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Innovation and Human Development Perspectives in West Africa

Dominic E. Azuh[1], Jeremiah O. Ejemeyovwi[1], Queen Adiat[1], and Babatunde A. Ayanda[1]

Abstract

Innovation during this era of globalization plays a crucial role in the growth and development of an economy. This study empirically investigates the role of research and development (innovation) on human development in West Africa (2004—2014). The estimation techniques utilized to carry out the objective are the standard variations of the Generalized least squares—Panel Fixed and Panel Random effects estimation techniques. The empirical results show that research and development in West Africa has a statistically significant positive impact on human development which emphasizes the potentials of human development to be harnessed by consistent research and development. The study recommends increased research and development (innovation) through adequate research and development funding and university-industry partnership for real human development problems to be solved.

Keywords

human development, innovation, research, university-industry partnership

Introduction

The African continent is the second largest and second most populous continent in the world, endowed with rich natural resources and yet the poorest. Incidentally, majority of the world's poor countries, living on $1 a day or less are in Africa (Caesar et al., 2018). Causes of these ironies include lack of research and innovation, poor domestic and external market shocks, production of non-competitive goods, and non-diversification of the economic base of these nations. Research (innovation) is the core of human progress, comfort, a meaningful life, value, and technological advancement. Every sphere of life is touched by research and innovation. Research brings the product of science to the people and guarantees innovation which impacts all areas of human endeavor. Research creates knowledge that can be used to improve workplace organization and therefore provide very large payoffs in terms of productivity which further spurs economic growth (Bello et al., 2020). It is a major driver of information and communication technology (ICT) that influence people's opinion, culture and widen the advantage of globalization. Research builds up knowledge which is an intangible human capital that increases productivity in business operations which significantly improves growth in turn.

The world is in the midst of research driven revolution leading to economic development. The product of research has impacted every sphere of life, be it social, economic, cultural, political, and technological aspects of human endeavor. The impact of research with respect to ICT adoption is what significantly distinguished countries such as Singapore, India, Taiwan, China, Korea, and Malaysia from other developing countries. It is the oil that lubricates the engine of socio-economic transformation of any nation and encourages industrial development. With the development of mobile banking and e-commerce, the concept of market has not only been demystifying but improved upon in terms of its operational efficiency, cost reduction and facilitates location tracking of client's goods at any point in time as seen with companies such as Jumia, and Konga.

By way of definition, research is the systematic investigation, probe, enquiry, and analysis to establish existing facts or new ones to come up with a new generalization or consolidate old facts. According to Okojie (2017) applied research is initiated to address a specific need and seeks knowledge that will facilitate the process for achieving the desired result, as it delves into raw materials manufacturing, energy, exploration activities, and health among others. Innovation is

[1]Department of Economics & Development Studies, Covenant University, Ota, Nigeria

Corresponding Author:
Ejemeyovwi, O. Jeremiah, Department of Economics and Development Studies, & Centre for Economic Policy and Development Research, Covenant University, Ota 112212, Nigeria.
Email: jeremiah.ejemeyovwi@covenantuniversity.edu.ng

concerned with ideas, change, and positive value addition on the existing way of doing things. While Atayero (2019) refers to innovation as the implementation of a novel idea which addresses a specific challenge and achieves value for both the company and customer in a new (and potentially disruptive) way; Caesar et al. (2018) states that research and innovation involves coming up with well-designed and efficient production techniques for current production and also the creation of new and improved products.

The 23rd Ordinary Session of African Union Heads of State and Government Summit, in June 2014, adopted a 10-year Science, Technology, and Innovation Strategy for Africa (STISA-2024); with its strategy aiming at supporting the AU Agenda 2063 which has science, technology and innovation as enablers for achieving continental development goals (African Union, 2014). Also, according to Atta-Mensah (2015) the Agenda stresses on the diversification of sources of growth and a strong need to sustain the current robust economic performance of Africa so that a large section of people of Africa are lifted out of poverty. Notably, a strong research base is the fulcrum to achieve sound economic competitiveness and social transformation that will include the much sought-after human capital development, industrialization and meaningful entrepreneurship. All the six priority areas of STISA-2024 ([i] Eradication of Hunger and Achieving Food Security, [ii] Prevention and Control of Diseases, [iii] Communication [Physical and Intellectual Mobility], [iv] Protection of our Space, [v] Live Together-Build the Society, and [vi] Wealth Creation) anchor on solid research and innovation.

Innovation is the applicative aspect of research that directly lead to socio-economic transformation, poverty reduction, and industrialization within an economy. Innovation is essential in the globalization process and furthermore, helps achieve work demands across commerce, manufacturing, and health sectors of any economy. Research-innovation finds more application in computers, multimedia equipment, assistive technological devices and gadgets. Illustratively, innovation finds merits in e-health care and m-health, electronic governance, employment of youths and migrant workers, e-commerce, e-learning, and e-security, thereby contributing to the growth of the economy. African countries have relatively weak research infrastructure, lack research capabilities and research experience. It is not surprising to note that the gross expenditure on research and development intensity of 1% gross domestic product (GDP) has not been reached by the vast majority of African countries. According to African Union & New Partnership for Africa's Development (2010) only Malawi, Uganda, and South Africa spend above 1% of their GDP on research and development (R&D), whereas the remaining 16 countries in the 19-country survey spend only between 0.2% and 0.48%.

