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# Information and Communication Technology, Energy Consumption and Financial Development in Africa

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## ABSTRACT

The study investigated the impact of information and communication technology (ICT) and energy consumption on financial development in Africa using dynamic generalised methods of moments with secondary annual data spanning from 2001 to 2015. Literature is unanimous that ICT and energy consumption separately contributes towards financial development although there are so far scarce case studies which focused on the African continent. When domestic credit to private sector (% of GDP) was used as a measure of financial development, ICT and energy consumption were found to have a non-significant negative influence on financial development, a finding that contradicts majority of literature on the subject matter. When broad money (% of GDP) was used as a proxy of financial development, both ICT and energy consumption had a significant positive effect on financial development. The finding generally resonates with Kirmani et al. (2015) whose study argued that ICT increases efficiency, reliability, effectiveness, performance and other characteristics of modern-day commercial operations through the way transactions are catered for in any financial system. African nations are therefore urged to increase their use of modern ICT technology and increase energy consumption in order to boost financial development. Future studies can also focus whether ICT and energy consumption influence financial development through other channels such as economic growth, among others.

**Keywords:** Information and Communication Technology, Energy Consumption, Financial Development, Africa

**JEL Classifications:** N7, Q4, E44, O55

## 1. INTRODUCTION

### 1.1. Background of the Study

Information and communication technology (ICT) is the use of computers to store, retrieve, transmit, and manipulate data, or information, often in the context of some business or other enterprises (Deb, 2014). Humans have been storing, retrieving, manipulating, and communicating information since the Sumerians in Mesopotamia developed writing in about 3000 BC, but the term ICT in its modern sense first appeared in a 1958 article published in the Harvard business review by authors Leavitt and Whisler (1958). Their definition consists of three categories: techniques for processing, the application of statistical and mathematical methods to decision-making, and the simulation of higher-order thinking through computer programs (Leavitt and Whisler, 1958). The

term is commonly used as a synonym for computers and computer networks, but it also encompasses other information distribution technologies such as television and telephones. Several products or services within an economy are associated with ICT, including computer hardware, software, electronics, semiconductors, information, telecom equipment and e-commerce.

ICT has turned into a significant factor in future development of financial services industry and especially the banking industry. The transformations occurred in the ICT industry significantly contributed to the growth and profitability of financial institutions especially in the banking industry around the world (Spremic et al., 2008). In the current century, using ICT in banking is comprehensive and necessary. Today, considering the fact that data is stored electronically in databases, at the

time of facing with any problem which results in the failure of ICT systems, a limited number of banks can quickly present accurate information regarding their customers' bank accounts (Spremic et al., 2008).

ICT has continued to play an important role in the growth of the business industry in the 21<sup>st</sup> century (Lee, 2009). The dawn of computers, ICT and the Internet has changed the way businesses operate. From human resources to marketing and financial management, everywhere the role of ICT has grown. None of these functions can be run without using ICT as the use of ICT means adding speed, efficiency, and convenience to these functions. Businesses are using every form of technology to grow their sales and revenue whilst finance is an important and a bit complex function that cannot be run efficiently without the use of ICT (Pratap, 2018). Although the impact of ICT on financial development has been investigated by empirical studies, none of them comprehensively focused on Africa. It is against this background that the current study focused on investigating the role of ICT on financial development in the African context. The current study helps African countries to develop ICT usage and growth related policies that enhances financial development.

## 1.2. Gaps Found in the Literature (Problem Statement)

There is not much available empirical research on the impact of ICT and energy consumption on financial development. In other words, empirical studies that investigated ICT-energy consumption-financial development nexus are quite scant, especially in the African context. Most related research that has been done focused on the influence of IT and energy consumption on financial institutions, financialization, financial performance and services. The imperial research available also reveals quite diverse, divergent and mixed findings, a clear indication that the matter is not yet conclusive and therefore, further empirical investigations still need to be done.

