CBN Journal of Applied Statistics (JAS)

Volume 4 | Number 1 Article 2

6-2013

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This study examined the technical efficiency (TE) of two different remote internet access methods, wireless and wired in Nigeria using the stochastic frontier production function analysis. Primary data were obtained through the use of a set of questionnaire from four hundred and fifty representative samples of cyber café operators. The results show that in Nigeria, in spite of the acclaimed superiority of wireless technologies internationally, wired technology (within the context of Nigeria's socio-economic constraints) is (still) more efficient technically with mean technical efficient indices of 0.914 and 0.797 respectively. The analysis also suggests that age and years of education of cyber café operators have positive significant influence on the level of technical efficiency. The policy implication of the findings in this study is that there is scope for raising the present level of TE of production in the study area. More so, since age and education variables have direct relationship with the level of TE therefore, policies should encourage more of the younger and better educated potential operators to go into the enterprise.

Keywords*:* Cyber Café wireless; Efficiency Measurement; Stochastic Frontier Production**.**

JEL Classification: O3.

1.0 Introduction

Applications of Information communication technologies (ICTs) in the recent past have demonstrated its important role in various globalized economies. The magnitude of the impact varies from country to another, depending on the stage of country's economic development. In Nigeria, ICT projects such as the 'school connects' and 'computerize Nigeria' have attempted to improve the reach, enhance the base, minimize the processing costs, increase transparency, and reduce the cycle times. In Nigeria's formalized private sector, such as the banks, ICTs are being increasingly used to deliver services at the convenience of consumers. In the public sector, ICT applications attempt to offer the services of central agencies (like administration of state and federal

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government departments) to the citizens at their village door steps. These applications utilize the ICT in offering improved and affordable connectivity and processing solutions.

The establishment of an efficient, reliable and cost effective telecommunications infrastructure is a catalyst to rapid economic, political, social and cultural development of any nation. Although Telecommunication is about a century old in Nigeria, it is yet to record a commensurate growth in spite of its overwhelming importance in the economy. According to Fashola (2009), the introduction of telecommunications services in Nigeria dates back to nineteenth century. During this period, the facility was mainly used for promotion of administrative functions rather than the socio-economic development of the country. This probably was responsible for the little attention paid to its expansion in the country. For example, at independence in 1960, the country had only 18,724 telephone lines for an estimated population of 45 million people, giving a tele-density of 0.4 telephones per 1000 people. The paper stated that the telephone network then consisted of 121 exchanges of which 116 were manual operated magnetic type, while the remaining 5 are automatic. Since independence however, there has been a number of development plans for the expansion and modernization of the telecommunications network and services.

Nigeria's GSM (Wireless) revolution began in August 2001 and changed the face of Information and Communications Technology in the country. Since the GSM (Wireless) launch, mobile telephony has rapidly become the most popular method of voice communication in Nigeria. Growth has been so rapid that Nigeria has been rightly described in various fora as "one of the fastest growing GSM markets in the world". Indeed these developments have been truly explosive: according to statistics from the Nigerian Communications Commission (NCC), compared with just about 450,000 working lines from NITEL in 2001, by August 2004, the GSM operators had recorded over seven million subscribers.

However the mass establishment of Internet cafés in Nigeria predates the acclaimed GSM revolution though its entrance provided yet another boost to its growth and expansion. Atkinson and McKay (2007) observed that growth trend of these cafés is partly explained by personal characteristics of customers, different aspects of their internet use such as duration of internet

usage access time, motivation for using the Net, search engines employed, internet skills acquisition, frequency of internet use. Adopting an efficient, reliable, and cost effective techniques for managing the operations of cyber cafes across cities of Nigeria will not only bring about sharp increase in the number of internet cafes in Nigeria, but will also enhance the achievement of the needed development in the country's economy, evaluation of internet information content and problems encountered while using the internet. The question now is how this melting pot of several ICT technologies came to be. Is there a significant difference in efficiency between Wireless and Wired Technologies deployed in Cyber cafés in Nigeria?

