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The impact of mobile money, remittances, and financial development on innovative growth in sub-Saharan Africa[1]

Mobile money has become a mode of banking for the unbanked residents and the system has been gaining patronage among citizens of developing countries. This trend especially refers to sub-Saharan Africa, where the level of financial inclusion is low. Thus, the expansion of the mobile money as well as easy access to it promotes the development of the financial sector in the region. To define the role of the financial elements in innovation growth in sub-Saharan African countries, we examined the relationship between mobile money activities, remittance, financial development, and innovation growth in sub-Saharan Africa (SSA). Using partial least squares (PLS), we conducted a comprehensive analysis to econometrically establish the nexus between innovation development and financial activities in sub-Saharan African region. The results show that significant positive relationship exists between all the independent variables and innovation growth (the dependent variable). Thus, this study indicates that mobile money services, financial development and remittances have significant impact on economic growth. However, mobile money services are the most influential variable. Hence, these results can be used by policymakers to encourage and improve mobile money payment and banking system as this could facilitate the pooling of resources and their effective allocation to productive sectors, thus leading to the promotion of innovative growth in the region.

Keywords: mobile money, banking, economic growth, GDP per capita, developing economies, financial inclusion, remittances, financial system, electronic payment system, finance

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ИССЛЕДОВАТЕЛЬСКАЯ СТАТЬЯ

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Влияние мобильных денег, денежных переводов и финансового развития на инновационный рост в странах Африки к югу от Сахары

Мобильные деньги — один из способов банковского обслуживания населения, не охваченного банковскими услугами, который становится все более популярным среди граждан развивающихся стран. Эта тенденция особенно актуальна в странах Африки к югу от Сахары, где уровень финансовой доступности достаточно низок, поэтому распространение мобильных денег и также легкость доступа к ним способствуют развитию финансового сектора в регионе. Для определения роли финансовых элементов в инновационном развитии в странах Африки к югу от Сахары была изучена взаимосвязь между операциями с мобильными деньгами, денежными переводами, финансовым развитием и ростом инноваций в этом регионе. С использованием метода частичных наименьших квадратов (PLS) был проведен комплексный анализ, чтобы эконометрически установить связь между развитием инноваций и финансовой деятельностью в регионе Африки к югу от Сахары. Выявлено, что существует значимая положительная связь между всеми независимыми переменными и ростом инноваций (зависимая переменная). Таким образом, исследование показывает, что услуги мобильных денег, финансовое развитие и денежные переводы оказывают значительное влияние на экономический рост, при этом услуги мобильных денег были выявлены как наиболее влиятельная переменная. Результаты исследования могут быть использованы органами власти для поощрения и совершенствования платежной и банковской системы с использованием мобильных денег, поскольку это способствует объединению ресурсов и их эффективному распределению между производственными секторами, что приведет к стимулированию инновационного роста в регионе.

Ключевые слова: мобильные деньги, банковское дело, экономический рост, ВВП на душу населения, развивающиеся страны, финансовая доступность, денежные переводы, финансовая система, система электронных платежей, финансы

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1. Introduction

The significance of financial systems has been emphasized over several decades by economists, scholars, and politicians due to growing capitalism, industrialization, and economic development. For Schumpeter [1], financial intermediaries perform a crucial function in economic development as they select which businesses get to use the pool of resources or accumulated savings of society. However, development economists have for some time overlooked the financial system by dedicating more attention to other policy areas. For instance, Robinson [2] thinks that the economic growth predominantly precedes financial development, with Lucas (1988), arguing that the impact of finance in economic development process has been exaggerated.

Moreover, following the works of Goldsmith [3], Shaw [4] and McKinnon [5], large theoretical and empirical studies (including recent ones) have shown some link between financial development and the processes of economic growth. The existing empirical literature establishes that financial deepening has a statistically and economically significant positive effect on economic development. Hence, the development of the financial sector has been linked to the overall outcomes of the real sector, such as the pattern trade balance of a country, income distribution and poverty levels in some recent studies.

