

RESEARCH ARTICLE



The Impact of Financial Development, Financial Inclusion, Remittance Flows, and Exchange Rate on Economic Growth in Sub-Saharan African Countries: Evidence from RALS-EG Cointegration

Mehdi Seraj^{1,*}, Chibuikem Dibor Alfred¹ and Huseyin Ozdeser¹

¹Department of Economics, Near East University, Cyprus

Abstract: Financial inclusion (FININC) is increasingly becoming an important element of the policy debate in the region characterized by a shortage of FININC. This study analyzes the complicated interrelationship between gross domestic product (GDP), remittance (REMIT), financial development index (FDIX), FININC, and real exchange rates (EXR). Although energy access is identified as an important prerequisite for FININC in sub-Saharan Africa (SSA), the focus of this study lies in exploring the relationship between the above financial elements and GDP. Panel data ranging from 1990 to 2020 have been used to analyze the cointegration among the elements using the residual-augmented least squares Engle-Granger (RALS-EG) cointegration model. The study finds that there exists a long-run relationship between the mentioned elements. It is important to note that both the FDIX and EXR negatively affect economic growth in the long run. These results indicate that SSA economies remain vulnerable due to their dependence on fluctuating EXR that increase business risks. Alternatively, in the short term, the role of REMIT, FDIX, FININC, and EXR is positive toward GDP. Therefore, this research recommends that to improve FININC, certain policies must be implemented to reduce the cost of sending REMIT and ensure favorable conditions for FDIX.

Keywords: FININC, energy access, RALS cointegration, REMIT

1. Introduction

The rapid proliferation of financial technology (FinTech), spanning blockchain, Web 2.0, and Web 3.0, has fundamentally reshaped global financial landscapes. While these advancements facilitate growth, they also challenge conventional banking models. A critical question arises regarding the adoption of these technologies in developing economies, particularly concerning institutional stability and the necessity for robust anti-money laundering (AML) policies. Also, it has presented challenges for nations in SSA in effectively adopting new FinTech. In this article, we analyze the nexus between access to energy, FININC, FDIX and FinTech-driven remittance inflows across SSA. While energy access is recognized here as a critical contextual barrier to the effective deployment of digital financial tools in the region, this study empirically isolates the financial determinants (REMIT, FDIX, FININC, and EXR) to assess their direct contribution to economic growth. Sometimes, FinTech, or better called financial technology, economic advancement due to environmental advancement might lead to compromise of the environment,

while financial inclusiveness may bring about formidable climate quality [1]. However, the influence of digital banking has enhanced REMIT in the region, and creating a space for informal entrepreneurship and gender inclusion in this space has been voiced out for [2–6]. It is well-documented that electricity supply remains a critical bottleneck for SSA nations; literature frequently identifies this as a primary factor discouraging innovation and FDIX throughout the region. The rural areas are plagued with little to no access to energy, and this can reduce the financial inclusiveness preached in this region. It is well-documented that FinTech has rapidly proliferated across the continent in recent years. Some studies insist that the industry will see more improvement if access to energy is solved or reduced to its barest minimum [7–10]. With the rapid rise in innovation, the inflow and outflow of REMIT, FININC, and FDIX have also seen a surge upward in their trend owing to serial entrepreneurship and the younger generation adopting the FinTech way of transaction rather than the traditional way [11–16].

Through the analysis of the relationship between FDIX, FININC, REMIT, and EXR, this research contributes tremendously to the existing literature regarding the role played by FININC in fostering economic growth in SSA countries. This is because the results obtained from the analyses were made

*Corresponding author: Mehdi Seraj, Department of Economics, Near East University, Cyprus. Email: mehdi.seraj@neu.edu.tr

possible with the help of some of the most sophisticated econometric approaches, including Autoregressive Distributed Lag (ARDL) and RALS. The current research is focused exclusively on SSA due to its peculiarities in terms of financing and REMIT. In order to ensure that there is consistency in the analysis carried out in this study, all empirical tests, discussion, and implications will only be applied to the SSA region, and any reference to sub-regions of SSA like the Economic Community of West African States (ECOWAS) will only be used for the purpose of providing context in the literature. While earlier studies may have considered some parts of SSA, like ECOWAS, this study takes an approach focusing on SSA.

The findings of this research have helped us understand better the factors that drive FININC in SSA. We have found better support for our hypotheses, and this is because the use of the RALS-EG cointegration method and the ARDL approach has made our findings stronger and more credible as we get the short- and long-run relationship among the variables. Our research aims to provide valuable knowledge concerning one of the most important areas, namely, that of SSA. This is due to the fact that there may be some local aspects regarding REMIT and the economic development of a country that may differ in other parts of the world. The study investigates how currency variations affect FININC and development by taking EXR dynamics into account. This gives policymakers important information to manage EXR regulations.

This research aims to examine the nexus between GDP and REMIT, FDI, FININC, and EXR in SSA countries, given the growing preference for mobile transfers over physical visits to financial institutions to conduct transactions. The study was divided into five sections, ranging from the first that introduced the concept of the research, the literature, and the conceptual and theoretical framework in Sections 2, 3, and 4, which contain data presentation and the methodology that was employed in the study. Finally, a summary of the study and policy recommendations was given to enhance future studies in the field of FinTech.

2. Literature Review

In this section, the paper aimed to address the issues faced as FinTech companies are making their mark in the region, providing a seamless way for banking and money transfer, different from the traditional way. This study will review related papers, connecting theories relating to finance and digital finance at large and also mirroring the relationship of FININC. Finally, the empirical review section contains an assessment of papers and studies that have been carried out in relation to this research work.

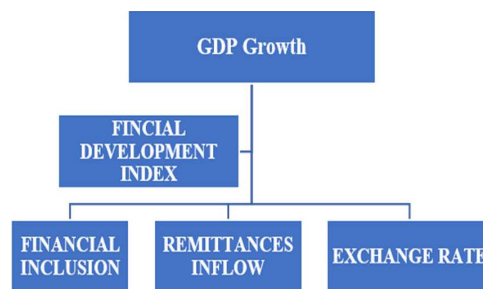
2.1. Theoretical framework

The concept of the paper is to examine the nexus between these variables, FININC and REMIT, and how they foster growth and innovation using GDP growth in the region as the dependent variable (Figure 1).

2.2. FININC, FDI, and REMIT

In this context of things, FININC simply means when individuals have access to good financial products and services and no discrimination regardless of class in society [17, 18]. Chakrabarty [18] discussed the issues of another concept, financial exclusion, as well as a mirror opposite of FININC, and how

Figure 1
The conceptual framework of the research



most regions are still struggling to eradicate it because of the high level of poverty in existence in Africa, Asia, and the Middle East region. There is no way we can educate the masses in FININC and forgo financial literacy; the region, especially the SSA countries, cannot fully solve this issue without making moves to solve the problem of financial literacy in the region [19, 20]. Some studies have shown that households with less income are more likely to experience less FININC in the Middle East and North Africa regions [21].

FinTech and REMIT have a highly synergistic relationship, and one can't have a growing FinTech space without a corresponding increase in REMIT and remittance outflow (REMOU) in the economy. These concepts are important as the world is trending to be almost fully digitalized. There is a strong positive relationship between FININC, FDI, and REMIT; if FININC is fully utilized, the success that comes with FinTech can be harnessed [22]. FinTech REMIT is not a cash-based system but requires traditional banks to still run their operations; individuals, especially the young generations, are more attracted because of the cost benefits and the seamless way of carrying out REMIT without hassle [23, 24]. Electricity is an important aspect for this research because one cannot be financially inclusive or operate digitally without electricity; the internet in SSA is contingent upon reliable electricity. While some nations within the region have made strides in energy infrastructure, many others continue to face significant stability challenges that hinder digital adoption. Electricity is a huge factor to consider if FININC is to be achieved [9, 25, 26]. FDI and FININC can be harnessed if proper electricity supply is made readily available to the low-income households since they hold a major percentage of the total population in the region. In an era of digital and technology-driven development, FinTech-driven REMIT and FININC are essential for achieving this objective.

