FINANCIAL SECTOR, ICT-DRIVEN FINANCIAL SECTOR AND HUMAN DEVELOPMENT IN WEST AFRICAN COUNTRIES: PANEL GENERALIZED METHOD OF MOMENTS.

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ABSTRACT

The study focuses on financial deepening and its interaction with ICT on human development in West Africa from 2012 to 2022 using GMM approach. The human development indicator is the HDI. The indicators of financial deepening used are Money supply to GDP, Credit supply to GDP, Liquid liabilities to GDP while the indicators of ICT are internet subscription and mobile subscription. The findings affirm that positive changes in current human welfare depend on the previous quality of education, health and life span. Whether inflation is included or not included in the model, money supply worsens human development and when the internet subscription and mobile subscription were used as catalysts to complement money supply and drive human development, the effect of the interaction of ICT with money supply on human development is mixed. Specifically, the interaction between money supply and internet subscription in West African has significant negative effect on human development while the interaction of money supply with the mobile subscription has an insignificant positive effect on human development. The interactions of liquid liabilities with both the internet subscription and mobile subscription have mixed effects on human development. By decomposing the effect of ICT interaction with liquid liabilities, the study affirms that the interaction between liquid liabilities and internet subscription significantly improves human development on one hand and on the other hand, the interaction between liquid liabilities and mobile subscription has insignificant negative impact on human development. Credit supply showed a positive significant effect on human development but the interaction of credit supply with both the internet subscription and mobile subscription significantly improve human development in the West African countries. Inflation appeared to worsen human development. Policymakers must enforce the adoption of financial technology to minimize cash outside the banking system and enhance liquid liabilities/money and credit supply.

Keywords: *Financial deepening, ICT-controlled financial deepening, West Africa, human development, Panel GMM*

JEL Classification: 010,011,015

1 Introduction

The importance of ICT in driving financial services to combat human development challenges cannot be overemphasised. The rate at which the presence of ICT drives human activities and other facet of life is second to none. ICT development has revolutionized the whole world (Castells, 2000) and the deployment of ICT for enhancing not just growth and efficiency but also human welfare;

has attracted the attention of development experts nationally and internationally to the extent that the World Economic Forum (WEF) recognizes the ICT role as a crucial enabler in order to guarantee human and balanced socio-economic development (Gupta, Jain & Nagpal, 2019; WEF, 2016). ICT has been confirmed to be essential in influencing various spheres such as human capital creation.

As observed by US Census Bureau (2020), IT sector as a part of U.S. firms that contribute hugely to the world economy accounts for 28% of firms, 22.4% of job opportunities, and 30.7% of payroll expenses. Report also has it that an increase in broadband penetration from 35% to 70% in developing markets is linked with GDP growth of $2 trillion and 140 million job opportunities (World Bank, 2022). Many organizations globally now have online presence and are able to interact with clients and compete for market share with the help of ICT. It is also obvious that ICT enhance financial access, limit physical contact, and provides access to financial products and services that can be used to improve human development. ICT-compliance financial system takes a form of automated teller machine (ATM) services, electronic fund transfer (EFT) services, clearing house automated payments (CHAPs) service, electronic purse (E-PURSE), automated check sorter (ACS), point of sale electronic and transfer (EFTPOS) services which permit easy financial transactions (Osabuohien 2008).

The financial sector is a unit of the national economy consisting of institutions and organizations that render financial services to customers. African countries place much emphasis on the financial sector development to combat developmental challenges in Africa. This is because the financial sector has the potential to enhance human development, economic progress and management of cashflows among others through the channeling of funds from the surplus unit to the deficit units (World Bank, 2023).

However, lack of access to financial services is a common feature of emerging economies. As at 2024, average private sector credit to GDP of most African nations is around 35% but still fall the suggested threshold of 70% (World Bank, 2022; World Bank, 2024). Clearly, West African countries are confronted with poor access to finance due to financial constraints, poor ICT among other factors as the available information shows that 55 - 68% of formal Micro, Small and Medium enterprise (MSME) in Africa have unmet financing demands while access to bank loans by enterprises remained 45 - 32% and the entire credit to economy by the financial sector stood at 36% as at 2022 (World Bank, 2024). The mean value of account ownership with a bank or similar financial institution or with a mobile money service in Africa as at 2022 stood at 48% (WEF, 2023). The account ownership has consistently shows wider gap in economic status of WAEMU citizens as the poorest 40% of households have 11% point fewer accounts than the richest 60% (World Bank, 2021). Therefore, the existing barriers to digital access and usage continue unabated.