However, as much as finance could positively impact on growth, in the same vein it poses as a source of risk. For instance, Reinhart and Rogoff [6] explained that finance is associated with boom-and-bust cycles, bank failures, and currency crises. Thus, there is equally a comprehensive literature on the causes of financial weakness, and banking crises, with historic assessments and case studies stressing on systemic cross-country examination of idiosyncratic and systemic banking distress including their determinants.

It is the extent of financial system's significance on economic growth, related risks, and the possible socio-economic costs of banking crises that the financial sector remains the top policy agenda in every economy. However, the impact of access to finance as an entry barrier into the real sector and the ease with which owners and creditors of financial institutions could expropriate resources also indicates the importance of finan-

cial sector policies in the political process. The need for access to external finance makes the financial sector crucial in an effort, where the ruling class wants to establish their socioeconomic dominance and thwart competitions. The dependence of financial organizations and markets on contractual institutions leads them to be reliant on the political circle.

The above mentioned caused doubts or concerns about earlier findings on the positive effect of finance on growth. Nevertheless, a huge amount of empirical literature establishes how important financial systems are for firm productivity and growth (see Greenwood and Jovanovic [7], King and Levine [8]; Rajan and Zingales [9]; Rousseau and Wachtel [10]; Levine et al. [11]).

Furthermore, there is evidence that total credit accessible or available to the private sector matters for economic development (King and Levine [8]), and as such the development of both bank lending and stock market benefits cross-country growth (Levine and Zevros [12]), thus this evidence suggests that financial development indicators are correlated with overall factor productivity growth and investment (Behabib and Spiegel [13]). In support of the above findings, Hasan et al. [14] think that an improvement in the bank efficiency spurs regional economic growth fivefold more than the same degree of increase in credit, while Inklaar and Koetter [15] establish that deeper credit and more effective capital markets also improve production and promote productivity growth.

The adoption and further development of electronic banking and payment system affect the general national economy via various channels such as trade (through capital accumulation) and consumption of household, mobile money system provides the platform through which the working class or people generally remit to their families and friends, hence improving the income distribution of households. This inspires us to undertake this rare study to underscore the empirical significance of the financial sector and other related areas such as mobile money and migrants' remittance on growth in the selected region.

This study examines the relationship among mobile money activities, remittance, financial development, and economic growth in sub-Saharan Africa (SSA). The dataset used to proxy for mobile money development was retrieved from GSMA for the period of 2011–2018 due to limited data availability, while economic development variable (GDP per capita) and other variables such as migrants' remittance and financial development were explored from the World Economic Indicators [17] database covering the same period.

Partial least squares (PLS) regression, a form of structural equation modelling, helps examine the cause-effect relationship with dependent and explanatory variables, hence, it was employed in this paper to test the impact among the variables. The paper established a positive relationship between the variables, hence the explanatory variables: mobile money, remittance and financial development have a significant impact on the overall economic growth in sub-Saharan Africa. Therefore, these results complement previous studies aimed at settling the discourse on finance-growth nexus.

The rest of the paper is organized as follows: the literature review section covers previous studies and empirical evidence, the methodology section explains the source of data and the model used, the results and discussion section presents the findings of our research, and the final section concludes the paper by summarily presenting the results and calling for further policy development and implementation in the region.

2. Literature Review

As stated earlier, financial-development nexus has gained comprehensive studies among scholars, with some academics taken a further microeconomic approach. For instance, Rajan and Zingales [9] examined the link between financial growth and the level growth performance of industries across countries. Some scholars equally established that the level of access to well-developed stock markets influences firms' growth, as businesses tend to grow faster in an environment where access is significantly high [16].

Moreover, another well-established study in this financial development and growth link is McKinnon [5], who argues after examining the relationship between the financial system and economic growth in several countries in the post-World War II period that a better functioning financial sector supports rapid economic development. In the context of sub-Saharan African context, Gelbard and Pereira Leite [17] established that a lot is left to be done in the financial sector although there has been some progress with respect to upgrading the financial sector since the mid-1980s. However, empirical evidence supports the positive link between the level of financial development and economic growth in sub-Saharan Africa [17].

