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Empirical Estimation of the Impacts of Wireless Mobile Phone Technology in the Diffusivity of Technologies and Productivity Growth of the Nigeria's Economic Sectors

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Abstract

In 1999, the GSM (General System of Mobile Telephone) and some Networks licensing started in Nigeria but was cancelled in the early quarter of 2000. A measure of industries' dependence on telecommunication hereafter called telecom dependence was defined to observe the influence of the share of expenditures on telecommunication out of total expenditure on intermediate inputs as stated in Jerbashian and Kochanova (2013). It has been shown that cell phones allow farmers to know the weather or input and output prices at the nearest market. Hence, the aim of the study is to determine the impacts of Wireless Mobile Phone Technology in the diffusion of technologies and productivity growth of the Nigeria's Economic Sectors. The marginal impact of mobile phone technology is higher in high-capital-intensive industries than in low-capital-intensive industries except in Media and Services industries in Nigeria. These two industries are the base of mobile phone technology and this could be the reason why less investment in capital does not affect the diffusion impact. The empirical results confirm that the diffusion of mobile phone technology in various sectors of the economy lead to labor productivity increase. A positive relationship exists between labor productivity growth rates and mobile phone subscription rates in Nigeria. The marginal impact of telecom diffusion is also positive as shown by the derived marginal impact rates by industry. Secondly, the question: "Is diffusion effect on productivity larger in more telecom-technology dependent industrial sectors?" The answer is not in the affirmative.

Keywords: Wireless mobile phone technology, economic growth, productivity, technology transfer

Introduction

In 1999, the GSM (General System of Mobile Telephone) and some Networks licensing started but was cancelled in the early quarter of 2000. In December of that same year, the Nigerian government started again the process in which they auctioned four wireless licenses. They did this, after they had canvassed for competent and credible bidders. There were four winners that emerged from this process and they agreed to pay $285 million (USD) license fee per winner. The winners were MTN (Mobile Telephone Networks), Econet (Airtel) Wireless Nigeria, CIL and M-Tel (NITEL). Three firms paid their license fees within the 14-day mandatory period while Communication Investments Nigeria Limited (CIL) failed to settle its license fee by making a deposit into the NCC bank account. This made CIL forfeit its license and the company was barred from participating in Nigerian Communications Commission (NCC) organized auctions. This would last for a period of five years. CIL went to court to contest this verdict given by NCC. They, however, lost. The firm's spectrum was allocated to the bidders of the Second Network Operator where Globacom emerged the sole winner. Over 25 licenses were granted to various firms by President Obasanjo (1999 to 2007) and President Yaradua /Vice President Good luck Jonathan (2007 to 2010). Moto-phone was a beneficiary and a more successful wireless phone operator than M-TEL. M-Tel got involved in a court case over its cancelled operational rights and sued the government of Nigeria represented by NCC.

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M-Tel lost the legal battle at the end and until now, its infrastructure lies idle, and the owner has placed such a high price on the firm that it is difficult to sell to other network operators. The GSM licenses in Nigeria cover a period of five years and it is renewable. Furthermore, it necessary to verify whether the availability of mobile phone technology has the ability to reduce cost and improve internal industry innovation (Tehranian, 1997). There are very recent literatures on the effects of mobile phones technology on agricultural development in particular. It has been shown that cell phones allow farmers to know the weather or input and output prices at the nearest market. Then, farmers can better predict when to plant the seeds, harvest the crops, and sell the crops. This reduces price dispersion and enhances productivity (Robert Jensen, 2007 and Aker & Mbiti 2010).Furthermore, there is also a literature on the effects of cell phones on mobile money, saving rates, and investment rates. Tavneet Suri (2011) observed that mobile phone technology increases productivity in the financial sector. It is also further observed that mobile phones help in reminding HIV patients on timely intake of their retroviral drugs. These sectors before the advent of mobile phone technology were less dependent on phone services. Hence, the aim of the study is to determine the impacts of Wireless Mobile Phone Technology in the diffusion of technologies and productivity growth of the Nigeria's Economic Sectors**.** Bearing all these considerations in mind, this research would verify how telecom technology diffusion has impacted on productivity of various sectors of Nigeria's economy. Specifically, the following research questions would be answered :(i).What is the impact of mobile phone technology diffusion on productivity in various industrial sectors? (ii).Is the effect of diffusion on productivity larger in more telecom-technology dependent industrial sectors?