Despite the importance of research, and the agreement of African countries to develop their research activities through investment, Economic Community of West African States (ECOWAS) has invested little in research (science, technology, and innovation) over the past three decades. Lemarchand (2015) emphasizes that Mali (0.7%) is the closest to the AU's target while other West African countries such as Ghana and Nigeria reported 0.4% and 0.2% which are less than half the world average of 0.4%. Where will this take us, in a world of technology and globalization? The answer is obviously nowhere! This lack of investment in research has handicapped development in strategic areas of West Africa. Furthermore, West Africa's research expenditure performance was averaged at about 0.3%.

Drawing from the above introductory paragraphs, the objective of this study is to examine innovation's impact on human development in West Africa. To achieve this, the study utilizes panel dataset with the fixed and random effect techniques of estimation. The paper is structured as follows: Section one contains the introductory section, section two consists of the literature review on the subject matter, to examine the various reports of researchers to provide the theoretical and analytical framework upon which the research is built, section three consists of the methodology, section four consists of the results and discussion, while section five discusses the conclusion and recommendation of the study on ways to drive human development through innovation.

Literature Review

Innovation occurs in many facets and it also cuts across various aspects of the economy, including finance, trade, production, technology, academic research, agriculture, and security (Klein & Woodell, 2015). If harnessed effectively, nearly all forms of innovation are capable of impacting human development positively (Pellicer-Sifres et al., 2017). Yet, over decades, studies explored innovation mainly in the context of technology diffusion, and how advancement in technology could lead to positive outcomes in health and education (AfriAfya, 2007; Chandrasekhar & Ghosh, 2001) and more recent studies continue to create similar links as seen in (Kuyoro et al., 2012; Salahuddin & Alam, 2016; Ejemeyovwi et al., 2018; Ekong et al., 2019; Olaloye et al., 2019).

It appears, based on reviews, that a consensus has been reached with regard to innovation promoting sustainable development. Nonetheless, the focus is mainly on the manner in which innovation in science, technology, engineering, and mathematics (STEM) would lead to development, causing other innovative ventures such as cultural and social innovation, to be sidelined (Braunerhjelm, 2010; Jowi et al., 2012; Klein & Woodell, 2015; Pellicer-Sifres et al., 2017). This has been attributed to the fact that the flexibility in these other forms of innovation apart from technology, creates difficulty in their measurement, and could render attempts at creating estimates inaccurate (Archibugi & Coco, 2005). This is especially true for developing countries such as those in West Africa, where measurements for innovations might not be standardized, and where data are unavailable

(UNESCO, 2005). However, more recent standardized data such as the 2019 World data index, covers indicators for various forms of innovation, including mobile data coverage, academic research, and agricultural productivity.

The theoretical pillars of this study are found in the works of Schumpeter (2005), and the National System of Innovation theory (Lundvall, 1992; Nelson, 1993; Freeman, 1995). These theories emphasize the role of innovation and its flow among the actors (the individuals, firms, and the government) in an economic system. More so, within an economic system, Fagerberg et al. (2010), examined social innovation, as well as technological improvements and their effects on development. A lot of emphasis was placed on production, trade, and whether or not firms were likely to innovate ideas, that would facilitate trade investments and contribute to economic growth. However, Stanton (2007) pointed out that for a country's human development index, to be considered as advancing, there have to be improvements in education, health outcomes, and standard of living alike, and not just economic development.

Klein and Woodell (2015) deviated from what they described as a narrow view of economic development and adopted a broader definition of the concept. The study defined economic development as the process where an economy strives for sustainable improvements in the standard of living through innovation. The study went further to depict how economic development was the nexus between innovation, human capital, and institutions. Other studies corroborated these findings by concluding that academic institutions, in particular, contribute to economic development and remain an integral part of innovation (Meek et al., 2010; Oluwatobi et al., 2014; Marić & Kristina, 2016; Nübler, 2016).

The effect that academic innovation from research has on human development has been expressed as being both direct and proximate (Acemoglu et al., 2014). A proximate determinant relationship could explain how higher levels of educational attainment, and novel ideas, strengthen negotiating powers and facilitate better pay, thus improving the standard of living (Pendleton & Yang, 1985; Gangadharana & Valenzuela, 2001). The availability of resources from earnings could also lead to improved health outcomes at the individual level (Oni, 1985; Zimmerman & Woolf, 2014), manifested in better lifestyle choices, improved health seeking behavior, and better access to treatment and rehabilitation (Pampel et al., 2010). At the national level, greater earnings from better education could contribute to the national income and could in turn, lead to improved health care, thus impacting human development (Anand & Ravallion, 1993).

Human development index is considerably lower in West Africa, compared to other of African regions. Gyimah-Brempong et al. (2006) performed a panel analysis of human development in African countries, covering 40 years from 1960 to 2000. The study found that the impact of education on human development was significant and increased steadily across the decades. Unfortunately, the study also confirmed that in West Africa, a huge portion of the investment made on human capital is lost by emigration. Studies have also pointed out that innovation does not stem from all forms of education, and that education effects development to different degrees (Acemoglu et al., 2014). The nature of education received greatly affects the quantity and quality of innovation output in the region. Ukwuoma (2015) concluded that inculcating indigenous African education results in better quality and performance. In addition, it was noted that essentially, education remains of particular importance in innovation because it creates an avenue for sophisticated innovation, particularly in the field of science and technology (Marić & Kristina, 2016).

