Lafia Journal of Economics and Management Sciences: Volume 9, Issue 2; 2024
ISSN: 2550-732X
Published by Department of Economics, Federal University of Lafia, Nigeria

Remittance Inflow, Digital Technology and Human Development in Sub-Saharan Africa

Chinedu Callistus Onyia[1], Samuel Felix Okereke[2] & Aloysious Ezike Agada[3]
[1]Department of Banking & Finance, Enugu State University of Science and Technology, Enugu State.
[2]Department of Economics and Development Studies, Federal University Dutsin-Ma, P.M.B. 5001. Katsina State,
[3]Department of Business Administration, Cosmopolitan International Business School, Abuja.
Corresponding Email: sokereke@fudutsinma.edu.ng

Abstract
Money transfers from abroad serves as a significant source of finance to many households and countries in Sub-Saharan Africa (SSA) have been hampered by cost of transfers, amidst advancement in digital technologies. This study explores how remittance inflows and digital technology together impact well-being improvement in Sub-Saharan Africa. The study employed the conditional panel quantile regression methods and a panel data of forty-five (45) SSA countries from 2010 to 2022 for data analysis. The study found that the effect of remittance and digital technology on human development varies across SSA countries. The study also found that the combine impact of money transfers from abroad and digital technology on human development has noticeable variations across the lower HDI (25^{th} quantile), middle HDI (50^{th} quantile) and higher HDI (75^{th} quantile) levels. This effect of remittance and digital technology on human development and their interaction is higher for countries at the middle HDI level (50^{th} quantile). The study concludes that as remittances from abroad are becoming major sources of foreign financial inflows, harnessing the drivers of these remittance inflows is vital for improvement in human developmental process in SSA. The study therefore recommends that to boost personal remittance inflow from abroad for improvement in human development index amidst advancement in digital technologies, Sub-Saharan African countries should introduce consumer oriented digital platforms for remittance services which should be adequately protected.

Keywords: Digitalization, Human development index, Panel quantile regression, Remittance
JEL Classification Codes: O30, C32, O15, F24

1. Introduction

The primary aim of improving living standard in both high income and low-income countries is to reduce poverty, enhance healthcare, education, and income growth, and improve overall socioeconomic conditions (Etudaiye-Muhtar, Johan, Lawal, & Sakariyahu, 2024). These goals are parts of the key targets of the Sustainable Development Goals (SDG) with the overall aim of improving human development. The human development index (HDI) is used to represent regions and countries with superior socioeconomic conditions and serves as a key measure of a country's living standard. A HDI value of 0.70 or above indicates good performance in terms of socioeconomic conditions. Most advanced countries in other regions in the world have high and very high HDI, whereas Sub-Saharan Africa (SSA) generally ranks low on the index, with exceptions like Botswana, Gabon, Mauritius, Seychelles, and South Africa (United Nations Development Program [UNDP], 2022) According to the UNDP, the average HDI in SSA is significantly lower than the global average.

Emphasis on human development is crucial as it guides policymakers and governments to attract financial inflows that enhance socioeconomic status and overall well-being. To improve their socioeconomic status and quality of life, there has been an increase in migration from low and medium-income countries, such as those in SSA, to developed and advanced nations (United Nations Department of Economics and Social Affairs, 2014). These migrants often remit part of their earnings to their countries of origin, forming a vital portion of financial inflows that improve socioeconomic conditions and well-being (Mohammed, 2021).

Thus, remittances from Sub-Saharan Africans living abroad have been a key component of the region's foreign financial inflows, (World Bank, 2023). Scholars such as Ratha (2019) suggest that remittance inflows are poised to become the largest source of overseas financial contributions for developing nations. The global trend in remittance inflows peaked in 2020 during the COVID-19 pandemic, surpassing both foreign direct investment and official aid combined (World Bank, 2021). Recent global trends by region show that in 2022, remittance inflows to East Asia and the Pacific rose by 0.7% to reach $130 billion; in Europe and Central Asia, it grew by 19% to $79 billion, (World Bank, 2023). Furthermore, the report showed that remittance increased by 11.3% to $145 billion in Latin America and the Caribbean region, fell by 3.8% to $64 billion in the Middle East and North Africa after strong growth of 12.2% in 2021, and grew by 6.1% to $53 billion in SSA. The role played by remittances has been captured in the goal 10.C of the sustainable development goals (SDGs) which targets less than 3 per cent reduction in transaction costs of migrant remittances and elimination of remittance corridors with costs higher than 5 per cent by 2030 (United Nations, 2015).