The primary objective of this paper is to compare the level of technical efficiency between wired and wireless cyber café operating platform in Nigeria. The other objective is to identify the factors that determine their technical efficiency in order to provide information that may be useful in designing effective policies toward boosting human capital productivity, and hence economic growth and development in Nigeria in order to catch up with South African economy and the rest of the world. Hence, the motivation for this article is to provide a benchmark for policy makers to assess the technical efficiency of our cyber cafes.

2.0 Literature Review

Cyber café is a place where subscribers paid for airtime in order to surf the net. The founder of the first internet café, Eva Pascoe was working on her PhD, when she got the idea to mix sipping coffee to surfing the web while sitting at one of the coffee shops near the City University of London. It was named Café Cyberia on September 1st, 1994. It started with half a dozen HP computers, connected to the internet through dial-up modems that were able to transfer data at 9.6 kilobits per second. With the success of Café Cyberia, the internet café business got into a flying start, and there were over 60 similar cafes over the world by the summer of 1995.

Although the first internet café was launched in Europe, there had been similar activity already in the U.S even before the launch of Café Cyberia. SFnet was launched in San Francisco in 1991 as a network of 20 coin-operated computers providing a dial-up connection to the internet with a 2400 baud modem. According to Totty (2005), the first actual internet café was in Chicago called Suba, launched in 1995 by Todd Bodenstein and Alex Strasheim. The internet Cyber café industry has since then been experiencing

exponential growth and expansion in terms of investment, innovation, and patronage.

According to Yusuf (2005), majority of the cybercafés in Nigeria were established between 2000 and 2003, most are connected to the Internet through the wireless technology. The facilities/equipment in the cafes are inadequate, and all the servers and client systems (workstations) operate on the Window/DOS platform, using MS explorer. The findings also indicated that e-mail was the most prevalent resource used by clients, although other Internet resources were being used for educational purposes. In addition, problems of poor electricity, inadequate facilities, poor service from ISP, location of café and so forth, were recognized as major problems militating against effective operation of cafés.

On one hand, cyber cafés differ based on their factor of production such as capital, labour management, etc., which add to their efficiency of production. It is important to high light the fact that mobile products such as phone banking, internet banking and e-commerce have caught up with the increasingly mobile Nigerian population. However, Atkinson and McKay (2007) observed that there are differences in their response system efficiencies. For instance, Tiwari and Buse (2007) defined Phone banking as a service provided by a financial institution which allows its customers to perform transactions over the telephone.

Most phone banking uses an automated phone answering system with phone keypad response or voice recognition capability. To guarantee security, the customer must first authenticate through a numeric or verbal password or through security questions asked by a live representative. These access methods are predefined by the architecture of the technology deployed per time. This service is hosted/supported by the internet which itself is affected by various systemic crisis in the country that have severely imposed constraints on our economic growth path. This is so because within the Nigerian context, the efficiencies of these systems suffer as a result of some endemic (endogenous) power problems even as these consumers engage in financial activities both online and offline like in any other part of the globe. Then on the other hand, consumers also have different endowments, (such as product awareness paradigms that confer on them certain information access rights and level of education/exposure), different levels of human capital skills, and different access and adoption of ICT technologies.

Common methods of Internet access include dial-up, landline (over Cable Internet access, Optical fiber or Twisted pairs), T-lines, Wi-Fi, satellite and cell phones. Dial-up connections are the most common type of Internet connection available from ISPs and the slowest and (usually) the least expensive. A dial-up connection allows users to connect to the Internet via a local server using a standard 56k modem, the PC literally dials (hence the name) a telephone number (provided by the Internet Service Provider) and connects to the server's modem and therefore the Internet. Once connected users are free to search the web as they please, however, compared to modern speeds of broadband Internet, dial-up is very slow and can only nominally transfer at 56 Kilobits per second. It is common sense and logical to expect these activities to engender economic growth and development in their several host economies. Several authors argue that ICT oriented development policies should be mainstreamed. They stressed that ICTs' contributions to economic development (especially in sub-Saharan Africa) were unrecognized and are unaccounted for. Consequently, development outcomes such as bridging the digital divide have met with little successes.