Harnessing the benefits of innovation in order to leapfrog the stages of economic development has been a major development discourse in the last decade. Technological innovation has potential to positively affect human development in West Africa, by improving healthcare and raising the standard of living (AfriAfya, 2007; Ejemeyovwi et al., 2018). This is because ICT innovations would upgrade information dissemination in the health sector, enable remote consultation, and ensure that systems are effectively monitored and evaluated (AfriAfya, 2007). Mobile phone technology would also have a tremendous impact on human development by improving gender empowerment and education (Asongu et al., 2016; Ejemeyovwi & Osabuohien, 2020). However, for innovation to be effective, it should be kept simple and made to be relevant in solving challenges as they arise. AfriAfya (2007) also recommended that more systematic studies are required to measure the effect that ICT has on the health outcomes in developing countries. This could be because a variety of reports, reviews, and policy documents abound that explore the potential that innovation has on human development.

The human development index is ranked based on a high standard of living, good health, low mortality, and a high quality of education as well as education coverage (United Nations Development Program [UNDP], 2018). Despite the fact that economic growth is on the rise in some West African countries, unequal distribution of income, and consequently, unequal outcomes in health and education, make them unable to harness the dividends of economic growth causing them to rank low on human development index (African Development Bank, 2013). Although the relationship between innovation and economic growth has been researched, the nature of the relationship is still not understood (Ramadani & Veland, 2010). Nübler (2016) argued that while technological innovation could improve development by creating jobs and improving the standard of living, sophisticated innovations could also obviate the need for human capital, and as such reduce employment level, the standard of living and by extension, reduce the human development index. For innovation to have an effect at the national level, there must be a favorable socio-economic, legal, and political climate (Oluwatobi et al., 2014;

Zanello et al., 2015). Also, to drive innovation, investment in ICT (Ejemeyovwi et al., 2018), education and research (Alalade et al., 2019); and at the same time, political development to ensure intellectual property security, (Ramadani & Veland, 2010).

Disputing the fact that technologies and innovation have been major drivers of human development progress is difficult (Karakara & Osabuohien, 2019). Innovation plays a significant role in economic and social development in most less-developed and developing countries. Innovation faces a range of modern and serious challenges, particularly in developing countries exposed to climate change (Ejemeyovwi, Gershon & Doyah, 2018), price shocks, energy insufficiency (Ejemeyovwi, Adiat, & Ekong, 2019), and continued infrastructural deficiencies in rural areas. The 21st century signaled an unprecedented leap in the pace of innovation and technology adoption unlike any other time in history. Hence, adoption of efficient innovation cannot be overemphasized in the provision of an array of advantages to a country's economy and human development (Akerkar et al., 2016).

Method of Analysis

The Empirical Model

The formulation of the study's empirical model is derived from the empirical model of Ejemeyovwi and Osabuohien (2020), which assumes an augmented Schumpeterian growth model which is also an extended version of the endogenous growth theory. The study expressed growth as a function of institutions, technology, and other growth components. The model explains that for growth in human development to be achieved, a number of factors must be present such as institutions, technology adoption, and innovation alongside the necessary control variables as initially emphasized by Ejemeyovwi, Osabuohien, Johnson, et al. (2019).

The simple implicit functional form of the model is given as:

$$HDI_{it} = f(Inn_{it}, Pse_{it}, Rule_{it}, Credit_{it}, Ecogrwth_{it}, Intusit) \quad (1)$$

Where "HDI_{it}" represents human development index of country "i" at time "t," inn represents innovation which is expected to affect human development positively; "PSE_{it}" represents primary school enrolment; "$RULE_{it}$" represents institution; "$CREDIT_{it}$" represents domestic credit provided by financial sector; "$Ecogrwth_{it}$" represents GDPs growth rate in the model; and "$Intus_{it}$" represents which captures technology adoption.

Specifying equation (1) explicitly as following an augmented Cobb Douglas production functional form, produces equation (2). The C-D production function is assumed because of the input-output system as found in the endogenous and Schumpeterian growth models. Hence, Equation (2) is presented below:

$$HDI_{it} = Inn_{it}^{\alpha}, Pse_{it}^{\beta}, e^{Rule_{it}^{\mu}}, e^{Creditit\Omega}, e^{Ecogrwthit\pi}, Intus_{it}^{\infty} \quad (2)$$

The non-linear nature of the model invoked the need for a logarithmic transformation to be employed to linearise the empirical model. Notably, the exponential function symbol was introduced with the intention of justifying the non-logged variables because mathematically, the log of an exponent equals the actual value. This is necessary to justify the variables that were not log-transformed within the nonlinear C-D function for various reasons from theory. More specifically, the two variables (Credit and Ecogrowth) which are measured in percentages were also not log transformed. Also, Institutions (rule of law) on the other hand has many negative values which cannot also be logged, hence the introduction of the exponent function for that variable. Thus, the model in its double log form is presented in equation (3):

$$hdi_{it} = \alpha.inn_{it} + \beta.pse_{it} + \mu.rule_{it} + \Omega.credit_{it} + \pi.ecogrwth_{it} + \infty.intus + \mu_{it} \quad (3)$$

Ejemeyovwi and Osabuohien (2020) avowed the use of human development index as a measure of human development, consistent with the African knowledge economy as the measure captures the necessary perspectives to the development of the labor force of economies. The development of the labor force is a guaranteed way to increase productivity and growth in economies hence the measure (HDI) indicates the level of the welfare of the labor force. The control variables are consistent with literature for inclusive growth—development (Binder & Georgios, 2011; Ejemeyovwi & Osabuohien, 2020) and also essential for the Schumpeterian growth model. The apriori expectations of study from theory state that innovation should have a significant positive impact on human development in West Africa.