Accordingly, the UNESCO Institute for Statistics (2024) refers to ICT as a variety of technological tools and resources deployed to transmit, create, store and exchange information. The presence and adoption of digital technologies are drivers of economic progress, job opportunities, financial inclusion and innovation globally and nationally. However, ICT development in Africa is considerably thin and internet usage rates are below 10% in the Africa's poorest region due under-development of digital facilities, lack of accessibility, unaffordability of connectivity and skills gap among others. The percentage of individuals using internet in Africa increased at rate from 24.8% in 2017 to 28.6% in 2019 (ITU, 2020). Household that has access to the internet increased by 0.1% points from 14.2% in 2017 to 14.3% by the end of 2019. As at 2019, only 6.3% of townlet had access to the

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internet compared with 28% of citified areas. 39.6 % of people whose age group fall within 15-24 years old, used the internet which higher than the region average but considerably thin than the world average of 69%. The broadband per 100 inhabitants rose from 25.5% in 2017 to 33.1% in 2020 but still lower than the global average (ITU, 2020).

As at 2021, 84% of people in SSA lived in areas where 3G service was available, and 63% had access to 4G mobile service but only 22% made use of mobile internet services. There is also alarming gap between the coverage and usage of broadband with 61% of people in sub-Saharan Africa living close to broadband range but failed to use it. Mobile connections' affordability still remains a critical challenge in Africa, the average cost of 1GB of mobile internet as a % of monthly per capita Gross National Income was 10.5% which is significantly higher than the 2% threshold of United Nations Broadband Commission (World Bank, 2024). There is a wider disparity for internet use, as at 2023, women that use mobile internet are about 37% less than men (World Bank, 2024). Thus, the minimal adoption and usage of mobile internet is a lost opportunity for inclusive growth in Africa (Andrew, 2024).

Inspite of the strategic steps (such as World Bank's Digital Economy for Africa) taken by World Bank, International Development Association, African Union Commission and ADB to close digital connectivity gaps and investing in digital public facilities, less than 50% of people still make use of internet in Africa while the cost of connectivity only decreases by 11.5% between 2019 and 2021. The slow growth of technology due to poverty level, its affordability in African nations significantly contributes to its development crisis (World Bank, 2024). According to the most recent economic outlook for West Africa, growth in West Africa is projected to rise from 3.6% to 4.2% (World Bank, 2024) with the exception of Cape Verde and Ghana which have a low Human Development Index score of (less than 0.5), with per capita gross national income standing at $2,300 (UNDP, 2023). West African countries' average birth per woman from the poorest quantile is 6.7% and 3.7% births from the richest implying inequitable access to health (UNDP, 2021).

Despite ICT adoption in Africa having been going on for more than ten years, there are very few studies that address the direct impact of ICT on the financial sector, the interactive impact of ICT and financial sector on development in West Africa. The existing research concentrates on the entirety of Africa and restricts its analysis to the direct impact of ICT on the financial sector or the impact of ICT on human development (Asongu & Le Roux 2016; Ejemeyovwi et al., 2019; Badri et al., 2019; Migdamisi & Djijo, 2021; Dhahri et al., 2023). By focusing on the West African region and expanding on earlier research, this study overcome the constraint by looking at the interaction between ICT and the financial sector and how it affects human development.

This study would not only add to the body of research by analyzing how ICT's modulating effect on the financial sector affects human development in West African nations, but it will also provide additional insight into the ways in which the financial sector influences this development.

Scope of the study

The choice of West Africa as the geographical location of the study was premised on the fact that studies that focus in this area of research in West-Africa are scanty. The population for this study was the sixteen West-African countries. The study used a purposeful sampling approach by taken the whole population of West-African countries as the sample, because West-African countries share similar characteristics and the size is manageable. However, the researcher dropped both Niger and Mauritania due to data inconsistence for empirical investigation; thus, the sample size for the study was limited to 14 West African states. The choice of 14 states out of 16 states is also consistent with

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Krejcie and Morgan's (1970) rule guiding sample size determination. The study covered 2012 to 2022 and employed a Generalized Method of Movement. The choice of the year was based on the availability of data. GMM for this study is appropriate in the context of semi parametric/ non parametric models where the distribution function of a data may not be known or when data does not follow a specific distribution (Drukker, 2010). GMM estimation is often possible where a likelihood analysis is extremely difficult and there is need for partial specification of the model. It is also most suitable for a situation where N>T in a panel analysis and as well help to solve the problems of serial correlation, heteroskedasticity variation and endogeneity issues (Korkmaz, 2015).