There is a dearth of empirical literature specifically on technical efficiencies of cyber cafes. Most empirical literature on technical efficiencies of cyber cafes are on engineering technologies and coefficient and are not relevant in economic analysis. In-depth empirical literature in this area has not been undertaken. It is a relatively new area of research in Nigeria. However, there is a lot of academic research and scholarship work which sought to highlight the relevance of ICT to economic growth and development and prescribe strategies for integrating fully ICTs into the development process (especially in sub-Saharan Africa). A review of the various studies on the contributions of ICT to economic growth and development in the highly digitalized economies of the West shows that the technology has made considerable contribution to production.

According to Tiwari *et al*. (2006) & Wikipedia (2009) the massive adoption of ICT oriented production processes have boosted service production in terms of efficiency and productivity. An example is account information such as mini-statements and checking of account history. Others border on payments, Deposits, Withdrawals, and Transfers platforms that facilitate micro-payment handling and mobile recharging, some investment services such as Portfolio management services, real-time stock quotes and personalized alerts.

There are numerical support services such as requests for credit, including mortgage approval, and insurance coverage. With the obvious exception of cash withdrawals and deposits, the technology enables virtually all the features of an automated teller machine (as outlined earlier): account balance information and list of latest transactions, electronic bill payments, funds transfers between a customer's accounts, etc. All these were massively made possible by mobile/internet banking. Usually, customers can also speak to a live representative located in a call centre or a branch, though this feature is not guaranteed to be offered in Nigeria.

In addition to the self-service transactions listed earlier, phone banking representatives are usually trained to do what was traditionally available only at the branch: loan applications, investment purchases and redemptions, cheque book orders, debit card replacements, change of address, etc. Wikipedia (2009) noted that mobile banking now handles a huge volume of transactions providing an avenue for most of the ICT skilled labour and micro managing many small firms' financial activities on a daily basis. Several authors explained that face to face menial banking operations is fast giving way to mobile banking because of the rapid increase in population/urban lifestyle pressure. This has resulted in customers turning to online transaction medium.

Despite these innovations, there are still daunting challenges, arising from limited access to information. These challenges include handset operability – there are a large number of different mobile phone devices and it is a big challenge for banks to offer mobile banking solution on any type of device; security – security of financial transactions, being executed from some remote location and transmission of financial information over the air. These are the most complicated challenges that need to be addressed jointly by mobile application developers, wireless network service providers, banks' IT departments, power experts and policy makers.

2.1 Analytical Framework

This study employs a stochastic production function model to measure technical efficiency of wired and wireless internet access through cyber café in Nigeria. It was basically assumed that cyber café internet access technologies were clearly divided into two platforms – wired and wireless. This feature is their distinctive distinguishing characteristics. Oladeebo &

Fajuyigbe (2007) defined technical efficiency as the ability to produce maximum output from a given set of inputs, given the available technology.

According to Oladeebo & Fajuyigbe (2007) the modeling, estimation and application of stochastic frontier production functions to economic analysis assumed prominence in econometrics and applied economic analysis during the last two decades. Early applications of stochastic frontier production function to economic analysis include those of Aigner *et al*. (1977), Battese and Cora (1977), and Meeusen and Broeck (1977) for developed countries. More recently in Nigeria, empirical applications of the technique in efficiency modeling have been reported by Ajibefun and Abdulkadri (1999), Ojo and Ajibefun (2000) and Ojo (2003). The stochastic frontier production function model is given as:

$$Y_i = X_i^{\beta_i} \mathrm{e}^{(V_i - U_i)} \qquad (1)$$

Where Y_i is the number of successful online transaction in a specified unit, X_i is the vector of input quantities and β_i is the vector of production function parameters. The frontier production function $f(X_i, \beta_i)$ is a measure of maximum potential output for any particular input vector X. The V_i and U_i cause actual production to deviate from this frontier. The V_i is the systematic component, which captures the random variation in output, which are due to the factors that are not within the control of the operators of cyber cafés (e.g. energy/fuel availability, GSM network efficiency, internet network availability and efficiency). The V_i is assumed to be independently, identically distributed with zero mean and constant variance {i.e. $V_i \sim N(O, \sigma^2)$} and independent of U_i. The U_i is a non-negative term representing the deviations from the frontier production function, which is attributed to controllable factors (technical inefficiency). It is half normal, identically and independently distributed with zero mean and constant variance {i.e. $U_i \sim N(O, \sigma^2)$}.The stochastic frontier production function model is established using the maximum likelihood estimation procedure (MLE). The technical efficiency of either wired or wireless internet access is defined in terms of the observed output (Y_i) to the corresponding frontier output ($Y_{i\mathrm{i}}$) given the available technology, that is, according to Seyoum *et al.* (1998):

$$TE = Y_i$$

$$\ln Y_i = \beta_i \ln X_i + V_i - U_i \qquad (2)$$

So that,

$$0 \leq TE \leq 1.$$

3.0 Methodology

The study was conducted in Lagos, Abuja, and Kano. These cities serve as educational, commercial or administrative centers of the country with high awareness about internet facilities in Nigeria.

The data for this study were essentially primary data which were obtained from a cross-sectional survey of some clients (cyber café operators) of notable (a) Internet Service Providers (ISPs) and (b) Global System Mobile communication (GSM) firms in the year 2009. The data were elicited through the use of a set of structured questionnaire. Data were obtained on socio-economic characteristics of their clients such as age, years of education, frequency of contacting the ISP in a week on network related issues, license fees paid to ISP, frequency of using the bank web portal using a laptop, etc. Data related to output/production such as number of successful online transactions per week, labour utilization (self and hired), user airtime cost, web surfing experience, among others, were also collected.

3.1 Sampling Procedure

Multi Stage sampling procedure was employed. The first stage involved a purposive selection of Lagos, Kano, and Abuja based on a priori knowledge that these areas are the commercial nerve centers for both wireless and wired means of internet access (ISP, Internet Service Providers; ICT Information Communication Technology; GSM, Global System Mobile Communication) actively used in cyber café service production per unit time (*t*). The second stage involved a simple random selection of clients, while the last stage involved random selection of equal number (30 each) of their clientele. The client therefore cut across 3 categories of Firms (ISP, ICT, and GSM) with a random selection of 90 clients each, bringing the total observations to 270 clients. The Data was collected by means of administrating questionnaire.

3.2 Method of Data Analysis

Descriptive Statistics was used to analyze the socio economic characteristics while the stochastic frontier production functions which build hypothesized

efficiency determinants into the inefficiency error component (Battese and Coelli, 1995) so that one can identify focal points for action to bring efficiency to higher levels were used to analyze the technical efficiency of internet access methods. The production technology of the cyber café operators was assumed to be specified by the Cobb-Douglas frontier production function (Krishnamoorthy, 1997) which is defined by:

$$\ln Y_i = \ln \beta_0 + \sum_{j=1}^{7} \beta_j \ln X_{ji} + \mathrm{V_i} - \mathrm{U_i} \quad (3)$$

where

Y_i = number of successful online transactions per week of the ith client

X_{1i}= airtime cost of the ith client

X_{2i}= self labour used (hours/week) by the ith client

X_{3i}= hired labour used (hours/week) by the ith client

X_{4i}= frequency of contacting the ISP in a week on network related issues by the ith client

X_{5i}= license fees paid to ISP by the ith client

X_{6i}= ICT/Cyber Café related Taxes imposed by various government agencies on the ith client