Oluwatobi et al. (2014) and Ejemeyovwi, Osabuohien, Bowale, et al. (2019) justified the measure of innovation by the number of scientific journal articles. The studies outlined that

> Scientific journal articles capture output from innovation compared to other measures because innovative individuals from various disciplines readily express their ideas through scientific journal publications. Profitable innovative ideas that emanate from non-engineering disciplines can easily be stored for retrieval/referral. Such innovative ideas may not require patenting; hence, scientific and technical journal articles will be a veritable platform for expression of such. 2) The process of securing a patent and trademark, such as documentations and requirements, is cumbersome especially in most African countries. In Nigeria, for instance, the process involves bureaucratic exigencies, which cause delays in securing the protection of innovative ideas. Some

Table 1. Variables Definition, Mean and Source of Data.

Data	Identifier	Data source	Measurement
Human Development (proxied by HDI)	HDI	UNDP (2015)	Unit
Innovation (Scientific and Technical Journal)	Inn	World Bank (2018a)	Unit
Number of Internet Users per 100 people	Intus	World Bank (2018a)	Unit
PSE (pupils)—female	PSE	World Bank (2018a)	Number
Institution: Rule of Law	Rule	World Bank (2018b)	Unit
Domestic credit by financial institutions	Credit	World Bank (2018a)	Percent of GDP
GDP per capita growth rate	Ecogrwth	World Bank (2018a)	Percent

Source. Compiled by the Authors'.
Note. HDI = human development index; UNDP = United Nations Development Program; PSE = primary school enrolment; GDP = gross domestic product.

innovative outputs and ideas may therefore end up insecure and stolen. Others may end up becoming obsolete and unnecessary before they are registered.

Number of internet users is used as a proxy for technology adoption as specified by the augmented Schumpeterian model: primary school enrolment (PSE), institutions, domestic credit by financial institutions and GDP per capita growth rate are necessary factors that from theory, also contribute to human development, hence, the inclusion of these variables is necessary to eliminate omitted variable bias which could affect the reliability and validity of the estimated coefficients to be derived by the empirical estimation and investigation (Ejemeyovwi et al., 2020).

Technique of Estimation

The study adopts the methodology utilized by Ejemeyovwi et al. (2019) which uses the dimensions of the generalized least squares (GLS): the fixed effects estimation technique, random effects estimation technique and the Hausman specification test. The fixed effect estimation (FEM) strategy accounts for the unobserved heterogeneity between countries within West Africa. Furthermore, FEM caters for the possible individual fixed effects that could occur from the nature of the panel data and bias the estimated result. The random effect (REM) panel data analysis also exist on the other hand as a variation of the FEM. The REM assumes that there is no correlation between the error term and the independent variables (absence of fixed effects). The Hausman test (probability value of the chi-square test) is usually performed after the FEM and REM to determine the most appropriate between the two. The estimated coefficients could be used to determine the degree of relationship and impact existing between the variables of interest.

Sources of Data and Variable Description

The dataset utilized during the course of this study consists of a panel dataset of 15 West African countries, covering the period 2004 to 2014. The period was strategically selected based on sporadic increase in innovation within the region and data availability to reduce panel attrition which could also affect the reliability of the estimated results. The data were sourced from World Development Indicators (World Bank, 2018a), World Governance Indicators (World Bank, 2018b), and United Nations Development Project (UNDP, 2015). The variables included in the empirical model above are defined in Table 1 below with the presentation of the sources of data.

Table 2. Multicollinearity Test A: Pairwise Correlation Matrix.

Variable	Lintus	Inn	PSE	Rule	Credit	Ecogrwth
Lintus	1.00					
Inn	.07	1.00				
PSE	.35	−.05	1.00			
Rule	.34	−.11	.18	1.00		
Credit	.29	−.28	.56	.19	1.00	
Ecogrwth	.11	.09	.08	.33	.07	1.00

Source. Compiled by the Authors' using Stata 13.
Note. PSE = primary school enrolment.

Results and Discussions

Multicollinearity Test

Table 2 presents the Pairwise correlation matrix for the variables in the model; the existence of strong correlation among the independent variables may violate the working assumptions of the estimation technique and hereby produce unreliable estimates. The result indicates that the strongest correlation is seen between PSE and domestic credit (credit), followed by the relationship between (Inn), and internet users (intus). The overall assessment of the Pairwise correlation shows that multicollinearity (a perfect relationship) is absent in the model which guarantees the reliability of the model.

Table 3 presents a sensitivity check for the existence of multicollinearity: Variance Inflation Factor Test (VIF). The rule of thumb for interpreting the VIF states that if the VIF values are greater than (>10) or the 1/VIF values are less than 0.10 (<0.10), there is presence of multicollinearity. The

Table 3. Multicollinearity Test B: VIF.

