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Information and Communication Technology Investment and Firm Productivity: Evidence from the Nigerian Banking Industry (2005-2013)

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Abstract
This study investigates the impact of information and communication technology (ICT) investment on Nigeria banks productivity for the covered period 2005-2013. Specifically, we contribute to existing literature by measuring the ICT investment, Non-ICT investment and the banks productivity respectively. We use cross section data derived from the annual reports of the three selected deposit money banks (DMBs) in Nigeria. The methodology employ is graphical Least-Square techniques. We find that both ICT and non-ICT investments do have high positive impact but ICT investment is sufficient and superior over the non-ICT investment (physical investment) on banks productivity in Nigeria, thus, disregard the "IT-productivity paradox" as postulated by Solow. We recommend the following for improve and sustain banks productivity in the Nigerian DMBs. First, the banks management should apportion more of the firm's capital into ICT investment and invest on quality labour size with commensurate staff salaries to boost their productivity effectively. Second, the Government should provide proactive enabling business environment such as constant power, guarantee security and others for intensive use of ICT towards greater productivity in the Nigerian banking industry.
Keywords: ICT-Investment, non-ICT investment , Banks Productivity, IT-Productivity Paradox, and Graphical Least –Square

1. Introduction

Over the past decade, the theoretical consensus about capital being one of factors of production played significant impact on productivity at both micro and macro level respectively. Even at present, the term capital, often referred as information and communication technology (ICT) or information technology (IT), is largely conceived by business firms and government as an inevitable impetus for productivity growth and competitive weapon in the 21st century era.

Unfortunately, this IT- productivity hypothesis since the mid- 1970s was not validated until the mid-1990s in United States (US). This gave birth to the phenomenon known as "productivity paradox" by Robert Solow, the famous Economics Noble Laureate in 1987. He states that "*you can see the computer age everywhere but not in the productivity statistics!*" (Syrine, 2013; Belu, 2012). Therefore, this statement aroused more empirical studies on the impact of ICT investment on productivity in developed countries, but lesser in developing countries in the late 1990s.

Following the "IT productivity paradox", the early 1990s studies (Loveman, 1988, 1994; Morrisson and Brendt, 1990; 1992) also corroborate with Solow postulations. However, recent studies from the late 1990s till date ceased the existence of "IT productivity paradox" and found a relationship between ICT and productivity, although mix findings prevails (Apol, Djumilah, Mintarti and Riyanarto, 2013). Some studies (Shu and Strassman, 2005; Kozak, 2005; Brynjolfsson and Hitt, 1996, 2003; Lichtenberg, 1995; Syrine, 2013; and Prasad and Harker, 1997) found positive effects of ICT on productivity. While fewer studies work of Brynjolfsson (1995) and Morrisson and Brendt (1995), all found negative effects at micro levels.

A cursory examination of the above cited studies, reveals that a very large volume, if not all was conducted in developed countries, using data from U.S or other developed countries. In spite of the fact that ICT has now spread worldwide, only little or no studies of the impact of ICT investment on productivity at both micro and macro levels had been conducted in the less developed countries (LDCs), including Nigeria as case study. For instance, Obasan (2011) recently study the impact of ICT on banks profitability in Nigeria. However, the study was unable to measure ICT investment which was pointed by Brynjolfsson (1993) as one of reasons for "IT productivity paradox". Furthermore, recent late 1990s studies approach of "IT productivity paradox also advocate for more sophisticated estimation techniques to avoid spurious estimates, leading to bias or misleading conclusion.

In Nigeria context, much empirical works on ICT and firms' productivity or related such as Obasan (2011); Agboola (2006); Ogunyomi, et al. (2014); Ovia (2001); and Osabuohien (2008) had all conducted their study but none of these studies had measured ICT investment. Also, they neither examine the extent at which the ICT investment had contributed to the selected firm's productivity. Fortunately, the included Nigerian authors all used the Nigerian banking industry as case study for their studies. However, these mentioned studies do not

measure ICT investment from their financial statement, except Ugwuanyi and Ugwuanyi (2013) which did but disregard other non-ICT investment capital factor and other complementary investment inputs.

In summary, a careful examination of previous studies of both developed and developing countries with much emphasis on Nigeria research, it exposes the research gap in the Nigerian banking industry vis-à-vis measuring the ICT investment and impact on the banks productivity in Nigeria. Furthermore, this study also aims to measures non-ICT investment and its impact on the selected Nigerian banks productivity. Thus, the salient question for this study is: to what extent does ICT- capital investment or non-ICT capital investments (that is, complementary physical capital) do contribute to banks productivity in Nigeria. Therefore, the objective of this study is to empirically investigate the impact of ICT investment on firm's productivity in the three selected DMBs in Nigeria for the covered period of 2005-2013, using graphical Least-Square techniques. The rest of this paper is organized as follow: section 2 presents the literature review and section 3 presents brief history of ICT investment in the Nigerian banking industry. While section 4 provides the trends of IT-investment and non ICT investment inputs in the selected Nigerian banks from the period covered and finally section 5 provides the recommendations and conclusion for the study.