A measure of industries' dependence on telecommunication hereafter called telecom dependence is the share of expenditures on telecommunication out of total expenditure on intermediate inputs as defined in Jerbashian and Kochanova (2013). The variable can reflect the industries' current state of the mobile technology adoption and therefore we use it as an estimate of technology adoption. Due to non-availability of this kind of complex data in Nigeria, the US data set was adopted from the US Bureau of Economic Analysis (BEA) Use Tables/Before Redefinitions/Producer Value for the years 1999 to 2016. It was calculated by deriving the ratio of the share of expenditures on telecommunication out of total expenditure on intermediate inputs for each industry. The use of the US data for Nigerian economic sectors is based on the assumption that sectors behave alike worldwide. Jerbashian and Kochanova (2013) also estimate dependence rates of industries in OECD (Organization for Economic Co-operation and Development) countries using the U.S. data based on the same assumption. The description of the variables is shown in Table 1while the basic statistics for the main variable are found. The mobile phone subscription rate was calculated as mobile telephone subscribers per capita (per 100 persons) in Nigeria from 1999 to 2016. The data were obtained from World Bank databases, 2013-2016. The variable can capture the progress of the latest mobile telephone technologies in Nigeria for the period of study and therefore it is an estimate of the state of technology.

Table 1. List of Definitions and Sources of Variables

Variable Name	Definition and Source
Industry–level Variables	
Sector capital labor ratio	The ratio of capital employed to labor employed in each Sector (1999–2016). Source: Authors' calculation using data from Nigeria Bureau of Statistics (2016).
Sector capital intensity	It is calculated by dividing total assets of industry by its sales. Source: Federal office of statistics, Abuja Nigeria (2016).
Sector Expenditure on R&D	It is the total amount of fund spent on research and development on each economic sector in Nigeria. It is expenditure on innovation in each sector (1999-2016). Source: Author's calculation using data on government yearly budget (expenditure) on the development of each sector. It is calculated as a percentage of yearly budget expenditure on each economic sector (Department of Economic planning and budgeting, 2016).
Industry Telecoms dependency ratio	The share of real expenditure on telecoms out of total expenditures on intermediate inputs in US sectors averaged over the period 1999–2016. Source: Author's calculations using data from. 1997-2013- 15 industries (XLSX), 71 industries (XLXS), 2007-389 industries (XLSX) from

	Bureau of Economic Analysis web site http://www.bea.gov/industry/io_annual.htm
Sector Labor productivity Rate	The unit productivity per employee in a sector (total sector output/number of employees) (1999-2016). Source: Author's calculation using sectors total output and labor force data from Federal office of Statistics, Nigeria 2016 and Central Bank of Nigeria Statistical Bulletin (2016).
Sector Labor productivity growth rate	Labor productivity growth rate is the change in growth level from year to year. This distinction allows for accurate description of economic policies on the long run growth. Source: Author's calculation using 1999-2016 total sectors output data and labor force data from Nigeria Bureau of statistics, Abuja.
Country level variable Mobile phone Subscription rates	The mobile phone subscription rate per 100 persons in Nigeria (1999-2016). Source: World Bank (2017).

Labor productivity was used as an index of industrial sector productivity rate. Let y_{it}^{*} be its productivity growth rate (which is the difference in labor productivity of the current year minus the previous year divided by the labor productivity of the current year). The period of study is from 1999 to 2016. Table 1contains the details of data while Table 2 offers the basic statistics.