In the same vein, Park [18], Patrick and Park [19], and Fry [20] all using pure time series found positive and significant causality between financial development and economic growth. Additionally, current empirical studies have also reignited the ancient discourse on the comparative advantages

of bank-based financial systems (as in countries like Japan) against market-based financial systems (like the case of U.S.). Proponents of bank-based systems argue that the combination of factors such as high liquidity rate and the inability of small external investors to exert adequate corporate influence or control on decision-making processes brings about market failures and lead to an unproductive allocation of funds or savings.

Nevertheless, the supporters of bank-based systems think that banks can mitigate such market failures through their long-term relationships with certain businesses or companies [21]. While the proponents of market-based systems emphasize on certain weaknesses of bank-based systems such as big banks encouraging industries and business to assume very conservative investment projects, with little motivation to produce new and innovative products and that shareholders have little oversight over bank managers who control the banks, including the businesses, indirectly through bankrolling or financing [22].

That notwithstanding, we should note that the major indicators that measure the level at which the banking systems channel financial resources to the real or private sector include

i) the share of bank credit to the overall credit from bank and central bank, which shows the extent to which banks allocate credit against the central bank;

ii) the share of private credit to domestic credit;

iii) the fraction of private credit to gross domestic product (GDP).

Hence, the ultimate frictions that lead to financial intermediaries happen technologically or by way of incentive, and while the latter transpires because of the cost of information, which subsequently circulates asymmetrically via agents, the former prevent undue access to economies of scale among individuals.

One aspect that has equally caught the attention of scholars is how system payment systems facilitate economic growth, as it is argued that safer and efficient systems and measures currently exist in the wholesale and retail payment mechanisms (ECB[1]). A well-designed payment framework is vital for markets to function and to eradicate frictions in trade and investment, ECB underscores that reliable and safe payment systems for the transfer of finance are the condition sine qua non-for vast of economic interactions. Technological developments over the past 3 decades remain as one of the dynamic powers responsible for the various structural changes in the financial sector as well as the creation of new financial instruments. Hence, Scholnick et al. [23] posits that several major changes have taken in the retail payment market, including the development of current and innovative platforms and instruments like electronic cards (debit and credit) are progressively substituting cash payments. This makes payment systems and instruments a major point of debate, with activities ongoing in this field drawing attention among researchers (Hasan et al. [24]; Kahn and Roberds [25]; Carbó Valverde et al. [26]) from macroeconomics, monetary theory, financial and banking economics and regulatory economics.

Berger [27] posited that technological growth and innovation such as internet banking, electronic payment platforms, and information exchanges in the financial system is related to major productivity growth, and further argued that a shift from cash to cashless payment instruments could reduce the costs of activities in back-offices that constituent the larger operational costs of banks, and considerably increase productivity as well as economies of scale.

In support of the above postulation, Humphrey et al. [28] and Hasan et al. [24] established in their studies that a rise in the use of cashless payment systems, essentially electronic retail-payment tools, has a link to remarkable improvements in banks' costs and revenue. The literature on the economics of retail payments partly put emphases on the impact of consumer choices and system developments. For instance, with the objective to discover the replacement effect between checks and cards, a model was developed by Humphrey et al. [29] to estimate consumers' demand for three point-of-sale payment tools such as checks, cash and debit cards. While another study found after analysing the impact of reducing interchange fees on card payment services that the volume of consumer and merchant patronage and transactions grew as substitution fees were reduced.

Despite, several studies demonstrate that financial development and intermediation boost economic development. However, the significance of safe and efficient retail payment modes has not yet been well studied. Moreover, a comprehensive search indicates that aside this paper there is no paper with a complex combination of remittance, financial development, and mobile money development variables. However, the rapid development of mobile banking in SSA makes it necessary to determine its causative effects on other finan-

[1] European Central Bank (ECB). The Payment system. Payments, Securities and Derivatives, and the Role of the Eurosystem. Frankfurt, Germany. Retrieved from https://www.ecb.europa.eu/press/pr/date/2010/html/pr100906.en.html (Date of Access: 24.12.2019).