X_{7i} = spare parts/maintenance cost incurred by the ith client

V_i= random error as previously defined of the ith client

U_i= technical inefficiency of the ith client

The technical inefficiency effects U_i is defined by:

$$U_i = \alpha_0 + \sum_{j=1}^{7} \alpha_j Z_{ji} \quad (4)$$

where $Z_{ji}(j = 1, \ldots, 7)$ represent age of respondent, years of education, number of contact with adverts/information on remote bank account management per financial year, internet related income level, web surfing experience, household size, and amount of bank credit obtained, respectively. These variables were included in the model to determine their influence on the technical efficiencies of the respondents. Generalized likelihood ratio test was used to test for the null hypothesis of no inefficiency effects while t-test was used to test for the null hypothesis of no significance difference between the average technical efficiencies of the two distinct groups of operators. The β's and α_j are scalar parameters to be estimated. The variances of the random errors, σ_v^2 and that of the technical inefficiency effects σ_u^2 and overall variance of the model $\sigma^2$are related. Thus:

$$\sigma^2 = \sigma_v^2 + \sigma_u^2 \quad (5)$$

The ratio

$$\sigma_u^2 / \sigma^2 = \theta \quad (6)$$

where, θ measures the total variation of output from the frontier which can be attributed to technical inefficiency (Battese and Cora, 1977). The estimates for all the parameters of the Stochastic frontier production function and the inefficiency model are simultaneously obtained using the program frontier version 4.1 (Coelli, 1994). In order to obtain the estimates of the parameters specified in (3) and (4), two different models are estimated separately for the two options.

Table 1: Summary Statistics of the variables for Wired and Wireless Internet Access Technologies of Cyber Café services in Nigeria

Variable	Wireless cyber café Technology				Wireless cyber café Technology			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Age (years)	32	6.72	24	42	36	9.11	21	56
Education (years)	13	6.98	10	19	9.3	6.34	6.1	8
Number of exposures to online adverts/we post on innovations	6.32	2.01	1	9	5.81	2.9	3	21
Amount of bank Credit	94,850	15,821	11,853	843,210	56,321	10,593	39,281	362,100
Web surfing Experience	16.56	12.89	2	76	11.39	6.94	1	45
Airtime Cost	38,650	1,267	784	54,900	70,580	1,065.40	1,000	162,000
Self Labour	7.8	5	2.9	23	9.52	7.61	1.9	34
Hired labour	3.1	0.89	1.2	9.5	5.38	4.15	4	17
Number of successful online transactions	34	5.87	12	46	19	3	1	31

Source: Authors' computation

Model 1 is the traditional response function in which the inefficiency effects (U_i) are not present. It is a special case of the stochastic frontier production function model in which $\theta = 0$.

Table 2: Maximum likelihood estimates for the parameters of the stochastic frontier production function for wireless and wired cyber cafés Nigeria

Variable	Wireless cyber café Technology		Wired cyber café Technology	
Efficiency Model	**Model 1**	**Model 2**	**Model 1**	**Model 2**
Constant	-0.604	-0.075	-0.123	-0.196
	(-0.149)	(-0.029)	(-2.542)	(-1.279)
Per user airtime cost	0.958*	0.901*	0.907*	0.995*
	(-8.87)	(-3.38)	(-11.23)	(-8.25)
Self labour	-0.093	-0.096	0.108	0.106**
	(-21.71)	(-0.029)	(-1.622)	(-10.36)
Hired labour	0.114*	0.112*	0.601	-0.1004
	(-6.43)	(-12.45)	(-0.003)	(-5.1735)
Number of contacts made to ISP over network issues	0.1509*	-0.602	0.1049*	-1.9079
	(-6.56)	(-6.189)	(-11.37)	(-0.0362)
ISP licensing fees	-0.343	-0.505	-0.5001	-0.517
	(-1.457)	(-0.249)	(-0.8737)	(-0.983)
Taxes/Levies	0.0562	-0.933	-0.6304	-6.0003
	(-0.024)	(-0.340)	(-0.281)	(-3.361)
Spares/Maintenance cost	0.235	0.367	-0.239	9.756
	(-0.189)	(-0.29)	(-0.359)	(-0.749)
Inefficiency Model		**Model 2**		**Model 2**
Constant		0.175		-0.0099
		(-0.184)		(-0.0006)
Age of operators		-0.946*		-0.0788*
		(-9.087)		(-0.19)
Years of education		-0.111		-0.159
		(-0.130)		(-11.703)
Numbers of exposures to adverts/web post on innovations		0.251*		0.196
		(-9.02)		(-11.532)
Non café income		0.515		0.918
		(-1.946)		(-0.669)
Café Mgt experience		-9.133		0.356
		(-11.599)		(-1.671)
Household size		0.69		-9.029
		(-11.79)		(-2.64)
Amount of bank credit obtained		0.215		0.434
		(-0.892)		(-5.472)
Variance Parameters		0.228*		0.665*
Sigma squared		(-6.47)		(-2.503)
Gamma		0.870*		0.848
		(-5.985)		(-18.58)
Log likelihood function		4.49		21.46
χ^2_c		28.07		27.66
$\chi^2_{0.95,98}$		16.92		16.92