2.3. Theoretical framework

For better understanding of the research topic, the study employed Diffusion of Innovations (DOI) theory [27] to serve as an anchor to study objectives and gaps observed in the empirical findings of this paper. According to DOI theory propounded by Rogers et al. [27], the rapid adoption of FinTech solutions in the digital era is driven by how technologies like mobile banking and online payment platforms expand REMIT and advance FININC. The theory shows the distinctions in cultural norms, time, and level of technological know-how in the regions being researched as they differ across regions. Obviously, economies with more advanced and stable electricity supply will see a more improved FININC than the developing economies. The theory helps the

paper to explore FinTech advancement in SSA countries and connect nexus on REMIT [13, 28–31]; the theory shows process of adopting new innovation, and its complexity have no significant effect on adoption. The theory looks at the Innovation-Decision Process, attributes of innovations and rate of adoption, adopter categories, and technology-related studies are the basis of Rogers et al. [27].

2.4. Empirical review

The empirical review section contains research in line with the paper's view looking at the concepts of GDP and their relationship with FININC and FinTech-driven REMIT within the SSA. While FININC significantly impacts economic growth and sustainable development, [15] specifically investigated the nexus between adopting a comprehensive FININC strategy and fostering long-term sustainability. FININC can also increase financial literacy as more and more individuals in the economy will have access to financial products and services and, in return, increase their literacy level in that subject matter, and all their authors agreed that financial literacy is important in pushing for a more financially inclusive population [19–21, 32].

Lyons et al. [22] found that FININC had a strong and significant indicator as a signaling model to harness the full potential of the FinTech powerhouse.

Digital FININC experienced a statistically significant positive effect on economic growth and also showed to have partial spillovers to neighboring countries, as neighboring countries experienced the same positive impact according to research carried out by Shen et al. [33]. The FININC in an environment showed to have an adverse effect on patriarchal systems; the need to increase human capital, close income gaps, and promote financial literacy rose high, and government interventions in terms of loans, palliatives, and direct cash payments improved economic growth by reducing gender bias, as reported by Sahu et al. [34].

Hahm et al. [23] ascertained the cost of REMOUT from Small Island Developing States (SIDS); the study confirmed that FININC is a means for the unbanked to strive and be absorbed into the system, and this motive can furthermore accelerate economic growth and development in the SIDS region. Limited electricity is a huge hurdle for FDIX, more so for FININC in the region; FinTech as an emerging concept is still receiving little acceptance due to most of the populace in the SSA countries experiencing a high level of illiteracy [7, 9, 25]. They all agreed that when electricity is accessible, the region will experience a more positive spike in FININC.

In examining 24 countries, Sugözü & Ünver [35] found that there was a causal relationship between GDP, which is a proxy for economic growth, and FDIX across Asian countries. These findings further showed that policies should be made in accordance with each country's uniqueness, as both variables influenced each other [36]. Adopting the newly developed RALS-EG cointegration model and pairing this econometric model with the Quantile ARDL model, the author was able to ascertain the following: that the distributions are substantially asymmetrical and that inflation has a huge influence on per capita income, which influences financial inclusiveness [37]. In assessing the contribution of financial institutions and financial markets to economic growth, it is stated that financial institutions, especially the ones operating within international markets, become very important catalysts to the economy's growth. In addition, the increase in the number of companies obtaining access to capital markets through listing is considered to be another reason for the deepening process of

FDIX and, therefore, economic growth of Türkiye. Meanwhile, Takyi et al. [38] investigate the relationship between FININC and FDIX with respect to the effectiveness of monetary policies in SSA. With the use of the Generalized Method of Moments technique, the authors show that FININC has a double effect in SSA. While it increases economic growth and assists in reducing the level of inflation, the fast-growing pace of its implementation may limit the growth of the economy.

The study by Akinlo and Dada [39] assesses the impacts of FDIX and REMIT separately as well as collectively toward poverty alleviation in SSA. The results reveal that income level exerts little influence on determining the long-term relation between REMIT, FDIX, and poverty alleviation while having a slight influence in the short term. This implies that regardless of personal and organizational incomes, structural barriers such as high transaction costs continue to represent an important challenge toward making significant contributions to poverty alleviation in SSA. The authors argue that a need exists to improve regulations and cut costs in order to increase the effectiveness of REMIT and financial systems toward reducing poverty. Also important is the contribution by Baafi and Kwame Asiedu [40], who focus on the significance of REMIT, domestic savings, and formal education toward fostering economic growth and development in SSA. According to their research, these determinants positively influence economic growth and development not only individually but also interactively. The interaction between REMIT and domestic savings and education is shown to be particularly important in fostering economic growth in SSA.

2.5. Research gap

In Africa, the issue of financial inclusiveness is on the rise as developed countries continue to pave way in vast technological advancement; the continent of Africa still struggles to keep pace of their counterparts. From corrupt leaders to political instability and coups in major parts of Africa, the question beckons if Africa will adopt a high level of FININC. Modifying access to the internet and electricity and also educating the masses on the benefits of this said inclusion will help increase FININC in the region and improve FDIX.

Current research investigating the finance-growth relationship in SSA has predominantly utilized conventional econometric methodologies, including Vector Error Correction Models and ARDL models. While such methods prove to be robust in case of the conventional approach, there exists a likelihood of producing inefficient estimates in case of non-normal distribution errors, which is witnessed in macroeconomic data of the developing countries. The present study addresses such methodological weakness by adopting the RALS-EG approach to cointegration. Unlike the conventional approaches, the RALS-EG approach incorporates higher moments of residuals. This study offers more dependable long-term estimates of the correlation among FININC, FDIX, REMIT, and EXR fluctuations and economic growth in SSA.

3. Data and Methodology

3.1. Data

The panel dataset employed in this study comprises 15 SSA countries observed annually from 1990 to 2020 ($T = 31$). The countries included in the sample are Nigeria, Ghana, Cameroon, Mauritius, Côte d'Ivoire, Seychelles, Uganda, South Africa,

Kenya, Togo, Senegal, Sierra Leone, Niger, Namibia, and Mali. This results in a balanced panel dataset with a total of 465 observations. All data were sourced from the World Development Indicators (WDI) and the International Monetary Fund Financial Development Index Database, ensuring consistency and reliability across the selected period (see Table 1).

This concept is based on the fact that there has been an emergence of numerous FinTech firms in the region not just due to the population size but also due to the digital revolution and the rising trend in financial inclusiveness in the region. The information used in this research was economic growth, which was measured through the GDP rate. The GDP represents the total value of the production (products and services) produced within the fiscal year in the economy. The GDP is therefore the dependent variable since we seek to evaluate the impact of other independent variables on the economic growth of that particular region. The independent variables are as follows: The REMIT flow indicates the flows of funds either into and out of a nation's borders through remittances or money transfer transactions. The REMIT is therefore used as an indirect measure of financial activity, hence FININC. Generally speaking, FININC is defined as access to and use of financial products and services. However, due to the lack of statistics on SSA states during the research time span, gross savings are taken as the proxy for FININC. Although gross savings can be seen as an instrument to assess how extensively FININC is developed in a certain economy, they give incomplete information about FININC since variables such as access to banks and other credit institutions and use of e-money are not considered in this study. Further investigations can refine this method by employing more direct proxies like Demirgüç-Kunt and Klapper [12] or FININC indices.