Table 2. Summary Statistics

Variable	Obs.	Mean	SD	Min	Max
Labor productivity	255	118	1746	0	27888
Capital/Labor ratio	255	0.372	0.667	.0002	2.174
Mobile phone subscription rate	255	28	27	0	77
Dependence rate on mobile technology	255	0.089	0.172	0	0.734
Expenditure on R&D	255	5.6E+07	2.0E+09	0	9.99E+08
Capital intensity	255	887004	5294390	176	59873632

Industry R&D Intensity

This is the ratio of expenditures by an industry on research and development to the industry's sales. This variable was calculated by dividing the total expenditure on R&D by industry salable output. The current study derive classification of low and high R&D intensities from the data and the outcome is similar to EU R&D intensity classification in Survey on industrial R&D Investment Trends European Commission JRC/DG RTD (2013) in the Table below.

Table 3. R&D Industries

Low R&D intensive industries		High R&D intensive industries	
ISIC (ind.cl.)	NAICS CODES	ISIC (ind.Cl)	NAICS
A(01,02,03)	11	Education	61
Agriculture		P(85)	
Oil and Gas	211	Health	62
B(06)		Q(86,87,88)	
Solid Mineral			
B(05,07,08,09)	212, 213	Services	54,55,56
		S(93,94,95,96)	71,72,81
Wholesale & Retail	42,44-45	T(97,98)	I(56)
G(45,46,47)	493	R(90,91,92,93	
Transport	excluding 491	Public Admin /Defense	92

H(49,50,52)	&493 48-49		
Post &Telecom* H(53) J(61)	491, 517	Manufacturing C(10,…33)	31-33
Electricity D(35)	2211, 2212	Media J(58,59,60,62,63)	511,512 515,518, 519
		Water Resources E(36,..39)	2213
Finance and Insurance K(64,,66)	52		
Real Estate L(68)	53		
		Construction F41,42,43)	23

Source: Authors classification using R&D data from Federal office of statistics, Nigeria, 2017. Median expenditure on R&D by all industries was used as benchmark for grouping into low and high R&D intensive industries.

Capital Intensity

Capital intensity is the amount of fixed capital present in relation to other factors of production, most importantly labor. It is a measure of the amount of capital needed per dollar of revenue. It is calculated by dividing total assets of industry by its sales. In this study, fixed capital formation is approximated as capital. I derive the classification of capital intensive industries in this study from the data as explained above. The data is from Nigeria's Office of Statistics, 2016 and Federal Nigerian Ministry of Trade and Industries, 2016.

Method

Transfer of technology and diffusion of technology are most times used interchangeably in many scholarly literatures. In this work, the former is used to describe the process of transferring scientific knowledge, skills, and methods of manufacturing for practical purposes in industry from the technologically advanced country to the non-advanced country. In this paper, diffusion of technology is differentiated from transfer of technology and is used to describe the movement of technical knowledge received from the world frontier of technology to the various sectors of the economy of the recipient country. In my previous paper on technology transfer, it has been empirically established that mobile phone technology greatly assists in technology transfer by decreasing the cost of transfer. However, in this study, efforts are centered on the verification of the impact of these diffused technologies on the productivity growth of different industries (sectors) in Nigeria. In order to derive this, a baseline econometric specification is constructed to capture this impact of industry level technology diffusion on productivity growth.

Baseline Econometric Model Specification

The model below was constructed to provide answers to stated research questions. Let's define the labor productivity of industry i at time t as

$$Y_{it}^{*} \equiv \left(\frac{\text{output}}{\text{labor}}\right)_{it} \qquad (1)$$

for i = 1, 2, 3 …I, and let y_{it}^{*} be its productivity growth rate.
The model is written as:

$$y_{it}^{*}=\alpha_i+\beta_1\log\left(\frac{K}{L}\right)_{it}+\beta_2 mph_t+\beta_3 dpn_{it}+\beta_4 dpn_{it}\times mph_t+\beta_5 r\&d_{it}+\beta_6 k^{*}_{it}+\varepsilon_{it} \qquad (2)$$

