Information and Communication Technology and Unemployment:
Is Technology Labor-substitutive in the Nigerian Banking Industry?

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Abstract

The increasing demand for better banking service delivery has prodded Nigerian Banks to deploy more information and communication technology (ICT) in their production. While several studies have evaluated the effects of the technological innovations on service delivery and financial performance in the Nigerian banking industry, limited attention has been paid to the role of ICT deployment on labour employment in the industry. This study therefore analysed a neoclassical production function to estimate the effects of ICT on labour employment in the industry. General Method of Moment was employed to analyse annual data on selected banks from 2003 to 2014. Results show that banks' production functions in Nigeria are not perfectly factor-substitutive but characterized by some elements of complementarity. ICT did not substitute for labour and thus not worsen unemployment. Banks should thus be encouraged to further embrace ICT in their production processes as this not only improves their service delivery and financial performance but also enhances employment generation in the country.

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ICT and Unemployment Effects in the Nigerian Banking Industry

1. Introduction

Trade openness, financial integration and increased demand for efficiency to survive competition in the global markets have increased deployment of ICT in contemporary businesses. This has however brought tremendous shifts in production technology in all the sectors of the economy. Technological progress has changed the relationship between factors of production, and factor input ratio has consequently been altered. Most modern technologies are, howeve biased toward increasing capital-labour ratio, and this has grave consequences for employment generation capacity of various sectors of the economy.

Contemporary banking services across the globe are not left out in usage of technological innovations to improve service delivery and enhance customer's satisfaction. Does this affect employment in the banking industry? Is the banking sector in Nigeria immuned from this syndrome? The banking sector in Nigeria is fraught with high level of job insecurity among employees. Is this phenomenon associated with increasing deployment of ICT in the industry?

In line with global trend, the Nigerian banking industry has been investing greatly in ICT (Salawu and Salawu, 2007) to offer greater value to customer such as timeliness of service delivery (Willcocks and Lester, 1996) and security of financial transaction[1]. Moreover, the investment enables banks to save cost (Ou et al. 2008), increase shareholders' value and remain competitive (Idowu, Aliu & Adagunodo, 2002). The technological investment entails purchase, installation and servicing of automated teller machine (ATM) and electronic banking (e-banking) platforms/software.

ATMs and e-banking products are being globally adopted by banks, given numerous benefits they offer to both the banks and their customers. While ATMs enable depositors to withdraw funds anytime outside banking hours (Olatokun and Igbinedion, 2009), e-banking services enable customers to complete their financial transactions from any location at any point in time

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[1] Banks invest in certain information and communication technology to protect their customers from theft and electronic fraud that they may be prone to as a result of sensitiveness of financial information (Adewoye and Omoregie, 2013)

(Abubakar and Rosmaini, 2012) and help them save time (Quresh, Zafar & Khan, 2008). Besides the convenience and sweet service experience for customer, banks save cost and increase profits as they no longer need many branches to offer these services to their customers; hence the imperative to reduce their branch networks and the (un)intended effects of downsizing the number of service staff maintained (Adewuyi, 2011, ATMIA, 2010).

The foregoing shows that the banks' deployment of ICT has multi-dimensional effects on the economy. The gains may not be without costs. While most studies have focused on the effects of the technological innovation in the industry on service delivery and the sector's financial performance, limited attention has been paid to possible unemployment implication of this advancement. This study therefore examined effects of increased deployment of information and communication technology on labor employment in the Nigerian banking sector.

The rest of the paper is organized as follows. Section 2 presents the background while section 3 reviews the relevant literature. Section 4 highlights the methodology. Empirical evidence is provided in section 5 and section 6 concludes.

2. Background to the Study

Prior to the recapitalization of the Nigerian commercial banks in 2005, very few banks in the country fully employed ICT in their operations. Electronic banking products such as Internet Banking, Automated Teller Machine (ATM), Point of Sale (PoS) terminals were not common. According to CBN (2003), only 17 and 24 banks, out of 89 existing banks in 2002 were offering Internet Banking and Telephone Banking respectively in the country.