Table 1

Mobile money development indicators

Year	Volume of transactions	Number of active agents	Value mobile money services (US dollars)
2011	173,065,536	90,934	3,568,106,003
2012	285,607,961	216,413	5,606,636,300
2013	386,693,248	364,384	7,896,255,773
2014	547,178,479	531,535	10,665,159,621
2015	721,059,906	705,455	13,283,227,359
2016	994,162,866	908,391	17,968,282,627
2017	1,493,789,817	1,187,593	23,258,341,364
2018	1,670,341,027	1,400,815	26,806,458,086

Source: Authors', based on Database of GSMA (GSMA. Explore the growth of the mobile money industry through this comprehensive set of global metrics. GSMA dataset. Retrieved from https://www.gsma.com/mobilemoneymetrics/#global?y=2018?v=overview?g=global (Date of Access: 24.12.2019)).

cial development as well as its role in economic growth. This, therefore, calls for further studies. Hence, this paper directly analyses the dimension of mobile money development in financial systems and its impact on real economic growth by considering retail payment market infrastructures and remittances.

One of the major electronic payment systems in many developing economies currently, particularly in Sub-Saharan Africa is mobile money, which is assumed to be a driving force in the region's financial systems. The development of mobile money has become a medium through migrants send remittances to their countries of origin, thereby easing the generational difficulty, previously, associated with transactional costs and charges. The continuous growth in annual volume and value of transactions as well as the number of mobile money agents is evident that this type of electronic payment system is safe and reliable, and thus is well accepted and patronized in sub-Saharan African economies.

Thus, in developing countries, specifically in sub-Saharan Africa, mobile money has been distracting traditional financial services, which over the past decade has been transforming the lives of hundreds of millions of residents in these countries. Table 1 presents the growth tendency of mobile growth in the Sub-Saharan Africa. Mobile money, currently, serves as a mode of banking for residents, who previously did not have or want to open traditional bank accounts. Hence the system becomes a conduit through which financial resources (savings) can be pooled from the unbanked and under banked population for effective allocation to productive sectors for development.

The table above show that all development indicators of mobile money have continuously been growing since 2011 to 2018, where the total number agents undertaking mobile money activities, volume of transactions, and overall value of transactions recording closed to 1.5 million agents, about 1,7 billion transactions and annual value of over $26 billion, respectively. Currently, it is estimated that more than $1.3 billion worth of transactions are processed a day by about 866 million registered accounts in 90 countries, hence mobile money has advanced into a larger payment platform that offers life-enhancing services such as education, healthcare, employment, and transportation.

Mobile money is therefore seen to be fuelling economic development at a macro-level by easing savings and investments, creating employment, improving business productivity and entrepreneurship, formalizing the economy, and providing stability in the event of economic downturns. As such, mobile money can be described as a major driver of socio-economic growth and is providing the means through economies of those developing countries can be transformed into digital economy.

Hence, the more national economies are rapidly becoming dependent on digital technology, the more important mobile money would continue to be in harnessing digital finance for sustainable growth (Farooq [30]). It is therefore not surprising that various studies including this paper attempt a link between mobile money growth and economic development in SSA.

Remittances, over the past 15 years, have become a major instrument in the global development agenda, especially in developing countries. With an estimated amount of over $500 billion being sent by migrant employees to their countries in 2015, thus remittances currently serve as a key component of foreign currency flow to developing countries.