While the measure does not fully capture the multidimensional nature of FININC, it reflects the degree of financial participation within the formal financial system. Lastly, the EXR variable is the amount of local currency that can be used to purchase a foreign currency. The EXR variable helped us ascertain how EXR fluctuation influences REMIT and, in return, determines the level of financial inclusiveness. It is important to note that while energy access is discussed as a major hurdle to FININC in the literature review and introduction, it serves as a qualitative contextual factor in this study. The empirical model focuses exclusively on the quantifiable financial interactions between GDP growth, REMIT, FININC, FDIX, and EXR. Below is the mathematical notation of the dependent variable and the independent variable:

$$\text{GDP}_{it} = \beta_0 + \beta_1 \text{REMIT}_{it} + \beta_2 \text{FININC}_{it} + \beta_3 \text{FDIX}_{it} - \beta_4 \text{EXR}_{it} + \mu_i \quad (1)$$

where β_0 , β_1 , β_2 , β_3 , and β_4 represent the coefficients of each variable, it indicates the country and time dimensions, and μ_i represents the error term. The expected signs show that REMIT, FININC, and FDIX are all expected to have positive relations to economic growth; EXR in the long run is expected to have a negative effect on the economy because high EXR may lead to economic downturn in the region.

3.2. Methodology

The stability of the variables was tested through unit root and cointegration analysis. Particularly, the Augmented Dickey-Fuller (ADF) test was performed in assessing the level of integration and stability of the series. Thereafter, the study made use of the RALS-EG test for cointegration in checking for any long-run relationship between the variables. The RALS-EG method is an improvement on the basic EG model, providing more efficient results through the inclusion of distributional information derived from the residuals. Higher moment information is used in the RALS technique, obtained from residuals, which enables efficient estimation when there is non-normality in the distribution of errors, especially in macroeconomic data of developing countries. Though the conventional EG methodology assumes normal distribution of residuals, any deviation from this assumption can cause inefficiency in estimations [41]. The RALS extension addresses this limitation by augmenting the estimation process with additional moment conditions, thereby enhancing robustness without altering the fundamental structure of the cointegration test [42].

The RALS cointegration test equation below.

$$\Delta p_t = \varphi_0 + \varphi_1 p_{t-1} + \sum_{i=1}^q \varphi_{i+1} \Delta p_{t-1} \hat{U}_t \pi + e_t \quad (2)$$

Also, the ADF unit root test was employed for stationarity to measure the integration level associated with residuals. Below is a mathematical notation of the ADF unit root test

$$\Delta p_t = \varphi_0 + \varphi_1 p_{t-1} + \sum_{i=1}^q \varphi_{i+1} \Delta p_{t-1} + e_t \quad (3)$$

The ARDL approach was used to estimate both the short- and long-run dynamics. This was done by obtaining the short- and long-run relationship between the dependent variable (GDP) and the independent variables (REMIT, FDIX, FININC, EXR). Furthermore, the Error Correction Model, which estimates the rate at which equilibrium is adjusted to, was also employed. The data were mathematically denoted as follows in their simplest form:

$$\text{GDP}_{it} = \beta_0 + \beta_1 \text{REMIT}_{it} + \beta_2 \text{FININC}_{it} + \beta_3 \text{FDIX}_{it} + \beta_4 \text{EXR}_{it} + \mu_i \quad (4)$$

Table 1
Variables information

Variables	Abbreviation	Definition and measurement	Source
Gross Domestic Product	GDP	Gross domestic product, growth (%)	WDI
Remittance inflow	REMIT	Personal remittances, received (% of GDP)	WDI
Financial inclusion	FININC	Adjusted savings: gross savings (% of Gross National Income (GNI))	WDI
Financial development index	FDIX	Financial development index (annual)	IMF
Exchange rate	EXR	Real exchange rate (LCU)	WDI

The short-run dynamics were estimated using an ECM. The standardized specification is presented as follows [43]:

$$\begin{aligned}\Delta L(GDP_{it}) = & \alpha_0 + \sum_{i=1}^p \beta_{1j} \Delta REMIT_{t-1} \\ & + \sum_{i=1}^{q_1} \beta_{2j} \Delta FININC_{t-1} + \sum_{i=1}^{q_2} \beta_{3i} \Delta FDIX_{t-1} \\ & + \sum_{i=1}^{q_3} \beta_{4i} \Delta EXR_{it-1} + \phi ECM_{it-1} + \varepsilon_{it}\end{aligned}\quad (5)$$

The long-run relationship is derived from the following specification:

$$\begin{aligned}L(GDP_{it}) = & \alpha_0 + \theta_1 REMIT_{it} + \theta_2 FININC_{it} \\ & + \theta_3 FDIX_{it} + \theta_4 EXR_{it} + \mu_{it}\end{aligned}\quad (6)$$

4. Empirical Results and Discussion

The study examined the dataset for cross-sectional dependency using the Pesaran and Fisher tests in Table 2; the p -values denote 0.103 and 0.577, respectively, and we failed to reject the null hypothesis. This indicated that there is no significant evidence of cross-sectional dependency.

Table 2

Cross-sectional dependency tests (null: no cross-dependency)

Test	Statistic	p -value
Pesaran test	1.630	0.103
Fisher test	27.881	0.577

4.1. Unit-root test

As for Table 3, the stationarity test was done using the ADF test and RALS-ADF unit root test. As shown, in the ADF test, EXR, FDIX, and FININC were stationary at level, while REMIT was stationary at 1% significance level and GDP at first difference and 5% significance level. On the other hand, using the RALS-ADF test, all variables were stationary at first difference and 1% significance level except for EXR, which was stationary at level.

Table 3
RALS unit root test results

variables	ADF	RALS-ADF unit root test	ρ^2
GDP	0.038	-2.149	0.797
REMIT	0.866	-2.661	0.623
FDIX	0.156	-2.861	0.694
FININC	0.084	0.000	0.721
EXR	-2.78*	-12.973***	0.723
Δ GDP	-2.946**	-36.916***	0.837
Δ REMIT	-6.188***	-17.989***	0.824
Δ FDIX	-2.614*	-20.404***	0.794
Δ FININC	-2.601*	-12.125***	0.780

Note: ***, **, and * show significant results at 1%, 5%, and 10% levels, respectively. At 1%, 5%, and 10% levels, the critical values of ADF are -3.58, -2.93, and -2.60, respectively. Similarly, at 1%, 5%, and 10% levels, the critical values of RALS-ADF are -3.75, -3.30, and -3.05, respectively.

4.2. Cointegration test

From the result of the Pedroni residual cointegration test in Table 4, it can be seen clearly that the variables have a long-run equilibrium relationship. This happens because the Panel rho-statistic (Panel Rho), Panel Phillips-Perron (PP) statistic, and Panel ADF statistic have rejected the hypothesis of no cointegration at the 1% significance level, both within and between dimensions. It shows clearly that a long-run relationship exists between the variables being considered.

From the results of the RALS cointegration test using the EG approach, there is evidence of strong cointegration among the variables. In both cases of the RALS-EG and EG tests, the test statistics are -3.99 and -4.01, respectively, which are significant as indicated by the asterisk. From the value of $\rho^2 = 0.871$, there is a strong correlation among the variables (Table 5).