## 1.3. Contribution of the Study

The current study contributes to literature in that it investigates the influence that ICT and energy consumption has on financial development and extending our understanding of financial development by connecting it to the field of ICT and energy consumption research. Lagoarde-Segot and Currie (2018) claims that IT researchers are used to looking through the microscope rather than the telescope to analyse the adoption and deployment of information technology (IT). The study of financial development in the field of IT and energy consumption research will therefore provide fresh opportunities for understanding the broader implications of how technology plays a mediating role in economies and societies.

## 1.4. Organization of the Study

Section 2 discusses the theoretical literature and empirical literature whilst Section 3 Summarises how other factors (apart from ICT and energy consumption) influence financial development. Section 4 is the research methodology and Section 5 deals with main data analysis. Section 6 is the summary of the paper.

# 2. LITERATURE REVIEW

## 2.1. Theoretical Literature Review

Salehi et al. (2010) have indicated that IT is one of the most important variables which has become a fact of life in the organizations of today. IT plays a key role in removing time and place limitations and causes information to become available to users more quickly and in a more satisfactory way. It also changes the way of performing tasks and transforms paper methods into electronic ones. The changes provide conditions in which time needed for information exchange is shorter and the way of making financial exchanges has changed that is financial information is exchanged instead of money.

Countries in their business sectors invest in IT to improve their economic performances. IT can improve information sharing, decision-making, coordination, product quality, responsiveness and distribution (Mitchell and Kovach, 2016; Perez-Arostegui et al., 2015; Moharana et al., 2011; Clemons et al., 1993). IT, defined as computer and related digital communication technology has extensive power to reduce the costs of coordination, communication, and information processing (Rouleau et al., 2015; Deb, 2014; Cordella, 2006; Brynjolfsson and Hitt, 2000).

This study focused on the impact of ICT on financial development. Previous research has shown that IT does not automatically improve financial development of a country (Munyanyi, 2017) but can increase productivity (Dedrick et al., 2013). Previous research has found that IT investment is associated with significant productivity gains for developed countries but not for developing countries (Chwelos et al., 2010). ICT is an essential tool but not sufficient, and should therefore be coupled with organizational factors such as business strategies (Shin, 2001).

The advances in IT have heavily influenced commercial businesses in several ways. The most important role of IT in a business is to provide a commercial advantage (Deb, 2014). IT provides commercial benefits in advances such as computer aided design, relational database technologies, spreadsheets, and word processing software (Deb, 2014). The same study noted that the use of IT to monitor a business performance can also enable the business to highlight areas where they are not making the most use of their resources.

An infrastructure of computing and communication technology provides 24-h access at low cost to almost any kind of price and product information desired by buyers, reduce the information barriers to efficient market operation (Deb, 2014). This infrastructure might also provide the means for effecting real-time transactions and make intermediaries such as sales clerks, stock brokers and travel agents, whose function is to provide an essential information link between buyers and sellers redundant (Clemons et al., 1993). The information technologies have facilitated the evolution of enhanced mail order retailing, in which goods can be ordered quickly by using telephones or computer networks and then dispatched by suppliers through integrated transport companies that rely extensively on computers and communication technologies to control their operations (Clemons et al., 1993).

## 2.2. Empirical Literature Review

Most previous research has focused on the impact of IT on financial performance (Tang et al., 2012; Wang et al., 2008; Shin, 2001; 2006; Cron and Sobol, 1983). Shin (2001) examines empirically the contribution of IT to financial performance as measured by net profit, return of assets (ROA), and return of equity (ROE) by focusing on the alignment of IT with business strategies such as vertical disintegration and diversification. Empirical analysis showed that IT does not directly improve financial performance. In conjunction with vertical disintegration and diversification, however, it does improve financial performance as measured by net profit. Financial performance ratios such as ROA and ROE, however, are not correlated with the alignment (or interaction) factor of IT with vertical disintegration and diversification. The results indicate that increased IT spending improves net profit, but not performance ratios of firms with decreased vertical integration and higher diversification. Cron and Sobol (1983) investigated the impact of IT investment on financial performance for medical wholesale suppliers and found that, on average, the impact of IT was not significant. Investing in IT such as internet, computers and telecommunications technologies can help in improving economic performance of companies (Farhadi et al., 2012; Shin, 2001).