Nevertheless, in 2023, it was estimated that remittance flows to low and middle-income countries totalled $669 billion, with notable regional growth: South America and the Caribbean increased by 8%, South Asia by 7.2%, East Asia and the Pacific region by 3%, and Sub-Saharan Africa by 1.9%. However, remittance transfers to the Middle East and North Africa decreased in 2023, falling by 5.3% because of a steep reduction in transfers to Egypt (Ratha, Chandra, Kim, Plaza, & Mahmood, 2024). These reports highlight that SSA is trailing behind some other regions in remittance inflows and faces an unpredictable and volatile inflow of remittances. Elmi and Ngwenyama (2020) attribute the remittance gap in SSA to several factors, which include high-cost remittance transfers caused by the underdeveloped nature of digital technology in the region. According to Elmi and Ngwenyama (2020), remittance inflows in other global regions improved following the expansion of internet and smart-phones, leading to digital remittances. According to Ratha, *et al.* 2024) in the last quarter of 2023, the international average cost of digital remittances, which represent 30% of all transactions in the remittance prices worldwide (RPW) database, was 4.96%, while the cost for non-digital remittances stood at 7.0%. This implies that the cost of remitting money is generally lower when using digital channels or money transfer operators providing cash-to-cash services compared to traditional bank transfers (Beck, Janfils, & Kpodar, 2022).

However, the reduction in the cost of remitting money achieved in other regions is not the same with Sub-Saharan Africa, the region still has the highest remittance cost globally, in addition to critical challenges in the digital economy. In the fourth quarter of 2023, remittance senders paid an average of 7.9% to transfer $200 to African countries, which is an increase from 7.4 percent in the fourth quarter of 2022 (Ratha, *et al*. 2024). This record is not aligning with SDG 10.C target of reduction in remittance cost. Although SSA has made significant strides towards digital transformation over the last decade, with hundreds of millions gaining internet access and engaging in various digital activities like mobile payments and transfers, (World Bank, 2024); this is not in commensurate with improvement in remittance inflow to the region. This is in addition to the challenges of underdeveloped digital infrastructure and a lack of accessible and affordable connectivity (Elmi & Ngwenyama, 2020). These challenges contribute to the high costs and fees associated with remittances.

Thus, while means of improving remittance transfers have received attention in the SDGs, they have not received such interest in SSA making it difficult for the region to be on track for the SDG target in 2030. As long as the barriers to remittance inflows in SSA remain high, individuals and societies will be denied the funds they need to improve their human development. As a result,

the paper tries to unravel if the effects of remittance inflows and digitalization on human development in SSA differ due to their HDI level. This is an empirical contribution to knowledge in addition to an investigation of the combined effect of money transfers and digitalization on human developmental progress in SSA.

Following the introduction, the literature review is taken up in Section 2. The methodology is presented in Section 3, while section 4 covers the results and associated discussions, and section 5 centers on conclusion and recommendations.

2 Literature Review

2.1 Conceptual Clarifications

2.1.1 Remittance

Remittances are funds transferred from one country to another, either by individuals or businesses for personal support, trade payments or investment purposes (Adams & John, 2003). These transfers can be performed through banks, agents and specialized fund transfer services, or electronic means. Money transfers from abroad serve as a significant source of external funding in Africa. In recent years, remittances have exceeded other financial inflows, such as official aids, foreign direct investment (FDI), and portfolio investments, establishing themselves as the largest and most stable source of external funding on the continent, (African Development Bank, 2022).