4.3. The results of the ARDL model

According to the findings in Table 6, the long-run relationship between REMIT and GDP growth, it was discovered that there was a positive and statistically significant impact of REMIT on GDP growth. This means that whenever there is an increase of one unit in REMIT, GDP will increase by 0.404 units. This discovery proves that as the inflow of REMIT increases in the region, there would be an increase in the economy, thus showing that REMIT plays a vital role in improving the economy. In line with this observation, it was observed that the development of FinTech is rapidly growing in the region, particularly in Nigeria. Positive effects are therefore associated with the economy through the rapid growth in the region. The finding disagrees with the work of Cazachevici et al. [44], which states that REMIT helps to improve economic growth in Asia but not Africa. The findings show that REMIT positively and significantly affects economic growth in Africa. In addition, the work of Sutradhar [45] shows that REMIT has a negative impact. This analysis included Bangladesh, India, Pakistan, and Sri Lanka [46, 47]. This is consistent with the findings of the current study that REMIT significantly affects economic growth. The positive impacts of REMIT on the economy cannot be overlooked. FDIX demonstrated a negative long-run relationship with economic growth. This indicates that financial deepening in SSA does not automatically trigger growth, likely due to several structural impediments:

- 1) Credit is frequently disproportionately allocated to nonproductive sectors, such as personal consumption or speculative trade, rather than industrial expansion or long-term infrastructure projects.
- 2) Weak regulatory and governance frameworks in the region may exacerbate issues such as moral hazard, bad loans, and resource misallocation, which undermine the positive growth potential of financial expansion.
- 3) The region may be experiencing “over-financialization” where the rapid growth of financial products outpaces the real sector’s capacity to absorb capital efficiently, leading to debt accumulation rather than wealth creation.

In line with existing literature [48–50], our empirical findings indicate that unmanaged FDIX adversely affects economic growth, with GDP growth decreasing by 0.6808 units. FININC positively affects GDP growth; for every unit increment in FININC, the GDP growth in the region rose by 0.411 unit increment. FININC shows the level of how the region is adopting innovative

Table 4
Pedroni residual cointegration test

Alternative hypothesis: Common autoregressive coefficients (AR coeffs.) (within-dimension)				
	Statistic	<i>p</i> -value	Weighted statistic	Probability
Panel v Statistic	0.336	0.368	−0.853	0.803
Panel Rho	−4.087	0.000	−4.156	0.000
Panel PP Statistic	−9.146	0.000	−9.044	0.000
Panel ADF Statistic	−2.393	0.008	−4.229	0.000
Alternative hypothesis: Individual AR coeffs. (between-dimension)				
	Statistic	<i>p</i> -value		
Group Rho Statistic	−2.792	0.003		
Group PP Statistic	−12.470	0.000		
Group ADF Statistic	−3.983	0.000		

Table 5
RALS cointegration test results

Methods	<i>K</i>	Test statistics	ρ^2
EG	0	−3.99*	–
RALS-EG	0	−4.01*	0.871

Note: ***, **, and * denote significance at 1%, 5% and 10% levels, respectively; *K* is the optimal lag length obtained through recursive statistics, while the critical values for the EG test are −5.02, −4.32, and −3.98 for 1%, 5%, and 10% levels, respectively, and those of the RALS-EG test are −4.80, −4.19 and −3.88, respectively.

FinTech and financial systems; when technological advancement is improved, the economy grows. We can see in the findings that FININC has a strong positive effect on the economy [51–53].

The EXR exerted a negative and statistically significant impact at the 10% level. This confirms that the regional reliance on the dollar leads to adverse economic outcomes during periods of fluctuation, as depreciation increases the cost of imports and triggers economic shocks. Exchange refers to the amount of local money that is needed to purchase another foreign money; EXR has a negative impact on economic growth, particularly for nations that rely on trading with the dollar in the foreign exchange (FX) market, financial markets, and even the oil market. With an increase in the dollar index, it implies that the local currencies in

the African region weaken, and thus, there would arise problems such as hoarding of FX currencies, increasing prices of products and services (inflation), and several others. Fixed effects estimation by Morina et al. [54] shows that there is a significant negative relationship between EXR volatility and economic growth in Central and Eastern Europe. Although the positive value of the short-run coefficient indicates that the effect of currency devaluation may give an immediate advantage to the competitiveness of exports, the negative long-run value of the coefficient points to the existence of a weakness in the system. With time, exchange rate instability leads to a higher cost of intermediate goods imports needed for the development of industries in SSA and generates inflation. The increase in uncertainty discourages the process of capital creation and investment. Therefore, what is a stimulus in the short run becomes a burden in the long run because of the reliance on foreign currency in SSA.

In the short run, the speed of adjustment toward equilibrium for ECM was 24.3%, and this was significant at the 10% level. In the short run, the independent variables—FDIX, FININC, and EXR—had a positive and significant relationship with economic growth in the region. In particular, FDIX had a positive and significant effect on economic growth at the 5% level, whereby every one-unit increase in FDIX had a one-unit increase in economic growth of 0.843. This implies that in the short run, an increase in finance results in growth in the economy since there is easy access to credit and liquidity, resulting in consumption and investment.

Table 6
ARDL long-run and short-run model

Variable	Coefficient	Standard error	<i>t</i> -Statistic	<i>p</i> -value
Long-run coefficients				
REMIT	0.404	0.073	5.542	0.000
FDIX	−0.608	0.083	−7.288	0.000
FININC	0.411	0.031	13.127	0.000
EXR	−0.002	0.001	−1.740	0.083
C	2.851	0.950	3.000	0.003
Short-run coefficients				
ECM (−1)	−0.243	0.141	−1.726	0.085
D (GDP (−1))	0.323	0.154	2.095	0.037
++D(FDIX)	0.843	0.400	2.108	0.033
D(FININC)	0.235	0.116	2.027	0.043
D(EXR)	0.295	0.159	5.006	0.000

Also, the negative sign of FDIX implies that financial deepening will not necessarily result in growth through productive channels because of inefficiencies in the structure of the economy, such as inefficient allocation of credit facilities, lack of institutions, and development of productive sectors. In the long run, flows of finances could be utilized to fund consumption activities, speculation, and rent seeking, thus implying that financial deepening is beneficial in the short run, while the long-run effect of the process on economic growth hinges on the efficiency and structure of the financial system. Additionally, considering other short-run determinants of growth, FININC and EXR have a positive impact on growth at the 5% significance level. For each unit increase in FININC and EXR, GDP growth increases by 0.235 and 0.295 units, respectively.

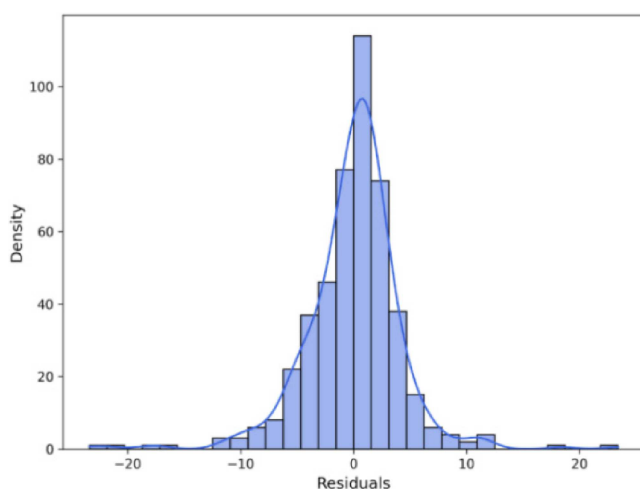
4.4. Residual diagnostic test

The normality test was conducted to determine whether there was any normal distribution of the data and whether it was valid. With regard to the kurtosis value, it had a value of 8.973495, which is greater than 3. This implies that the variable distributions are leptokurtic. According to the Jarque–Bera test, the null hypothesis that states that the residuals are normally distributed is strongly rejected. Therefore, the residual does not exhibit a normal distribution due to the significance of the Jarque–Bera test and the high kurtosis value. Even though the distribution looks like a bell shape, there is some level of skewness and heavy tails. This might affect the results when conducting hypothesis tests and constructing confidence intervals because of the normality assumption. The objective function gradients will help to analyze how the different factors affect different countries and periods. The factors that seem stable are the FDIX factor and the constant factor, whereas the REMIT factor and EXR factor seem to be more volatile. In addition, the FININC factor also exhibits some level of volatility (Figure 2).