Kamssu et al. (2003) found out that the choice of a particular technology to implement a firm's business strategy may impact the firm's market performance. Their study assessed the impact of being an internet-dependent firm on a firm's stock valuation and the results they got indicated that there are lower excess returns in internet-dependent firms than non-internet firms. The high returns can be explained by the fact that internet stocks traded at relatively higher prices than non-internet stocks, and this meant that choosing a particular technology to implement business strategy might have a significant impact on a firm's stock performance.

Sadeghimanesh and Samadi (2013) in their study indicated that the dimensions of IT including IT knowledge, IT operations and IT infrastructures had a significant effect ( $P < 0.01$ ) on financial performance of the banks listed in Tehran stock exchange. Kirmani et al. (2015), state that ICT has increased efficiency, reliability, effectiveness, performance and other characteristics of modern-day commercial operations through the way transactions are catered for in any financial system with optimal levels of performance and efficiency.

The emergence of ICT has opened multiple facets of enterprises that collectively interact with geographically dispersed workstations to carry out business activities more efficiently, over digital networks. ICT has contributed openly to eliminate time, distance and space constraints in order to furnish the business activities with ease and efficiency by integrating the capability of high-speed devices with high speed communication links carrying multimedia information. ICT deals with the collection, storage, manipulation and transfer of information using electronic means (Kirmani et al., 2015). Generally, ICT is considered one of the most reliable means of providing a strong platform for effective system of internal control over financial reporting. It stands to reason that a sound ICT system provides a sure and guarantee medium of financial information delivery that covers the entire

accounting cycle of the firm. ICT creates conducive atmosphere that integrates all financial transactions with the help of accounting software to generate financial report which thereto, would have very difficult to prepare.

Pratap (2018) points out that the application of IT in financial management has also accounted a lot more success and efficiency in performing various operations related to different activities to commit a financial transaction and has notably produced better throughputs which are acceptable and reliable. The internet has brought the biggest change in this area by making storing, sharing and publishing of financial data easier. The key advantages of IT in the area of financial management is the use of automation, shared management information systems which enable the sharing of data between the various departments and faster workflow. The field of IT has seen a lot of innovation and made everyone's task easier. Several companies share their financial information publicly online from their websites. Balance sheets and proforma statements get ready within minutes and are published and shared with stakeholders with ease. However, one important challenge that IT has faced is that of data safety. However, in the sphere of IT, as the challenges take place innovation too happens. Cloud based storage systems have helped companies store their data with care. IT saw a swift jump with increased reach and better performance. Banking and finance sector have grown very fast in the past decade because of IT which has added speed and efficiency in the sector. It has brought growth in the financial world and helped it in several spheres. Data processing, quality of reporting and marketing in the banking world, all have grown very fast with the arrival of the internet (Pratap, 2018).