for i = 1, 2, 3 …I, where y_{it}^{*} is the productivity growth rate, k_{it} is the logarithm of capital per labor, α_i is the industry fixed effects, mph_t is the mobile phone subscription rate per 100 persons, dpn_{it} is the dependence of industry i on mobile phone technology, $r\&d_{it}$ is the industry expenditure of industry i on research as a ratio to salable output, k^{*}_{it} is the capital intensity variable of industry iand ε_{it} is the error term (residual). The dependence on telecom technologies is the share of expenditures on telecommunication out of total expenditure on intermediate inputs. Mobile phone subscription rate is the mobile subscription per 100 persons in Nigeria. The capital-labor ratio is the logarithm of ratio of capital employed to labor employed in each industry. The interaction term of mobile phone subscription rate and dependency on mobile technology shows how the availability of mobile phone technology and the industry current level of technology adoption interact to impact on labor productivity. R&D represents the expenditure on R&D which is the total amount of fund spent on research, development and innovation in each sector. Capital intensity is a measure of the amount of capital needed per dollar of revenue in a given industry. The regression model for eq. 2 above was estimated using all variables above for all industries except R&D. This is because production can take place without R&D in the short run but not without capital.

In order to answer research questions (i) and (ii), we grouped all the industries into high- and low-capital-intensive and high- and low-R&D-intensive industries. We defined high-capital-intensive industries as industries with greater-than-the-median investment rate in capital and similarly, we define high-R&D-intensive industries as industries with greater-than-the-median expenditure in research, development and innovation. Specifically, in order to group the industries; the average capital intensity value for every of the seventeen industries for the period 1999 to 2016 was determined. Then using the median value, we classified them into high-capital-intensive industries and low-capital-intensive industries. Industries that have averages equal or less than the median value are grouped under low-capital-intensive industries otherwise high-capital-intensive industries. Therefore, the former are eight in number while the latter are nine in number. The same applies in grouping the industries into high- and low-R&D-intensive industries. The marginal rates of the diffusion impact on the industry's productivity (β_4) × (dpn_{it}) plus (β_2) are compared and tested for statistical significance.

Data and Measures

Using ISIC and NAICS industry classification systems at 2-digit and 2, 3, 4-digit respectively, Nigeria's economic sectors are categorized into seventeen industries. The period of focus is from 1999 to 2016. In this research, data are homogeneously collated mainly from Nigerian institutions and a few international organizations.

There are other industry classification codes like Global Industry Sector Codes which might classify Nigeria sectors better but due to the fact that my dependence variable data is based on US data, it is statistically wise to use the NAICS criteria. The major limitation of this study is that the dependence rates on mobile phone technology of industry sectors were calculated based on the US data due to the non-availability of such data for Nigeria. The intuition behind the use of US data for other countries was based on the assumption that economic sectors behave alike globally. For example, Jebershan and Kochanova (2013) applied the US mobile phone technology dependence rates to the European industry sectors. The study, applied the US rates to Nigeria industry sectors. However, the study have to admit that there is a possibility that the US industry structure is different from that of Nigeria.

Results

For the diffusion impact of mobile phone technology on R&D high-or low-intensive industries, aregression was conducted on eqn. 2 for eight high-R&D-intensive industries and for nine low-R&D-intensive industries by dropping R&D variable and controlling for capital intensity variable. The coefficients of the variables mobile phone subscription rate, dependence on mobile phone technology and their interactioncoefficients are positive in both high and low intensive groups. For high-R&D-intensive industries, the result found that in that (0.043(.065), (0.730(3.93) and (-1.78e-06), respectively, and are significant at 10% level. In case of low-R&D-intensive industries, also (0.142(0.110), (3.283(6.149) and (-0.0451). This implies positive correlation; however, the marginal impact on the industries is higher in low-R&D-intensive industries than high-R&D-intensive industries in Table 4. This could imply that mobile phone technology is bridging the gap caused by lack of investment in research and innovation in the low R&D intensive industries.