2. Literature review

There is a rapid growing literature on information and communication technology (ICT) or often interchangeable called information technology (IT) and productivity at micro and macro levels. However, most of the literatures exist at the firm and industry, with little or none at the macro level. Furthermore, most of the micro-level literatures were concluded at the developed countries, leaving the developing countries very behind despite the intensive usage of the ICT in achieving productivity. Therefore, this study fills the existing literature gap from three empirical reviews. The first review emphasizes on the impact of ICT investment on firms' productivity. The second review literatures relating to non-ICT investment in firms' productivity and the third review recognizes the complementary effects of both ICT and investments on firms' productivity.

2.1 Relationship between ICT investment and firm's productivity

Following the Solow (1987) postulations that "*you can see the computer age everywhere but not in the productivity statistics!"* implying that IT does not affect productivity. Shu and Strassmann (2005) conducted a survey on 12 banks in the US for the period of 1989-1997. They found that IT plays an essential dynamic factor relating all efforts, but does not improve banks' earnings.

Egland et al. (1998) in his study compare a number of US banks offering internet banking and banks without internet banking analyzing their structure and performance characteristics. He found no major differences in their performances such as profitability and efficiency. Furthermore, in the study of Morrison and Berndt (1990), they found that additional IT investments contributed negatively to productivity, arguing that "estimated marginal benefits of investment in IT are less than the estimated marginal cost". Also, Dos Santos et al. (1993) examine the impact of IT on productivity and performance, using profitability and stock's value for their analysis. They found an insignificant correlation between IT spending and profitability measures implying that IT spending is unproductive. Similarly, Loveman (1994) and Brynjolfsson (1993) both found an insignificant contribution of IT spending or increased IT spending on output or profitability of the firms.

However, investigations conducted in the late 1990s use sophisticate econometric techniques and devoid of IT capital measurement errors and output measurement errors respectively, thus, accounted for the positive effects of ICT on productivity researches conducted.

Lichtenbery (1995) in his study uses Cob-Douglas production function and found increasing returns on investment in computers. He further found that one information system (IS) employee is equivalent to six non-IS employees, in terms of marginal productivity.

Also, Brynjolfsson and Hitt (1996) in their collaboration study use Cobb-Douglas production function and found that computerization aids the firm's level output significantly. They found the computer related capital investment contributes 81 percent to the marginal increase in output, whereas non – IT capital contributes only 6% to the marginal output. Thus, there study concluded that IT capital is more superior over non – IT capital on firm's productivity.

In same vein, Choudhari and Tripathy (2004) applied DEA to measure the relative performance of public sector banks and conclude that the corporation banks is efficient in all financial indicators, that is, profitability, financial management, growth, productivity and liquidity.

Abri and Mahmoudzadeh (2015) in their study of the impact of IT on productivity and efficiency in Iranian manufacturing industries from 2002-2006, found a positive significant effect of IT on the productivity of Iranian manufacturing industries.

Miyazaki et al. (2012) in their study classified ICT applications into four stages of Sophistication (non-performing ICT assets, section-wide system applications, companywide system applications and inter-corporate system applied) in Japan and found that the impact of ICT on firm productivity increases with a successive stage

of ICT usage.

In summary, of these empirical studies reviewed, it indicates that most of the studies proved a positive effect of IT on production while their earlier study was mixed findings of no effect and negative regime.

2.2 Relationship between non-ICT investment and firm productivity

This empirical review examines the effects of non- ICT investment (Land and Buildings, furniture, plant and equipment, human factors and other physical capital investment) on firm productivity, as apposed only ICT investment on productivity. Black and Lynch (2001, 2004) in US examine the effect of workplace organization and payments innovations on productivity growth.

Caroli and Van Reenen (2001) found that skilled workers adapt more easily to changes in organization they found that there is empirical relationship between workplace innovation and human capital and its influence on productivity.

In summary, the empirical reviews conclude that non- ICT investment had positive significant impact on firm productivity, though, these few literatures indicate that there are need for more intensive study for validation of above claims.

2.3 Relationship between ICT and non- ICT Investment and firm productivity

Following the Cobb-Douglas production theory that advocates for fusion of labour and capital as well as efficiency parameter on productivity necessitated the review of relevant literatures on debate.

Gretton et al. (2004) examine the interactions between ICT use and human capital, history of innovation, advanced business practices and intensity of organizational restructuring on productivity. This study was carried out on sample Australian firms and found positive effects of these complementary factors on productivity.

Another comparative study of Swiss and Greek firms by Arvanitis and Loukis (2009) show positive effects of physical capital, ICT, human and new organizational practices in labour productivity. Furthermore, the Swiss firms study revealed that the complementary factors are more efficient, while the Greek firms found that physical capital play crucial role more in labour productivity. In addition, Torrent-Sellens and Fiscapal-cusi (2010) in their research for the Catalan firms confirmed role of new co-innovative sources in technology and knowledge-intensive firms. Also, the Germany set of studies (Henpell, 2005; Hempell and Zwick, 2008), all on several time samples, they confirmed the existence of dependence relationship between labour productivity and digital technology and organizational innovation processes. In summary, the authors found that ICT investment is most productive than other non –ICT complementary investment factors.

In recent study, Hall et al. (2012) examine the firm level relationships between product, process and organizational innovations, productivity, research and development (R&D) and ICT, using data on manufacturing industries in Italy. They found that ICT and R&D contribute to productivity both directly and indirectly and neither complements nor substitutes on productivity.

In summary, the above included empirical works establish positive effects of ICT and Non–ICT investment on firm productivity, but the complementary and substitutability effect are mixed findings. The table 1 below shows the summary of three empirical studies reviews.