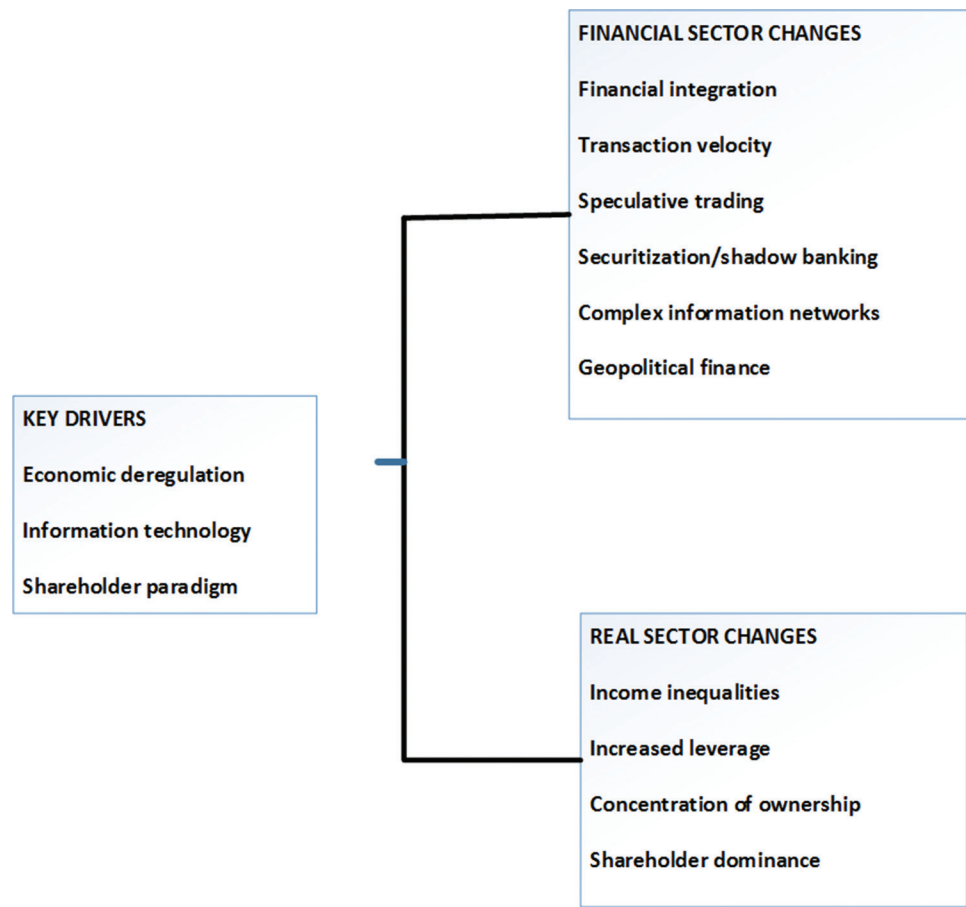
Salehi and Torabi (2012) investigated the role of IT in financial reporting as well as the relationship between using IT and its impact on the quality of financial reporting. They found out that the use of IT has considerably changed financial reporting, especially with regards to the relevance of accounting information, mainly because the use of IT (particularly the Internet, its instruments and protocols or software formats based on that) has resulted in on-line financial reporting in which IT can help users make better economic and managerial decisions.

Furthermore, the results of the research indicate that apart from various advantages of IT in financial reporting, its reliability is reduced due to the fact that it decreases reliability in the security of information (Salehi and Torabi, 2012). As mentioned earlier, by using IT, financial reporting of firms will move towards on-line financial reporting, in which firms use a specific format and define harmonized reporting procedures thus enhancing the stability of this process in those firms.

Figure 1 summarizes the role that IT plays in financial development.

Kamel (2005) points out that the vital role ICT is playing is felt across many industries and sectors, affecting both economic development and growth at large in many societies. The resulting implications have had a major role in transforming such sectors and have affected the economic-development process in developing nations. The banking sector is an example in which



**Figure 1:** Financialization: A conceptual framework adapted from Lagoarde-Segot (2016)

IT infrastructures have had positive implications. It is important to note that the banking industry was one of the very first to utilize IT back in the 60s and has thus a record of influencing the development process through the technology. There are many examples of IT applications in the banking sector that have helped build new markets and fuel the economy like, automated teller machine technology adoption has increased community efficiency, which led to a reduction in costs, improvement of quality, and increase in the added value to customers. However, some of the implementations of IT in the banking sector in the context of developing nations are often hindered by a number of challenges, including (but not limited to) lack of stability of the legislation, weak financial sector, poor technological infrastructure and relatively small internet and computer penetration (Kamel, 2005).

Recently, developing nations are increasingly investing in building up and improving their technology infrastructure, focusing on electronic commerce, electronic banking, and electronic learning (Makame et al., 2014). Consistent with both theoretical and empirical literature, there is no doubt that IT and or ICT has had a significant influence on business and financial development in recent years. What the literature has so far failed to adequately capture is how ICT has had an immense contribution towards financial development in the context of developing nations, especially Africa. The current study seeks to fill in that gap.