Source: Authors' computation.

*Estimate is significant at 5% level

**Estimate is significant at 10%level

Figures in parentheses are t-values.

Model 2 is the general frontier model where there is no restriction in which θ and σ^2 are present. The two models are compared for the presence of technical inefficiency effects using the generalized likelihood ratio test which is defined by chi-square test statistic,

$$\chi^2 = -2\{\mathrm{LLF}(\mathrm{H}_0) - \mathrm{LLF}(\mathrm{H}_1)\} \quad (7)$$

where,

χ^2 has a mixed chi-square distribution with the degree of freedom equal to the number of parameters imposed under the null hypothesis. $\mathrm{LLF}(\mathrm{H}_0)$ and $\mathrm{LLF}(\mathrm{H}_1)$ are the values of the log-likelihood function under the null and alternative hypotheses, respectively.

Cobb-Douglas function is criticized as having no meaningful economic use due to its inherent weakness in terms of dimensional analysis, lack of constancy over time, and lack of micro foundations (Wikipedia, 2009). However, current models of Cobb Douglas production function give its robust micro foundation. More so, it has been applied to many economic phenomena such as utility and technical efficiency. It has ease of use and flexibility. Besides, no single model possesses all justifiable characteristics.

4.0 Results and Discussion

Table 1 presents the summary statistics of some important socio economic variables for cyber cafés operators in the study area. The minimum and maximum ages of operators of wireless cafés are 24 and 42 years, respectively, while the minimum and maximum ages of wired operators are 21 and 56 years, respectively. The table shows that operators of wired cyber cafés are relatively older in age (average of 36 years) compared with their wireless counterpart (average of about 32 years). The Table also shows that on the average, operators of wireless and wired had about 13.00 and 9.3 years of formal education, respectively. These clients do have substantial web surfing experience. The average number of successful transactions for clients using the wireless technology is 34 whose transaction is valued at N38,650/day while their wired counterparts recorded 19 valued at N70,580/day. The sampled average amount of bank credit available to wireless operators and wired operators are N94,850 and N56,321 respectively.

4.1 Estimates of the Stochastic Frontier Production Function Parameters

The maximum likelihood estimates of the stochastic frontier production functions for cyber café service production in the study area are presented in Table 2. The Table shows that there was presence of technical inefficiency effects in cyber café service production in the study area as confirmed by the test of hypothesis for the presence of inefficiency effects using the generalized likelihood ratio test. The Chi-square computed for cyber cafés offering services on wireless platform is 28.07 while the critical value of the chi-square at 95% confidence level and 9 degrees of freedom, $\chi^2(0.95,9) = 16.92$. The Chi-square computed for cyber cafés offering services on wired platform is 27.66 while $\chi^2(0.95,9) = 16.92$. The null hypothesis of no inefficiency effects in cyber café service production, $g = 0$, was rejected for both categories of firms. Thus equation 5 was not an adequate representation of the data; hence equation (6) was the preferred equation for economic and econometric analyses. The estimated sigma squared (s^2) in Table 2 for the two categories of operators are significantly different from zero at the 5 percent level. This indicates a good fit and the correctness of the specified distributional assumptions of the composite error term. The estimated gamma (g) parameter of 0.870 for wireless technology operators and 0.848 for wired technology operators indicate that about 87% and 85% of the variation in cyber café service production by wireless and wired operators was due to differences in their technical inefficiencies subject to their individual location constraints such as power availability, system malfunctions, and manpower issues.