According to Strive Masiyiwa [31] in totality the remittances income from the diaspora to Africa, $62 billion, is larger than the volume of Foreign Direct Investment (FDI), $55 billion as well as

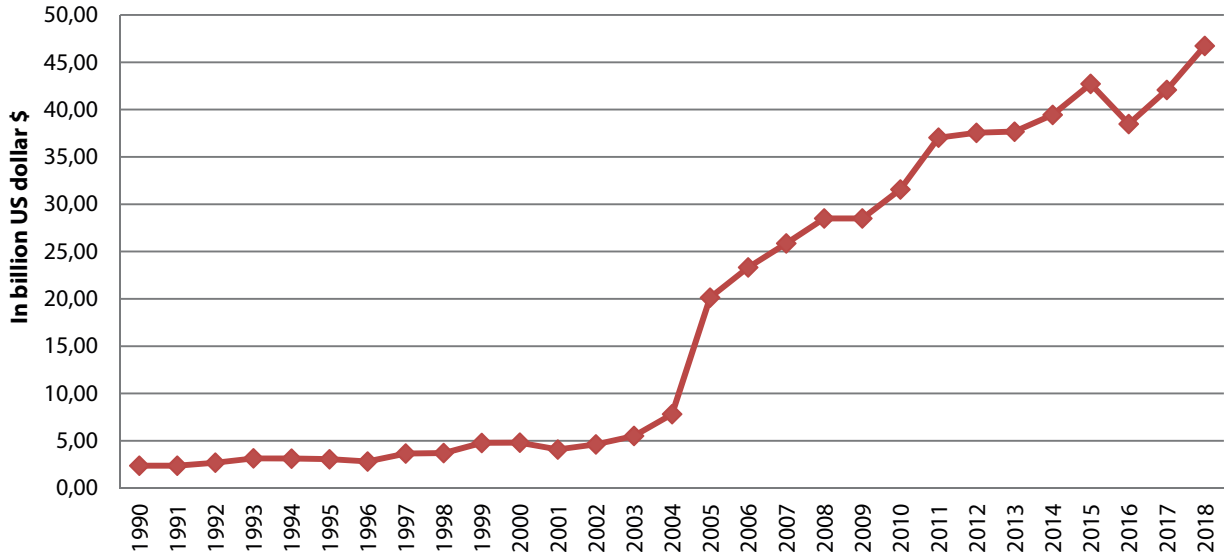

Fig. 1. *Remittance flow to sub-Saharan African countries between 1990–2018 (World Economic Indicators of the World Bank. World Bank national accounts data, and OECD National Accounts data files", World Bank. Retrieved from https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=ZG&most_recent_value_desc=false (Date of Access: 24.12.2019))*

overall foreign aid, of about $50 billion. In certain African economies, the income of their citizens that flow from the diaspora is essentially more than what earned from their export of key natural resources, including agricultural production.

The trend of remittances flows into sub-Saharan African economies is illustrated on Figure 1. The effect of remittances on local societies is remarkable, as remittances come in large amounts of capital that sustain or serve as relief to millions of families. Remittances was introduced officially for discourse in 2004 at the Group of Eight (G8) meetings, and it has since remained and been recognised as a significant developmental theme on various platforms such as governments, international organisations, and Non-Governmental Organizations (NGOs).

The above graph shows that remittance flows to Sub-Saharan African countries over 2 decades grew steadily until 2016, where a sharp decline in remittance flow was recorded, however, this trend did not stay long as the flow shot up next year and subsequently recorded close to $50 billion in 2018. Migrants' remittances present a major opportunity for mobile money services to link their deployments to large diaspora groups.

Several other studies like Levine et al. [32] on developing economies; Barua and Rana [33] on Southern Asia economies; Cooray [34] on South Asia have analysed the nexus among remittances, financial development, and economic development. However, conflicting, and contradicting evidence still exists on the link among remittances, financial development, and economic development.

For instance, Feeny et al. [35] in their study empirically established that remittances cannot be a substantial source of funds for economic growth, thus no significant link exists between remittances and economic growth in developing economies. However, to some scholars like Kratou and Gazdar [36] and Aggarwal et al. [37] migrants' remittances serve as a complement to financial development, as such remittances play or become a conduit to development in economies with a well-functioning financial system. Sobiech [38] equally thinks that remittances offer an alternative means to finance investment and support to prevent liquidity constraints.