2. Literature review

Financial sector development and the usage of digital technologies are drivers of economic progress, job opportunities, financial inclusion and innovation globally and nationally. The literature review focus on the concepts of ICT, financial sector, human development and highlights relevant economic theory and empirical review to support the study

Human development

Human development concerns with providing the human race with fundamental facilities to improve their welfare, constitutional right including provision of sound education, sound health, political and economic autonomy (United Nations, 2015; UNDP, 2019). Human development is a burning issue in the global conversation because of the acclaimed nexus between economic performance and economic advancement in the 20th Century (United Nations, 2015). In the 1960s, there were clamour and cry to place little emphasis on GDP due to the fact economic growth (GDP) is the foremost goal and the indicator of economic improvement in many economies even when it was obvious that GDP was not originally conceived as an indicator of living standard. From 1970s to 1980s, development economists started putting up divergent view about using GDP as a measure of development strongly support using alternative measures that go beyond GDP**.** The alternative indicators as put up by the experts are availability of payable job, income redistribution and whether human beings are able to satisfy their basic needs. Thus, the divergent views on using GDP as an indicator of development gave room for the introduction and adoption of human development approach, which is about improving people social welfare, rather than focusing on the economic prosperity. The indicators of HD are long life, measured as life's duration of mankind, educational qualification and health. The fact that SDGs gives a picture of development destination on one hand, while human development permits stakeholders to design the route to development destination on the other hand make the understanding of social well-being a necessity for policy makers in African continent so as to articulate relevant policy agenda (UNDP, 2019).

Information and Communication Technology

Information and communications technology (ICT) is a term that includes any communication tools, system and or application which are radio, television, phones, computer and technology hardware and software, satellite systems, and many more, as well as the other services and applications connected with them. Financial Technology which is synonymous with ICT is a phrase use to describe any form of technology that is employed to deliver financial product and services through online banking, mobile payment applications or even crypto-currency (Carney, 2016; United State Chamber of Commerce, 2020). Information Communication Technology has been in existence since 1950.

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ICT is a matching word for information technology (IT) which emphasise the importance of incorporating enterprise communication and information transmitting technologies (telegraph lines, wireless telegraph, computers etc) which enable clients to pass, store and maneuver information. The reason behind the ICT is to combine all technologies distribution and process into a formidable enterprise matrix. Information Communication Technology has become a success and the driver of growth and development in advanced and emerging economies and also has great potential to lift Africa out of current developmental challenges (Albiman, & Zunaidah, Sulong, 2016). This is because recent evidences have shown that innovations, Information Communication Technology improve financial deepening in African (ADB, 2013).

According to Sassi and Goaied (2013); and Chavula (2013); Efobi et al. (2018), the dimensions of ICT are: Internet subscriptions (per 100 People), Mobile Phone Subscription (per 100 people), Broadband subscription (per 100 people).

Financial deepening

Conceptually, financial deepening refers to as an expansion in the scale of financial transactions in comparison with a national economy (Afolabi et al., 2022). Financial deepening simply means providing avenue to financial access through financial sector, financial system and enabling process that would improve financial intermediation and capital market development. This view is premised on the fact that the more the availability of liquid money in country, the higher the level of the financial deepening and opportunities for ceaseless growth and expansion (Shaw, 1973; Deema & Buthiena, 2016; Afolabi et al., 2022).

Theoretical Review

The theoretical issues highlight economic theory(ies) that are relevant to technology, financial deepening and human development. This study is backed by neoclassical growth model.

Neoclassical growth model

The theoretical framework is the theory that links information technology economic performance and is in accord with the conventional views (Kwan & Chiu, 2015). Based on literatures, the key elements of the neoclassical growth models support the perspective that information technology promotes economic prosperity and reduces income disparity in developing countries (Abramowitz, 1986; Bernard & Jones, 1996; Asongu, Nwachukwu and Aziz, 2018). Moving forward, the neoclassical model is often employed to assess the nexuses between ICT and the economic development of African countries (Uduji and Okolo-Obasi, 2018a, 2018b; Bongomin et al., 2018; Asongu et al., 2019a, 2019b). Notably, the neoclassical view is supported by the fact that economic performance/ can be enhanced or retarded by ICT through education, innovation and critical thinking.

Empirical Studies on West African Countries

The empirical review focuses on the relationship between ICT and financial sector in West African countries, ICT and human development in West African countries and lastly the interaction between ICT and financial deepening on human development.

Evans et al. (2018) conduct a research on ICT, human capita development and institutions in ECOWAS from 2004 – 2015 using a GMM approach. The result of the study reveal that investment in ICT does not have significant effect on human capita development due to low investment in communication facilities, high cost of technology and unfavourable policy stands but the study did not

report the causal impact of institutions in Africa and the effect of the interaction of ICT with the financial sector on development.