Table 3: Elasticity of Cyber café service production and returns to scale (RTS)

Variables	Wireless cyber café Technology	Wired cyber café Technology
Per client airtime cost	1.011	1.091
Self labour	-0.005	0.009
Hired labour	0.003	0.0004
Number of contacts made to ISP over network issues	0.0003	0.007
ISP licensing fees	-0.004	-0.00007
Taxes/Levies	-0.008	-0.0093
Spares/Maintenance cost	-0.045	-0.021
RTS	0.909	1.099

Source: Authors' computation.

The estimated elasticity of the explanatory variables of the production function is shown in Table 3. It is revealed that the elasticity of per user airtime cost for both group of operators were estimated to be slightly greater than one, which indicates that the operators are operating in an irrational zone of production (increasing returns to capital). This is an indication of the fact that cyber cafés sampled are small scale in nature. This may explain the sudden boom as reported in NCC (2009), Yusuf (2005) and Akporido (2005). Thus, they can expand their cyber café sizes in order to achieve decreasing returns. The coefficient of the size of internet café is statistically significant at 5 per cent level. The estimated elasticity of self labour was positive decreasing function to the factor for wired operators.

The use of self labour by Cyber cafés offering wired platforms was in the stage of economic relevance of the production function (stage II). However, the estimated elasticity of self labour for cyber cafés offering wireless platforms was negative and insignificant decreasing function to the factor indicating over use and in stage III. This is due to the fact that most owner operators do not pay themselves (self labour) hence its over use. The production elasticity with respect to hired labour is positive decreasing function to the factor as expected for the two categories of cyber café operators and it is statistically significant at the 5 per cent level. The estimated elasticity of number of contacts made to ISP over network issues was positive decreasing function to the factor for both categories of cyber operators and it is statistically significant at the 5 per cent level.

The significance of the variable- number of contacts made to ISP over network issues is because it is a major network efficiency augmenting input in the sense that it improves the productivity of existing hardware (computer systems deployed) by increasing number of successful online transactions per client. The estimated elasticity of ISP licensing fees, taxes/Levies and spares/maintenance cost are insignificant negative decreasing function to the factor. The return to scale (RTS) was 0.909 for Cyber cafés offering wireless platforms and 1.099 for Cyber cafés offering wired platforms indicating a positive decreasing return to scale and almost constant return to scale for Cyber cafés offering wireless and wired platforms respectively. The productivity of the factors involved in Cyber cafés service production could be improved by expanding their firm size at the existing level of broadband license spectrum allowable limits, taxes, levies, spares and maintenance costs

so that these variables could move from stage III to stage II of the production function.

Table 4: Decile Range of Frequency distribution of TE of Cyber café service production

Decile of Range of TE	Wireless cyber café Technology		Wired cyber café Technology	
	Frequency	%	Frequency	%
0.95 - 0.99	77	0.513	84	0.56
0.86 – 0.94	68	0.453	53	0.35
≤ 0.85	5	0.033	13	0.086
Total	150	100	150	100
Average	0.797		0.914	
Minimum	0.842		0.523	
Maximum	0.959		0,912	

Source: Authors' computation.