Table 4. Mobile Technology impact by industry R&D intensity

Low R & D industries		High R & D industries	
Agriculture	1.42E-01	Health	4.40E-02
Oil & Gas	1.4E-01	Water Resources	4.40E-02
Solid Mineral	1.41E-01	Education	4.40E-02
Electricity	1.40E-01	Construction	4.40E-02
Finance &Ins	1.36E-01	Manufacturing	4.40E-02
Wholesale & Retail	1.27E-01	Public Adm./Def.	4.40E-02

Transport	1.22E-01	Services	4.40E-02
Real Estate	1.13E-01	Media	4.40E-02
Post & Telecoms	-3.80E-02		

In order to study how industries with different capital intensities (high and low-capital-intensive industries) respond to diffusion effect of mobile phone technology, the regression was run by dropping the capital intensity variable and controlling for R&D-intensity variable. The low-capital-intensive industries are eight in number while high-capital-intensive industries are nine in number. The coefficients of mobile phone subscription rates, dependence on mobile technology ratios and their interaction terms are reported in Tables 5-7 for low and high-capital-intensive industries. They are (-0.005(1.009), -6.25(7.115) and (0.471(0.466), respectively, for the low-capital-intensive-industries but they are not significant. The regression for high-capital-intensive industries with the following coefficients are (0.63(0.114), (19.341(18.538) and (-1.15e-06(4.23e-06), respectively, and they are significant at 10% level.

Table 5. Baseline Specification Ordinary Least Squares Results of Technology Diffusion for high-capital-intensive industries, low-capital-intensive industries and all industries

	High capital	P > | t |	Low capital	P > | t |	All industries	P >|t|
Variables						
Mobile Subscription Rate	0.063	0.586	- 0.006	0.885	0.083*	0.235
	(0.114)		(0.041)		(2.623)	
Dependence on Mobile Tech	19.341	0.299	-6.257	0.381	2.794*	0.595
	(18.538)		(7.115)		(5254)	
Mobile Subscript*Dependence	-1.15e-06	0.787	0.471	0.315	-0.083	0.656
	(4.23e-06)		(0.466)		(0.187)	
Capital Labor Ratio	3.902	0.500	0.337	0.739	2.121	0.419
	(5.766)		(1.001)		(2.622)	
-Cons	0.713	0.799	1.642	0.307	-0.547	0.806
	(2.791)		(1.599)		(2.219)	
Capital intensity	-		-		-	
Expenditure on R&D	1.28e-06	435	5.68e-08	242	4.96e-09	0.455
	(1.64e-06)		(4.83e-08)			(5.43e-09)
Number of Industries	9	9	8	8	17	17
Number of Observations	119	119	135	135	255	255
	R-Squared: 0.0099		R-Squared: 0.0350		R-Squared: 0.0349	

Dependent variable: Labor productivity growth rate and the levels of significance are 1%, 5% and 10%. The standard errors are robust and reported in parenthesis. The sample period is 1999 -2016.

Table 6. Baseline Specification Ordinary Least Squares Results of Technology Diffusion industry fixed effects for high-capital-intensive industries, low-capital-intensive industries and all industries

	High capital	P > | t |	Low capital	P > | t |	All industries	P >|t|
Variables						
Mobile Subscription Rate	0.047	607	0.0014	0.978	0.088	0.041
	(0.092)		(0.049)		(0.043)	
Dependence on Mobile Tech	65.134	0.515	175.519	0.034	38.333	0.454
	(99.637)		(81.872)		(5254)	
Mobile Subscript*Dependence	-2.14e-06	0.943	0 .801	0.457	-0.072	0.724
	(0.000)		(0.542)		(0.206)	
Capital Labor Ratio	-33.869	201	-4.347	0.107	1.356	0.795
	(26.33)		(2.679)		(5.206)	
-Cons	-19.969	0.306	-14.405	0.074	-3.566	0.498
	(19.395)		(7.993)		(5.251)	
Capital intensity	-		-		-	
Expenditure on R&D	-3.15e-07	909	7.13e-08	336	9.26e-09	0.620
	(2.74e-06)		(7.38e-08)		1.86e-08)	
Number of Industries	9	9	8	8	17	17
Number of Observations	119	119	135	135	255	255
R-Square: 0.0225, 0.1545, 0.0111; R-Square: 0.0975, 0.0103, 0.0045; R-Square 0.0267,0.0028, 0.0023						
Hausman Test	Chi2(3) =3.07		Chi2(3)=9.61		chi2(3)= 3.33	
Prob>chi2= (0.3814), Prob>chi2= (0.022); Prob>chi2 =0.3436						