Study by Seydou (2021) examines the factors that drive the adoption and the use of mobile banking in the West Africa countries in comparison with East African countries by employing probit and multinomial logit regressions. The outcomes the research affirmed that the factors that drive the adoption also affect use of mobile money accounts by the residents of the two countries, categorically the weakest social categories (i.e., men, elderly person, more knowlegeable, wealthier and part of the workforce). Therefore, the slow-moving penetration of mobile money accounts associated with the West African countries when compared with the East African nations is likely to be as a result of inadequate policy focus to create more awareness on the benefits of mobile banking. The study recommends that governments in West African countries should try to promote the use of mobile money accounts among the active citizens or the employable group (matured adults between 25 and 64) by improving the individual income level, and the provision of incentives to the education sector so as to motivate the citizens to pursue higher levels of education but ignore how development can be drived by both the ICT and the Financial Sector.

Senou et al., (2019) research into the factors that drive mobile money adoption and the policies tools that is likely to remove the stumbling block that inhibits digital financial inclusion in that area. The study employ national data and individual-level data obtained from the World Bank. Analysis of the study was done using a cluster analysis and a logistic regression to examine the macroeconomic and microeconomic variable capable of driving mobile money adoption and it was revealed that country unique features such as the level of education, labour force, mobile facilities and banking facilities like ATM per 1,00,000 people are the key macroeconomic factors that influence mobile money adoption. The research work conclude that being young, matured, literate, relatively wealthier and having bank account motivate and increase the chance of embracing mobile money in WAEMU but ignore the role of mobile money adoption on development in WAEMU region.

Soumare et al., (2016) attempts to know and investigate the determinants of financial inclusion in Central and West Africa, being two of the least financial inclusive regions of the Africa region. The findings reveal that access to formal finance in the two regions is mainly influenced by individual characteristics such as gender, education, age, income, residence area, employment status, marital status, household size and degree of trust in financial institutions. Interestingly, Central Africa and West Africa are different from the whole Africa continent on a number of essential factors that define access to finance. Specifically, education, employment-age, metropolitan status and permanent employment are key individual features that influence access to formal account in both countries and the whole African countries. The study reveals that being man and/or wedded are positive factors that influence financial inclusion in Central Africa and Africa at large, on the other hand, income significantly influence financial inclusion in West Africa and Africa. Moreover, size of the family negatively influence account ownership in West African and not in Central Africa. By using the other financial inclusion indicators (saving level, borrowing or frequency of use), the aforementioned factors are all significant for Africa, but not compulsorily for Central Africa or West Africa, which experience different degree of significance. The study therefore recommends that governments and their partners in in Central Africa, West African and Africa at large should adopt or strengthen its regulations to better protect the consumers of financial services, improve access to education, improves access to

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finance by the poor and other weak groups. Obviously, the study is limited to the determinants of financial inclusion in West African

Guorene and Mendy (2019) investigate the causal link between financial access and economic performance of the West African Economic and Monetary Union (WAEMU) from 2006 to 2015. The study employs heterogeneity panel causality test proposed with the Maximal Overlap Discrete Wavelet Transform (MODWT) to analyze the bi-directional causality at different time scales using financial access indicators such as the Financial Inclusion supply and Financial Inclusion demand. The results of the study reveal that at scale 1 (2 - 4 years), there is no causal link between economic performance and Financial access determinants. On the other hand, at scale 2 (4 - 8 years), the study reported a bi-directional causal link between economic performance and Financial access. The study suggests that Policymakers should therefore promote reforms that are beneficial to financial access, specifically on the supply side, while making the levers for macroeconomic growth more efficient, which also seems to be an indispensable factor in financial access. However, the importance of ICT in driving West Africa progress did not received any attention from the study

Daniel and Drissa (2022) assess the impact of ICT diffusion in examining the link between financial development and economic performance in WAEMU countries and the interactive effect of ICT and financial development on economic performance using 7 countries as case study from 1997 - 2019, using a Pooled Mean Group (PMG) method of panel regression. The findings reveal that in the long term, the direct effect of financial development on economic performance is significantly negative in WAEMU countries. Also, development is assured once a threshold of ICT diffusion is reached and this ICT diffusion threshold is respectively 168.7% and 38.1% for mobile and Internet. Countries like Ghana, Angola, Rwanda, Botswana, Lesotho, and Ethiopia record high growth rates and reduced extreme poverty levels in the past three decades by halve yet poverty levels in most West Africa nations are still alarming.

It is against the claim and counter-claims that West Africa differs from other Africa region in term of financial access and the lack of adequate attention by the existing studies on the importance of ICT to drive growth and development in West Africa that this study intends to investigate the relationship among financial deepening and its interaction with Information Communication Technology on human development in West-African nations.

3 Methodology

This chapter focuses on model specification, brief data description and sources, sources and measurement of variable, descriptive statistics, methods of data analysis (Generalized Method of Moments).

