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TECHNICAL ASSESSMENT OF FINANCIAL TECHNOLOGIES IN NIGERIA

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Abstract: *This study employs a stochastic production function model to measure technical efficiency of FINTECHs via point of sales, POS and automated teller machines, ATM in Nigeria. Primary data were obtained through the use of a set of questionnaires from three hundred and sixty representative samples. The results show that in Nigeria, (within the context of Nigeria's socio-economic constraints) POS operations seem the most efficient in terms of technical efficiency with mean TE index of 0.914 followed by ATM service provision 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 users'/operators' TE while number of contacts made to FIs over transaction issues significantly decreases the FINTECHs' TE.*

Keywords: FINTECH, ICT Economics, POS, ATM
JEL Classification: 03

1.0 Background to the study

According to Adeoti (2013) Nigerian payment system that was wholly cash-driven could not guarantee efficiency and deliver an effective payment platform required for a sustainable economic development. This he argued, was because over the decades, the economic and social role of the internet and hence of recent, the point of sale terminals in particular has attracted significant academic and policy attention especially in the context of studies relating it to poverty reduction, employment generation, economic growth and development. Magaji and Eke (2020) submit that these financial technologies, FINTECHs, though despite attracting growing attention, there is still widespread unemployment and poverty. However, due to numerous interests in aspects of Point of Sales technology, certain characteristics of the subsector were outlined by (Rose & Hudgins, 2012; Magaji & Eke, 2013): ease of entry; reliance of indigenous and imported resources; predominantly micro scale and family oriented enterprises; small scale operations (adapted technology); skills acquired outside formal education system and a fiercely competitive market.

Researchers were interested in economic and social activities related to the POS revolution. In line with mainstream economics, POS technology provides services in exchange for value. Adaptation of Point of Sale machines/technologies (POS) in the recent past have demonstrated its important role in various globalized economies. The magnitude of its impact varies from one country to another, depending on the country's economic development. In Nigeria, the several retail POS training projects offered by a huge number firms have attempted to

reach, enhance the base, minimize the processing costs, increase transparency and reduce the cycle times. In Nigeria's formalized private sector, such as the different types of licensed financial institutions, FINTECHs, are increasingly being used to deliver services at the convenience of consumers (Osayaba and Osiobe, 2020). Similarly,

Sahay, Ulric, Lahreche, Khera, Ogawa, Bazarbash, and Beaton (2020) buttressed that in the public sector, FINTECH applications attempt to offer the services of financial institution (like financial transactions by some state and federal government departments) to the citizens at their village door steps. These applications enable offerings such as improved and affordable access and processing solutions. For instance, Okechi and Kepeghom (2013) reported that Nigeria's financial regulatory agency – Central Bank – in an attempt to reduce the volume of cash in circulation, introduced electronic payment system platforms and terminals points such as POS, automated teller machines, ATMs, and debit cards into the Nigerian economy.

An ATM, Sanusi (2011) observes stands for automated teller machine, which is a specialized computer that makes it convenient to manage a bank account holder's funds. He went further to buttress that it enables account holders to access cash or perform other banking services when he or she inserts a smart debit bank card. In Nigeria, the several financial institutions have deployed. The Nigerian Interbank Settlement system, NIBSS, in 2020 reported that there are over 20, 000 ATMs spread across the county – that is about 8.7 ATMs per 100,000 Nigerians. This will help these institutions to reach more clients, enhance their customer base, minimize the processing costs, increase transparency and reduce inefficiencies. In terms of e-payment statistics, the CBN in 2020 reported that there were over 970 million ATM transactions. In table 1.0 below, it summarizes that over 5 billion e-payment transactions were conducted within 8 months alone, which was valued at over 750 Trillion naira.