Variable	VIF	1/VIF
Credit	3.33	0.30
Intus	3.00	0.33
Rule	2.85	0.35
Inn	2.76	0.36
PSE	1.98	0.50
LGDPCGR	1.13	0.88
Mean VIF	2.51	

Source. Compiled by the Authors using Stata 13.
Note. VIF = Variance Inflation Factor Test; PSE = primary school enrolment.

Table 4. Panel Autocorrelation Test.

Wooldridge panel autocorrelation	
$F(1, 6)$	2.048
$p > F$	0.20

Table 5. Hausman Test Result.

Hausman	
p: .02	
Fixed effect	Random effect
Accept	Reject

Source. Compiled by the Authors using Stata 13.

VIF values in the table for all the variables satisfy the condition stated above. Hence, there is absence of multicollinearity in the model.

A further preliminary test for panel autocorrelation is carried out to check for the existence of autocorrelation which could affect the reliability of the result. The rule of thumb states that if $p > F$ is insignificant, then there is absence of serial correlation. The probability value of the F statistics in Table 4 is insignificant (>.05), there is absence of autocorrelation.

Econometric Results

The rule of thumb for deciding the most appropriate GLS model (between the REM and FEM) states that: Having run the fixed effect technique before the random effect technique, if the Chi-Square probability value is less than .05, the FEM is most appropriate and if the Chi-Square probability value is greater than .05, the REM is most appropriate for estimation. Furthermore, the use of the FEM signifies the presence of individual specific fixed effects which could affect the result if not taken care of during the estimation process while the choice of the REM indicates the absence of the individual specific effects. Table 5 shows the Hausman test result:

Table 6. Generalized Least Squares Result (Dependent Variable: Human Development).

Variables	FEM	REM
Innovation	0.014*	0.010**
	(0.00)	(0.09)
Primary school enrolment	0.086*	0.906*
	(0.00)	(0.00)
Institution (rule of law)	−0.16*	−0.011**
	(2.48)	(0.09)
Domestic credit provided by financial sector	−0.0048	−0.0025
	(0.66)	(0.73)
Economic growth	0.00085	0.00039
	(0.36)	(0.87)
Internet usage	0.02*	0.02*
	(6.24)	(0.00)
Constant	−1.96*	−2.02*
	(9.36)	(0.00)
F statistics	82.91	
$p > F$	.000	
Wald Chi^2 (5)		455.68
Corr (u_i, Xb)	−0.20	0
Number of observations	97	97
Number of groups	15	15

Source. The Authors'.
Note. The values in the round parenthesis "()" are the t statistic values. FEM = fixed effect estimation strategy; REM = random effect.
*Denotes that the coefficients are significant at 5% level. **Denotes that the coefficients are significant at 10% level.

The Hausman test shows that the fixed effect technique of estimation is the most appropriate given the characteristics of the dataset. This implies that the existing individual specific fixed effects are being taken care of. The F statistic and its probability value show the overall significance of the independent variables, and the values confirm the presence of a good overall fit of the variables in the model.

For the most appropriate technique of estimation (FEM), the result shows that innovation statistically impacts human development (column 1) at 5% level of significance. The value of the statistically significant coefficient result is positive. Furthermore, a 1% increase in innovation will lead to a less than proportionate increase in human development in West Africa This shows that innovation has a positive and significant impact on the level of human development in West Africa, which implies that the apriori expectation is attained for the hypothesis being tested by the study in West Africa.

The result indicates that innovation in terms of knowledge improvement and solution provision is essential to human development as pointed out by Ejemeyovwi et al. (2019). This finding brings to light the specific individual impact of innovative solutions to human development in West Africa, hence presenting a potential policy option for improving the performance of human development within the region. This finding further supports the National System of Innovation theory. The result is displayed in Table 6.

Table 7. Robustness Checks (Dependent Variable: Human Development).

Variables	FEM	REM	GLS (PSSCH)	GLS (PSSCH)
Innovation	0.000016*	0.00008*	0.00002*	0.00001*
	(2.38)	(4.12)	(5.67)	(3.66)
Primary school enrolment	0.00068	0.014	0.013*	0.01*
	(0.94)	(6.62)	(10.00)	(9.31)
Institution (rule of law)	−0.0078	0.06	−0.03*	−0.005*
	(–2.30)	(7.07)	(3.44)	(0.86)
Domestic credit provided by financial sector	0.000013	0.0008	−.00014	−.00004
	(0.36)	(4.28)	(–2.38)	(0.33)
Economic growth	0.0002029	−0.0016	0.0006	−0.00006
	(1.70)	(–1.51)	(0.19)	(–0.39)
Internet usage	−.0000009	−.00005		
	(2.88)	(–2.33)		
Constant	0.43	−0.2343	−0.95*	−.0.95*
	(12.44)	(–2.21)	(–16.01)	(–14.98)
F statistics	116.44			
$p > F$	0.00			
Wald Chi^2 (5)		215.09	152.83	
Corr (u_i, Xb)	−0.06	0		
Number of observations	127	127	127	127
Number of groups	15	15	15	15
Time effects	Yes	Yes		

Source. The Authors'.
Note. The values in the round parenthesis "()" are the t statistic values. FEM = fixed effect estimation strategy; REM = random effect; GLS (PSSCH): Generalized Least Squares with Panel Specific Serial Correlation and Heteroscedasticity.
*Denotes that the coefficients are significant at 5% level.