Model Specification

This study adapted extensive and intensive margin theories (Chipote et al., 2014; Chiwira et al., 2016; Orji et al., 2015; Odhiambo, 2014) and empirical model of Levine and King (2002) because of its relevance to this study. However, the adapted empirical model of Levine and King(2002) was expanded by the author to capture the interactive effect of ICT because ICT-banking enhances or opens room to financial access by the unbanked populace

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Accordingly, the expanded panel regression formulated for this study is as follows: $hdi_{it} = f\left(\frac{m2_{it}}{gdp_{it}}, \frac{cpsdb_{it}}{gdp_{it}}, \frac{cps_{it}}{gdp_{it}}, \frac{LiqLib_{it}}{gdp_{it}}, intbnk_{it}, mobbnk_{it}, Inter\ var_{it}, inf_{it},\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (i)$

Where $\frac{m2_{it}}{gdp_{it}}$ is the ratio of broad money supply to GDP (financial deepening), $\frac{cpsdb_{it}}{gdp_{it}}$ is the ratio of credit to private sector to GDP from deposit money banks (financial deepening), $\frac{cps_{it}}{gdp_{it}}$ is the ratio of credit to private sector to GDP (financial deepening), $\frac{LiqLib_{it}}{gdp_{it}}$ is the ratio of Liquid Liabilities to GDP (financial deepening), $intbnk_{it}$ is the internet subscription, $mobbnk_{it}$ is the mobile subscription, $inter\ var_{it}$ is the interaction of ICT with Financial deepening and inf_{it} is the inflation rate.

Brief Data Description and Sources

This study focuses on how Information Communication Technology dimensions complement financial deepening to improve or enhance human development within the 16 West Africa countries with exception Niger and Mauritania. As a way of dealing with the research focus, the researcher sources for data from:

(1) World Bank indicators of the World Bank for Information Communication Technology variables.
(2) United Nation Development Report for Human development.
(3) The Financial Development and Structure Database (FDSD) of World Bank for financial deepening variable.
(4) The scope/coverage of the study is limited to 2012 – 2022 due to data availability constraint and the fact that Information Communication Technology usage in West Africa is relatively new. The data for all the 16 West-African countries except Niger and Mauritania is available from 2012-2022.

In line with the extant literature, Human development index (HDI) was used as the dependent variable. The choice of HDI is premised on the fact that previous studies in West-Africa used simple income approach to measure human development which does not provide more information about education, health and life expectancy. The independent variables (ICT) was measured with mobile phone penetration per 100 people, internet penetration rate per 100 people and fixed broadband penetration per 100 people. The choice of the independent variables is premised on UNDESA claims of 2012, UNDP report of 2015, ITU report of 2015, UNDP of 2017 and empirical study of Efobi et al. (2018) on economic growth boosting capacity of the ICT and broadband. Based on the extant literature on finance-growth nexus, the study employed inflation as the control variables. The choice of inflation as the control variables is to avoid the problem of overidentifying restriction issue normally associated with instrument validity in GMM. Having more control variables in the model could result in variables proliferation and loss of key information from the GMM result. Inflation is expected to have negative effect on development because most African countries are battling with a rising cost and double digit inflation and this is said to be accounted for rising cost of living and poor human development (Qiao et al. 2019).

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Table 1: Sources and Measurement of Variable

Variables	Definition/Meaning	Sources
HDI	Human development index	United Nation Development Programme Report (2012-2022)
$\frac{m2_{it}}{gdp_{it}}$	Ratio of money supply to GDP	World Bank (FDSD) (2012-2022)
$\frac{cpsdb_{it}}{gdp_{it}}$	Ratio of credit to private sector to GDP from deposit banks	World Bank (FDSD) (2012-2022)
$\frac{cpsfi_{it}}{gdp_{it}}$	Ratio of credit to private sector to GDP	World Bank (FDSD) (2012-2022)
$\frac{LiqLib_{it}}{gdp_{it}}$	Ratio of Liquid Liabilities to GDP	World Bank (FDSD) (2012-2022)
$intbnk_{it}$	Internet subscriptions (per 100 People)	World Bank (WDI) (2012-2022)
$mobbnk_{it}$	Mobile Phone Subscription (per 100 people)	World Bank (WDI) (2012-2022),Organization for Economic Cooperation and Development (OECD, 2022)
$Broband_{it}$	Broadband subscription (per 100 people)	World Bank (WDI) (2012-2022)
Interactive variables	ICT*financial deepening	
inf_{it} (control variable)	Consumer Price Index (Annual %)	World Bank (WDI) (2012-2022)

Source: UNDP (2020), CBN (2020), World Bank 2022 (FDSD), World Bank 2022 (WDI), WTO (2022), OECD (2022.)