Table 1.0 Industry E-Payment figures for January to August 2020

CHANNELS	VOLUME	VALUE
Cheques	11,612,206	9,113,317,397,877
ATM Transactions	968,433,479	12,004,067,823,108
POS Transactions	382,845,859	2,806,304,086,834
Online Transfers	3,432,692,730	235,617,811,325,903
NEFT Transfers	125,273,977	172,541,542,685,671
RTGS Transfers	11,083,961	338,886,171,481,012
USSD Transfers	292,969,790	2,975,572,689,715
Mobile App Transfers (not mobile money)	249,076,105	19,377,841,240,563
Direct Debits	1,766,353	1,766,400,251,382
MMOs	449,745,924	9,428,612,332,832
Total E-Payment Transactions	5,081,286,395	783,168,507,497,344

Source: https://www.cbn.gov.ng/paymentsystem/epaymentstatistics.asp

The adoption of these FINTECHs have given rise investment opportunities in switch firms that midwifes seamless connectivity. This device can be used for retail financial services such as e-payments, and peer to peer transaction. CBN policy prescribes that for individuals conducting cash transactions up to N0.5M or corporations up to N3M must deploy a POS terminal to avoid been charged 2% in excess of the approved free lodgment limits. The establishment of an efficient, reliable and cost-effective digital service (telecommunication) infrastructure is a catalyst to rapid economic, political, social and cultural development of any nation, (Magaji and Eke 2013). They further added that 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 the nineteenth century. During this period, the facility was mainly used for

promotion of administrative functions rather than the socio-economic development of 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 phones 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 telephone 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.

The mass adoption of POS in Nigeria compliments the desired drive to deepen financial inclusion and boost to economic growth and development. Generally, electronic payment (e-payment) refers to an electronic means of making payments for goods and services procured online or offline. Nwaolisa and Ezu (2012) submits that the technology and platform enable seamless transactions online using smart debit cards with embedded microchips encoded with sensitive information and information protocols which simultaneously access mainframes of financial institutions' supercomputers bearing the card bearer's monetary value. Pierce (2001) notes that the e-payment system follows this simple protocol: e-payment infrastructure, smart card payment processing system, an accounting framework or algorithm. Alexander (2012) posits that this framework empowers an efficient audit trail as it reduces physical money in circulation, thereby improving financial efficiency in the economy.

Adeoti and Ayo (2010) observed that growth trend of these POS operators is partly explained by personal characteristics of customers, different aspects of their internet usage access time, motivation for using the service, POS brand used, financial needs, frequency of use. Adopting an efficient, reliable and cost effective technique for managing the operations of POS across cities of Nigeria will not only bring about sharp increase in the number of POS operators in Nigeria, but will also enhance the achievement of the needed development in the nation's economy, evaluation off internet information content and problems encountered while using the internet. The question now is how to improve the POS adaptation process so as to further employment opportunities while it's still trending. Secondly, is there a significant difference in efficiency between using the POS and ATM both of which are deployed in strategic locations by various financial institutions in Nigeria? The primary objective of this study is to compare the level of technical efficiency between POS and ATM operating platforms 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 towards boosting human capital productivity, and hence economic growth and development in Nigeria. Hence, the motivation for this article is to provide a benchmark for policy makers to assess the technical efficiency of our FINTECHs. No doubt, most of the POS operators are single/sole proprietorships with limited education and skills who essentially operate for subsistence. While ATM operators are firms with more sophisticated and knowledge intensive operation. The latter among them can operate in the markets with higher capital requirements and can be dynamic businesses with streamlined wage employment.

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In this subsector POS firms may prefer to remain small, rather than large, if they perceive advantages to doing so. Some of which are the ability to respond to changes in the technological or competitive landscape. Others are the dire need to be resilient in the face of harsh, cut throat competition from ATM firms and systemic macroeconomic risk and adversity such as the recent recessionary trends in Nigeria. The table 2.0 below shows the POS operators' economic characteristics.

Table 2.0: POS Operators' economic characteristics

S/N	VARIABLES	CHARACTERISTICS
1	Business Size	1 paid employee
2	Startup capital	N100,000; moderately easy to start
3	Factor of Production	Automated
4	Work condition	Unprotected by contract, social welfare or unions
5	Internet surfing skills of employee	Passed on by semi-formal apprenticeship
6	Core raw materials	Local/ indigenous and imported device
7	Core firm infrastructure	Unreliable public power; generator dependent
8	Firm resource	Limited access to capital and funding
9	Internet airtime tariff	Affordable for local population
10	Demand for POS service	Moderate
11	Network quality	Moderate
12	Medium of exchange	Cash
13	Firm overall flexibility	Adopts well
14	Firm efficiency	Based on coordination between firm owner, staff and equipment
15	Operators' risk attitude	Risk takers
16	POS culture	Embedded in local population's social relations