2.1.2 Human Development

The human development index is described as a reflection of the living standard of people in a society. It comprises of three indicators of wellbeing such as healthy living, educational attainment and standard of living measured in gross national income (GNI) per capita, (UNDP, 2021). Thus, the living standard component of HDI is measured based on income (GNI) per capita adjusted for purchasing power parity (PPP) (GNI) (Lashmar, 2018).

2.1.3 Digital Technology

Digital technology defined as the integration of modern technologies into financial transactions, has been widely embraced in the financial sector (Agarwal & Zhang, 2020). It encompasses various products such as online banking, mobile payments, POS terminals, and cryptocurrencies, along with their applications, which have revolutionized traditional methods of delivering banking and financial services (Suprun, Petrishina, Sadovenko, Voloshanyuk, & Khodakevich, 2021).

2.2 Theoretical Review

The theoretical review explored the theoretical backgrounds of the key variables used in the study and some of the empirical findings relating to the study. These theories are theory of motivations for remittance, the capability theory and the technology diffusion theory.

2.2.1 Theory of Motivations for Remittances

The theory supporting remittances originates from the work of Lucas and Stark (1985), who developed a theory on the motivations for remittances. This theory identifies two broad motivations: altruism and self-interest. These motivations were further refined by Rapoport and Docquier (2005) into altruism, insurance, investment, and strategic motives. Thus, the theory highlighted the main reasons for remittance which are: altruism, insurance, and investment. Thus, migrant workers send money or resources to support their families and communities out of altruism. However, this theory on remittance motivations does not explicitly address well-being and human development, underscoring the importance of revisiting capability theory.

2.2.2 Capability Theory

The capability theory, proposed by Sen (1980), is crucial for defining, understanding, and measuring well-being and human development. It emphasizes using the Human Development Index (HDI) as a key measure of well-being, arguing that quality of life should reflect people's capabilities and capacities rather than their earnings or income (Clark, 2005). Through educational attainments, these capabilities can be linked to digital innovations, impacting economic growth and human development.

2.2.3 Theory of Technology Diffusion

Meanwhile, the technology diffusion theory focused on the diffusion of technological products in order to promote digitalization propelled by factors such as knowledge and financial transfers, (Corrocher, Moschella, Staccioli, &Vivarelli, 2023). Thus, the diffusion of technology into financial transfers is also depicted by the theory of financial innovation, as propounded by Silber (1983). The theory of financial innovations posits that innovations in financial transactions became necessary to remove regulatory restrictions and costs imposed on financial transactions.

These theories collectively show how remittances motivated by various reasons, is potentially enhanced by innovations in financial technology, thereby enhancing well-being and capabilities leading to broader human development.

2.3 Empirical Literature

Studies have explored the nexus between money transfers from abroad and financial development. Ikpesu (2024) analysed the joint effect of migrant money transfers and advancements in financial markets on growth in Sub-Saharan Africa (SSA) from 2000 to 2020. Through dynamic pooled mean group analysis of data from 27 SSA countries, the study identified a positive and significant interaction between remittances and advancements in financial market on growth in the SSA. The study recommended that SSA needs improvements in the financial market equity stocks to boost remittances.

Similarly, Odhiambo and Musakwa (2024) studied the effects of remittance inflows, financial development, and government regulatory quality in 26 SSA countries from 2013–2017. Using GMM estimation, they found that remittances positively impact bank-centered financial development. However, governance weakens this effect when financial development is measured by liquid obligations and deposits held by. Remittances alone had no significant impact on commercial bank assets, but their interaction with government effectiveness positively influenced financial development in SSA. The study recommended that SSA countries should prioritize good governance in order to boost remittance inflows.

Jemiluyi and Keke (2024) analysed the connection between digital innovation and remittance transfers in the same 35 SSA countries, using panel data from 2011 to 2020. Their findings, based on internet access and mobile phone subscriptions, revealed a significant positive relationship with internet usage mobile cellular subscription, and remittance inflows in SSA. The study recommended advancements in digital infrastructure and connections to enhance remittances.