Estimation Technique

The study adopts a Generalised Method of Moments regression. GMM for this study is appropriate in the context of semi parametric/ non parametric models where the distribution function of a data may not be known or when data does not follow a specific distribution (Drukker et al., 2010). GMM estimation is often possible where a likelihood analysis is extremely difficult and there is need for partial specification of the model. It permits to solve the problems of serial correlation, heteroskedasticity and endogeneity for some explanatory variables (Korkmaz, 2015) and lastly it accounts for cross-country difference. The GMM model for this study is specified as:

$$HDI_{i,t} = a_0 + a_1 HDI_{i,t-l} + a_2 FINDEP_{i,t} + \sum_{r=1}^{n} br\, Z_{r,i,t-l} + C_i + P_t + U_{i,t} \dots\dots\dots\dots (ii)$$

$$HDI_{i,t} - HDI_{i,t-l} = a_0 + a_1(HDI_{t-l} - HDI_{t-2l}) + a_2(FINDEP_{i,t} - FINDEP_{i,t-l}) + \sum_{ri=1}^{n} br\,(Z_{r,i,t-l} - Z_{r,i,t-2l}) + P_t - P_{t-l} + U_{i,t} - U_{i,t-l} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (iii).$$

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Where HDI is human development index in country I at time t, FINDEP is the financial deepening dimensions in country I at time t, a_0 is the constant, l is the lag coefficient of autoregression, Z (inflation) is the control variable, C_i is the country specific effect, P_t is the time specific constant and $U_{i,t}$ *is* the error term.

However, to capture the effect of interactive variable and financial deepening on HDI, model iv and v is expanded and re-specified as:

$$HDI_t = a_0 + a_1HDI_{t-l} + a_2FINDEP_{i,t} + a_3FINEC_{i,t} + a_4INRAC_{i,t} + \sum_{r=1}^{n} dj\, Inflation_{i,t-l} + C_i + P_t + U_{i,t} \dots\dots (iv)$$

$$HDI_{i,t} - HDI_{i,t-l} = a_0 + a_1(HDI_{t-l} - HDI_{t-2l}) + a_2(FINDEP_{i,t} - FINDEP_{i,t-l}) + a_3(FINEC_{i,t} - FINEC_{i,t-l}) + a_4INTRAC_{i,t} - INTRAC_{i,t-l} + \sum_{ri=1}^{n} dj\,(Z_{r,i,t-l} - Z_{r,i,t-2l}) + P_t - P_{t-l} + U_{i,t} - U_{i,t-l} \dots\dots (v).$$

Where HDI is human development index in country I at time t, FINEC is Information Communication Technology, FINDEP is the financial deepening dimensions in country I at time t, a_0 is the constant, l is the lag coefficient of autoregression, $INTRAC_{i,t}$ is an interactive variable, Z (inflation) is the control variable, C_i is the country specific effect, P_t is the time specific constant and $U_{i,t}$ *is* the error term.

4. Diagnostic Test

Descriptive statistics

Average human development index in West Africa for the period under review is 0.5 out of 1 which is considered low and very weak due to the fact that HDI is a key indicator for development and human long run economic growth (Solow, 1996). The maximum value of 0.67 and the minimum value of 0.35 for HDI give a clearer picture that the rate of human development in West African countries is completely not encouraging. The huge deviation as revealed by high standard deviation is an indication that no stable human development in West African countries. The skewness value of 0.42 is low suggesting that West Africa witness periodic poor human development. The kurtois value of 2.8 indicate mesokurtic situation which indicates that human development is neither high nor encouraging in West Africa. The Jarque Bera P-value of 0.008 indicates that the data set is abnormally distributed suggesting that the data has endogeneity issue which necessitate the adoption of GMM which is capable of addressing endogeneity problem.

Average credit supply to private sector (CPS) for the period under review is 2.9 and this is considered low due to the fact that CPS is one of the essential policy variables for driving growth and development. The standard deviation of 0.55 is low indicating that CPS movement has been low and not changed. Thus, the CPS value has been similar over the period. The J-Bera value of 0.013 for CPS is an indication that the data set is abnormally distributed and that CPS is being influenced by other unobserved variable(s) resulting in endogeneity issue which would necessitate the adoption of GMM to address endogeneity problem.

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Average Credit supply by the financial system for the period is 2.7 and the value is also considered low because CPSDB is a policy instrument for development. The standard deviation of 0.6 implies that CPSDB value has not changed significant for the period under review. The J-B value of 0.05 evidenced abnormal distribution of the data.

Average value of 3.5 for a log transformed money supply is not too low but cash outside the banking (COB) system is a threat to its efficiency on the West African economy. With standard deviation of 0.4, the movement of M2 has been stable in West Africa over time. Similarly, average value of 3.5 for a log transform liquid liabilities is not too low but the threat of COB has made liquid liabilities less effective on West African growth and development. Standard deviation of 0.4 indicates that the liquid liability is relatively stable but not used for productive purposes. Both M2 and liquid liabilities exhibit endogeneity variations.