Table 1 summarizes the empirical literature that exclusively focused on the impact of IT or ICT and energy consumption on

financial development also Dabbous (2018), Rafindadi and Ozturk (2017), Nasreen et al. (2017 for the recent literature).

### 3. OTHER VARIABLES THAT HAVE AN INFLUENCE ON FINANCIAL DEVELOPMENT

Foreign direct investment, trade openness, population growth, unemployment, economic growth, human capital development and infrastructural development are some of the variables that have an impact on financial development (Table 2).

### 4. RESEARCH METHODOLOGY

The study used secondary panel data ranging from 2001 to 2015 for fifteen African countries. These fifteen African countries include Burundi, Kenya, Rwanda, Algeria, Morocco, Tunisia, Ghana, Nigeria, Senegal, Cameroon, Democratic Republic of the Congo, Gabon, Namibia, South Africa and Mozambique. The data was extracted from World Bank Indicators, African Development Indicators, United Nations Development Programme Various Reports and International Financial Statistics database.

There are two versions of the same econometric methods used in this study.

**Table 1: A summary of the impact of information technology on financial development—empirical literature**

Author	Country/countries of study	Methodology	Findings
Ho and Mallick (2006)	US banking industry	Panel regression	The results show that the bank profits declined due to the adoption and diffusion of IT investments, reflecting negative network effects in this industry
Sadeghimanesh and Samadi (2013)	Tehran	Two-variable linear regression test	The results indicated that information technology dimensions including IT knowledge, IT operations and IT infrastructures had significant effect ( $P < 0.01$ ) on financial performance of the banks listed on Tehran stock exchange
Kirmani et al. (2015)	India	Literature analysis	ICT has sophisticated the way transactions are catered in any financial system with optimal levels of performance and efficiency
<b>A summary of the impact of energy consumption on financial development—empirical literature</b>			
Gomez and Rodriguez (2019)	North American Free Trade Agreement (NAFTA) countries	Fully modified and dynamic ordinary least squares	The study found out that energy consumption had a negligible positive influence on financial development in NAFTA countries
Saudi et al. (2018)	Next 11 countries	Panel data analysis	A feedback relationship between energy consumption and financial development was detected in the next-11 countries
Saini and Neog (2018)	India	Vector error correction model	A bi-directional causality between energy consumption and financial development in India was observed
Zeren and Koc (2014)	New industrialized countries	Toda-Yamamoto causality test	Energy consumption was found to have had a positive influence on financial development in newly industrialized countries
Faisal et al. (2017)	Pakistan	Auto-regressive distributive lag (ARDL)	Energy consumption and financial development were found to have affected each other

Source: Authors' compilation

**Table 2: Theory intuition and a priori expectation**

Variable	Proxy used	Theory intuition	Expected sign
Foreign direct investment (FDI)	Net FDI inflow (% of GDP)	FDI inflows enhances competition and efficiency in the financial sector (Shahbaz and Rahman, 2010). According to Misun and Tomsik (2002), private investment did crowd out private investment in Poland thereby negatively affecting financial development. Hailu (2010) argued that there is an inverse relationship between FDI and financial development	±
Trade openness (OPEN)	Total of exports and imports (% of GDP)	Svaleryd and Vlachos (2002) noted that trade openness boost domestic firms' competitiveness in the international markets. The newly found competitive space in the international markets trigger the need to use sophisticated financial risk management services that helps to absorb external shocks	+
Population growth (POPUL)	Population growth (% annual)	In circumstances of increased population growth, the government end up borrowing from the domestic financial markets to meet the people's social needs thus crowding out private investment and lowering down the rate of financial development	–
Unemployment (UNEMPL)	Unemployment total (% of total labour force)	According to Han (2009), more unemployed people means more unbanked or financially excluded people. This is because unemployed people do not have income that they can use to meaningfully participate in financial markets	–
Economic growth (GDPPC)	GDP per capita	Ceteris Paribas, higher economic growth means that the general population has higher levels of savings and wealth to invest back into the financial markets and enhance financial sector development (Robinson, 1952)	+
Human capital development (HCD)	Human capital development index	People who are educated, skilled and healthy are likely contribute better towards financial development because they are able to make meaningful financial choices (Becker, 1964)	+
Infrastructure development (INFR)	Fixed telephone subscriptions per 100 people	Higher levels of infrastructural development push down the cost of doing business not only for financial sector players but the overall business sector thus creating more avenues and possibilities for financial development (Ifekachukwu, 2015)	+