In a related study, Jemiluyi and Keke (2023) investigated the mediating role of digital technology in the relationship between overseas money transfers, improvement in financial system and economic growth across 35 SSA countries from 2011 to 2020. Utilizing the Generalized Method of Moments for their analysis, they found that digital technology enhances the effect of remittance transfers on financial development and growth in SSA. The study recommended formulating policies that will enshrine diffusion of digital technology in order to reduce costs of remittance.

The role of remittance inflows in enhancing economic growth and human development was the focus of the study by Delessa, Alemu, and Bane (2024) that examined the nexus between capital inflow, money transfers from abroad and economic growth, as well as the moderating role of institutional and macroeconomic stability in SSA between 2005 and 2019. Using the Dynamic OLS panel-based cointegration approach, the study found a positive relationship between per capita income and remittance transfers when

combined with macroeconomic policy in SSA. The study recommended addressing institutional quality to addressing remittance inflows.

Acknowledging the different income and human development levels, Kamalu, Ibrahim, and Ahmad (2022) investigated the impact of money transfers from abroad on human development in Organization of Islamic Cooperation (OIC) member countries between 1990 and 2018. Using dynamic common correlated effects (DCCE) and cross-sectional autoregressive distributed lags (CS-ARDL), the analysis found that remittance transfers improve quality of life advancement. The study recommended in developing countries should come up with policies that will encourage remittances which include reducing cost of remittances.

However, Kamalu and Ibrahim (2022) studied remittance impacts in 66 developing countries across Africa, Asia, Europe, South America, and the Middle East using panel quantile regression. The study found that remittances enhance quality of life depending on a country's human development level, and therefore suggested the need for stronger financial sectors to attract remittances.

In the same vein, Mlambo and Ntshangase (2021) examined the causal link between remittance transfers and mobile telecommunication in five SADC nations (Democratic Republic of Congo, Eswatini, Lesotho, Mozambique, and Zimbabwe) utilizing data from 2005 to 2018. Employing Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) methods, the study found a unidirectional causality nexus between remittances and mobile subscriptions, indicating that remittances influence mobile subscriptions but not vice versa.

Also, Muhammed (2021) analysed the connection between money transfers, institutional quality and human development in SSA from 2004 to 2018. Using the system GMM, the study revealed that money transfers significantly influence advancement in life in SSA. It also found that the interaction between institutional quality and money transfers stimulates human development. The study suggested that to boost remittances SSA countries need to strengthen their institutional quality.

Bibi and Ali (2021) examined the influence of remittances on human development in low-income countries. The study employed a 2014 cross-sectional data from the following countries, Afghanistan, Pakistan, Turkey, Bangladesh, Iraq and China, and the result of the analysis found that remittance transfers have a positive but non-significant effect on human development in the selected countries. The study recommended reduction in money transfer taxes to encourage more remittance transfers.

However, influence of remittance transfers on human development varies depending on the level of human development and digital innovations.

The paper acknowledges the fact that progress in human development differs among the SSA countries, as a result, the study contributes to existing knowledge by simultaneously investigating the effect remittance inflow and digital technology on human development in SSA. In addition, makes a methodological contribution to the existing literature with the introduction of the interaction between remittance inflow and digitalization to ascertain whether digitalization enhances the impact of remittance transfers on human development in SSA or it serves as a substitute based on their levels of HDI.

3. Methodology

3.1 Model Specification

The study sample covers the period from 2010 to 2022, including data from 45 SSA countries following the World Bank's classification of countries. This timeframe is selected based on the availability of data for various variables in SSA countries. The Human Development Index data is obtained from the United Nations Development Programme (2022) database, while data on remittance inflows, internet usage, FDI, and GDP per capita are sourced from (World Bank, 2023). In analyzing the interaction effect of remittance inflow and digitalization on different levels of HDI in Sub-Saharan Africa, the study employed the Quantile regression for panel data (QRPD). The specified quantile regression captures the conditional distribution rather than the conditional mean distribution, as established by Koenker and Bassett, (1978). The model for the conditional quantile estimates of the regressand (y_i) given the regressor (x_i) is specified following the work of (Xu, Xu, & Xu, 2017):

