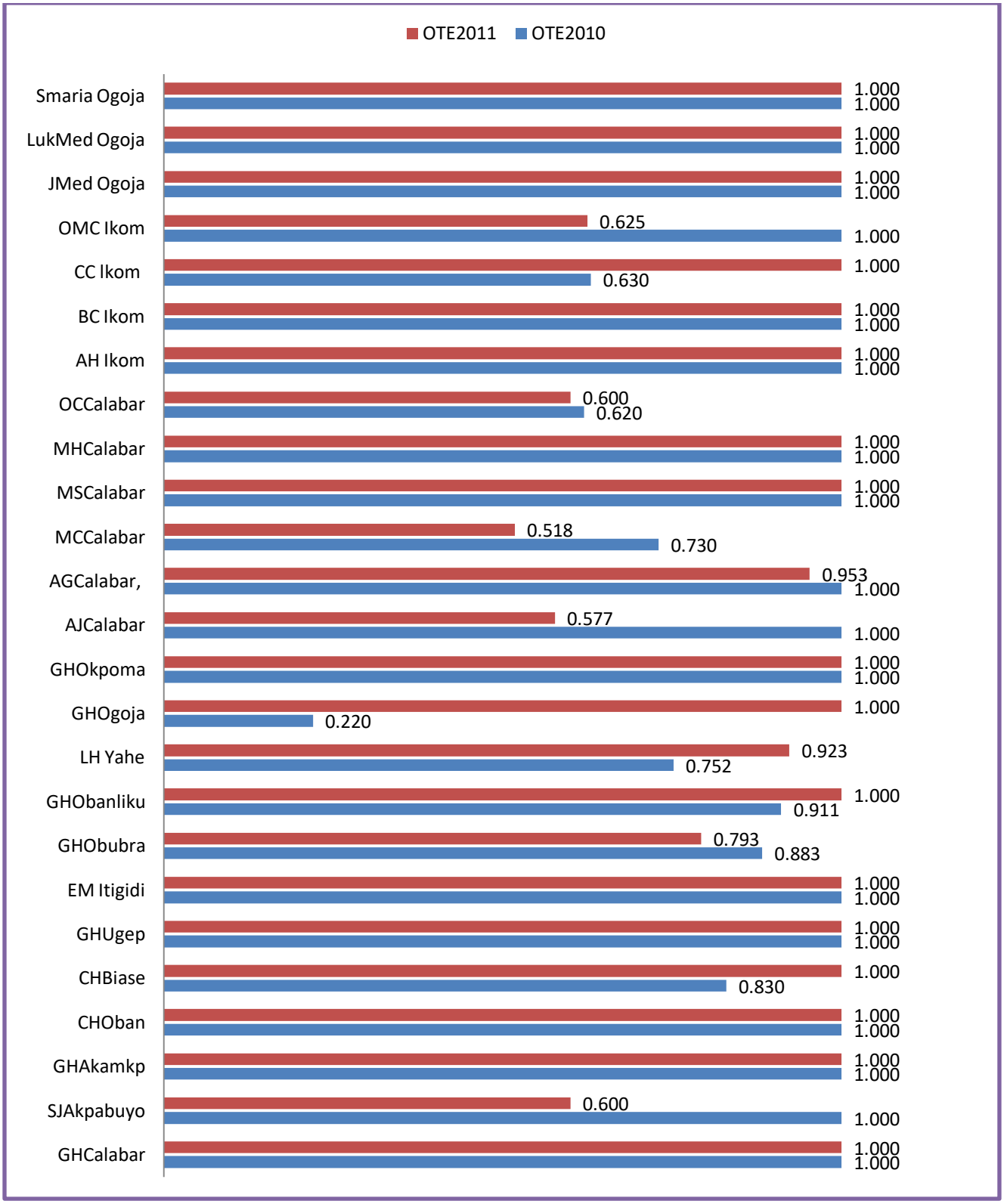

Figure 1: Distribution of relative technical efficiency of hospitals

Technical efficiency of public versus private hospitals

Among those hospitals that were efficient in 2010, seven (41.2 per cent) were public while ten (58.8 per cent) were private. All the inefficient hospitals had efficiency score below the average for all the hospitals which was 93 per cent. Five public hospitals and three private hospitals were inefficient. The mean efficiency score of private hospitals (92.2%) was higher than that of public hospitals (88.3%). The number and percentage of private hospitals on the frontier were higher than that of public hospitals in 2010.