Table 1: Summary of included literature reviews at microeconomics (Firms- level).

Author(s) and Year	Sample country	Period	Impact of ICT on firm productivity	Impact of non-ICT on firm productivity	Impact of ICT & non-ICT on firm productivity
Solow (1987)	USA		X		
Shu & Strassmann (2005)	12 banks	1989-1997	X		
Morrison & Berndt (1990)	USA	1952-1991	-		
Dos Santos, Peffers & Mauer (1993)	USA	1981-1988	X		
Loveman (1994)	60 Sample	1978-1984	X		
Brynjolfsson (1993)	USA		X		
Ltichenberg (1995)	Taylor & Francis Business Sector	1988-1991	+		
Brynjolfsson & Hitt (1996)	367 Sample	1987-1993	+		
Choudhari & Tripathy (2004)		2002-2006	+		
Abri & Mahmoud (2015)	23-industry	2002-2006	+		
Miyazaki, Idota & Miyoshi (2012)	JAPAN	2006-2010	+		
Black& Lynch (2001; 2004)	USA MIT	1987-1993		+	
Caroli & Van Reenen (2001)	UK & FRANCE	1984-1996		+	
Gretton, Gali & Parham (2004)	AUSTRALIA	1994-1998			+ complementary
Arvantis & Loukis (2009)	SWITZERLAND	2005			+ complementary
Torrent-Sellens & Ficalpal-cusi (2010)	SPAIN	2003			+ complementary
Hempell (2005)	GERMANY	1994-1999			+ ICT most superior
Hempell & Zwick (2008)	GERMANY	2002-2004			+ complementary
Hall, Lotti & Mairesse (2012)	ITALY	1995-2006			+ ICT & R&D (individually)

Source: Compiled by the authors (2015).
Note: The following above sign "x", "+" and "-" indicates no relationship, positive effects and negative effects
Respectively.

3. ICT investment and Nigerian banks' productivity: A brief background

The advent of information and communication technology (ICT) into the Nigerian banking industry is traceable to the early 2000. Precisely in 1996, Societe Generale Bank of Nigeria (SGBN) earmarked as the first Nigerian bank to commence banking operations with use of ICT in only 5 branches in Lagos metropolitan.

Therefore, the awareness and relevance of ICT utilization among the Nigerian banks between 1998 and 2000, necessitated the Nigerian banks' management to apportion huge capital expenditure on website launching, acquisition of computers , software purchases , installation of various technology products such as Automated Teller Machine (ATM), Point-on-Sale (POS), Mobile banking (MB), Internet banking (IB) but to mention few. All these capital investment is often called ICT-Investment.

By and large, the post-benefits of ICT-investment in the Nigerian banks cannot be overemphasized, in terms of increased customer bank deposit, increased banks earnings, increased banks profit as well as reduces banks operational cost . However, this aftermath of Nigerian bank ICT investment benefits have not been largely empirically validated; therefore, it becomes imperative for this study to fill the research gap.

The purpose of this study is to empirically examine the effects of ICT-investment on the Nigerian banks productivity, using the three selected Deposit Money Banks (DMBs) as case study. The three selected Nigerian DMBs are Zenith Bank Plc, Guaranty Trust Bank Plc, and Diamond Bank Plc respectively and covered the annual period from 2005 to 2013. The study use graphical Least-Square fitness techniques to achieve the objective of the study.

4. Data presentation and analysis

4.1 Trends of ICT-investment and Nigerian banks productivity: A cross-section analysis

The cross-section trends of ICT-investment and the selected Nigerian banks productivity from 2005 to 2013 is demonstrated in table 2 and figure 1-3 respectively as follows:

Table 2: Pooled Data of ICT-Investment and Selected Nigerian Banks Productivity (2005-2013)

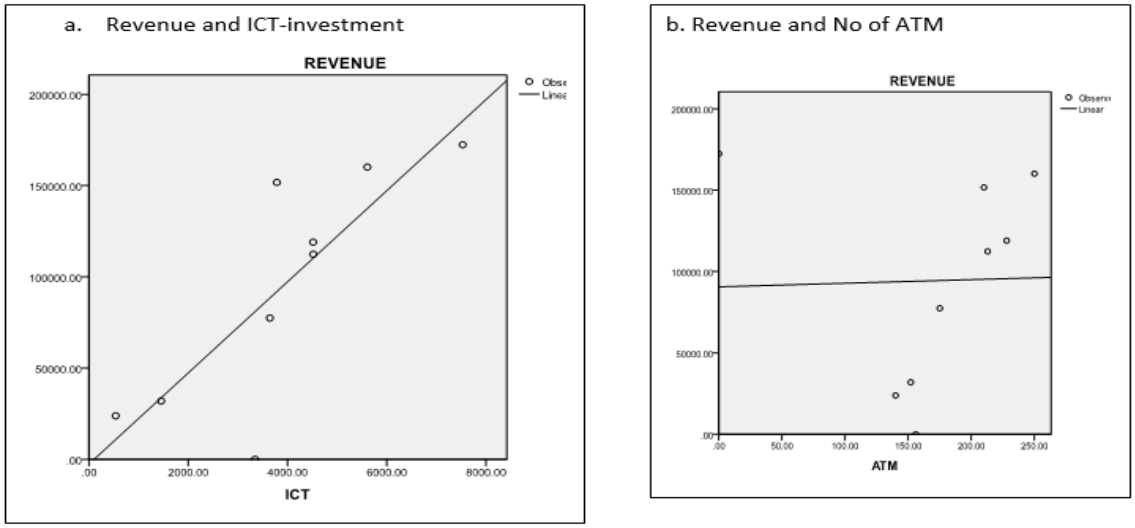
Year	Banks	Revenue	ICT-capital Investment	No of ATM
2005	GTB	23,834	540	140
	ZENITH	22,885	830	185
	DIAMOND	10,010	971	NA
2006	GTB	31,970	1455	152
	ZENITH	37,295	1374	210
	DIAMOND	14,400	1805	NA
2007	GTB	NA	3346	156
	ZENITH	62,017	2078	253
	DIAMOND	24,826	2410	NA
2008	GTB	77,464	3645	175
	ZENITH	137,815	3109	302
	DIAMOND	34,811	3919	NA
2009	GTB	151,698	3785	210
	ZENITH	186,019	7434	312
	DIAMOND	74,627	5397	201
2010	GTB	112,397	4518	213
	ZENITH	118,491	5023	333
	DIAMOND	64,176	4086	236
2011	GTB	119,016	4517	228
	ZENITH	155,871	3708	373
	DIAMOND	79,889	4111	240
2012	GTB	160,125	5609	250
	ZENITH	213,230	3421	NA
	DIAMOND	105,512	4396	408
2013	GTB	172,433	7530	NA
	ZENITH	243,852	2170	NA
	DIAMOND	133,485	3241	671