The few ICT-based products offered by Nigerian banks in the early 2000 resulted from the economic reform programmes in the late 1980s. The Structural Adjustment Programme (SAP) introduced in 1986 during General Ibrahim Babangida military dispensation led to dramatic rise in the numbers of banks[2]. The engendered competition in the industry led many banks to introduce innovative ICT-based banking products as a means to enlarging their market share (Adewuyi, 2011). Since then, there has been tremendous improvement in the deployment of ICT in banking operations. Ezeoha (2005)

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[2] The number of banks in Nigeria rose in post-SAP era from 40 in 1985 to 125 in 1991.

noted that the percentage of banks employing ICT has increased from 19.1% in 2002 to about 90% in 2005.

Use of ICT in banking operations has been known to confer numerous benefits on banks as well as their customers. Banks are enabled to make quick and better decisions as a result of timely information, deliver services more efficiently, design and deliver new products that meet their customers' need, save costs and remain competitive. Customers, on the other hand, enjoy better services and spend less time accessing the services. All these benefits translate into economic growth. Deployment of ICT in the banking sector has been acknowledged to enhance specialization, job creation and commerce (Idowu, 2005).

The positive impacts of ICT in the banking industry notwithstanding, there have been attendant detractions. These include money laundering, fraud and job losses (Adewuyi, 2011). While the first two unintended shortcomings are not uncommon in Nigeria, and have been largely discussed in the literature, the effects of ICT on decline in employment of labour in the sector have not received adequate attention in recent times.

Figure 1: ICT-based banking products (average supply by 11 sampled banks) and labor employment conditions (% of 2003 values)
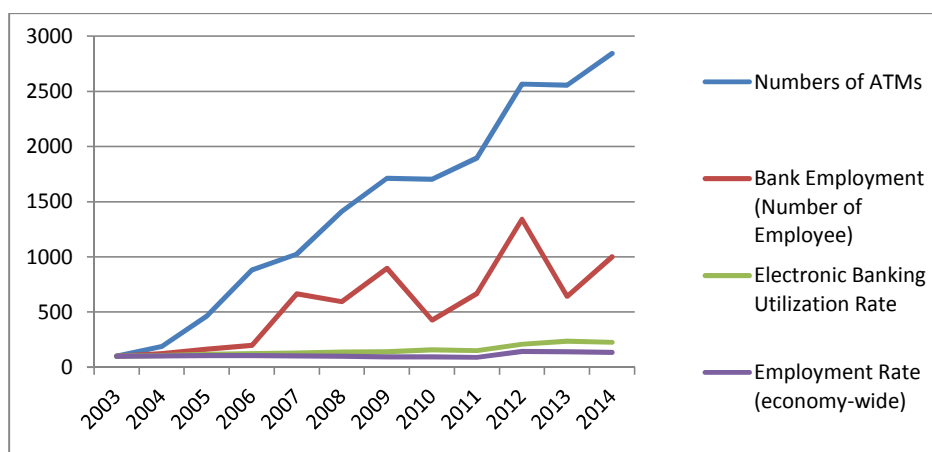
Source: Authors' computation

Figure 1 above shows that use of ATMs (measured by the average number of ATMs deployed by the sampled banks) and electronic banking utilization rate (average e-banking utilisation rates by the banks' customers) trend with bank's labour employment (the average size of sampled banks' employees). While the

production and supply of the ICT-based products rose over the years, labour employment also increased. Though the economy-wide employment rate (as a percentage of 2003 value) did not rise, it did not show visible or significant decline. This evidence runs contrary to the claims by Adewuyi (2011) and ATMIA (2010) that production of ICT-related banking products bias banks' production function toward capital intensiveness with the (un)intended consequence of job losses.

3. Literature Review

This section presents both the theoretical and empirical literature relating to issues on Information and communication technology (ICT) and its effects on not only the banking sector but also the economy at large.

Most production functions utilize two or more inputs, variation in combination of which is feasible in the long run (Varian, 2012). The effects of variation of input combinations on output level has been analysed with isoquants within the microeconomic model of output maximization.

Figure 2: Long run production function and factor combination ratio effects on input employment
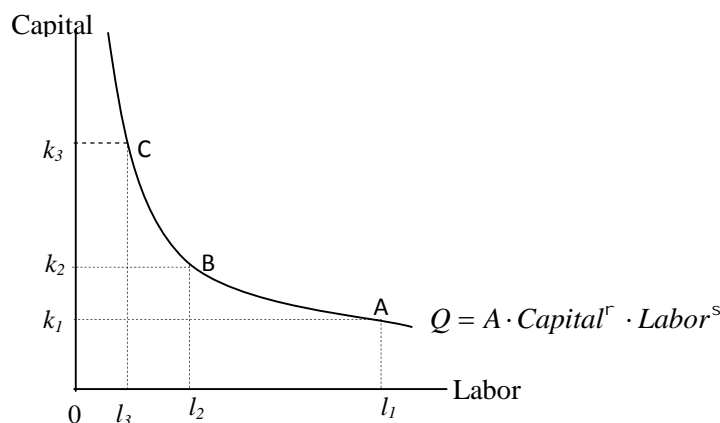
Source: Authors' representation of isoquant as a tool for long run analysis of input combination in production (see Varian, 2012)