Some prominent scholars with optimistic view like Kindleberger [39], Todaro [40], Beijer [41] and Massey et al. [42] based on the development theory consider return migrants as key partners for changes and innovations. According to De Haas [43], this is centred on the fact that migrants do not only facilitate the flow of foreign capital but equally generate new ideas and entrepreneurial skills, thus migrants play a worthwhile role in the developmental process.

Hence, migrants' remittances are considered crucial as they bring about improvement in household's incomes, support investments and innovations, which at a larger extent stimulate economic growth of these beneficiary countries (Kindleberger [39] and Beijer [41]). However, opponents of migrants' labour theory think that migration and remittances bring about underdevelopment in the beneficiary countries (Olufemi and Ayandibu [44]). Binford [45] thinks that migrants' remittances lead receiving countries to over de-

pendent on the sending countries receiving countries as the receivers of these remittances tend to depend solely on the sender, therefore causing moral hazard to the receiving economies.

3. Data and Methodology

The data for this study was primarily collected from secondary sources like database of the World Bank and GSMA, the data gathered on Sub-Saharan Africa (SSA) covers the period 1980–2018. However, there was a data limitation on the mobile money variables as the set of data available is not beyond 2011–2018 period. We analysed and interpreted the data by using linear regression to examine the relationship or causality effects among the variables used for this study. Electronic payment system, and in the context of sub-Saharan Africa, mobile money is a broad and complex field of analysis, as such the following variables: number of active mobile money agents, volume of annual mobile money transactions, annual value of mobile money transactions were used to proxy for mobile money (electronic payment and banking in the region) in our analysis.

For this study, our dependent variable is GDP per capita, while financial development and remittance were employed as a control variable to ensure that the study results are not bias. To accomplish our study objectives, the data composed was scrutinised using statistical techniques such as mean, simple percentage, standard deviation and regression analysis, and the research findings are presented in tables and graphs. The following hypotheses were composed in our urge to get to solutions to our research questions (objectives):

H0: Financial intermediation or activities cause economic growth in Sub-Saharan Africa;

H1: The growth of mobile money transactions boosts economic development in Sub-Saharan Africa;

H2: Remittance facilitates mobile money development in developing economies;

H3: The growth of mobile money platforms in Sub-Saharan Africa spurs economic development. This assumption stems from the fact that the proximity of mobile money platforms in the region will increase in usage and patronage (as demonstrated over the years through the number of transactions and subscriptions), ceteris paribus; this will lead to an increase in mobile money deposits. Thus, these deposits, which could end up under pillows, can therefore be channelled into various economic activities, thereby causing economic growth.

To achieve the purpose of this paper, partial least squares (PLS) technique was applied. This method helps examine the relationship, while also making comparison between the multiple response and explanatory variables in line with our hypotheses, a multivariate statistical technique of structural modelling equation (SEM) such as partial least squares was preferred.

Partial least squares (PLS) can construct a group of factors that consider many variations in the data while also modelling the dependent (y) variables effectively. This method works by obtaining a set of factors that change the raw data of X to form a set of x-values. Likewise, the data of Y are used to establish an additional group of elements called the y-scores. Thus, the y-scores are predicted with the help of the x-values and help in predicting the response Y-components at the same time. This multivariate process is seen to be "concealed" as the outcome of this method since the partial least squares model forecasts a set of linking responses Y for a group of predictor X components. It was, therefore, necessary to employ the linear regression equation (1) below. Thus, this equation must test our hypotheses by specifically estimating that:

$$y = \beta_0 + \beta_1(FD)_i + \beta_2(Remit)_i + \beta_3(MM)_i + \varepsilon_i. \quad (1)$$

where y represents GDP per capita income, which is the proxy variable for economic growth (the outcome of economic activities in the SSA region), while *FD*, *Remit* and *MM* represent financial development, migrants' remittances and mobile money development indicators, respectively. Mobile money growth indicators involve all the various activities such as the growth in the number of registered agents, rise in volume of transaction as well as increase in overall capitalisation of these activities.

To achieve the objective of this study, the data collected was analysed using statistical techniques such as mean, simple percentage, standard deviation and other relevant statistical tools in this study, and the results are presented in the form of tables and graphs. The summary descriptive statistics of the proxy and control variables employed in this study are illustrated in table 2 below.