Source: Compiled by the authors (2015).

Note: Revenue proxies as interest and similar incomes (in naira) and ICT capital investment proxies as purchase software and computer equipment respectively.

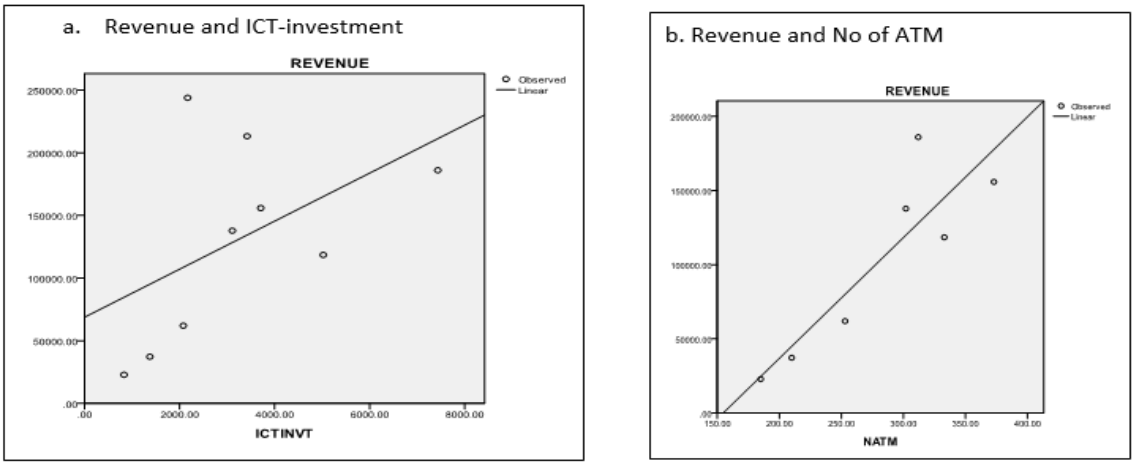
4.1.1 Graphical Least-Square fitness techniques for selected Nigerian banks (2005-2013)

Figure 1: Relation between Revenue and ICT-Investment variables of GT Bank Plc for 2005-2013.



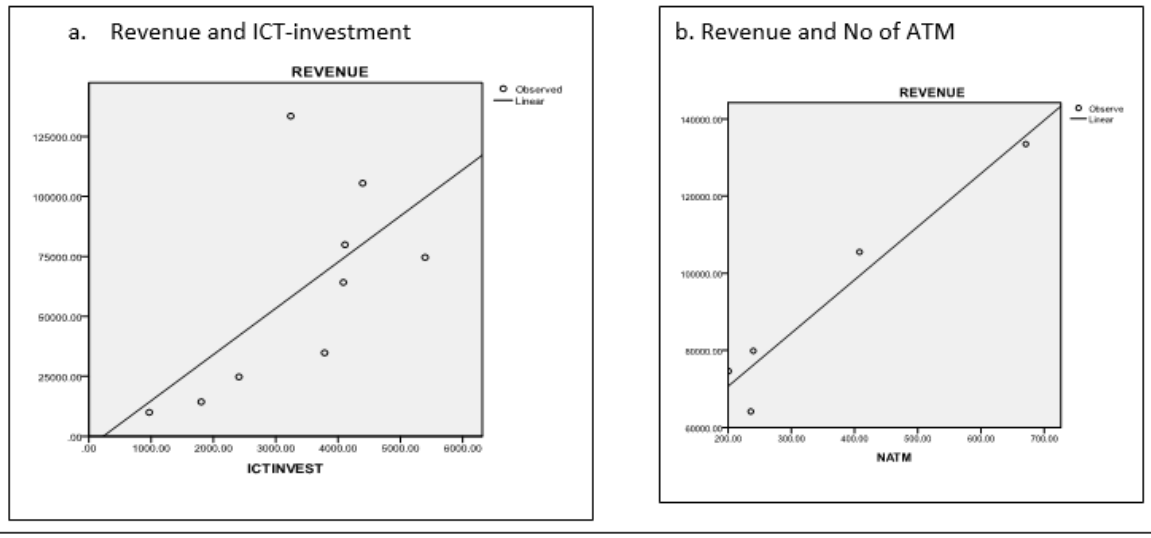
Source: Compiled by the authors (2015).