A given level of output Q is producible in the long run with any factor combination A, B, or C (figure 2). The analysis of the isoquant describing a neoclassical production function represented by $Q = A \cdot Capital^r \cdot Labor^s$

(where A is the technology determining productivity of factor inputs, r and s are elasticity of capital and labor respectively) shows that factor inputs are substitutive. Deployment of more capital in the production process results into employment of less labor. By choosing input combination B above A and increasing capital from $0k_1$ to $0k_2$, labor employment falls from $0l_1$ to $0l_2$. Factor are not however perfectly substitutive, but to some extent complementary. This is obvious from the fact that larger units of capital employment (from $0k_2$ to $0k_3$) are required to substitute for smaller reductions of labor employment (from $0l_2$ to $0l_3$). This explains the convexity of the isoquant. The more convex a production function is, the more complementary, rather than substitutive, factor inputs are.

Variations in relative prices and productivity of ICT and other factor inputs necessarily lead to variations in input combinations in favour of lower price and higher factor productivity. While the equilibrium of factor input combination is reached when the ratio of marginal productivity to factor price are equal across inputs, change in either components of the ratio disturbs the equilibrium, and the firm uses more of a factor whose productivity-price ratio has increased.

Information and communication technology (ICT) encapsulates the process of harnessing electronic technology for the information needs of businesses at all levels (Anderson, 1990). According to Mejabi (2008) and Sajuyigbe and Alabi (2012), ICT is any technology that helps to generate different kinds of information, process, save and propagate the information. ICT has provided the platform for automation of processes that were hitherto performed manually in the traditional production technology.

ICT in the banking business entails use of computers, telecommunications, software and other ancillary equipment, and this has facilitated design and sales of many products to enhance customers' satisfaction (Sajuyigbe, 2012). These include Automated Teller Machines (ATMs), telephone banking, direct bill payment, electronic fund transfer, the online (internet) banking and Point of Sale, POS (Safeena, Abdullah and Date, 2010).

In this modern day of technological innovation, banks employing traditional methods (manual methods) find it difficult to compete favorably in the industry (Agboola, 2003). Thus, many retail banks are becoming alerted to the need to keep abreast of technology in the modern day when new technology delivers financial services directly into people at their homes. The author posits that

investment in technology has become an important component of the overall strategy in banks. With the new technologies, economies have been so fully networked in way that has never been so paralleled that transfer of money from one geographical location is now completely easy, thus aiding business transactions and economic growth.

Several studies have examined the relationship between ICT and other factors of production with a view to determining whether they are complements or substitutes. Dewan and Min (1997) note that ICT are being increasingly deployed in all firms in United States of America. Service industry, especially the financial sector, however deploys ICT more than other sectors in the economy (Franke, 1987). In the United States, the price of ICT products relative to those of other inputs significantly declined at annual average rate of 20% over the period of 1960 and 1992, and this led to substitution of ICT in production process for other inputs (Dewan and Min, 1997).

Adapting from the translog production function by Christensen et al (1970) and the CES-translog production function by Pollak et al (1984), Dewan and Min (1997) estimated CES-translog production function using firm level data in United States and found that ICT is substitutive to other factor inputs, as the marginal productivity of ICT is very high and the return to this input is highly in excess of returns to other input, especially labour. The share of output due to ICT, the elasticity of ICT contribution from the CES-translog function, is however not significantly different from that found in Cobb-Douglas production function estimated by Brynjolf-sson and Hitt's (1995).

The effects of ICT on banks' operational and financial performance (Carvallio and Siegel, 2011; Hernando and Nieto, 2007 and Siam, 2006) have been largely examined, but very few have paid attention to labor employment effects of ICT deployment in the banking sector in Nigeria. One of the few studies is Atiku, Genty and Akinlabi (2011). The study analyzed the effects of ICT deployment in production on job security of banks' employees' in Nigeria. Using a survey design that covered four hundred respondents from five commercial banks in Nigeria, the study finds that use of e-banking technology and automated teller machine (ATM) negatively affected job security of employees in the sector. The few studies on the ICT-(un) employment nexus rely on primary data; and their result may not have been free from sample-selection bias and other problems. The analysis of the nexus in the Nigerian banking industry using secondary data has received limited attention.