Average value for the internet subscription is 1.04 which is low for driving the much needed development in West Africa. The maximum value is 13.15 while the minimum is 0.0065. This huge variation as confirmed by the high standard deviation is an indication that growth of internet subscription is not encouraging.

Lastly, average value for mobile subscription is 1.02. The maximum value is 5.1931 and the minimum is 0. The small variation as affirmed by relatively small standard deviation of 1.04 is an indication that its penetration has been gradual over the period.

Table 1: Descriptive statistics

	HDI	LOGCPS	LOGCPSDB	LOGM2	LOGLIQLIB	FBBSP	MPS
Mean	0.50009	2.86727	2.7285	3.46661	3.50614	1.04583	1.02266
Median	0.495500	2.80211	2.65726	3.35599	3.40452	0.1756	0.77095
Maximum	0.676000	4.29309	4.28451	4.83071	4.8307	13.1532	5.1931
Minimum	0.354000	1.7781	1.55069	2.76188	2.76252	0.0065	0.0000
Std. Dev.	0.0736	0.55227	0.61719	0.42691	0.41565	2.84757	1.04068
Skewness	0.63867	0.61406	0.50711	1.14859	1.1853	3.31024	1.43189
Kurtosis	3.1839	3.00093	3.10321	4.39089	4.63595	12.2572	4.93603
Jarque-Bera	9.57623	8.67267	5.97584	41.4667	47.7023	744.774	68.7093
Probability	0.00833	0.01308	0.05039	0.000000	0.000000	0.000000	0.000000
Observations	138	138	138	138	138	138	138

Generalized Method of Moment

The table 2 is the result of a model specification that focuses on how financial deepening and its interaction with the ICT affect human development in West African countries. In line with the extant literature, a difference Generalized Methods of Moment was used to appraise the study's focus because the difference GMM is asymptotically normal and the approach prioritize differencing of the data in order to eliminate fixed effects. The approach is preferred to the system GMM because of the difficulty of knowing the optimal weight for the system GMM which often result in finite sample bias. In the same vein, the Hansen J-Statistics is preferred to the Sargan-statistics because the number of instruments is below the number of cross-section and the preference is in line with rule of thumb that Sargan statistic is fragile and weakened by the instruments when compared with Hansen J-statistics. Hansen statistics is strong and not physically fragile by the instruments. Having met all the critical condition that preceded the use of difference GMM, the following result is affirmed from table 2: About 90% positive change in human welfare depend on the previous quality of education, health and

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life span which implies that the past quality of human development is significant in explaining the present human development. It was also affirmed that whether inflation is included or not included in the model, the effect of money supply (financial deepening) on human development remains negative. Even when the internet subscription and mobile subscription (ICT) were used as catalysts to enhance money supply (financial deepening) so as to effectively improve human development, the overall effect of financial deepening on human development is mixed. The interaction of money supply with the internet subscription in West African countries has significant negative effect on human development while the interaction of money supply with the mobile subscription has an insignificant positive effect on human development. Similarly, the interactions of liquid liabilities (financial deepening) with both the internet subscription and mobile subscription have mixed effects on human development with insignificant coefficients value of 0.000135 and -0.000191 respectively. The interaction of liquid liabilities with the internet subscription significantly improves human development on one hand and on the other hand, the interaction of liquid liabilities with mobile subscription has insignificant negative impact on human development. The implication of this is that excessive cash outside the banking system, financial dualism (formal and informal financial sector) and unwillingness to embrace financial technology by the informal sector are negatively affecting West African development focus.

Credit supply to private sector showed a positive significant effect on human development in West Africa but the interaction of credit supply with both the internet subscription and mobile subscription do not significantly improve human development in the West African countries which implies that efficient utilization of credit by the private sector to enhance human development in West African countries does not in anyway depends on ICT or financial technology because private sector is always efficient and productive to the economy. Inflation appeared to worsen human development in West African countries.

Post estimation diagnostic test

The Hansen J-statistics was used to prove the validity of the estimate and address the issue of over-identification restriction. The issue of endogeneity and exogeneity was addressed based on the researchers' a prori knowledge of what constitutes endogenous and exogenous variables in the model. The lagged dependent variable was used to address the issue of autocorrelation and reverse causality.The Hansen J-Statistics shows that the instrumental variables employed in the GMM analysis are exogenously linked to the margin of error given the probability value of 0.261. The associated J-Statistics of 0.261 is confirming and reflecting the validity of the instruments used. In line with Sargan's (1958) suggestion, a benchmark probability of 0.25 is a necessary condition to accept that the instrument is valid and exogenously related to the margin of error. Thus, the J- statistics from the model specification is in line with the orthogonally conditions.