Figure 2: Relation between Revenue and ICT-Investment variables of ZENITH Bank Plc for 2005-2013.



Source: Compiled by the authors (2015).

Figure 3: Relation between Revenue and ICT-Investment variables of Diamond Bank Plc for 2005-2013.



Source: Compiled by the authors (2015).

The table 2 above shows the pooled data of ICT investment and the three selected Nigerian banks productivity from 2005 to 2013. In the table, the first two columns show the year trends from 2005 -2013 and the three sample banks in arranged forms from GTB, Zenith and Diamond Bank respectively. The third column shows the selected banks revenue or interest income, which proxies as bank productivity. Furthermore, the fourth and fifth column indicate ICT-capital investment and number of ATM for the selected banks, proxies as ICT-investment in this study.

Following the table 2 above, figure 1-3 was plotted to demonstrate the graphical relationship between ICT investment and banks productivity for each sample banks respectively, to draw an inference for the study.

Figure 1 consists of figure 1a and figure 1b showing the graphical relationship between ICT-investment and GTB productivity as well as number of ATM installation and GTB productivity respectively. The figure 1a depicts very high positive relationship between ICT investment and GTB productivity. This implies that GTB productivity is largely influence by the level of ICT investment. In same vein, figure 1b, however shows low positive relationship between the number of ATM installed and GTB productivity. Furthermore, it reveals that without ATM installation, GTB productivity would be positive, thus, productive.

In summary, the effect of ICT investment included variables do have positive impact on GTB productivity, in terms of interest income or revenue accrued for the covered period of 2005-2013.

Figure 2 also shows the graphical relationship between ICT-investment variables and Zenith bank productivity for the period 2005-2013. First, figure 2a found that a high positive relationship exist between ICT investment and Zenith bank productivity. In addition, it shows that without ICT investment, Zenith bank productivity would be positive. Also, figure 2b found a very high positive effect of ATM on Zenith bank productivity within the covered period. However, the graph depicts that without ATM installation, Zenith bank productivity would be negative and unproductive.

In summary, the result indicates that Zenith bank productivity is highly positively affected by the number of ATM installed, while the ICT capital investment , in terms of software purchase and computer machines are insignificant for Zenith bank productivity within the covered period of study.

Finally, figure 3 shows the relationship between ICT investment variables and Diamond bank productivity for the covered period 2005-2013. Both figure 3a and 3b found positive effect of ICT investment and number of ATM on Diamond bank productivity respectively. Though, the study established that without ICT investment, Diamond bank productivity would be highly negative. While without ATM installation, Diamond bank would still be positively productivity. Therefore, this study concludes that ICT investment is prerequisite for Diamond bank productivity within the period of study.

By and large, the summary result of figure 1-3 indicates that none of the included types of ICT investments do not positively affect the selected Nigerian banks productivity, in terms of interest income or revenue for the covered period of study. These findings reject the Solow “Productivity paradox” and support empirical works of Abri and Mahmoudzadeh (2015) as well as Miyazaki et al. (2012), though methodology differs.

4.2 Trends of Non ICT-Investment variables and Nigerian Banks Productivity: A Pool Trend Analysis

The cross-section trends of non ICT-investment variables and the selected Nigerian banks productivity from 2005 to 2013 is demonstrated in table 3 and figure 4-6 respectively as follows:

Table 3: Pooled data of non ICT-investment and selected Nigerian banks productivity (2005-2013).