4. Theoretical and Empirical Framework
This study analyzed the effects of ICT on banking sector employment in Nigeria within the framework of the neoclassical growth theory.

4.1 Model Specification
The bank generates its output (turnover) using capital, labor and technology (ICT) as factor inputs. The production process is assumed to be captured by the neoclassical production function described in equation (1) below:

$$Y = A^r K^s L^x \quad \text{.................................(1)}$$

where:

Y= turnover; A= technology; K= capital employed; L=   labour/staff engaged

The quantity of labour employed by a bank in producing output (turnover) is determined, according to the microeconomic theory, when marginal productivity of labour (MP_L) equals wage rate (w). This condition determining the level of labour employment is given in equation 2 below.

$$MP_L = xA^r K^s L^{x-1} = w \quad \text{...........................(2)}$$

Where equation (2) uses the fact that MP_L is the first derivative of Y with respect to L

Linearising equation (2) by taking the natural logarithm of the equation yields equation (3) below:

$$\ln x + r \ln A + s \ln K + \ln L^x - \ln C = \ln w \quad \text{...........................(3)}$$

Expressing L in terms of other variables yields

$$\ln L = \ln x + r \ln A + s \ln K + \ln L^x + \ln w \quad \text{...........................(4)}$$

Writing L^x in equation (1) as a function of Y yields:

$$L^x = A^{-r} K^{-s} Y = wY \text{.................................(5)}$$

where

$$w = A^{-r} K^{-s}$$

Using equation (5) in (4) gives equation (6) below:

$$\ln L = \ln x + r \ln A + s \ln K + \ln(wY) + \ln w$$
$$\ln L = \ln w + \ln x + r \ln A + s \ln K + \ln Y + \ln w$$
$$\ln L = \ln \text{Œ} + r \ln A + s \ln K + \ln Y + \ln w \dots\dots\dots\dots\dots(6)$$

where $\qquad\qquad \text{Œ} = wx$

ATMs and e-banking (EB) platforms are both ICT-based products and are captured by technology, A, in equation (6) above. Bank leasehold/freehold assets or premises (P) are fixed assets employed in production, and is therefore captured by capital, K. Turnover is captured by Y while salary (SL) proxies wage rate, w.

On these bases, equation (6) can be written as follows:

$$\ln L = \}_0 + \}_1 \ln ATM + \}_2 \ln EB + \}_3 \ln P + \}_4 \ln Y + \}_5 \ln SL \dots\dots\dots(7)$$

Employing equation (7) above to estimate the degree of complementarity or substitutability between technological capital and labour, this study makes a methodological contribution by estimating direct effects of ICT capital on labour employment in the production process. This methodology controls for the effects of other factors that may affect the nexus. It differs from previous studies which computed elasticity of substitution between the factor inputs and used the result to infer complementarity or substitutability between the inputs.

The study's focus on labour and ICT is informed by Dewan and Min's (1997) findings that the effect of substitution of ICT for labour is significantly stronger than that for other inputs.

4.2 Estimation Techniques
The study employs General Method of Moments, GMM) to estimate equation (7) above. The choice of the techniques is informed by the endogeneity of the regressors (most obvious of which is the turnover). The instruments used in the GMM estimation are first difference of turnover (Y), wage rate/salary (SL), labour (L), ATM, EB and premises (P). Though the endogeneity of equation (7) violates the assumptions of the Ordinary Least Square (OLS) regression model, and hence renders OLS estimates inconsistent, the study still estimates the equation with OLS techniques for sake of comparing results.

4.3 Diagnostics
The statistical properties of the data are examined. Levin, Lin and Chu (LLC) unit roots, Im, Pesaran and Shin (IPS) unit roots tests and Kao cointegration

tests were conducted to determine if the variables are stationary and have long term relationship. Descriptive statistics of the variables were also obtained.

4.4 Data – Sources and Measurement
The data on eleven banks (listed in the appendix) selected on purposive sampling techniques (informed by data availability for the period 2003 to 2014) were employed. Banks that merged in the period were excluded because of the possible effects (structural break effects) of the merger on the relationship between factors of production and other variables of interest. Data were collected from the banks' annual reports and fact books published by the Nigerian Stock Exchange.