4.5. The gradient's objective function

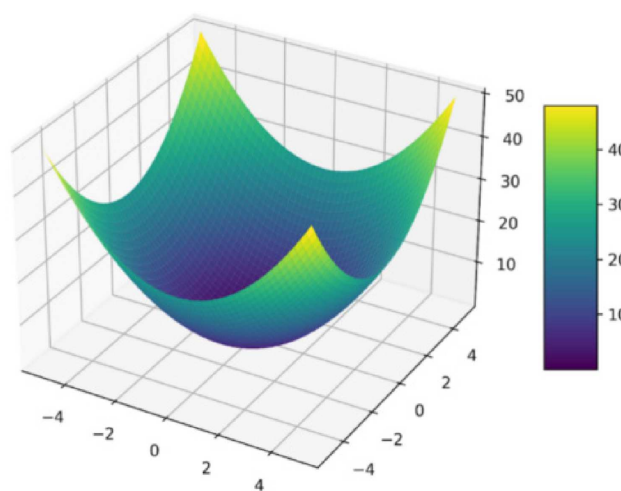
The objective function gradient offers critical insights into the influence of various parameters across different countries and time periods. While FDIX and the intercept parameter demonstrate relative stability in their effects, REMIT and EXR exhibit

Figure 2
Normality test



higher variability. Although FININC also displays some volatility, its localized peaks indicate specific periods of significant impact. This study enhances the understanding of how these variables interact with the objective function under various scenarios. The objective function utilized in the estimation procedure is depicted schematically in Figure 3. While standard residual-based cointegration relies on the minimization of the sum of squared residuals, the RALS-EG approach extends this objective function by incorporating higher moments of the residuals, thereby accounting for non-normal error distributions.

Figure 3
The gradient's objective function



4.6. Derivatives of the equation specification

Figure 4 illustrates the partial derivatives of the estimated equation, quantifying how the dependent variable, GDP growth, responds to variations in each independent variable (REMIT, FDIX, FININC, and EXR) while holding the others constant. The slopes at any given point on these curves represent the sensitivity of GDP growth to the respective independent variables. Furthermore, the sign of these derivatives indicates whether the relationship is positive (+) or negative (−), while any curvature highlights the nonlinearity of these associations. The contours, labeled c(1) through c(5), delineate the objective function values; c(1) corresponds to the value closest to the optimum, while c(5) represents higher values. The estimation process demonstrates a gradual convergence of parameter estimates across these contours toward the minimum point. In the RALS-EG framework, the contour surface is influenced by residual augmentation, which effectively modifies the topology of the optimization surface.

4.7. Confidential ellipse

Figure 5 presents the bivariate confidence regions for the estimated parameters, providing a concise visual assessment of model validity and parameter uncertainty. Observations falling within the high-density contour regions are consistent with the underlying dataset and model assumptions, while peripheral observations are identified as potential outliers. Furthermore, the density shading illustrates the joint concentration of observations, thereby highlighting the degree of correlation and potential interaction effects between the variables. The orientation and elongation of

Figure 4
Derivatives of the equation specification

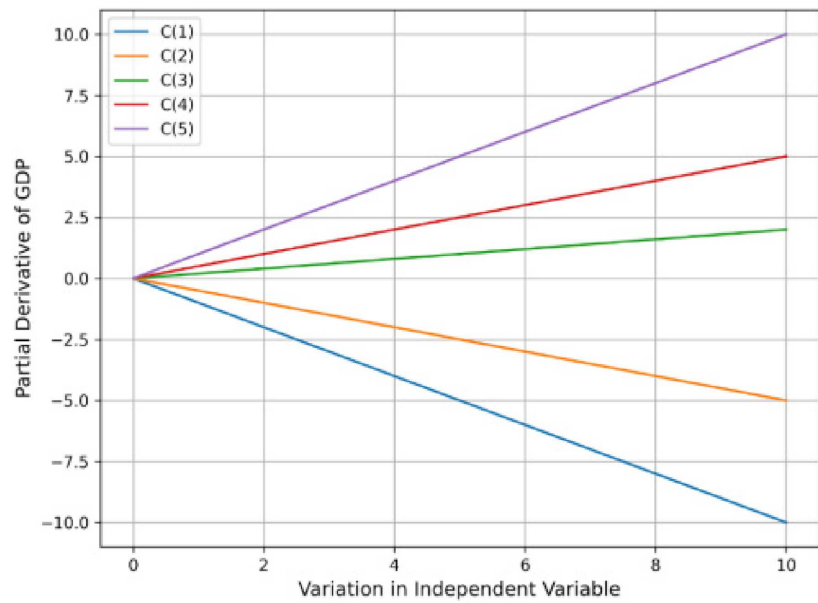
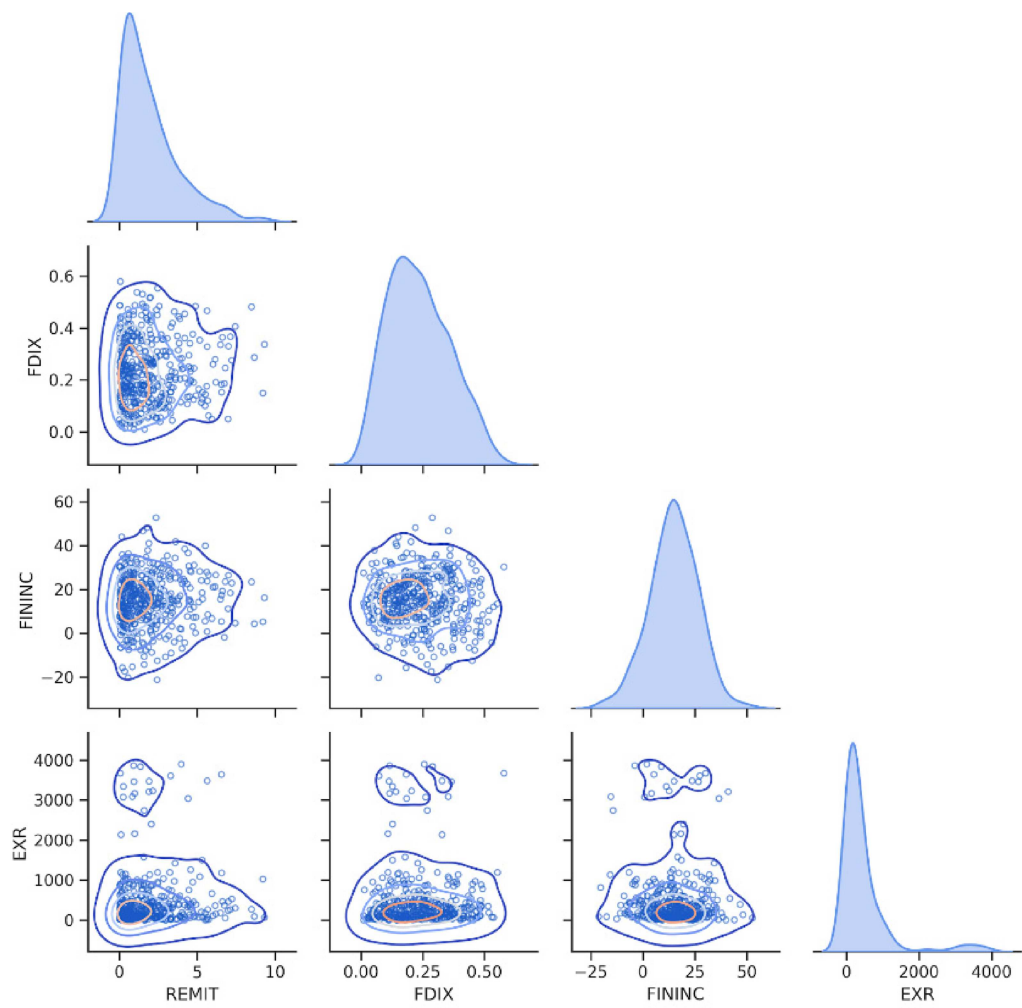