In addition, for the control variables, PSE, economic growth, and internet usage followed the apriori expectation by reporting a positive relationship on human development in the West African region. However, institutions and "domestic credit provided by the financial sector" reported a negative impact on human development. This goes against the apriori expectation and is shows that there are possible reasons why a negative relationship is found which seems similar to the descriptive assertion of African countries as having relatively weak institutions (Efobi & Osabuohien, 2015).

Human development as well as innovation in the developing and developed countries from observation have a distinctive difference. The Global Innovation Index (GII) 2014 surveyed 143 economies around the world, using 81 indicators to gauge both their innovation capabilities and measurable results. Mauritius, which tops the African countries in the ranking, came at the 40th position, followed by South Africa at 53rd. Nigeria was placed at the 110th position. Notably, Stiglitz (2002) stated that the way globalisation is managed in Africa has led to growing poverty, inequality, hunger unemployment, and conflict increase in the developing world; hence, innovation (Research & Development) is very important for maximizing human potential and resource efficiency.

Robustness checks. The study further supplemented the empirical analysis of random effects and fixed effects techniques with time effects versions of fixed and random effects modeling and also the feasible GLS model with panel specific serial correlation and heteroscedasticity across panels. These techniques were incorporated to not just ensure a robust hypothesis testing but also to handle other possible issues that may lead to doubt of the estimation process such as time effects and possible feedback mechanism. Table 7 presents the robustness checks. An observation of the robustness checks in Table 7 confirms that innovation has a significant relationship with human development.

As new technologies emerge, the adoption of innovation becomes vital for the progress of human development dimensions, which include health, education, income and security. Human development is about expanding the richness of human life, enlarging people's choices in a way which enables them to live longer, healthier, and fuller lives rather than simply the general richness of the economy in which people live. Education certificates and degrees can be attained with the presence of online courses without the need to be present in schools through the adoption of innovation, thus, increasing technical know-how and productivity. Innovation is a process inherent to human development; some emphasized its importance as a driving force and proven to increase human development (Romer, 1990).

As obtainable in empirical studies, this study identified limitations which could be overcome by future studies. One major limitation encountered by this study is data unavail-

ability for other variables of interest. The findings are as limited to the availability of data for the research.

Conclusion

This study was motivated by the debate on the role of innovation as a significant contributor to human development, and it provides an empirical investigation on the effects of innovation on human development for the period 2004 – 2014 using robust fixed and random effect estimation technique. The study finds that innovation in West Africa currently plays a significant role in achieving human development, which follows the apriori expectation and is in line with Ejemeyovwi et al. (2019) and Ejemeyovwi et al. (2020). The finding is deemed crucial based on the theoretical concern for development raised by the dismal level of innovation and competitiveness leaving much to be desired as pointed out by Oluwatobi et al. (2016).

On the basis of the findings above, it is recommended that West African economies should strive to improve the impact of innovation on human development by encouraging innovation through methods like scholarships and university-industry partnership because some ways innovation may impact human development (the health and education of the labour force) are through the consistent reproduction of innovation made by universities (responsible body for research outcomes—innovation) and the utilization of these innovations by the industry (health, education and other industries). This is in line with the National System of innovations theory.

As suggestions for further studies, areas such as the comparative examination of the determinants of innovation in economies across the world should be considered. Also, with a view to producing a robust study, qualitative research methods coupled with primary quantitative method of research to complement this research outcome is applauded. Third, a comparative study of the impact of innovation on human development and inclusive growth could be examined among the different income groups of the world to assess the level of impact between each income group, record the various perspectives existing on various regions of the word pertaining the same issue and resolve into a conclusion that will add to the knowledge economy-human development literature.

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ORCID iDs

Jeremiah O. Ejemeyovwi https://orcid.org/0000-0002-6856-1387
Babatunde A. Ayanda https://orcid.org/0000-0003-3352-4778

References

Acemoglu, D., Gallego, F. A., & Robinson, J. A. (2014). Institutions, human capital, and development. *Annual Review of Economics*, *6*, 875–912. https://doi.org/10.1146/annurev-economics-080213-041119

AfriAfya. (2007). *Improving health, connecting people: The role of ICTs in the health sector of developing countries*. InfoDev.

African Development Bank. (2013). *Chapter 4 human development in Africa*. United Nations Development Programme. https://www.afdb.org/en/knowledge/publications/tracking-africa%E2%80%99s-progress-in-figures/human-development

African Union. (2014). *Agenda 2063: The Africa we want* (2nd ed., Popular Version. No. 03).

African Union & New Partnership for Africa's Development. (2010). *African innovation outlook: Executive summary*.

Akerkar, S., Joshi, P. C., & Fordham, M. (2016). Cultures of entitlement and social protection: Evidence from flood prone Bahraich, Uttar Pradesh, India. *World Development*, *86*, 46–58.

Alalade, A. M., Ejemeyovwi, J. O., Ekong, E. E., & Adeyemo, A. D. (2019). Internet of things as a tool for enhancement of education administration and delivery. *International Journal of Mechanical Engineering and Technology*, *10*, 48–62.

Anand, S., & Ravallion, M. (1993). Human development in poor countries: On the role of private incomes and public services. *Journal of Economic Perspectives*, *7*(1), 133–150.