5. Empirical Evidence
The results of diagnostics are first presented and discussed. The statistical properties of the data are discussed as a means of verifying the appropriateness of regression analyses; and hence, the validity of the estimates reported. Following the diagnostics, the results on the estimated nexus re then presented and discussed.

5.1 Descriptive Statistics
Table 1 below shows that the natural logarithm of the data used in the linearised model show some stability as the standard deviation is low, compared to median values. Most of variables except electronic banking are negatively skewed, showing that there are many small banks and few big banks in the sample. Income and salary level are platykurtic and flat-tailed. This shows that banks have divergent incomes/turnovers and salary paid to staff varies largely across banks. All the banks are within the same range as far as other variables are concerned as data show leptokursis.

Table 1: Descriptive Statistics

	LNEB	LNATM	LNL	LNP	LNY	LNSL
Mean	1.838925	4.302688	7.543941	19.72281	24.44963	22.51949
Median	1.791759	5.023794	7.660765	19.90517	24.76014	22.72674
Maximum	3.218876	7.676474	9.375092	22.98127	26.45038	24.71713
Minimum	0.000000	0.000000	4.532599	13.12236	21.36276	19.50184
Std. Dev.	0.587271	2.191904	1.055906	1.821834	1.188107	1.235851
Skewness	0.257369	-1.005557	-0.580427	-1.071287	-0.415364	-0.448914
Kurtosis	3.834915	2.992861	3.244624	5.086016	2.411134	2.478133
Jarque-Bera	4.409345	18.53788	6.450680	40.98457	4.752339	4.942852
Probability	0.110287	0.000094	0.039742	0.000000	0.092906	0.084464
Sum	202.2818	473.2957	829.8336	2169.509	2689.459	2477.144
Sum Sq. Dev.	37.59274	523.6843	121.5282	361.7796	153.8641	166.4786
Observations	110	110	110	110	110	110

Source: Authors' Computation

5.2 Unit Roots Statistics

Table 2 below shows that all the variables except natural logarithm of e-banking are stationary as the statistics of common/panel unit roots analyses conducted (Levin-Lin-Chum (LLC) and Breitung unit roots tests) show that they are I(0); the natural logarithm of e-banking is of I(1). Given this property of the data, a cointegration test is necessitated.

5.3 Cointegration Statistics

Kao unit roots statistic, presented in table 2 below an augmented Dickey-Fuller based test, show that the variables are cointegrated.

Table 2: Unit Roots and Cointegration Statistics

Series	LLC		Breitung	
	Level	1st diff.	Level	1st diff.
LnEB	-1.05	-2.87***	1.69	-4.33**
	(0.147)	(0.002)	(0.954)	(0.000)
LnATM	-5.16***	-6.26***	2.97	-2.87**
	(0.000)	(0.000)	(0.998)	(0.002)
LnL	-6.93***	-2.77***	2.82	-3.57*
	(0.000)	(0.003)	(0.997)	(0.000)
LnP	-3.24***	-2.42***	0.095	-4.918)***
	(0.001)	(0.008)	(0.537)	(0.000)
LnY	-4.32***	-6.68***	4.38	-4.33**
	(0.000)	(0.000)	(1.00)	(0.000)
LnSL	-4.63***	-3.92***	4.36	-3.59***
	(0.000)	(0.000)	(1.00)	(0.000)
KAO Cointegration Statistics				

Series	t statistics	Probability	Null Hypothesis
LnEB LnATM LnL LnP LnY LnSL	-1.775864**	0.0379	No Cointegration

*p values in parenthesis, *, **, *** represent statistical significance at 10%, 5% and 1 % respectively*

Source: Authors' Computation

5.4 ICT and labor employment in the Nigerian Banking Sector

The results of the analyses on the nexus are presented in table 3 below. The table shows that ICT/technology does not crowd out labour in the banks' production process in Nigeria. Rather, it encourages employment of labour in the banking sector. Both the System GMM and difference GMM estimation show that investment in ATM and e-banking platform significantly improved employment (staffing) level in the sector. These findings contradict with some earlier studies that find that production of electronic banking products, and the increased use of ICT-based capital, tend to substitute for labour-based banking services and hence lead to reduction in labour employment in the sector. This study established that deployment in ICT by the banks does not substitute for labor employment but complemented it. Government should thus promote policies that would encourage banks to use more ICT as it leads to more labour employment not only in the sector but also in the economy.