Figure 5
Confidence ellipse matrix



these contours indicate the extent of correlation between parameter estimates, offering essential insights into the stability and precision of the model.

In summary, the stability tests confirm that the variables are stable, supporting the overall model estimation results and demonstrating strong reliability in the correlations among the variables.

5. Conclusion and Policy Recommendations

The paper examined the powering FININC the nexus between REMIT, FDIX, FININC, and EXR in selected African countries from 1990 to 2020. The study used the RALS cointegration model, a newly developed cointegrating technique, and also the ARDL modeling approach to estimate data to investigate the long-term link. The study fills the gap in existing literatures by adopting a new modeling technique for cointegration test and also stability testing. It also uses a different dataset to estimate FININC (the study adopted % of savings). This choice was influenced by the zeal to estimate financial inclusiveness with the level of awareness to savings. The FDIX and EXR were included in this paper to also estimate the effect of external factors outside of the region on its adoption of sustainable growth. EXR is a major influencer in the region's economic activities, hence its adoption in the study models.

In line with the outcomes of the ARDL model, it was seen that the variables FDIX and EXR negatively influenced the growth rate in the long run, although the impact of the variable EXR was less than that of the variable FDIX, while the variables REMIT and FININC had a significant positive influence on the GDP growth rate. In addition, in the short run, there was a high positive impact on the growth rate of the economy.

5.1. Theoretical contribution

The empirical discoveries of the paper contribute to the already existing body of knowledge on GDP growth, REMIT, EXR, FDIX, and FININC in the African region, especially in SSA, in numerous ways. Our study first enquired into the relationship between GDP growth, REMIT, FDIX, FININC, and EXR, unlike existing literature that used the obvious FDIX, REMIT, and FININC. Adekunle et al. [55] and Opperman and Adjasi [56] agreed with the suggestion of this study that REMIT has a positive and statistically significant short-run impact. As more REMIT comes into the country, it can be because of an increase in business and financially inclined investment, and this, in return, improves the economy [57]. In their work, they discovered that excess REMIT, if not properly checked and balanced by the government, can lead to a negative impact on economic growth as this REMIT might largely contribute to the shadow economy more instead of GDP growth, and that immigrants might exploit the lapses in EXR to their advantage; this exploitation leads to a negative impact of REMIT on GDP growth. Furthermore, our study employed the newly developed RALS cointegration test for the long-run relationship between variables.

The negative value of the long-term relationship coefficient indicates that FDIX in SSA does not necessarily mean productive investments. This can be attributed to the lack of efficiency in the system, such as institutional problems, resource misallocation, and lending that is more geared toward consumption than investments. This finding is consistent with the hypothesis that economic growth generated by FDIX without proper regulations may be suboptimal.

The results for FDIX presented a negative and statistically significant long-run relationship. This meant that the results disagreed with the traditional finance-growth nexus, which posits that huge financial systems enhance economic growth through improved capital allocation and investment efficiency. However, the research finding is not entirely inconsistent with emerging evidence from developing economies. These might be true for various reasons, such as inefficiencies in financial intermediation mechanisms in the SSA region. Expansion in the financial sector may not necessarily translate into productive investment if credit is disproportionately allocated to consumption or other nonproductive sectors. In such contexts, financial deepening may fail to stimulate real sector growth, thereby generating a negative growth effect. Additionally, the result may reflect weak institutional and regulatory frameworks, where FDIX occurs in the absence of strong governance structures. This can lead to poor credit monitoring and bad loans and, in the end, dampen the positive impact of FDIX or expansion on economic performance.

Our findings suggest that the “finance-growth” nexus in SSA is constrained by the quality of financial institutions. The negative long-run coefficient for FDIX indicates that mere increases in the size of the financial sector are insufficient. Policymakers must shift their focus from purely quantitative expansion to qualitative improvements in financial intermediation, ensuring that credit lines are directed toward productive, growth-enhancing activities that can foster sustainable development.

5.2. Policy recommendation

The financial inclusiveness of the people in the region is important if FinTech is to be adopted and fully utilized in the economy of the African nations investigated. The following policy recommendations are vital to support further review of these research fields. First, financial services, such as short-term loans and others, should be made readily available to rural and underserved areas; strengthening regulatory bodies in the region and supporting financial initiatives such as FinTech and mobile banking solutions are very important. Second, implementing programs that will enhance financial literacy among the populace can lead to more informed financial decisions. Third, reducing transaction costs to help encourage REMIT and REMOUT also, in return, fosters growth and development in the region. Lastly, cross-border financial integration can facilitate smoother financial flows, including REMIT and investments. The implications presented in this paper derive directly from the empirical findings. The substantial and beneficial effect of REMIT on economic growth indicates that bolstering financial mechanisms that enable REMIT utilization, such as digital financial services, can amplify their developmental influence. Furthermore, considering the complex role of FININC through savings behavior, improving access to finance, particularly in underdeveloped or rural areas, could help raise the participation level in formal financial institutions and promote growth. Therefore, policy approaches centered on rural finance extension, along with the development of financial products aimed at inclusive finance such as micro-saving mechanisms and credit lines, are encouraged. The negative long-run effect of FDIX highlights the lack of efficiency in financing within the financial sector; thus, an increase in the size of the financial sector alone will not solve problems. Policymaking efforts need to be geared toward improving the quality and direction of financial intermediation by directing credit to productive areas and away from consumption and speculative investments.

Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

The data that support the findings of this study are openly available at <https://databank.worldbank.org/source/world-development-indicators> and <https://data.imf.org/en/datasets/IMF-MCM:FDI>.

Author Contribution Statement

Mehdi Seraj: Conceptualization, Methodology, Software, Formal analysis, Writing – review & editing, Visualization, Supervision. **Chibuikem Dibor Alfred:** Validation, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Huseyin Ozdeser:** Conceptualization, Writing – original draft.