Source: Author compilation

$$FIN_{i,t} = \beta_0 + \beta_1 ICT_{i,t} + \beta_2 ENERGY_{i,t} + \beta_3 X_{i,t} + \mu + \varepsilon \quad (1)$$

$FIN$  is financial development and is proxied by two measures, namely the domestic credit to the private sector (% of GDP) and broad money (% of GDP).  $ICT$  represents information and communication technology and is proxied by individuals using internet (% of population).  $X$  are the control variables ( $ENERGY$ ,  $OPEN$ ,  $POPUL$ ,

$UNEMPL$ ,  $GDPPC$ ,  $HCD$ ,  $INFR$ ).  $ENERGY$  (Energy consumption) is measured by energy use (kg of oil equivalent per capita).

$\beta_0$  to  $\beta_9$  represents co-efficients of the variables.  $\varepsilon$  is the error term and  $\mu$  represents the time invariant and unobserved country specific effect. Subscripts  $i$  represents the country and  $t$  is the time.

The full econometric model which shows the dependent, independent and control variables is shown below.

$$FIN_{i,t} = \beta_0 + \beta_1 FIN_{i,t-1} + \beta_2 ICT_{i,t} + \beta_3 ENERGY_{i,t} + \beta_4 FDI_{i,t} + \beta_5 OPEN + \beta_6 POPUL_{i,t} + \beta_7 UNEMPL_{i,t} + \beta_8 GDPPC_{i,t} + \beta_9 HCT_{i,t} + \beta_{10} INFR_{i,t} + \mu + \varepsilon \quad (2)$$

The dynamic panel generalised methods of moments (GMM) approach by Arellano and Bond (1991) was used to estimate equation 2. The main advantage of using the dynamic GMM method is that it captures the dynamic characteristics of financial development data as observed by Tsaurai (2018a). The other benefit of using the dynamic GMM approach is that it addresses the endogeneity problem in the financial development function.

## 5. RESULTS, DISCUSSION AND INTERPRETATION

As expected, Table 3 shows a significant positive correlation between (1) financial development and ICT, (2) financial development and trade openness, (3) financial development and

unemployment, (4) financial development and economic growth, (5) financial development and human capital development and (6) financial development infrastructural development.

In line with Tsaurai (2018b), GDPPC is the only variable characterized by extreme values (standard deviation more than 100). Using Tsaurai (2018b), all other variables are not normally distributed except trade openness because the probability of their Jarque-Bera criterion is zero (Table 4). It is against this background that the current study had to first transform all the data into natural logarithms before using it in order to avoid producing spurious results.

Before estimating the results using the dynamic GMM approach, data was found to be stationary at first difference (Table 5) and also that a long run relationship existed between and among the variables being studied (Table 6).

In both model 1 and 2, the lag of financial development had a significant positive effect on financial development in African nations studied, consistent with Tsaurai (2018a. p. 77). Model 1 and 2 shows that ICT had a significant positive impact on financial development in African countries, a result which is generally in line

**Table 3: Correlation analysis**

	FIN	ICT	ENERGY	OPEN	POPUL	UNEMPL	GDPPC	HCD	INFR
FIN	1.00								
ICT	0.66***	1.00							
ENERGY	-0.01	-0.02	1.00						
OPEN	0.31***	0.26***	0.48***	1.00					
POPUL	-0.75***	-0.41***	0.13*	-0.27***	1.00				
UNEMPL	0.42***	0.21***	0.27***	0.49***	-0.43***	1.00			
GDPPC	0.37***	0.51***	-0.06	0.37***	-0.35***	0.58***	1.00		
HCD	0.65***	0.99***	-0.02	0.26***	-0.41***	0.21***	0.51***	1.00	
INFR	0.76***	0.51***	-0.12*	0.39***	-0.86***	0.50***	0.54***	0.51***	1.00