Archibugi, D., & Coco, A. (2005). Measuring technological capabilities at the country level: A survey and a menu for choice. *Research Policy*, *34*, 175–194.

Asongu, S., Boateng, A., & Akamavi, R. (2016). *Mobile phone innovation and inclusive human development: Evidence from Sub-Saharan Africa*. Munich Personal RePEc Archive.

Atayero, A. A. A. (2019, October). *Making innovation happen: Master class series*. Workshop of the Covenant University Centre for Research, Innovation and Discovery.

Atta-Mensah, J. (2015). *The role of science, technology, and innovation in Africa's growth*. United Nations Economic Commission for Africa.

Bello, H. T., Ayadi, F., Osabuohien, E. S., Ejemeyovwi, J. O., & Okafor, V. (2020). Economic analysis of growth finance and liquid liabilities in Nigeria. *Investment Management and Financial Innovations*, *17*(3), 387–396.

Binder, M., & Georgios, G. (2011). Determinants of human development: Capturing the role of institutions. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2031500

Braunerhjelm, P. (2010). *Entrepreneurship, innovation, and economic growth, past experiences, current knowledge and policy implications*. Swedish Entrepreneurship Forum. https://entreprenorskapsforum.se/

Caesar, A. E., Chen, H. B., Udimal, T. B., & Osei-Agyemang, A. (2018). The influence of R&D on economic development in the West African Sub-Region. *Open Journal of Social Sciences*, *6*, 215–228. https://doi.org/10.4236/jss.2018.63015

Chandrasekhar, C. P., & Ghosh, J. (2001). Information and communication Technologies and health in low-income countries: The potential and the constraints. *Bulletin of the World Health Organization*, *79*(9), 850–855.

Efobi, U., & Osabuohien, E. (2015). Technological utilisation in Africa: How do institutions matter? In S. Majumdar, S. Guhan,

& N. Marakkath (Eds.), *Technology and innovation for social change* (pp. 67–84). Springer.

Ejemeyovwi, J. O., Adiat, Q., & Ekong, E. (2019). Energy usage, internet usage and human development in selected Western African countries. *International Journal of Energy Economics and Policy*, *9*(5), 1–6. https://doi.org/10.32479/ijeep.7611

Ejemeyovwi, J. O., Gershon, O., & Doyah, T. (2018). Carbon dioxide emissions and crop production: Finding a sustainable balance. *International Journal of Energy Economics and Policy*, *8*(4), 303–309.

Ejemeyovwi, J. O., & Osabuohien, E. S. (2020). Mobile technology adoption and inclusive growth in West Africa. *Contemporary Social Science*, *15*(1), 48–61.

Ejemeyovwi, J. O., Osabuohien, E. S., & Bowale, E. I. K. (2020). ICT adoption, innovation and financial development in a digital world: Empirical analysis from Africa. *Transnational Corporations Review*. https://doi.org/10.1080/19186444.2020.1851124

Ejemeyovwi, J. O., Osabuohien, E. S., Bowale, E. K., Abuh, O., Adedoyin, J. P., & Ayanda, B. (2019). Information and communication technology adoption and innovation for sustainable entrepreneurship. *Journal of Physics: Conference Series*, *1378*(2), 022085.

Ejemeyovwi, J. O., Osabuohien, E. S., Johnson, O. D., & Bowale, K. E. (2019). Internet usage and inclusive growth in West Africa. *Journal of Economic Structures*, *8*(1), 5–30. https://doi.org/10.1186/s40008-019-0146-2

Ejemeyovwi, J. O., Osabuohien, E. S., & Osabohien, R. (2018). ICT investments, human capital development, and Institutions in ECOWAS. *International Journal of Business Research*, *15*(4), 463–474.

Ekong, E., Adiat, Q., Ejemeyovwi, J., & Alalade, A. (2019). Harnessing big data technology to benefit effective delivery and performance maximization in pedagogy. *International Journal of Civil Engineering and Technology*, *10*(1), 2170–2178. www.iaeme.com/ijciet/issues.asp?JType=IJCIET&VType=10&IType=1

Fagerberg, J., Srholec, M., & Verspagen, B. (2010). The role of innovation in development. *Review of Economics and Institutions*, *1*(2), Article 2. https://doi.org/10.5202/rei.v1i2.2

Freeman, C. (1995). The national system of innovation in historical perspective. *Cambridge Journal of Economics*, *19*, 5–24.

Gangadharana, L., & Valenzuela, R. (2001). Interrelationships between income, health and the environment: Extending the Environmental Kuznets Curve hypothesis. *Ecological Economics*, *36*(3), 513–531. https://doi.org/10.1016/S0921-8009(00)00250-0

Gyimah-Brempong, K., Paddison, O., & Mitiku, W. (2006). Higher education and economic growth in Africa. *Journal of Development Studies*, *42*(3), 509–529.

Jowi, J. O., Obamba, M., Sehoole, C., Alabi, G., Oanda, O., & Barifaijo, M. (2012). *Governance of higher education, research and innovation in Ghana, Kenya, and Uganda*. Organisation for Economic Co-Operation and Development.