Source: Authors' survey (2021)

2.0 LITERATURE REVIEW

Financial technology is the technology and innovation that aims to compete with traditional financial methods in the delivery of financial services. It is an emerging industry that uses technology to improve activities in finance. The use of smartphones for mobile banking, investing, borrowing services, and cryptocurrency are examples of technologies aiming to make financial services more accessible to the general public (Leong and Sung 2018). It also implies that the democratization of the access to financial services that meet the specific and generic need of the end users (McWaters, 2015). Similarly, financial technology or FinTech offers innovative financial services or products delivered via technology (World Bank, 2019). It also refers to any technologically enabled initiative that make formal financial services available, accessible, and affordable to all segments of the population (African Development Bank, 2019). It therefore connotes the increase in the access to formal financial services such as bank account, and/or the use of credit and saving facilities of banks (Efobi, Beecraft and Osabuohien, 2014).

According to Agu, Simon, Nwankwo, and Onwuka (2020), the Point of Sales (POS) was introduced in Nigeria in 2013 after the Central Bank of Nigeria (CBN) introduced the agent banking system in 2013, while Odusina (2014) posits that ATM was introduced in Nigeria in 1989. Most are connected to the internet through the wireless technology. The facilities/equipment deployed for most POS and ATMs are inadequate and all the servers and client systems (workstations) operate on the Windows/DOS platform, using MS explorer, (Odusina, 2014 and Agu et al, 2020). The findings by Agu et al (2020) also indicated that while ATMs are designed to rely on uninterrupted power supply circuits, POS have installed handy rechargeable batteries. In addition, problems of poor electricity, inadequate facilities, poor service from ISP, location of POS/ATM and so forth, were recognized as major problems militating against effective operation of e-

payments in Nigeria with associated challenges such as payment/cash dispensary error.

On one hand, FINTECHs deployed by various financial institutions differ based on their factor of production such as capital, labour management, etc. which add to their efficiency of production. It is important to highlight the fact that mobile products such as phone banking, internet banking and e-commerce which are also facilitated by POS and ATMs, have caught up with the increasingly mobile Nigerian population. However, Atkinson and McKay (2007) defined phone banking as a service provided by a financial institution which allows its customers 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, as posited by Magaji and Eke (2013); Magaji and Eke, C.I. (2015) and Eke, Magaji, Obalemo, Ezeigwe, (2020), 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 level of human capital skills and different access and adoption of FINTECHs. Common method of access is the smart debit card with its high-grade security features that provide personal identification, authentication, data storage, and application processing. Applications include identification, financial, mobile phones (SIM), public transit, computer security, schools, and healthcare, Wikipedia (assessed 10th February 2022).

It is common sense and logical to expect these FINTECHs to engender economic growth and development in their several host economies. Several authors argue that FINTECH oriented development policies should be mainstreamed. They stressed that FINTECH's contribution 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 FINTECHs vis-à-vis POS and ATMS. Most empirical literature on their technical efficiencies are on engineering technologies and coefficient that are not relevant in economic analysis. In-depth empirical literature in this area has not been undertaken. It is 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 FINTECHs vis-à-vis POS and ATMS to economic growth and development and prescribe strategies for integrating fully FINTECHs into the development process (especially in sub Saharan Africa). A review of the various studies on the contribution of FINTECHs vis-à-vis POS and ATMS to economic growth and development in the highly digitalized economies of the West show that the technology has made considerable contribution to production – service/real sector. According to Tiwari et al. (2006); Leong and Sung (2018); Efobi, Beecraft and Osabuohien (2014) & Wikipedia (2020), the massive adoption of FINTECH 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 request for credit, including mortgage approval and insurance coverage. With the obvious exception of cash withdrawals and deposits, the technology enables virtually all the features on an automated teller machine (as outlined earlier): account balance information and list of latest transactions, electronic bill payments, fund 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 center or a branch, although 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 (2020) noted that mobile banking now handles a huge volume of transactions providing an avenue for most of the FINTECH 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 via POS and ATM.