Source: Author compilation from e-views. \*\*\*, \*\*, \*Denotes statistical significance at the 1%/5%/10% level respectively

**Table 4: Descriptive statistics**

	FIN	ICT	ENERGY	OPEN	POPUL	UNEMPL	GDPPC	HCD	INFR
Mean	39.4	10.8	3.62	68.5	2.32	11.1	2277	10.8	3.50
Median	31.1	5.77	2.22	65.9	2.61	10.0	1309	5.77	1.49
Maximum	117.4	57.1	41.8	125.5	3.71	27.3	10716	57.1	12.5
Minimum	2.86	0.01	0.00	20.96	0.76	0.83	112.9	0.01	0.01
Standard. deviation	25.9	13.5	5.2	21.5	0.76	7.83	2347	13.5	3.8
Jarque-Bera	54.5	189	6711	3.1	21.2	20.2	94.1	187.2	35.0
Probability	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00
Observations	225	225	225	225	225	225	225	225	225

Source: Author compilation from e-views

**Table 5: Panel stationarity tests–individual intercept**

	Level				First difference			
	LLC	IPS	ADF	PP	LLC	IPS	ADF	PP
FIN	-1.71**	1.34	22.87	25.12	-6.18***	-4.69***	75.45***	121.55***
ICT	-1.65**	1.34	25.95	76.76***	-9.25***	-5.16***	72.52***	101.59***
FDI	-11.35***	-4.93***	77.11***	95.45***	-10.23***	-7.89***	117.43***	218.69***
OPEN	-2.50***	-0.75	34.90	34.84	-6.90***	-5.24***	83.90***	133.75***
POPUL	-10.52***	-6.14***	107.01***	59.37***	-6.81***	-3.34***	71.32***	58.37***
UNEMPL	-3.27***	-0.44	34.63	23.52	-7.23***	-4.23***	54.25***	74.44***
GDPPC	-7.90***	-4.27***	74.42***	79.18***	-3.08***	-2.52***	48.61**	69.28***
HCD	-1.53*	1.52	24.93	74.57***	-15.52***	-6.59***	65.36***	102.27***
INFR	-0.97	0.64	27.68	24.11	-3.96***	-3.14***	58.11***	109.40***

Source: Author's compilation from e-views. LLC, IPS, ADF and PP stands for Levin et al. (2002); Im et al. (2003); ADF Fisher Chi-square and PP Fisher Chi-square tests respectively.

\*, \*\* and \*\*\* denote 1%, 5% and 10% levels of significance, respectively

**Table 6: Kao residual co-integration test-individual intercept**

	T-statistic	Probability
Augmented Dickey-Fuller	-3.9460	0.0000

Source: Author's compilation from e-views

**Table 7: Dynamic GMM results – model 1 (FIN proxied by domestic credit to private sector [% of GDP])**

	Co-efficient	Standard error	t-statistic	Probability
FDILAG	0.6601***	0.0379	17.4259	0.0000
ICT	0.3202*	0.5495	0.5828	0.5607
ENERGY	0.0172*	0.0099	1.7248	0.0860
OPEN	0.0474	0.0531	0.8925	0.3731
POPUL	-0.1993***	0.0512	-3.8934	0.0001
UNEMPL	0.0892***	0.0236	3.7832	0.0002
GDPPC	-0.1106***	0.0277	-3.9881	0.0001
HCD	0.3685	0.5487	0.6717	0.5025
INFR	0.0658***	0.0167	3.9437	0.0001