Why is ICT-based capital (ATM and e-banking) labour-complementary rather than substitutive? Microeconomic theory posits that most equilibria in factor mix are interior, hence, there are elements of complementarity in empirical mix

of factors inputs; thus, perfect substitution is more of a theoretical gesture. Most isoquants are convex, portending some degree of complementarity.
Besides, increased use of a factor of production increases marginal productivity of another factor, leading to increase in employment of the other factor (McCallum, 1989).

Table 3: Impact of ICT on labor Employment in the Nigerian Banking Industry

Dependent variable:	GMM	
LnL	Sys.	Diff.
Independent variables	1	2
Lag LnL	0.046 (0.840)	-0.507** (0.045)
LnY	-0.012 (0.879)	0.171** (0.013)
LnP	0.0001 (0.996)	0.028 (0.252)
LnSL	0.436*** (0.006)	0.554*** (0.000)
LnATM	0.097*** (0.008)	0.127*** (0.000)
LnEB	0.126** (0.026)	0.189** (0.033)
Constant	-2.949 (0.196)	-6.812** (0.003)
Wald (t^2)/F Stat.	303.8	130.0
$p(t^2)$	0.000	0.000

p values in parenthesis, *, **, *** represent statistical significance at 10%, 5% and 1 % respectively
Source: Authors' Computation

This result differs from Dewan and Min (1997) who reported that ICT substitutes for labour in a production process. The divergence of our findings from Dewan and Min's (1997) study may arise from difference in context. Most studies like Dewan and Min (1997) focused on developed economies where wages are so high that any decline in the prices of ICT capital encourages large substitution of ICT for labour. Our study is located in the

context of a developing economy where labor is so cheap that productivity-wage ratio is high enough to douse the substitution effects arising from increased marginal productivity of ICT capital. Our findings however agree with Bresnahan et al. (2002) and Furukawa et al (2001) who find that ICT complements labour, especially the highly skilled ones - like those employed in banks.

Salary paid to staff is another determinant of employment in the banking sector. While demand for labor is an inverse function of wage/salary paid worker, supply of labor is a direct function of salary. Both system and difference GMM estimations show that labor supply (employment) to the bank increased with increase in salaries paid to staff.

Results from the difference GMM estimation show that turnover positively affects the labor employment in the sector. These findings agree with the theory which predicts that marginal productivity of labour rises with demand (turnover) and firms consequently increase labour employment.

6. Conclusion
Technological revolution has exerted significant influence on production structure and factor mix, and these effects have implications for unemployment. Given the global linkages, business operations in Nigeria have had their production functions influenced by global advancement of technology. Banks in Nigeria have had to increase their investments in ICT-based technological capital like ATM and e-banking platform to enable them satisfy customers' demand, reduce cost and increase profit. The investments and increasing deployment of ICT in banks' production of service have however been highlighted, by some studies, to have unintended consequence of labour unemployment in the sector.

This study therefore examined the relationship between ICT-related investments/products and employment in selected Nigerian banks in order to determine if technological capital substitute for labour in banks' production function and consequently lead to unemployment. General Methods of Moment (GMM) were employed to estimate data on selected Nigerian banks from 2003 to 2014. Our findings show that investment in ICT-based capital (ATM and electronic banking platform) by banks did not lead to loss of jobs. Rather, ICT-based capital enhances employment of labour. This suggests that banks' production functions are not perfectly factor-substitutive but characterized by some factor complementarity.

Our findings on ICT-unemployment nexus in Nigeria are supported by theories and many earlier empirical findings. On the basis of the findings, banks should be encouraged to invest more in ICT. Besides enhancing service delivery and profitability, use of ICT in bank's production leads to more labour employment not only in the sector but also in the economy.

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Appendix
Table A: Temporal scope of the study

S/No	Names of Banks Sampled	Years Covered
1	Access Bank	2003-2014
2	Diamond Bank	2003-2014
3	ECO Bank	2003-2014
4	Fidelity Bank	2003-2014
5	First Bank	2003-2014
6	GT Bank	2003-2014
7	Stanbic IBTC Bank	2003-2014
8	First City Monument Bank	2003-2014
9	United Bank for Africa	2003-2014
10	WEMA Bank	2003-2014
11	Zenith Bank	2003-2014