Despite these innovations, there are still daunting challenges, arising from limited access to information, 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), are the most complicated challenges that need to be addressed jointly by mobile application developers, wireless network service providers and the 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 FINTECHs via POS and ATM in Nigeria. It was basically assumed that financial technologies were clearly divided into two platforms – POS and ATM. This feature is their distinctive distinguishing characteristics. Oladeebo & Fajuyigbe (2007) defined technical efficiency as the ability to produce maximum output from a given set if inputs, given the available technology.

According to Oladeebo & Fajuyigbe (2007) the modelling 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 Van den Broeck (1977) for developed countries. More recently in Nigeria, empirical applications of the technique in efficiency modelling have been reported by Ajibefun and Abdul Kadri (1999), Ojo and Ajibefun (2000) and Ojo (2003). The stochastic frontier production function model is given as:

$$Y_i = F\left(X_i^{\beta i} e^{(Vi-Ui)}\right)$$

(1)

Where Y_i is the number of successful online financial transaction in a specified unit, X_a is the vector of input quantities and β_i is the vector of production function parameters. The frontier production function f ($X_{a,\beta}$) 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 factor that are not within the control of the operators of POS and ATM (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

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constant variance {i.e. N~(0, σ2)} 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. N~(0, σ2)}. 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 (Yi) to the corresponding frontier output (Yi) given the available technology, that is, according to Seyoum et al (1998):

TE = Y_i

In $Y_i = \beta_i In\, x_i + V_i - v_i (2)$

So that,

$0 \leq T\ E \leq 1$

3.0 METHODOLOGY

This study area was the Federal Capital Territory. This city serves 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 of POS kiosks, ATM and financial institutions in the year 2021. The data were elicited through the use of a set of structured questionnaires. Data were obtained on socio-economic characteristics of their clients such as age, years of education, frequency of POS/ATM or POS or ATM in a week, network related issues, POS/ATM charges, frequency of using FINTECHs, etc. Data related to output/production such as number of successful online financial transactions per week, Manhours, per user airtime cost, POS/ATM experience and so on were also collected.

3.1 Sampling Procedures

Multi stage sampling procedures was employed. The first stage involved a purposeful selection of six centers within the six Area Councils for administrative convenience and budget constraints: Gwagwalada (Gwagwalada); AMAC (Wuse II); Abaji (Abaji); Kwali (Kwali); Bwari (Kubwa) and finally Kuje (Kuje) based on a prior knowledge that these areas are the commercial nerve centers for both POS and ATM means of transacting via FINTECH actively used in 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 (60 each) of their clientele. The client therefore cut across 2 categories (POS & ATM) with a random selection of 450 clients each bringing the total observation to 120 clients. The data was collected by means of administrating questionnaire (see Appendix 1)

3.2 METHOD OF DATA ANALYSIS

Descriptive Statistics Q3 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 Q3 were used to analyze the technical efficiency of FINTECHs. The production technology of the FINTECH operators was assumed to be specified by the Cobb-Douglas frontier production function (Krishnamoorthy, 1997) which is defined by:

$$\text{In } Y_i = \text{In } \beta_0 + \beta_1 InX_{1i} + \beta_2 InX_{2i} + \beta_3 InX_{3i} + \beta_4 InX_{4i} + \beta_5 InX_{5i} + \beta_6 InX_{6i} + \beta_7 InX_{7i} + V_i - U_i \quad (3)$$

Where

Y_i = number of successful online financial transactions per week

X_1 = Bank Charges

X_2 = Manhours Consumed (hours/week)

X_3 = Gadget/Machine processing time (hours/week)

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X_4 = frequency of contacting your financial institution in a week on transaction related issues
X_5 = POS/ATM charges
X_6 = Transaction related taxes/duties imposed by the government
X_7 = spare parts/maintenance cost
V_i = random error as previously defined
U_i = technical inefficiency effects as previously defined
i = observation of the ith customer/respondent

Table 1: Summary Statistics of the variables for Point of Sale and Automated Teller Machine Technologies of FINTECH services in Nigeria.