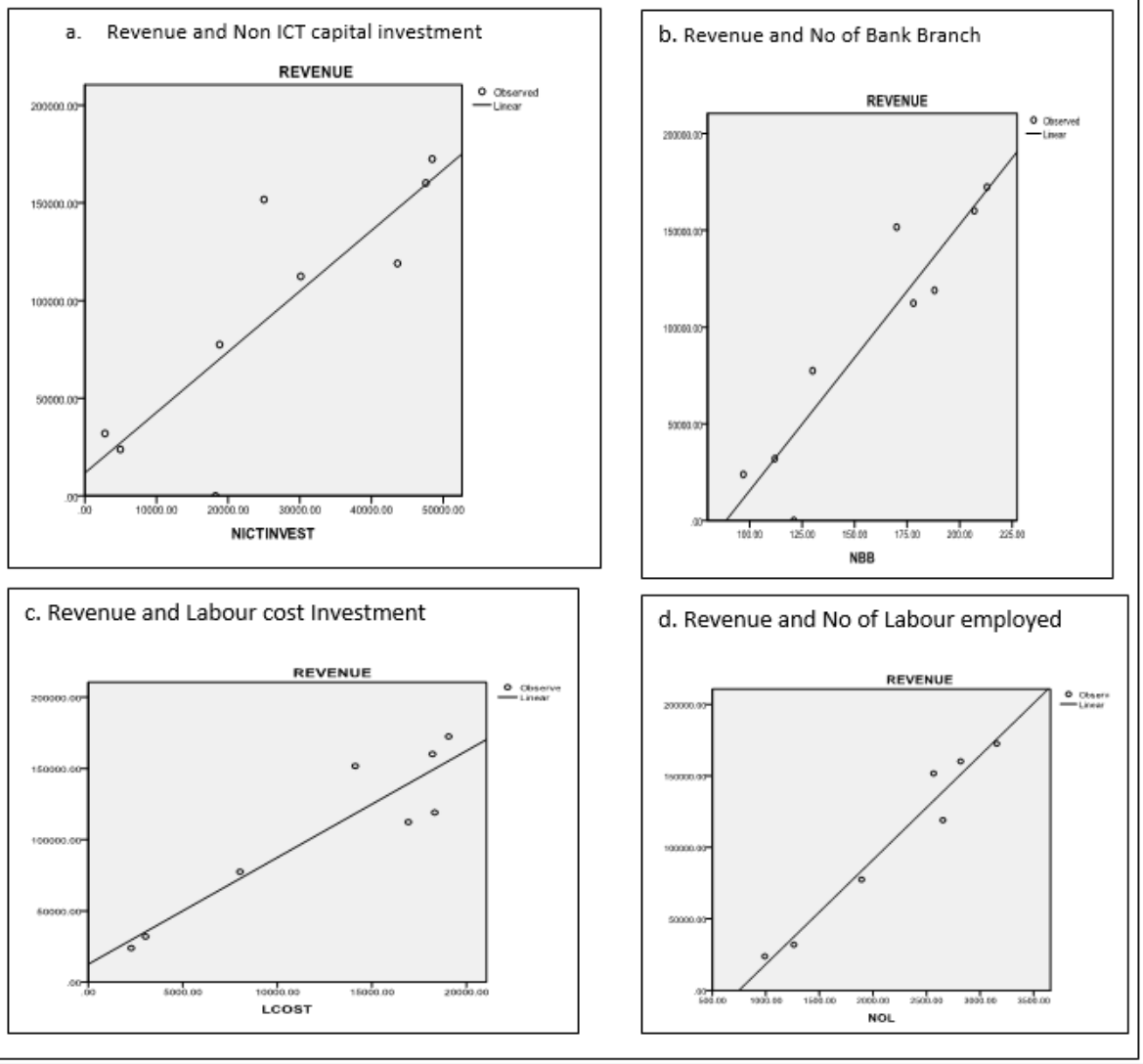
Year	Banks	Revenue	Non-ICT capital Investment	No of Bank Branch	Labour Investment	No of Labour
2005	GTB	23,834	4961	97	2276	990
	ZENITH	22,885	7406	130	5529	2627
	DIAMOND	10,010	1836	NA	3143	987
2006	GTB	31,970	2808	112	3030	1262
	ZENITH	37,295	14346	170	9225	3911
	DIAMOND	14,400	5305	85	3884	1632
2007	GTB	NA	18232	121	na	na
	ZENITH	62,017	22651	213	12630	4966
	DIAMOND	24,826	7283	NA	6525	2283
2008	GTB	77,464	18800	130	8026	1894
	ZENITH	137,815	30293	253	26649	7150
	DIAMOND	34,811	12150	NA	8487	2523
2009	GTB	151,698	25005	170	14120	2566
	ZENITH	186,019	38397	272	39674	7393
	DIAMOND	74,627	15688	na	9539	2605
2010	GTB	112,397	30131	178	16926	
	ZENITH	118,491	37548	293	29653	7190
	DIAMOND	64,176	22283	200	13028	2625
2011	GTB	119,016	43627	188	18319	2653
	ZENITH	155,871	42407	327	36875	7783
	DIAMOND	79,889	29134	na	14166	2686
2012	GTB	160,125	47577	207	18198	2819
	ZENITH	213,230	47217	na	37188	7164
	DIAMOND	105,512	25420	222	18545	2912
2013	GTB	172,433	48472	213	19055	3155
	ZENITH	243,852	48710	NA	45328	6615
	DIAMOND	133,485	33737	251	22755	3805

Source: Compiled by the authors (2015).

Note: Revenue proxies as Interest and similar incomes(in naira) and Non-ICT investment proxies as total fixed assets excluding capital work-in-progress and sometimes computer equipment (in naira) respectively.