4. Results and Discussion

The linear model equations defined in the data and methodology section were used to examine the hypotheses of this paper using the variables above. The model results from our regression analysis, where GDP per capita was used to proxy for economic development (thus dependent variable), financial development and remittance represented the control variables, while mobile money components (development dimensions) were em-

Table 2

Descriptive statistics of variables

Variable	Obs.	Minimum	Maximum	Mean	Std. deviation
GDP per capita	7	3349.328	3968.675	3676.861	217.487
Remittances	7	37030939709.886	46733928981.959	39945838283.776	3549978610.297
Number of active agents	7	90934.000	1400815.000	602561.000	449809.970
Mobile money value	7	3568106003.000	26806458086.000	12256303681.286	8027378996.067
Financial development	7	0.144	0.167	0.153	0.008

Source: Author's own calculations using data from World Development Indicators and GSMA.

Table 3

Correlation results

	Remittances	Number of active agents	Mobile money value	Financial development	GDP per capita
Remittances	1	0.861	0.849	0.891	0.812
Number of active agents	0.861	1	0.998	0.993	0.935
Mobile money value	0.849	0.998	1	0.988	0.916
Financial development	0.891	0.993	0.988	1	0.951
GDP per capita	0.812	0.935	0.916	0.951	1

Table 4

Analysis of model fitness

Multicolinearity statistics:				
	Remittances	Number of active mobile money agents	Mobile money value	Financial development
Tolerance	0.167	0.001	0.002	0.009
VIF	5.987	691.298	430.782	116.159

Goodness of fit statistics					
Statistic	Training set	Validation set	Statistic	Training set	Validation set
Observations	7.000	1.000	DW	2.116	
DF	2.000	–4.000	Cp	5.000	
R^2	1.000		AIC	27.082	
Adjusted R^2	0.999		SBC	26.812	
MSE	40.169		PC	0.002	
RMSE	6.338		Press	7365.070	
MAPE	0.073	0.000	Q^2	0.974	0.000

ployed as explanatory variables, are all illustrated in tables below. The correlation parameters among all variables used are shown in Table 3 below.

The matrix indicates a significant positive Pearson correlation between economic growth and explanatory (mobile money activities) and control variables (financial development and remittance) used in this study, likewise there is a significant positive correlation among all mobile money indicators and financial development as well as remittances. Although, all the mobile money development indicators record the least positive correlation coefficients with remittance, however, the values recorded are just as significant as in the other cases above.

Financial development and growth have also shown a positive relationship. Thus, it has been established that mobile money development dimensions have positive nexus with financial development, remittances, and the overall economic growth in SSA. Table 4 below shows the goodness-of-fit and multicollinearity statistics of the model.

Hence, the development of mobile money would lead to financial development as it facilitates financial inclusion and thereby serve as a mode of banking for the unbanked residents in developing countries. The increase in volume and capitalisation of mobile money transactions, thus cause financial development, which is spot-on because easy access to mobile money agents would to boost financial inclusion in the SSA region, and thus provide an alternative banking mode for people without traditional bank accounts.

The *R*-square shows the amount of variance of the proxy variable for economics in this case ex-

Table 5

Analysis of variance

Source	DF	Sum of squares	Mean squares	*F*	*Pr* > *F*
Model	4	283722.449	70930.612	1765.792	0.001
Error	2	80.339	40.169		
Corrected Total	6	283802.788			
Computed against model Y = Mean(Y)					
Test on the normality of the residuals (Shapiro-Wilk)					
W				0.793	
p-value (Two-tailed)				0.035	
Alpha				0.05	