Adjusted R-squared - 0.9271

J-statistic - 215.00

Prob (J-statistic) - 0.0000

Source: Author's compilation from e-views

**Table 8: Dynamic GMM results–model 2 (FIN proxied by broad money [% of GDP])**

	Co-efficient	Standard error	t-statistic	Probability
FDILAG	0.8064***	0.0298	27.0919	0.0000
ICT	0.2475**	0.6242	0.3965	0.6921
ENERGY	0.0208*	0.0112	1.8512	0.0655
OPEN	0.1280**	0.0605	2.1161	0.0355
POPUL	-0.1415**	0.0578	-2.4479	0.0152
UNEMPL	0.0286	0.0261	1.0977	0.2736
GDPPC	-0.1315***	0.0293	-4.4913	0.0000
HCD	-0.1088	0.6232	-0.1746	0.8616
INFR	0.0213	0.0186	1.1406	0.2553

Adjusted R-squared - 0.9433

J-statistic - 215

Prob (J-statistic) - 0.0000

Source: Author's compilation from e-views

with Kirmani et al.'s (2015) argument that ICT increases efficiency, reliability, effectiveness, performance and other characteristics of modern-day commercial operations through the way transactions are catered for in any financial system (Tables 7 and 8).

In both models, energy consumption was found to have had a significant positive effect on financial development in line with a prior study done by Zeren and Koc (2014). In model 1, trade openness had an insignificant positive impact on financial development whilst model 2 shows a significant positive relationship running from trade openness towards financial development in African countries studied. The results resonate with Svaleryd and Vlachos (2002) whose study noted that trade openness encourages more participation in international trade and more financial development due to the need to absorb external shocks associated with participating in international financial markets.

Both model 1 and 2 produced a significant negative relationship running from population growth towards financial development,

results which contradicts majority of the literature but resonates with the view that in the face of increased population growth, government's appetite to borrow from local financial markets increases in order to meet the social needs of the increased population. This then crowds out private investment and slows down financial sector development. Unemployment was found to have had a significant positive impact on financial development in model 1 whereas model 2 shows that unemployment had an insignificant positive influence effect on financial development in African nations. The finding is in line with Han (2009) whose study noted that more unemployed people means more unbanked or financially excluded people. This is because unemployed people do not have income that they can use to meaningfully participate in financial markets.

In line with Robinson's (1952) view that higher economic growth means that the general population has higher levels of savings and wealth to invest back into the financial markets and enhance financial sector development, the current study found out that economic growth had a significant negative influence on financial development in Africa.

Contrary to the literature (Becker, 1964), the study found out that human capital development had a significant negative influence on financial development in Africa (in both model 1 and 2). Last but not least, infrastructural development had a significant positive impact on financial development in model 1 whilst a non-significant positive relationship running from infrastructure development towards financial development in African countries was detected. The finding resonated with Ifeakachukwu (2015) whose study noted that higher levels of infrastructural development push down the cost of doing business not only for financial sector players but the overall business sector thus creating more avenues and possibilities for financial development.

## 6. CONCLUSION

The study investigated the impact of ICT and energy consumption on financial development in Africa using dynamic GMM with secondary annual data spanning from 2001 to 2015. Literature is unanimous that ICT and energy consumption separately contributes towards financial development although there are so far scarce case studies which focused on the African continent. When domestic credit to private sector (% of GDP) was used as a measure of financial development, ICT and energy consumption were found to have had a significant positive influence on financial development, a finding that contradicts majority of literature on the subject matter. When broad money (% of GDP) was used as a proxy of financial development, ICT and energy consumption had a significant positive effect on financial development.

The finding generally resonates with Kirmani et al. (2015) whose study argued that ICT increases efficiency, reliability, effectiveness, performance and other characteristics of modern-day commercial operations through the way transactions are catered for in any financial system. African nations are therefore urged to increase their use of modern ICT technology and energy consumption in order to boost financial development. Dedrick et al.



(2013) noted that the productivity effects of ICT are moderated by country factors, including human resources, openness to foreign investment and the quality and cost of the telecommunications infrastructure. Future studies can also focus whether ICT and energy consumption separately influence financial development through other channels such as economic growth, among others.

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