References

- [1] Liu, H., Chau, K. Y., Duong, N. T., & Hoang, N.-K. (2024). Fintech, financial inclusion, mineral resources and environmental quality: An economic advancement perspective from China and Vietnam. *Resources Policy*, 89, 104636. <https://doi.org/10.1016/j.resourpol.2024.104636>
- [2] Chen, X., He, G., & Li, Q. (2024). Can fintech development improve the financial inclusion of village and township banks? Evidence from China. *Pacific-Basin Finance Journal*, 85, 102324. <https://doi.org/10.1016/j.pacfin.2024.102324>
- [3] Chien, F., Hsu, C.-C., Moslehpour, M., Sadiq, M., Tufail, B., & Ngo, T. Q. (2024). A step toward sustainable development: The nexus of environmental sustainability, technological advancement and green finance: Evidence from Indonesia. *Environment, Development and Sustainability*, 26(5), 11581–11602. <https://doi.org/10.1007/s10668-023-03424-5>
- [4] Oyebola Etudaiye-Muhtar, F., Johan, S., Lawal, R., & Sakariyahu, R. (2024). Fintech, human development and energy poverty in sub-Saharan Africa. *Journal of International Financial Markets, Institutions and Money*, 91, 101931. <https://doi.org/10.1016/j.intfin.2023.101931>
- [5] Rahman, M. M. (2024). Moderating effects of energy poverty on financial inclusion, FinTech lending, and economic growth: Evidence from fsQCA, NCA, and econometric models. *Environmental Challenges*, 15, 100867. <https://doi.org/10.1016/j.envc.2024.100867>
- [6] Sun, X., & Xie, X. (2024). How does digital finance promote entrepreneurship? The roles of traditional financial institutions and BigTech firms. *Pacific-Basin Finance Journal*, 85, 102316. <https://doi.org/10.1016/j.pacfin.2024.102316>
- [7] Baker, L. (2023). New frontiers of electricity capital: Energy access in sub-Saharan Africa. *New Political Economy*, 28(2), 206–222. <https://doi.org/10.1080/13563467.2022.2084524>
- [8] Ogundipe, A. A., Akinyemi, O., & Ogundipe, O. M. (2018). Energy access: Pathway to attaining sustainable development in Africa. *International Journal of Energy Economics and Policy*, 8(6), 371–381. <https://doi.org/10.32479/ijeeep.7213>
- [9] Owolabi, O. A., Oku, A.-R. O., Alejo, A., Ogunbiyi, T., & Ubah, J. I. (2021). Access to electricity, information and communications technology (ICT), and financial development: Evidence from West Africa. *International Journal of Energy Economics and Policy*, 11(2), 247–259. <https://doi.org/10.32479/ijeeep.10344>
- [10] Ali, A., Radulescu, M., & Balsalobre-Lorente, D. (2023). A dynamic relationship between renewable energy consumption, nonrenewable energy consumption, economic growth, and carbon dioxide emissions: Evidence from Asian emerging economies. *Energy & Environment*, 34(8), 3529–3552. <https://doi.org/10.1177/0958305X231151684>
- [11] Ahmad, M., Majeed, A., Khan, M. A., Sohaib, M., & Shehzad, K. (2021). Digital financial inclusion and economic growth: Provincial data analysis of China. *China Economic Journal*, 14(3), 291–310. <https://doi.org/10.1080/17538963.2021.1882064>
- [12] Demirgüç-Kunt, A., & Klapper, L. F. (2012). Measuring financial inclusion: The global finindex database. *World Bank policy research working paper*, 6025. <https://doi.org/10.1596/1813-9450-6025>
- [13] Donovan, K. (2012). Mobile money for financial inclusion. *Information and Communications for Development*, 61(1), 61–73. https://doi.org/10.1596/9780821389911_ch04
- [14] Sarma, M. (2008). Index of financial inclusion. *Discussion Papers in Economics*, 10, 10–05. https://www.icrier.org/pdf/Working_Paper_215.pdf
- [15] Sarma, M., & Pais, J. (2011). Financial inclusion and development. *Journal of International Development*, 23(5), 613–628. <https://doi.org/10.1002/jid.1698>
- [16] Toxopeus, H. S., & Lensink, R. (2008). Remittances and financial inclusion in development. In T. Addison & G. Mavrotas (Eds.), *Development finance in the global economy: The road ahead* (pp. 236–263). Springer. https://doi.org/10.1057/9780230594074_10
- [17] Cevik, S. (2025). Promise (un) kept? Fintech and financial inclusion. *Scottish Journal of Political Economy*, 72(3), e70012. <https://doi.org/10.1111/sjpe.70012>
- [18] Chakrabarty, K. C. (2011). *Financial inclusion and banks-issues and perspectives*. <https://www.bis.org/review/r111018b.pdf>
- [19] Fatoki, O., & Oni, O. (2014). Financial literacy studies in South Africa: Current literature and research opportunities. *Mediterranean Journal of Social Sciences*, 5(20), 409–414. <https://doi.org/10.5901/mjss.2014.v5n20p409>
- [20] Refera, M. K., Dhaliwal, N. K., & Kaur, J. (2016). Financial literacy for developing countries in Africa: A review of concept, significance and research opportunities. *Journal of African Studies and Development*, 8(1), 1–12. <https://doi.org/10.5897/JASD2015.0331>
- [21] Lyons, A. C., & Kass-Hanna, J. (2021). Financial inclusion, financial literacy and economically vulnerable populations in the Middle East and North Africa. *Emerging Markets Finance and Trade*, 57(9), 2699–2738. <https://doi.org/10.1080/1540496X.2019.1598370>
- [22] Lyons, A. C., Kass-Hanna, J., & Fava, A. (2022). Fintech development and savings, borrowing, and remittances: A comparative study of emerging economies. *Emerging Markets Review*, 51, 100842. <https://doi.org/10.1016/j.ememar.2021.100842>
- [23] Hahm, H., Subhanij, T., & Almeida, R. (2021). Finteching remittances in paradise: A path to sustainable development.