Dependent variable: Labor productivity growth rate and the levels of significance are 1%, 5% and 10%. The standard errors are robust and reported in parenthesis. The sample period is 1999 -2016.

Table 7. Baseline Specification Ordinary Least Squares Results of Technology Diffusion industry random effects for high-capital-intensive industries, low-capital--intensive-industries and all industries

	High capital	P > | t |	Low capita	P > | t |	All industries	P >|t|
Variables						
Mobile Subscription Rate	0.063	0.466	- 0.006	0.905	0.083*	0.147
	(0.085)		(0.049)		(0.041)	
Dependence on Mobile Tech	19.341	0.138	-6.122	0.597	2.794	0.728
	(13.048)		(11585)		(8.021)	
Mobile Subscript*Dependence	-1.15e-06	0.967	0.470	0.118	-0.083	0.682
	(0.000)		(0.001))		(0.203)	
Capital Labor Ratio	-3.902	0.534	0.035	0.841	2.121	0.147
	(6.277)		(1.732)		(1.463)	
-Cons	0.713	0.856	1.710	0.388	-0.546	0.749
	(3.017)		(1.978)		(1.709)	
Capital intensity	-		-		-	
Expenditure on R&D	1.28e-06	0.287	5.79e-08	324	5.96e-09	0.219
	(1.21e-06)		(5.87e-08)		(4.85e-09)	
Number of Industries	9	9	8	8	17	17
Number of Observations	119	119	135	135	255	255
R-Square: 0.0019, 0.6601, 0.028;		R-Square: 0.0365, 0.0329, 0.0347;			R-Square 0.0244, 0.2011, 0.0349	

Dependent variable: Labor productivity growth rate and the levels of significance are 1%, 5% and 10%. The standard errors are robust and reported in parenthesis. The sample period is 1999-2016.

The implication is that in high-capital-intensive industries, there is positive relationship between capital intensity, labor productivity and mobile phone technology. The marginal impact of mobile phone technology is higher in high-capital-intensive industries than in low-capital-intensive industries except in Media and Services industries in Table 9. These two industries are the base of mobile phone technology and this could be the reason why less investment in capital does not affect the diffusion impact.

Table 8. Mobile Technology impact by Industry capital intensity

Low Capital intensive		High capital-intensive	
Media	0.295	Health	6.30E-02
Services	0.098	Oil & Gas	6.30E-02
Real Estate	0.024	Electricity	6.30E-02
Wholesale Retail	0.009	Education	6.30E-02
Finance &Insurance	5.4E-02	Construction	6.30E-02
Solid mineral	-0.005	Manufacturing	6.30E-02
Water Resources	-0.005	Public Adm. /Def	6.30E-02
Agriculture	-6.00E-03	Transport	6.30E-02
Post &Telecoms	6.30E-02		

$$\frac{\partial y_{it}^{*}}{\partial mph_t} = \beta_2 + \beta_4 dpn_{it} \gtreqless 0 \quad (3)$$

The marginal impact in equation 3 above is then derived by differentiating equation 2 with respect to mobile phone subscription rate and the results are presented in Table 9.