In 2011, the number of efficient hospitals remained the same as 2010, but number of public hospitals that were efficient increased from seven in the preceding period to nine (53 per cent). There was a decline in the number of private hospitals that were efficient from ten in 2010 to eight (47 per cent) in 2011. The public hospitals that were inefficient also declined from five in 2010 to three in 2011 while inefficient private hospitals increased from three to five between 2010 and 2011. Whereas all the inefficient hospitals in 2010 had efficiency score below the year's average, in 2011, two inefficient hospitals had efficiency score above the industry average of 90.4 per cent. These hospitals are Amazing Grace Specialist Clinic (private) with a score of 95 per cent and Lutheran hospital (public hospital) with a score of 92 per cent. The lowest score among the inefficient hospitals was 51.8% by Mambo Clinic (private).

Table 5: Technical efficiency scores using VRS model

Classification	Hospital type	number	Hospitals on frontier	Percentage of hospitals on the frontier
2010				
Ownership	Public	12	7	41.2
	Private	13	10	58.8
2011				
Ownership	Public	12	9	52.9
	Private	13	8	47.1

Average technical efficiency of hospitals

The average technical efficiencies of hospitals (public/private and medium/small) in Cross River State for 2010 and 2011 are shown in Figure 1. The average efficiency for all hospitals was higher in 2010 at 93.1% when compared to that in 2011 which stood at 90.4%. While private hospitals were more efficient than public hospitals and small sized hospitals were also more

efficient than medium sized hospitals in 2010, the reverse was the case in 2011 for both classes of hospitals.

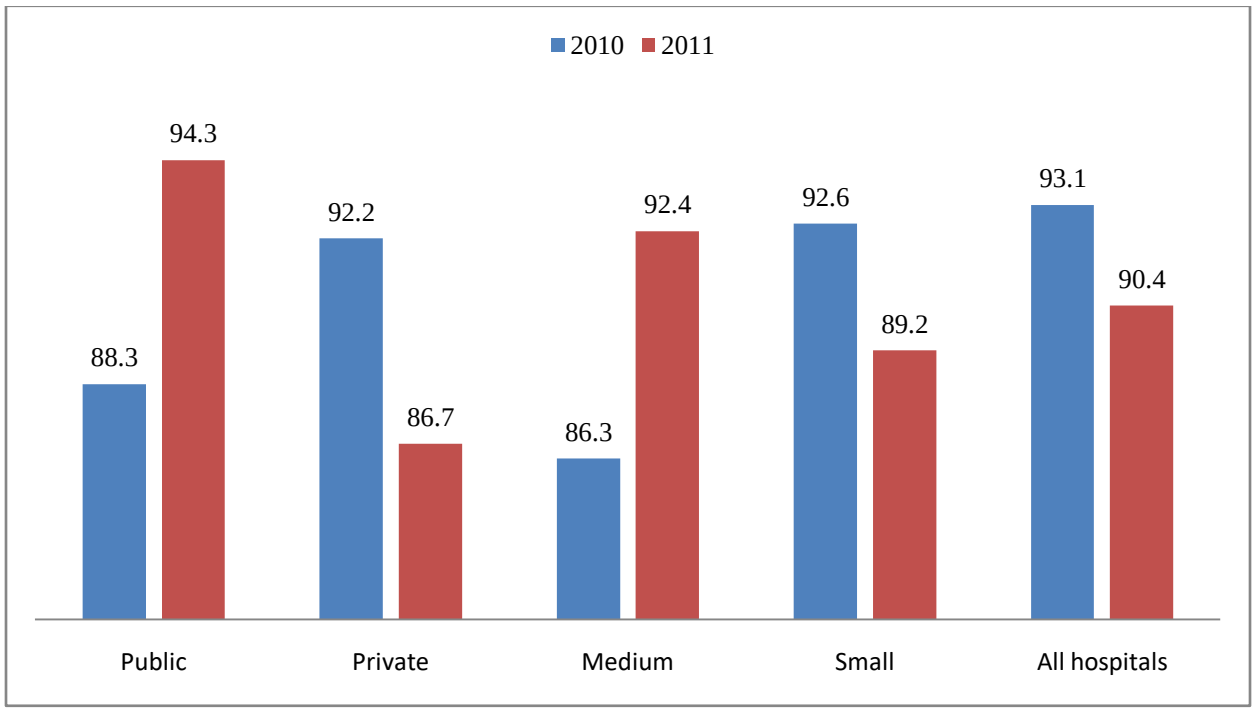

Figure 2: Average technical efficiency of hospitals

The average level of technical inefficiency was higher in private hospitals (10.5%) for the period of the study (2010 and 2011) than for public hospitals (8.7%). The average level of efficiency for the period was 91.3% for public hospitals and 89.5% for private hospitals. The average technical inefficiency of medium-sized hospitals (10.6%) was higher than that of small sized hospitals (9.1%).