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Table 2: Generalized Method of Moment

Financial Deepening and the Effect of its Interaction with the ICT on Human Development

Panel Generalized Method of Moments Approach

Variable	Coefficient	Std. Error	t-Statistic	Prob.
human development index(-1)	0.895162	0.041004	21.83103	0.0000
M2 * fixed broad band per 100 people	-0.000148	7.61E-05	-1.94986	0.0541
M2 * mobile phone subscription	6.82E-05	0.000177	0.384345	0.7016
CPSFS * fixed broad band per 100 people	-0.000307	0.000446	-0.68663	0.4940
CPSFS * mobile phone subscription	0.000324	0.000382	0.847786	0.3986
CPS * fixed broad band per 100 people	0.000332	0.000443	0.748752	0.4558
CPS * mobile subscription	-0.000206	0.00037	-0.558	0.5781
LIQLIB * fixed broad band per 100 people	0.000135	4.05E-05	3.331307	0.0012
LIQLIB * the mobile phone subscription	-0.000191	8.98E-05	-2.12567	0.0361
Inflation (control variable)	-0.000548	0.000291	-1.88392	0.0626
LCPS to GDP	0.009431	0.004232	2.22848	0.028
LCPSFS to GDP	-0.009566	0.019388	-0.49338	0.6229
LM2 to GDP	-0.015385	0.008478	-1.81476	0.0727
Mean dependent var	0.003518	S.D.dependent var		0.0046
S.E. of regression	0.005128	Sum squared resid		0.0026
J-statistic	41.24451	Instrument rank		48
Prob(J-statistic)	0.261297			
Instruments	12	12	12	12
Countries	14	14	14	14
Observations	110	110	110	110

5. Conclusion and Policy implications

The study focus on how financial deepening and its interaction with ICT affect human development in West Africa countries from 2012 to 2021. The findings of the study are based on Generalized Method of Moments. The human development variable employed is the HDI. The indicators of financial deepening used include Money supply to GDP, Credit supply to private sector in relation to GDP, Credit supply by financial system in relation to GDP and Liquid liabilities. Two indicators of ICT used are internet subscription and mobile subscription. It is affirmed that about 90% positive change in human welfare depend on the previous quality of education, health and life span which implies that the past quality of human development is significant in explaining the present human development. It was also affirmed that whether inflation is included or not included in the model, the effect of money supply (financial deepening) on human development index remains negative. Even when the internet subscription and mobile subscription (ICT) were used as catalysts to enhance money supply (financial deepening) so as to effectively improve human development, the overall effect of financial deepening on human development is mixed. The interaction of money supply with the internet subscription in West African countries has significant negative effect on human development while the interaction of money supply with the mobile subscription has an insignificant positive effect on human development. Similarly, the interactions of liquid liabilities with both the internet subscription and mobile subscription have mixed effects on human development with insignificant coefficients value of

0.000135 and -0.000191 respectively. The interaction of liquid liabilities with the internet subscription significantly improves human development on one hand and on the other hand, the interaction of liquid liabilities with mobile subscription has insignificant negative impact on human development. The implication of this is that excessive cash outside the banking system, financial dualism (formal and informal financial sector) and unwillingness to embrace financial technology by the informal sector are negatively affecting West African development focus.

Credit supply to private sector showed a positive significant effect on human development in West Africa but the interaction of credit supply with both the internet subscription and mobile subscription do not significantly improve human development in the West African countries which implies that efficient utilization of credit by the private sector to enhance human development in West African countries does not in anyway depends on ICT or financial technology because private sector is always efficient and productive to the economy. Inflation appeared to worsen human development in West African countries. Based on our findings, the following policy measures are recommended;

Firstly, policymakers must enforce the adoption of financial technology by both the formal and informal sector to minimize cash outside the banking system and enhance money and credit supply. Informal sector saving through financial technology should be created to increase circulation of money and enhance the belief of the less educated people that they have control over their money through their mobile phones. This without doubt, this will guarantee the effectiveness of monetary policy tools in West Africa

Secondly, an ICT-driven credit supply to the private sector should be given priority and should receive more attention from the policymakers more than before to promote development. Provision of digital flexible loan through financial technology will promote small businesses and have multiplier effect on economic activities of the informal sector which in turn will enable them to finance their education and health.

Thirdly, cash transactions should be replace with cashless policy. In fact, government empowerment programme such agric loans, traders loan, farmers loans can be provided directly to the direct beneficiaries rather than through the third-parties. This will make policymakers policies on credit to be effective and minimize credit diversion.

Without doubt, the result of this study is an eye opener for the stakeholders and the findings support previous empirical and theoretical views yet our reservations on some of the outcomes are due to the insignificance of the model coefficients but this does not imply that small coefficients has insignificant economic meaning.

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