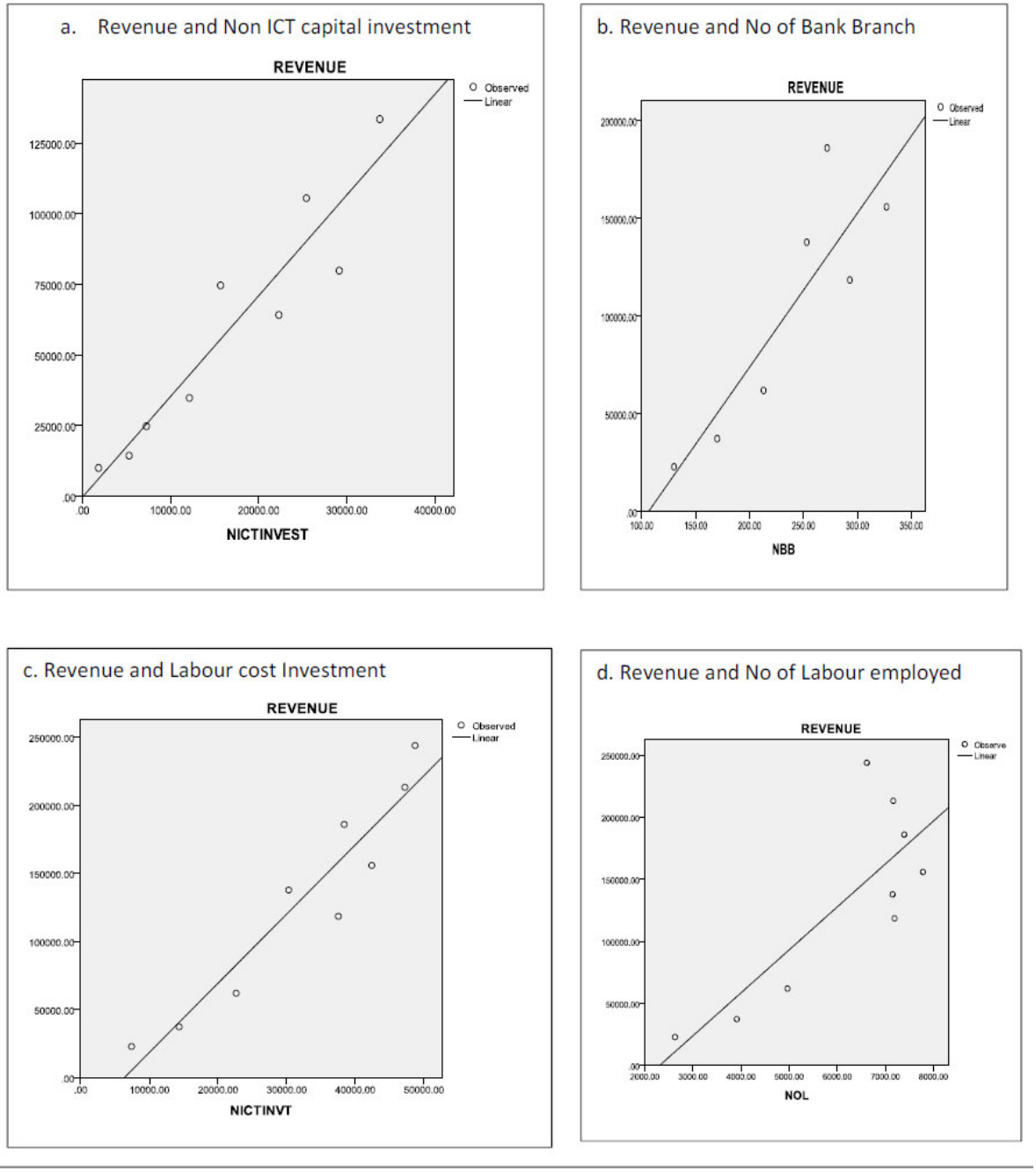
4.2.1 Graphical Least-Square Fitness Techniques for Selected Nigerian Banks (2005-2013)

Figure 4 : Relation between Revenue and Non ICT-Investment variables of GT Bank Plc for 2005-2013.



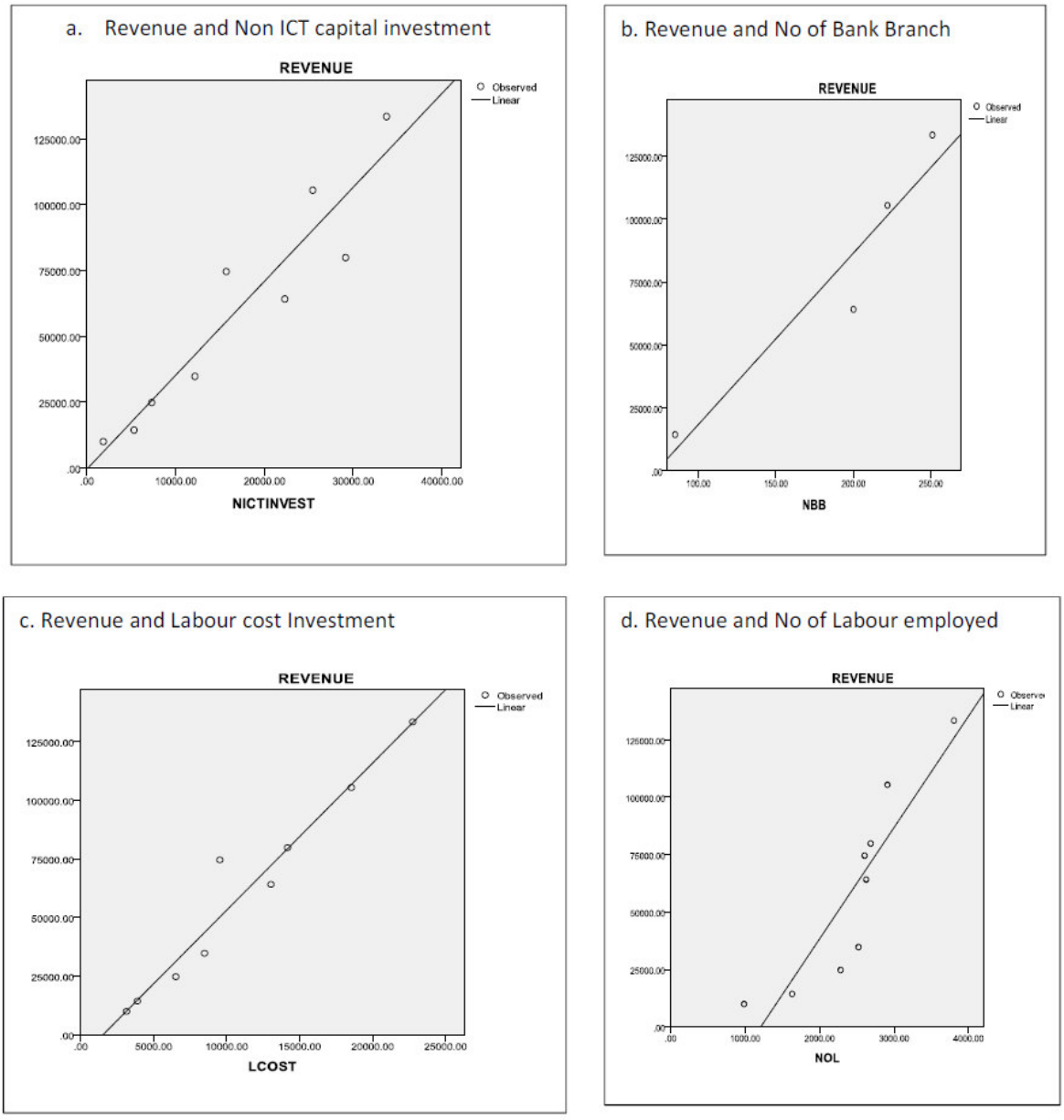
Source: Compiled by the authors (2015).