Table 6

Model parameters

Source	Value	Standard error	*T*	Pr > | *t* |	Lower bound (95 %)	Upper bound (95 %)
Intercept	–572.483	167.543	–3.417	0.076	–1293.361	148.396
Remittances	0.000	0.000	–33.561	0.001	0.000	0.000
Number of active agents	0.003	0.000	51.233	0.000	0.003	0.003
Mobile money value	0.000	0.000	–62.564	0.000	0.000	0.000
Financial development	35244.069	1214.327	29.024	0.001	30019.240	40468.899
Standardized coefficients						
Remittances	–0.379	0.011	–33.561	0.001	–0.428	–0.331
Number of active agents	5.667	0.111	51.233	0.000	5.191	6.142
Mobile money value	–5.660	0.090	–62.564	0.000	–6.049	–5.271
Financial development	1.256	0.043	29.024	0.001	1.070	1.442

plained by the explanatory variables, while the adjusted *R*-square value serves similar function but by the number of cases and variables used. The *R*-square and adjusted *R*-square, which recorded 100 % and 99.9 %, respectively, indicate the extent of variance as explained by the mobile money indicators, financial development and remittance, and provide a more honest link between the dependent and explanatory variables used in the model. The analysis of variance results is illustrated in Table 5.

It can be seen, that the model has a *p*-value of 0.001, which defines the suitability and reliability of our model. The table above allows establishing that a significant positive nexus exists between mobile money development and economic growth, and further both financial development and remittances were found to have a positive impact economic development in SSA. The model parameters, which demonstrate the level of reliability and significance of the linear regression model used, are presented in Table 6 below.

The t-values examine the hypotheses such that the values are different from zero, and we must reject a hypothesis if their coefficients are higher than 1.96. Also, the two-tail *p*-values evaluate the hypotheses that each hypothesis are not same as zero, and a value lower than 0.05 are needed to prove the degree of impact of each the variables used on the proxy economic growth variable.

Thus, the above results prove that each variable used has a significant impact on GDP per capita, hence economic growth in SSA. To ensure that our model is more reliable and acceptable, two sums of squares analyses were done to achieve this aim, and the results are shown in Table 7 below.

Based on the Type III sum of squares, the following variables such as remittance, number of active agents, value money of mobile money, financial development bring significant and better information to explain the variability of the dependent variable GDP per capita (thus economic development). Among the explanatory variables, based on the Type III sum of squares, variable value of mobile money is the most influential. It can be argued that in two way:

i) mobile money serves as a platform, through which residents remit to their families and friends, thus it there boosts the overall capital redistribution, hence GDP per capita of the region;

ii) as the system serves the purpose of banking for a large group of residents, their savings would be pooled through the system for effective allocation to productive and innovative sector for economic development. Hence, it is not surprising

Table 7

Sum of square analysis

Type I Sum of Squares analysis					
Source	**DF**	**Sum of squares**	**Mean squares**	***F***	***Pr > F***
Remittances	1	187146.436	187146.436	4658.944	0.000
Number of active agents	1	61146.118	61146.118	1522.211	0.001
Mobile money value	1	31575.929	31575.929	786.071	0.001
Financial development	1	3853.967	3853.967	95.943	0.010
Type III Sum of Squares analysis					
Remittances	1	6819.661	6819.661	169.773	0.006
Number of active agents	1	13182.446	13182.446	328.172	0.003
Mobile money value	1	21104.672	21104.672	525.393	0.002
Financial development	1	3853.967	3853.967	95.943	0.010

that the capitalisation value of mobile money activities is the most influential for economic growth in this study.

5. Conclusion

The study examines the nexus among mobile money activities (number of active mobile agents, value of mobile money transactions, remittance, financial development, and economic growth). The study found a significant positive correlation among all variables used in this paper. Additionally, it was established that mobile money development, especially increased value of mobile money activities, has a great impact on economic growth in SSA, a region where the overall financial inclusion is low.

Thus, the more the mobile money system expands to cover the unbanked citizens, the more financial resources are channelled into the financial system through the mobile money service platform. In addition, since the financial development influences growth (which was also established in this study) through the pooling of capital for productive activities, we found the value of mobile money transactions to have the most influential impact on the economy through the growth of mobile money-registered agents in the region. It is evident that mobile money activities, especially if easily accessible, would spur overall financial market development, which per our findings should positively affect trade and consumption, hence leading to economic growth.

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