Variable	Automated Teller Machine Technology				Point of Sale Technology			
	Mean	Stddev	Min	Max	Mean	Stddev	Min	Max
Age (years)	26	7.72	18	30	40	12.11	31	53
Education (years)	10	4.72	8	10.3	7.52	5.7	6.1	8.0
Number of exposure to adverts/web post on FINTECH innovations	4.85	4.04	7	8	6.722	3.40	4	29
Amount of bank credit	183990	14923	19132	453210	47891	10593	39281	362100
Web surfing experience	16.56	12.89	2	76	11.39	6.94	1	45
Financial Institution charges	38650	1267	784	54900	70580	1065.4	1000	162000
Manhours	7.8	5.00	2.9	23	9.52	7.61	1.9	34
Gadget processing time	3.1	0.89	1.20	9.5	5.38	4.15	4	17
Number of successful online financial transactions	34	5.87	12	46	19	3.0	1	31

Source: Eke et al (2021) Field Survey on FINTECH Services.

The technical efficiency effects U_i is defined by:

$$U_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_{2i} + \alpha_3 Z_{3i} + \alpha_4 Z_{4i} + \alpha_5 Z_{5i} + \alpha_6 Z_{6i} + \alpha_7 Z_{7i} \quad (4)$$

Where,
$Z_1, Z_2, Z_3, Z_4, Z_5, Z_6 \; and \; Z_7$ represents 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 significant difference between the average technical efficiencies of the two distinct groups of operators. The β's and α's are scalar parameters to be estimated. The variances of the random errors, σv_2 and that of the technical inefficiency effects σu_2 and overall variance of the model σ_2 are related thus:

$$\sigma^2 = \sigma v^2 + \sigma u^2 \quad (5)$$

The ratio

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

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.

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 the parameter $\theta = 0$.

Model 2 is the general frontier model where there is no restriction in which θ and σ2 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,

$$X^2 = -2\{LLF(H_0)\} - \{LLF(H_1)\} \quad (7)$$

Where,

X^2 has a mixed chi-square distribution with the degree of freedom equal to the number of parameters imposed under the null hypothesis.

LLF (H_0) and LLF (H_1) are the values of the log – likelihood function under the null and alternative hypothesis 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, 2022). However, current model of Cobb-Douglas production function gives 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.

Table 2: Maximum likelihood estimates for the parameters of the stochastic frontier production function for Point of Sale and Automated Teller Machine Technologies in Nigeria.

Variable (Production function)	**Automated Teller Machine Technology**		**Point of Sale Technology**	
Efficiency Model	**Model 1**	**Model 2**	**Model 1**	**Model 2**
Constant	-1.604 (-9.149)	-4.075 (9.029)	-1.123 (-0.542)	-5.196 (-9.29)
Per user airtime cost	2.958* (3.87)	2.901* (4.38)	5.907* (14.23)	6.995* (3.25)
Manhours	-2.093 (8.710)	-1.096 (-1.029)	0.108 (3.622)	0.106** (15.36)
Machine processing time	1.114* (4.43)	0.112* (10.45)	5.601 (0.003)	-0.1004 (-4.1735)
Number of contacts made to financial services over transaction issues	9.1509* (5.56)	-5.602 (-4.189)	3.1049* (14.37)	-2.9079 (-0.0362)
FINTECH operator charges	-7.343 (-9.457)	-9.505 (-3.249)	-4.5001 (-5.8737)	-9.517 (1.983)
Taxes/FI duties	3.0562	-1.933	-0.6304	-0.0003

	(7.024)	(-0.340)	(-19.281)	(9.361)
Spares/Maintenance cost	9.235 (2.189)	3.367 (2.290)	-4.239 (-0.359)	4.756 (0.749)
Inefficiency Model				
Constant	0	1.175 (1.184)	0	-3.0099 (-9.0006)
Age of Operators	0	-1.946* (-7.087)	0	-0.0788* (1.190)
Years of education	0	-0.111 (-6.130)	0	-0.159 (-4.703)
Number of exposures to adverts/web post on innovations	0	9.251* (5.02)	0	0.196 (9.532)
Non digital/traditional income	0	8.515 (6.946)	0	0.5918 (1.669)
POS mgt/ATM usage experience	0	-7.133 (-1.599)	0	0.356 (5.671)
Household size	0	8.690 (10.790)	0	-3.029 (-0.64)
Amount of POS/Merchant credit obtained	0	8.215 (3.892)	0	6.434 (2.472)
Variance parameters **Sigma squared**	1.084	1.228* (9.470)	1,042	9.665* (4..503)
Gamma	0	0.970* (9.985)	0	0.948 (10.58)
Log likelihood function	-2.539	8.49	10.63	19.46
$\chi c2$	-	18.07	-	20.66
$\chi 0.95, 982$	-	8.92	-	15.92