Scale efficiency of hospitals

The scale efficiency model answers the question is there inefficiency in the hospital which is attributable to size. Thus we may ask how large or how small are they compared to their respective levels of output. These questions were answered by calculating scale efficiency scores for each of these hospitals using DEA with input orientation. Scale effect was disentangled using a VRS data envelopment analysis model. Variable returns to scale is of two dimensions; increasing and decreasing returns to scale. The former arises when output increases more proportionately than increases in inputs while the latter case is when output increases less proportionately than input increase.

Table 6: Scale efficiency scores

Year 2010	Increasing returns to scale (IRTS)		Constant returns to scale (CRTS)		Decreasing returns to scale (DRTS)		Number
Ownership	number	percentage	number	percentage	number	percentage	
Public	4	33.3	5	41.7	3	25	12(100)
Private	3	23	5	38.5	5	38.5	13(100)
	7	28	10	40	8	32	25(100)
Year 2011							
Ownership							
Public	3	25	5	41.7	4	33.3	12(100)
Private	2	15.4	5	38.5	6	46.1	13(100)
	5	20	10	40	10	40	25(100)

Table 6 shows the scale inefficiency of hospitals in Cross River State and based on ownership and size. In 2010, 15 (60%) of hospitals based on ownership were scale inefficient while based on size 15(55%) were scale inefficient. Private hospitals were more scale inefficient 8 (61.5%) than public hospitals 7(58.3%) while medium sized hospitals 7 (77%) were more scale inefficient than small sized hospitals 8 (50%). Decreasing returns to scale was predominant in both classes of hospitals for that year. In 2011 15 (60%) and 13 (52%) of hospitals were scale inefficient based on ownership and size respectively. Private hospitals remained more scale inefficient than public hospitals with the same magnitude while medium sized hospitals were more scale inefficient than small hospitals by 5.7 per cent and decreasing returns to scale being the most prominent type of scale inefficiency

Sources of inefficiency

Table 7 shows the result of the second stage analysis using tobit model. Here, the transformed VRS inefficiency score was used as endogenous variable and regressed against two variables which measure size (numbers of beds and patients attended to in each hospital) and one variable for ownership (dummy for public and private hospitals). These transformations mean that a coefficient with a positive sign is interpreted as having a positive relationship with the dependent variable and vice versa. The results show that ownership and size are determinants of technical efficiency of hospitals in Nigeria.

Table 7: Result of the second stage estimation using tobit model

Variable	Coefficient	Std error	z-statistics	p-value
C	0.248120	0.515011	0.482121	0.6291
OWN	3.858161	0.712303	5.416463	0.0000
BED	-2.091778	0.977520	-2.139883	0.0324
NPS	-0.000320	0.000147	-2.174215	0.0297

The interpretation of the determinants of efficiency was guided by the transformation undertaken in equation 5 where a positive association between the coefficient of determinants of efficiency and the score is interpreted to be positive when it has a negative sign and vice versa. Thus, the number of patients seen (NPS) and number of beds had positive and significant impact on the efficiency of hospitals. The implication is that the larger the hospital, the more efficient it will be. This result conforms to the expectation and the efficiency score of individual hospitals obtained in the estimation of technical efficiency. This is supported by the fact that most of the large hospitals (in number of patients seen and bed size) were individually efficient for the two periods of analysis.

The small size of most hospitals as manifested in the low number of patients seen could be the reason for the averagely low level of hospital efficiency both individually and when categorised as public or private. Hospitals with large number of patients (large hospitals) may have been more efficient because they can produce at lower cost due to the benefits of economies of scale, the ability to procure specialized health services and equipment which require a minimum size to utilise. The availability of such services and equipment leads to larger output and makes its usage even more efficient. Another factor which may have been responsible for the higher efficiency of large hospitals is the benefit derived from division of labour in a hospital with large workforce. For instance, General hospital Calabar and General hospital Okpoma had the largest number of Doctors, Nurses, Admin/other staff and number of beds among public hospitals and were consistently efficient for the period of analysis. The large number of staff in these hospitals may promote restricting the workers to a range of services thereby ensuring standardization with possible efficiency effects even though this may only lead to over-production and not necessarily efficiency when cost and allocative efficiencies are considered.