Figure 5: Relation between Revenue and Non ICT-Investment variables of ZENITH Bank Plc for 2005-2013.



Source: Compiled by the authors (2015).

Figure 6: Relation between Revenue and Non ICT-Investment variables of Diamond Bank Plc for 2005-2013.



Source: Compiled by the authors (2015).

The above table 3 shows the pooled data of non-ICT investment and the three selected Nigerian banks productivity from 2005 to 2013. In this table, the first two columns also show the year trending and the three sample banks. Also, column 3 shows the banks revenue which proxies as banks productivity. While the last four columns represent the non-ICT capital investment variables, which consist of non-ICT capital investment in column 5; number of bank branches in column 6 and column 7 and 8 show the labour investment and the number of labour employed respectively.

Figure 4 shows the relationship between non-ICT investment variables and GTB productivity. The result shows that without non-ICT investment and labour cost investment GTB productivity would be positive. This implies that both non-ICT investments and labour cost investment do not positively affects GTB productivity within the period of study. While the other included non-ICT investment variables, such as number of bank branch and number of labour employed, both positively affect GTB productivity and without these variables, GTB productivity would be negative and unproductive. This implies that out of all the non-ICT investment variables, number of bank branch and number of labour employed significantly affect GTB

productivity respectively.

Figure 5 also shows the graphical relationship between non-ICT investment variables and Zenith bank productivity within the period of study. The study reveals that out of the included non-ICT investment variables, only non-ICT capital investment has high positive significant impact but insignificant without inclusion on Zenith bank productivity. While the other included three ICT investment variables, such as number of bank branches, number of labour employed and labour cost investment, all have high positive impact with and without inclusion on Zenith bank productivity. This implies that non-ICT investments, that is fixed assets investment has lesser significant impact than other included non-ICT investments, specifically, number of bank branches, number of labour and staff salaries respectively within the covered period of 2005-2013.

Finally, figure 6 also exhibits the graphical relationship between non-ICT investment variables and Diamond bank productivity within 2005-2013. In this vein, the result revealed that only the number of labour, out of the included non-ICT investments do have high positive significant impact on Diamond bank productivity as well as the non-inclusion of this variable would result in unproductivity of Diamond bank. While other included non-ICT investments also have positive impact on Diamond bank productivity but their non-inclusion does not affect Diamond bank productivity. In conclusion, the study found that only the labour size and staff salaries out of the included non-ICT investments variables are necessary and sufficient for Diamond bank productivity for the covered period of 2005-2013.

By and large, the summary results from figure 1-6 indicate that both ICT-investment and non-ICT investment variables do have high positive impact on the selected Nigerian banks productivity but empirically the ICT investments included variables is superior to the non-ICT investment included variables for the selected Nigerian banks productivity for the covered period of 2005-2013.

5. Conclusion and Recommendations

Based on the graphical Least-Square fitness of this study, it is concluded that ICT-investments is more sufficient and superior than non-ICT investments usage towards banks productivity in the Nigerian banking industry from 2005 to 2013. Furthermore, the findings also supported the significance of the complementary role of non-ICT investments, especially the labour size and salaries to enhance ICT-investments objectives.

Following the findings and the conclusion, the study recommends the following towards improve and sustainable banks productivity in the Nigerian banking industry as follows:

- The bank management should restructure their capital investment portfolio towards allocating more capital for ICT investments including software purchases, hardware machines , more ATM installation as well as intensive utilization of the technology products at their disposal to improve and sustained banks productivity, in terms of interest income, profitability, earnings per share and others efficiency indicators.
- Furthermore, the banks should equally invest more on labour, in terms of quality labour size, staff development on ICT usage and staff remunerations to boost their productivity morale.
- Lastly, the Government should provide favourable business environment such as security of physical capital investments as well as ICT security and uninterrupted power supply to intensively utilize the ICT investments at reduced operating cost.

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