Source: Eke et al (2021) Field Survey on FINTECH Services.
*Estimate is significant at 5% level
* Estimate is significant at 10% level

4.0 Result and Discussion

Table 1 presents the summary statistics of some important socio-economic variables for FINTECH operators in the study area. The minimum and maximum ages of ATM users are 24 and 42 years respectively, while the minimum and maximum ages of POS operators and users are 21 and 56 years, respectively. The table shows that operators of POS users are relatively older in age (average of 36 years) compared with their ATM counterpart (average of about 32 years). The table also shows that on the average, users of ATM and POS 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 ATM technology is 34

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whose transaction is valued at ₦48,655/day while their POS counterparts recorded 19 valued at ₦62,585/day. The sampled average amount of bank credit available to ATM clients and POS clients/operators are ₦91,870 and ₦66,441 respectively.

4.1 Estimates of the Stochastic Frontier Production Function Parameters

The maximum likelihood estimates of the stochastic frontier production functions cyber café production in the study area are presented in Table 4.2. The Table shows that there was presence of technical inefficiency effects in FINTECH service production in the study area as confirmed by the test of hypothesis for the presence of inefficiency effects using the generalized like likelihood ratio test. The Chi-Square computed for FINTECH services on the POS platform is 29.28 while the critical value of the Chi-Square at 95% confidence level and 9 degrees of freedom, $X^2(0.95,9) = 16.92$. The null hypothesis of no inefficiency effects in FINTECH 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 4.2 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 0.970 for POS technology and 0.948 for ATM technology which boldly indicates that about 97% and 94% of the variation in FINTECH service production in Nigeria due to their differences in their technical inefficiencies subject to their individual location constraints such as power availability, system malfunctions, and manpower issues.

Table 4.3: Elasticity of FINTECH service production and returns to scale (RTS)

Variables	POS Technology	ATM Technology
Per user airtime cost	1.041	1.131
Manhours	-0.045	0.049
Machine processing time	0.043	0.0044
Number of contacts made to financial services over transaction issues	0.0043	0.047
FINTECH operator charges	-0.044	-0.00054
Taxes/FI duties	-0.048	-0.0313
Spares/Maintenance cost	-0.085	-0.061
RTS	0.949	0.859

Source: Authors' computation

The estimated elasticity of the explanatory variables of the production function is shown in Table 4.3. it is revealed that the elasticity of per user airtime cost for both platforms were estimated to be slightly greater than one, which indicates that the platforms are operating in an irrational zone or production (increasing returns to capital). This is an indication of the fact that FINTECH consumers sampled are small. This may explain the sudden boom as reported in NCC (2019). Thus, they can expand their FINTECH outreach in order to achieve decreasing returns. The coefficient of the number of POS/numbers of ATM is statistically significant at 5% level. The estimated elasticity of manhours is a positively decreasing function to the factor for ATM platforms.

The manhours involved in ATM as a FINTECH platform is in the stage of economic relevance of the production function (stage II). However, the estimated elasticity of manhours for POS as a FINTECH platform was negative and insignificant decreasing function to the factor indicating over use and in stage III. This is due to the fact that most POS owner-operators do not pay themselves hence its over use. The production elasticity with respect to machine processing time is positive decreasing function to the factor as expected for the two categories of FINTECH platforms and it is statistically significant at the 5% level. The estimated elasticity of number of contacts

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made to ISP over network issues was positive decreasing function to the factor for both platforms and it is statistically at the 5% level.