$$Q_{y_i}(\tau / x_i) = x_i^{\tau} \beta_{\tau} . + \varepsilon_{it} \quad \text{.....1}$$

where $0 < \tau < 1$, Q_{y_i} (τ/x_i) represents the τ^{th} the conditional quantile of y_i, while x_i is the independent variable. β_τ is the estimated coefficient and show how the independent variable x_i impact on the conditional τ^{th} quantile of the conditional distribution of the dependent variable y_i, ε_{it} is the stochastic error, where the distribution of its conditional quantile equal is zero. Thus, the quantile is given:

$$Quant_{\tau}\left(\frac{y_{i,t}}{x_{i,t}}\right) = \beta_{\tau} x_{i,t} \quad \text{.....2}$$

Modifying the model of Kamalu *et al.* (2022), equation 2 is transformed to include the major variables used in the study;

$$Q_{hdi_t}(\tau / x_i) = \beta_{1\tau} REMT_{i,t} + \beta_{2\tau} INTUSE_{i,t} + \beta_{3\tau} MPS_{i,t} + \beta_{4\tau} FDI_{i,t} + \beta_{5\tau} GDPPC_{i,t} + \beta_{6\tau}\left(REMT * INTUSE\right)_{i,t} + \varepsilon_{i,t} \quad \text{.....3}$$

where HDI_{it} represents human development index, $REMT_{it}$ represents remittance inflow, $INTUSE_{it}$ is the internet use and MPS_{it} is the mobile phone subscription. Control variables include (FDI_{it}) for representing foreign direct

investment and ($GDPPC_{it}$) for GDP per capita. The panel quantile equation in Equation 3 does not consider fixed or random effects; instead, it estimates quantile versions of traditional panel data as pooled OLS estimators, allowing the use of variable lags as instruments. By applying varying values of τ bound between 0 and 1, the model estimates regression quantiles for varying distributions of HDI given remittance and digitalization variables, using quantiles at $\tau = (0.25, 0.5, \text{and } 0.75)$, which correspond to SSA countries with low, medium, and high HDI levels.

The interaction term β_6 is key to examining how digitalization and remittances jointly influence HDI across SSA. A significant positive β_6 would indicate that digitalization amplifies the impact of remittances, while a significant negative β_6 would suggest that digitalization downplays the effect of remittances on human development in SSA.

4. Results and Discussion

4.1 Descriptive Statistics

Table 1 presents the descriptive statistics of the data used in the study, showing the number of observations, mean, maximum and minimum values of the variables.

Table 1: Descriptive Statistics

Variables	Obs.	Mean	Min.	Max.	Std.dev.	Skewness	Kurtosis	J-B	Prob.
HDI	585	0.5323	0.33	0.817	0.096	0.7599	3.434	60.913	0.0000
Remittance	572	3.8922	0	27.302	5.133	2.111	7.538	915.75	0.0000
Internetuse	526	20.5743	0.58	81.59	18.11	1.126	3.519	117.06	0.0000
FDI	584	4.8258	-17.29	103.34	9.14	5.752	49.826	56576	0.0000
GDPPC	585	3.6297	-36.39	21.45	4.61	-1.932	16.325	4692.3	0.0000
MPS	574	80.222	7.6806	191.508	35.992	0.201	0.1399	21.40	0.0000

Source: Authors Computation (2024).

The mean value of human development index (HDI), remittance (REMT), internet use (INTUSE) and mobile phone subscription (MPS) for the period covered in the study is 0.53, 3.89, 20.57, 80.22 and 20.57 respectively. This implies that on average the HDI level in Sub-Saharan Africa is 0.53. Also, the average personal remittance received as a percentage of GDP in SSA for the study period is 3.89; while the average internet use is 20.5 and 80.2 for mobile phone subscription. The standard deviation for HDI, REMT, INTUSE, FDI and MPS are 0.097, 5.13, 18.11, 9.14 and 35.992 with mobile phone subscription and internet use having higher standard deviation than others which indicates more instability of mobile phone subscription followed by internet use and less instability of HDI. All the variables (HDI, REMT,

INTUSE and FDI) are skewed to the right except GDPPC that is skewed to the left. Also, the hypothesis of the Jarque-Bera statistics is rejected since the probability of the Jarque-Bera for all the variables are significant. Thus, since the Jarque-Bera statistics are significant with excess kurtosis observed, it signifies a data set that does not follow a normal distribution but evenly distributed.