Ownership has a negative and significant impact on efficiency of hospitals at the five per cent level of significance. This implies a negative relationship between public (hospital ownership) and efficiency of hospitals in the state which is in agreement with the a priori

expectation set for this study. This result is supported by the low efficiency of public hospitals when compared to that of private hospitals in the state. Several factors may be responsible for the low level of efficiency of public hospitals. These include the profit motive which obtains in private hospitals tend to motivate their owners for higher efficiency in order to continue to increase profits whereas in public hospitals where the goal is not profit but most times community service, there is lack of motivation for efficiency. Also with the small size and dominance of private secondary care hospitals in the state with evidence that this is the case in Lagos and Ogun in the study by Abiodun (2011), strict internal monitoring and supervision may enhance efficiency. This also shows that there is increased patronage of private hospitals, and reduced preference for public hospitals which may have possible negative implication on the efficiency of public hospitals.

The number of staff employed e.g Doctors, Nurses and Administrative staff) are higher for public hospitals compared to private hospitals. However these resource endowments only lead to over production (high output of public hospitals) but not efficiency. There is also the exercise of discretionary budgeting and expenditures by public hospitals with the bulk of human and material resources probably being misappropriated or misapplied. This causes a reduction in the quality of public hospital services due to the non-availability of the basic minimum requirements to effectively provide medical care. The large number of staff makes monitoring ineffective with its attendant negative manifestation in public hospitals such as absenteeism. This also makes leadership of these hospitals ineffective thereby causing them to operate below the production possibility curve and hence inefficient.

CONCLUSION AND POLICY RECOMMENDATIONS

This study is among the early studies to investigate the relative technical efficiency of public and private, and medium and small sized secondary care hospitals for two years and the effect of ownership and size on efficiency these hospitals in Nigeria. The mean and standard deviation of the hospitals showed there were wide variations in inputs and outputs of public and private hospitals as well as medium and small sized hospitals. For instance, the number of doctors in public hospitals was averagely four for 2010 and 2011 while that of private hospitals was two for these years. Based on size, the average number of doctors was five and two for medium and small hospitals respectively in 2010 and four and two for these hospitals respectively in 2011. The scale efficiency result showed that private hospitals were more scale inefficient than public hospitals while medium sized hospitals were more scale inefficient than small sized hospitals. The average level of technical inefficiency was higher in private hospitals (10.6%) than in public hospitals (8.7%) for the two periods of the study. On the basis of size, the level of inefficiency

was higher for medium sized hospitals (10.6%) than for small sized hospitals (9.1%). This higher level inefficiency found in private hospitals was contrary to the assumption that private sector health institutions are more efficient due to the incentives in terms of remuneration, human capital development which improves their capacity to use resources in a manner that yields the higher return.

The determinants of hospital efficiency were the number of patients seen (NPS) and number of beds which had positive and significant impact on the efficiency of hospitals. The implication is that the larger the hospital, the more efficient it will be. This result conforms to the expectation and the efficiency score of individual hospitals obtained in the estimation of technical efficiency which is supported by the fact that most of the large hospitals (in number of patients seen and bed size) were individually efficient for the two periods of analysis. However, taken collectively, medium sized hospitals were seen to be more inefficient than small sized hospitals. The study recommends that measures to boost patronage of hospitals such as reducing user fees and provision of health safety schemes could lead to expansion in size with beneficial effects on the efficiency of such hospitals.

LIMITATIONS OF THE STUDY

The scope of this study is limited to relative technical efficiency of secondary care hospitals. The other grey areas that were not explored included economic or allocative efficiency of decision making units like hospitals. The method of analysis applied in this study is the data envelopment analysis and the tobit regression method. There are however other methods for analyzing efficiency of hospitals such as the stochastic frontier analysis. It will also be worthwhile to investigate the efficiency of other tiers of healthcare provision such as the primary and tertiary level of care which are provided by primary health care centres and specialist hospitals respectively.

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