Karakara, A. A., & Osabuohien, E. (2019). Households' ICT access and bank patronage in West Africa: Empirical insights from Burkina Faso and Ghana. *Technology in Society*, *56*, 116–125. https://doi.org/10.1016/j.techsoc.2018.09.010

Klein, E., & Woodell, J. (2015). *Higher education engagement in economic development: Foundations for strategy and practice*. Association of Public and Land-Grant Universities and University Economic Development Association.

Kuyoro, S. O., Awodele, O., & Okolie, S. O. (2012). ICT: An effective tool in human development. *International Journal of Humanities and Social Science*, *2*, 157–162.

Lemarchand, G. (2015). Latin America. In S. Schneegans (Ed.), *UNESCO science report: Towards 2030* (pp. 174–209). UNESCO Publishing.

Lundvall, B.-Å. (Ed.). (1992). *National innovation systems: Towards a theory of innovation and interactive learning*. Pinter.

Marić, M., & Kristina, S. (2016). Institutions, education and innovation and their impact on economic growth. *Interdisciplinary Description of Complex Systems*, *14*(2), 157–164. https://doi.org/10.7906/indecs.14.2.5

Meek, L., Teichler, U., & Kearne, M.-L. (2010). *Higher education, research and innovation: Changing dynamics*. International Centre for Higher Education Research Kassel, University of Kassel. http://www.uni-kassel.de/incher/.http://www.uni-kassel.de/incher/v_pub/UNESCO_RR_09.pdf

Nelson, R. (Ed.). (1993). *National innovation systems: A comparative analysis*. Oxford University Press.

Nübler, I. (2016). *New technologies: A jobless future or a golden age of job creation?* International Labour Organization.

Okojie, J. A. (2017, July). *Research and innovation: Panacea to Africa's economic underdevelopment*. Text of the 12th convocation lecture at the Covenant University.

Olaloye, F. J., Adeyemo, A. D., Ekong, E., Lawal, C. O., & Ejemeyovwi, J. O. (2019). Cloud computing in education sector: An extensive review. *International Journal of Civil Engineering and Technology*, *10*, 3158–3171.

Oluwatobi, S., Efobi, U., Olurinola, I., & Alege, P. (2014). Innovation in Africa: Why institutions matter. *South African Journal of Economics*, *83*(3), 390–410.

Oluwatobi, S., Ola-David, O., Olurinola, I., Alege, P., & Ogundipe, A. (2016). Human capital, institutions and innovation in Sub-Saharan Africa. *International Journal of Economics and Financial Issues*, *6*(4), 1507–1514.

Oni, G. A. (1985, December). Effects of women's education on postpartum practices and fertility in urban Nigeria. *Studies in Family Planning*, *16*(6), 321–331.

Pampel, C. F., Krueger, P. M., & Denney, J. T. (2010). Socioeconomic disparities in health behaviors. *Annual Review of Sociology*, *36*, 349–370.

Pellicer-Sifres, V., Belda-Miquel, S., López-Fogués, A., & Aristizábal, A. B. (2017). Grassroots social innovation for human development: An analysis of alternative food networks in the city of Valencia (Spain). *Journal of Human Development and Capabilities*, *18*(2), 258–274. https://doi.org/10.1080/19452829.2016.1270916

Pendleton, B. F., & Yang, S.-O. (1985). Socioeconomic and health effects on mortality declines in developing countries. *Social Science & Medicine*, *20*(5), 453–460.

Ramadani, S., & Veland, G. (2010, April 23). *The impact of innovation into the economic growth*. Munich Personal RePEc Archive. https://mpra.ub.uni-muenchen.de/22270/

Romer, M. P. (1990). Endogenous Technological Change. The Journal of Political Economy, 98 (5). Part 2: The Problem of

Development: A Conference of the Institute for the Study of Free Enterprise Systems. S71–S102

Salahuddin, M., & Alam, K. (2016). Information and Communication Technology, electricity consumption and economic growth in OECD countries: A panel data analysis. *Electrical Power and Energy Systems*, *76*, 185–193.

Schumpeter, J. A. (2005). Development. *Journal of Economic Literature*, *XLII*(1), 112–120.

Stanton, E. (2007, February). *The human development index: A history*. Political Economy Research Institute, University of Massachusetts.

Stiglitz, J. (2002). *Globalisation and its discontents*. Penguin Books.

Ukwuoma, U. C. (2015). Educational development of Africa: Changing perspectives on the role of indigenous knowledge. *Research in Pedagogy*, *6*, 109–121. https://doi.org/10.17810/2015.28

United Nations Development Programme UNDP (2015). http://hdr.undp.org/en/data

United Nations Development Programme. (2018). *Human development reports*. Human Development Report Office. http://hdr.undp.org/en/content/human-development-index-hdi

UNESCO. (2005). *EFA global monitoring report*. United Nations.

World Bank (2018a). World Development Indicators. *World Bank Publications*. Retrieved April 27, 2018 from https://data.worldbank.org/data-catalog/world-development-indicators

World Bank (2018b). World Governance Indicators. *World Bank Publications*. Retrieved April 27, 2018 from http://info.worldbank.org/governance/wgi/#home

Zanello, G., Fu, X., Mohnen, P., & Ventresca, M. (2016). The creation and diffusion of innovation in developing countries: A systematic literature review. *Journal of Economic Reviews*, *30*, 884–912. https://doi.org/10.1111/joes.12126

Zimmerman, E., & Woolf, S. H. (2014). *Understanding the relationship between education and health*. Institute of Medicine.