The significance of the variable – number of contacts made to service providers over network issues is because it is a major network efficiency augmenting input in the sense that it improves the productivity of existing hardware deployed by increasing number of successful online transactions per client. The estimated elasticity of all myriad of fees, taxes/Levies and spares/maintenance cost are insignificant negative decreasing function to the factor. The return to scale (RTS) was 0.949 for POS and 1.859 for ATM indicating a positive decreasing return to scale and almost constant returns to scale for POS and ATM respectively. The productivity of the factors involved in FINTECH service production could be improved by expanding their outreach at the existing level of operational capacities, license limits, spares and other associated constraints so that these variables could move from stage III to stage II of the production function.

Table 4.4: Decile Range of Frequency distribution of TE of FINTECH service production

Decile of Range of TE	POS Technology		ATM Technology	
	Frequency	%	Frequency	%
0.95 – 0.99	81	0.614	81	0.511
0.86 – 0.94	65	0.342	50	0.41
≤ 0.85	2	0.022	16	0.076
Total	150	100	150	100
Average	0.814		0.949	
Minimum	0.870		0.621	
Maximum	0.981		0.936	

Source Authors' computation

4.3 Technical Efficiency Analysis

This study estimates stochastic frontier production functions for FINTECHS operating in Nigeria. The MLE results reveal that TE of FINTECH services production varied due to the presence of technical inefficiencies. The predicted FINTECH specific technical efficiencies (TE) ranged between 0.870 and 0.981, with a mean of 0.814 for POS technology sampled. While it ranged between 0.621 and 0.936 with a mean of 0.949 for ATM Technology. Thus, in the short run, there is a scope for expanding FINTECH service provision by about 9.49% for FINTECH providers using the ATM platform if these two categories of service providers adopt the technology and techniques used by the most efficient providers amongst them. One of the standard strategies based on the results obtained from the research, would be to address the negative elasticity of FINTECH charges, taxes, duties, and spiraling maintenance cost.

The null hypothesis of no significant difference in the mean TE between POS technology and its ATM counterpart, ($H_{POS} = H_{ATM}$) evaluated using t-test for large samples ($n > 30$) was accepted because $T_c < T_{0.95,\ 98}$ that is, $0.44 < 2.0$. The decile range of the frequency distribution of TE is presented in Table 4.4. It is revealed that 98.57% of the subscribers using the POS technology had TE exceeding 0.87 and 0.22% had TE ranging between 0.87 and 0.97 while 91% of subscribers using the ATM machines experienced a TE exceeding 0.86 and 0.9% had experienced TE ranging between 0.621 and 0.936.

The analysis of the inefficiency model shows that the signs and significance of the estimated coefficient in the inefficiency model can be used to formulate appropriate policies on the TE of FINTECH in Nigeria. The coefficient of age was estimated to be negative as expected and statistically significant at the 5% level for both categories of subscribers which indicate that the younger subscribers are more technically efficient (more exploratory, inquisitive, adventurous, flexible, etc.) as regards FINTECH service production than the older. Also, younger subscribers are likely to be more progressive and hence, more willing to research and experiment with new techniques, thus leading to higher technical efficiency in FINTECH service production.

The coefficient of education variable is estimated to be negative as expected and statistically significant at 5% level for the two categories of operators which indicate that

in Nigeria, FINTECH services operators greater years of formal education tend to be more efficient technically 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 (Sahay, 2020 and Eke, 2020)

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% for both categories of operators. The positive coefficient indicates that the operators' technical inefficiency tend to increase with the numbers of exposures to adverts/web post on innovation which implies that the ideas/techniques received by them were not properly followed, hence these contacts/exposures are not beneficial in reducing technical inefficiency. The coefficient 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 FINTECHs such as ATM and POS platforms in Nigeria. The MLE results reveal that TE of FINTECH services production varied due to the presence of technical inefficiency effects in their service production. The variables such as per user/client airtime cost, Manhours and number of contacts made to financial institutions, FIs, over transaction issues were found to be the significant production factors that are associated with changes in number of successful online transactions of FINTECH clients (Output). POS operations seem the most efficient in terms of technical efficiency with mean TE index of 0.914 followed by ATM service provision 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 users'/operators' TE while number of contacts made to FIs over transaction issues significantly decreases the FINTECHs' 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 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 optimizing usage of FINTECHs such that there will be increase in number of successful online transactions per FINTECH clients in Nigeria.

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