- Asia & the Pacific Policy Studies*, 8(3), 435–453. <https://doi.org/10.1002/app5.341>
- [24] Velasco Arellano, S. (2021). Fintech, remittances and migrants' prosperity: A systematic review and exploration of the Mexican case. <https://doi.org/10.14324/000.wp.10128014>
- [25] Mamadou Asngar, T. (2022). Does financial development improve access to electricity in sub-Saharan Africa? *SN Business & Economics*, 2(9), 146. <https://doi.org/10.1007/s43546-022-00324-0>
- [26] Mukalayi, N. M., & Inglesi-Lotz, R. (2023). Digital financial inclusion and energy and environment: Global positioning of Sub-Saharan African countries. *Renewable and Sustainable Energy Reviews*, 173, 113069. <https://doi.org/10.1016/j.rser.2022.113069>
- [27] Rogers, E. M., Singhal, A., & Quinlan, M. M. (2014). Diffusion of innovations. In *An integrated approach to communication theory and research* (pp. 432–448). Routledge.
- [28] Seraj, M., & Muhammad, A. T. (2026). The dynamic interactions between financial stability and economic development in emerging Sub-Saharan Africa markets: Evidence from S-VAR analysis. *SN Business & Economics*, 6(1), 34. <https://doi.org/10.1007/s43546-025-01031-2>
- [29] Al-Jabri, I. M., & Sohail, M. S. (2012). Mobile banking adoption: Application of diffusion of innovation theory. *Journal of Electronic Commerce Research*, 13(4), 379–391.
- [30] Dingfelder, H. E., & Mandell, D. S. (2011). Bridging the research-to-practice gap in autism intervention: An application of diffusion of innovation theory. *Journal of Autism and Developmental Disorders*, 41(5), 597–609. <https://doi.org/10.1007/s10803-010-1081-0>
- [31] Sahin, I. (2006). Detailed review of Rogers' diffusion of innovations theory and educational technology-related studies based on Rogers' theory. *Turkish Online Journal of Educational Technology*, 5(2), 14–23.
- [32] Oben, R. J., Seraj, M., & Zihni Eyüpoğlu, Ş. (2026). Assessing time-and-frequency-domain cross-market volatility contagion: A comparative study of decentralized finance assets and global traditional financial markets. *Journal of Modelling in Management*, 21(1), 419–454. <https://doi.org/10.1108/JM2-07-2024-0220>
- [33] Shen, Y., Hu, W., & Hueng, C. J. (2021). Digital financial inclusion and economic growth: A cross-country study. *Procedia Computer Science*, 187, 218–223. <https://doi.org/10.1016/j.procs.2021.04.054>
- [34] Sahu, V. K., Baral, S. K., & Singh, R. (2024). Financial empowerment of tribal women: An inquiry into sustainable economic justice initiatives and pathways towards inclusive development. *Asian Journal of Economics, Business and Accounting*, 24(4), 182–194. <https://doi.org/10.9734/ajeba/2024/v24i41272>
- [35] Sugözü, İ. H., & Ünver, E. (2024). A panel data analysis on the relationship between financial development and economic growth: The case of asian countries. *International Econometric Review*, 16(1), 1–23. <https://doi.org/10.33818/ier.1455226>
- [36] Qutb, R. (2025). Decoding the determinants of human capital formation in Egypt: New evidence from RALS-EG cointegration test and QARDL technique. *Review of Middle East Economics and Finance*, 21(2), 185–214. <https://doi.org/10.1515/rmeef-2025-0005>
- [37] Soyu Yildirim, E. (2025). The impact of financial institutions and markets in shaping economic growth in Türkiye. *Çankırı Karatekin University Journal of the Faculty of Economics and Administrative Sciences*, 15(3), 889–910. <https://doi.org/10.18074/ckuibfd.1610027>
- [38] Takyi, P. O., Sakyi, D., Yusif, H., Asante, G. N., Osei-Fosu, A. K., & Mensah, G. (2025). Financial inclusion and financial development: Implications for monetary policy effectiveness and economic growth in sub-Saharan Africa. *Journal of Economic and Administrative Sciences*, 41(3), 1042–1058. <https://doi.org/10.1108/JEAS-09-2022-0215>
- [39] Akinlo, T., & Dada, J. T. (2025). Remittances, financial development, and poverty reduction in Sub-Saharan Africa. *Iranian Economic Review*, 29(1), 50–85. <https://doi.org/10.22059/ier.2025.344191.1007475>
- [40] Baafi, J. A., & Kwame Asiedu, M. (2025). The synergistic effects of remittances, savings, education and digital financial technology on economic growth in Sub-Saharan Africa. *Journal of Electronic Business & Digital Economics*, 4(1), 132–150. <https://doi.org/10.1108/JEBDE-08-2024-0026>
- [41] Khalid, W., Seraj, M., Khalid, K., & Özdeşer, H. (2024). The impact of renewable and non-renewable energy consumption on aggregate output in Pakistan: Robust evidence from the RALS cointegration test. *Environmental Science and Pollution Research*, 31(45), 56621–56644. <https://doi.org/10.1007/s11356-024-34804-7>
- [42] Yilmaz, Y. U., Rezapouraghdam, H., & Kilic, H. (2025). The nexus between tourism and environmental quality in countries most dependent on tourism: A RALS approach to the cointegration test. *Sustainability*, 17(9), 3943. <https://doi.org/10.3390/su17093943>
- [43] Abid, I. (2025). Energy, finance, and innovation in high-income countries: Short-and long-run evidence from the ARDL–ECM framework. *Annals of Financial Economics*, 20(3), 2550017. <https://doi.org/10.1142/S2010495225500174>
- [44] Cazachevici, A., Havranek, T., & Horvath, R. (2020). Remittances and economic growth: A meta-analysis. *World Development*, 134, 105021. <https://doi.org/10.1016/j.worlddev.2020.105021>
- [45] Sutradhar, S. R. (2020). The impact of remittances on economic growth in Bangladesh, India, Pakistan and Sri Lanka. *International Journal of Economic Policy Studies*, 14(1), 275–295. <https://doi.org/10.1007/s42495-020-00034-1>
- [46] Bezabh, G. B., & Kumar, D. B. (2020). The effect of remittance on economic growth of eastern African countries. *International Journal of Social Science & Management Studies*, 6(1), 13–26. <https://doi.org/10.13140/RG.2.2.12270.23360>
- [47] Islam, M. S. (2022). Do personal remittances influence economic growth in South Asia? A panel analysis. *Review of Development Economics*, 26(1), 242–258. <https://doi.org/10.1111/rode.12842>
- [48] Chen, H., Hongo, D. O., Ssali, M. W., Nyaranga, M. S., & Nderitu, C. W. (2020). The asymmetric influence of financial development on economic growth in Kenya: Evidence from NARDL. *Sage Open*, 10(1), 2158244019894071. <https://doi.org/10.1177/2158244019894071>
- [49] Erdoğan, S., Yıldırım, D. Ç., & Gedikli, A. (2020). Natural resource abundance, financial development and economic growth: An investigation on Next-11 countries. *Resources Policy*, 65, 101559. <https://doi.org/10.1016/j.resourpol.2019.101559>
- [50] Osei, M. J., & Kim, J. (2020). Foreign direct investment and economic growth: Is more financial development better? *Economic Modelling*, 93, 154–161. <https://doi.org/10.1016/j.econmod.2020.07.009>

- [51] Emara, N., & El Said, A. (2021). Financial inclusion and economic growth: The role of governance in selected MENA countries. *International Review of Economics & Finance*, 75, 34–54. <https://doi.org/10.1016/j.iref.2021.03.014>
- [52] Erlando, A., Riyanto, F. D., & Masakazu, S. (2020). Financial inclusion, economic growth, and poverty alleviation: Evidence from eastern Indonesia. *Heliyon*, 6(10), e05235. <https://doi.org/10.1016/j.heliyon.2020.e05235>
- [53] Van, L. T.-H., Vo, A. T., Nguyen, N. T., & Vo, D. H. (2021). Financial inclusion and economic growth: An international evidence. *Emerging Markets Finance and Trade*, 57(1), 239–263. <https://doi.org/10.1080/1540496X.2019.1697672>
- [54] Morina, F., Hysa, E., Ergün, U., Panait, M., & Voica, M. C. (2020). The effect of exchange rate volatility on economic growth: Case of the CEE countries. *Journal of Risk and Financial Management*, 13(8), 177. <https://doi.org/10.3390/jrfm13080177>
- [55] Adekunle, I. A., Tella, S. A., Subair, K., & Adegboyega, S. B. (2022). Remittances and financial development in Africa. *Journal of Public Affairs*, 22(3), e2545. <https://doi.org/10.1002/pa.2545>
- [56] Opperman, P., & Adjasi, C. K. D. (2019). Remittance volatility and financial sector development in sub-Saharan African countries. *Journal of Policy Modeling*, 41(2), 336–351. <https://doi.org/10.1016/j.jpolmod.2018.11.001>
- [57] Donou-Adonsou, F., Pradhan, G., & Basnet, H. C. (2020). Remittance inflows and financial development: Evidence from the top recipient countries in Sub-Saharan Africa. *Applied Economics*, 52(53), 5807–5820. <https://doi.org/10.1080/00036846.2020.1776834>

How to Cite: Seraj, M., Alfred, C. D., & Ozdeser, H. (2026). The Impact of Financial Development, Financial Inclusion, Remittance Flows, and Exchange Rate on Economic Growth in Sub-Saharan African Countries: Evidence from RALS-EG Cointegration. <i>FinTech and Sustainable Innovation</i>. https://doi.org/10.47852/bonviewFSI62028777