Table 9. All Industry Average Dependence Rate and Marginal Impact

Industry	Dpn	Marginal Impact
Health	0	0.083
Agriculture	3.21E-06	8.30E-02
Oil & gas	2.08E-05	8.30E-02
Water Resources	0.00032	0.08297
Solid Mineral	0.00133	0.08289
Electricity	0.00337	0.08272
Education	0.01196	0.08201
Finance &Insurance	0.01274	0.08194
Construction	0.01987	0.08135
Manufacturing	0.0225	0.08113
Wholesale/Retail	0.0328	0.08028
Public ADM/Defense	0.04307	0.07943
Transport	0.0449	0.07927
Real Estate	0.06425	0.07767
Services	0.2216	0.06461
Post &Telecoms	0.39906	0.04988
Media	0.63913	0.02995

In order to confirm the authenticity of these results, some specification checks (fixed effects and random effects) tests were conducted and the result found that the values do not change. The correlation matrix of the variables in the labor productivity growth rate regression does not depict incoherent noise in Table 10. Therefore, the test is good and efficient.

Table 10. Correlation Matrix of the Variables in the Labor Productivity Rate

	LABPRRATE	MPH	DPN	DPNMPH	CPTALBORATIO	CAPITNSTY
MPH	0.1427					
DPN	-0.0273	0.0193				
DPNMPH	0.0096	0.3362	0.6559			
CPTALBORATIO	0.0858	-0.2405	-0.241	-0.1668		
CAPITNSTY	0.0991	0.1035	-0.105	-0.0662	0.0474	
EXPRD	0.0693	0.0163	-0.141	-0.0995	0.0995	0.744

The overall findings of this research give evidence-based, revealing answers to the following questions investigated. In the first place, we asked the question, "What is the impact of new telecoms technology diffusion on productivity in other industrial sectors?" The empirical results confirm that the diffusion of mobile phone technology in various sectors of the economy lead to labor productivity increase. A positive relationship exists between labor productivity growth rates and mobile phone subscription rates in Nigeria. The marginal impact of telecom diffusion is also positive as shown by the derived marginal impact rates by industry. Secondly, the question: "Is diffusion effect on productivity larger in more telecom-technology dependent industrial sectors?" The answer is not in the affirmative. The findings show that industries that are less telecom dependent have larger marginal technology diffusion impact. The diffusion impact in industries such as media, post and telecommunications and services can attest to the above claim. These industries depend more on telecom technology but they have least diffusion impact. Thirdly, the research question, "Is the diffusion effect on productivity larger in more internally innovative (R&D)-intensive industrial sectors?"Based on the classification adopted in this study, the diffusion impact is positive and low in high R&D intensive industries but high in low R&D industries. This could imply that mobile phone technology is bridging the gap caused by lack of investment in research and innovation in the low R&D intensive industries. Fourthly, we ask the question "Is the diffusion effect on productivity larger in industrial sectors that have a higher investment rate in capital?" It is found that the low capital intensive industries have less impact of the diffusion of mobile phone technology than the high capital intensive industries. Therefore, industries that invest at high rate in capital tend to have larger returns to capital and greater impact from technology.

Conclusions

In this research, industry data were used to show the impact of diffused telecom technology on seventeen sectors labor productivity in Nigeria from 1999 to 2016. It was found that the diffusion of this new mobile phone technology enhances labor productivity growth rate in various industrial sectors. This significant trend is outstanding in industries that are less dependent on telecoms technology. This outcome confirms the claim of that industries that are hitherto not exposed to a new technology tend to gain more from its introduction. The diffusion effects are more pronounced in low-R&D-intensive industries than high-R&D-intensive industries. It is the view of this paper that mobile phone technology bridges the gap created by less investment in research by low-R&D-intensive industries. In another development, the mobile phone technology diffusion impact in high-capital-intensive industries is higher than the impact in low-capital-intensive industries. These labor productivity gains that are wide spread in the economy are affected by capital intensity. In addition, it is right to believe that the marginal gains of mobile phone technology industry diffusion is higher in industries that are less dependent on it than those that are more dependent. Finally, wireless phone technology, therefore, helps to remove the inequality in the distribution of innovative benefits among industries.

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