4.3 Technical Efficiency Analysis

The predicted cyber café specific technical efficiencies (TE) ranged between 0.842 and 0.959, with a mean of 0.987 for Wireless cyber café Technology sampled while it ranged between 0.523and 0,912 with a mean of 0.914 for wired cyber café Technology. Thus, in the short run, there is a scope for expanding cyber café service production by about 9.1% for operators using wired cyber café Technology if these two categories of operators adopt the technology and techniques used by the most efficient operators amongst them. One of the measures is addressing the issue of negative elasticity of ISP licensing fees, taxes levies, spares and maintenance costs.

The null hypothesis of no significant difference in the mean TE between wireless Cyber café technology and their wired counterpart, (Hm= Hw) evaluated using t-test for large samples (n> 30) was accepted because Tc< T0.95, 98 that is, 0.44 < 2.0. The decile range of the frequency distribution of TE is presented in Table 4. It is revealed that 97.67% of the operators using the wireless technology had TE exceeding 0.79 and 0.33% had TE ranging between 0.842 and 0.959 while 91% of operators using the wired platform had TE exceeding 0.85 and 0.9% had TE ranging between 0.523 and 0.84.

The analysis of the inefficiency model shows that the signs and significance of the estimated coefficients in the inefficiency model can be used to formulate

appropriate policies on the TE of the cyber café operators in Nigeria. The coefficients of age was estimated to be negative as expected and statistically significant at the 5 per cent level for both categories of operators which indicate that the younger operators are more technically efficient (more adaptive, flexible, etc.) in cyber café service production than the older operators. Also, younger operators are likely to be more progressive and hence, more willing to research and experiment with new techniques, thus leading to higher technical efficiency in cyber café service production (Hausman, 1999; ICT Work Programme 2009).

The coefficient of education variable is estimated to be negative as expected and statistically significant at 5 per cent level for the two categories of operators which indicate that in Nigeria, cyber café operators with greater years of formal education tend to be more efficient technically in service production probably due to their enhanced ability to acquire technical knowledge (especially online), which makes them produce much closer to the frontier output. This finding agrees with the arguments outlined by Goolsbee and Klenow (2002); Rappoport *et al.* (2003); Atkinson & McKay (2007).

The coefficient of numbers of exposures to adverts/web posts on innovations was estimated to be positive contrary to expectation, and statistically significant at 5 percent for both categories of farmers. The positive coefficient indicates that the operators' technical inefficiency tend to increase with numbers of exposures to adverts/web post on innovations which implies that the ideas/techniques received by them were not properly followed, hence, these contact/exposures is not beneficial in reducing technical inefficiency. The coefficients of web surfing experience and household size, although conformed to a priori expectation, are insignificant determinant of TE. The coefficients of non-café income and amount of bank credit obtained which did not conform to a priori expectation showed that they are insignificant determinants of TE.

5.0 Summary, Conclusion and Recommendation

This study estimates stochastic frontier production functions for cyber cafés operating on wireless and wired platforms in Nigeria. The MLE results reveal that TE of cyber café services production varied due to the presence of technical inefficiency effects in their service production. The variables such as per user/client airtime cost, labour and number of contacts made to ISP over

network issues were found to be the significant production factors that are associated with changes in the number of successful online transactions of cyber café clients (Output).

Wired operators seem the most efficient in terms of technical efficiency with mean TE index of 0.914 followed by wireless operators with a mean TE index of 0.797 (this result is in spite of the engineering efficiency claims. These coefficients are based on socio-economic (realities) evaluations infused into the equation. The results of the inefficiency model show that the variables of age and years of education significantly increase these operators TE while number of contacts made to ISP over network issues significantly decreases the cyber cafés' TE.

The policy implication of the findings in this study is that there is scope for raising the present level of TE of their service production in the study area, given the wide variation in the level of TE. Since age and education variables have direct relationship with the level of TE therefore policies should encourage more of the younger and better educated potential male (and especially female) operators to go into the enterprise. They should also be encouraged to take into the various online trainings/innovation blogs/news on improved techniques of managing a cyber café such that there will be increase in number of successful online transactions per user of cyber café clients in Nigeria.

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