Table 2: The Correlation Matrix

Variables	HDI	Remittance	Internetuse	FDI	GDPPC	MPS
HDI	1.0000					
Remittance	-0.0841	1.0000				
Internetuse	0.5370	0.0663	1.0000			
FDI	-0.0951	0.1637	-0.0832	1.0000		
GDPPC	-0.0544	-0.0521	-0.2112	0.1061	1.0000	
MPS	0.5165	-0.0030	0.7591	-0.0615	-0.0647	1.0000

Source: Authors Computation (2024).

Table 2 shows the correlation matrix of the variables included in the study. The findings show that the regressors are not strongly correlated, with none exhibiting a correlation coefficient of 0.8 or higher. Therefore, there is no indication of multicollinearity among the regressors in the estimated models, with the highest coefficient being 0.7591.

4.2 Panel Quantile Regression

The findings from the panel quantile regression showing the interaction of personal remittance received and digital technology alongside the results without interactions across various quantiles groups representing distinct levels of human development in SSA are presented in Tables 3, 4 and 5. Since the countries have different HDI levels which are categorized into low, medium, high and very high HDI according the UNDP ranking, the estimated quantile groups are the 25^{th}, 50^{th}, and 75^{th} quantiles. These quantile levels were selected to reflect Sub-Saharan African countries HDI levels with majority of the countries at the lowest HDI level and middle HDI level.

Table 3: The 25th, 50th and 75th Quantile Results

Dependent Variable: HDI									
	25th quantile			50th quantile			75th quantile		
Variable	Coefficient	Std. error	Prob.	Coefficient	Std. error	Prob.	Coefficient	Std. error	Prob.
Remittance	0.00121	0.0003	0.000	0.00166	0.00005	0.000	0.00147	0.00112	0.000
Internet use	0.0021	0.00015	0.000	0.0023	0.00004	0.000	0.00242	0.000165	0.000
FDI	-0.00004	0.0001	0.712	-0.0014	0.00006	0.000	0.00053	0.00059	0.000
GDPPC	0.0011	0.00048	0.024	0.00009	0.00011	0.405	0.00093	0.00146	0.405
MPS	0.0003	0.00006	0.000	0.00068	0.00069	0.000	0.00084	0.00008	0.000
Remt*Intuse	-0.000092	0.000009	0.000	-0.000032	0.0000025	0.000	-0.000052	0.000029	0.000
F/Wald Test-Chi2 (5):	59. 20 (0.0000)			12.64 (0.0018)			37.78 (0.000)		
MCMC diagnostics	0.378			0.322			0.271		

Source: Authors Computation (2024).

Table 3 presents the 25th, 50th and 75th panel quantile regression results with interactions**.** The results across the 25th, 50th and 70th quantiles in SSA quantiles show that remittance inflow and digitalization have significant positive effect on human development in SSA. Notably, remittance, mobile phone subscription and internet use have positive influence on human development in SSA and the effect of remittance inflow is more substantial in countries at the 50th quantile (middle) HDI level, while that of digitalization is stronger in countries at the high (75th quantile) HDI level. According to Table 3, an increase in remittance inflow raises human development by 0.12% in the 25th quantile, 0.16% in the 50th quantile and 0.15% in the 75th quantile.

Also, an increase in internet use raises human development by 0.21%, 0.23% and 0.24% in the 25th, 50th and 75th quantile levels. Similarly, the effect of the interaction between remittance inflow and internet use is negative and significant suggesting the presence of interaction between remittance inflow and digitalization. The interaction effect is stronger in the middle HDI (50th) quantile group than in the 25th and 75th quantile levels. However, the negative sign signifies that digitalization serves as a substitute for remittance in improving human development in both the lower and middle HDI countries in SSA.

Foreign direct investment is negative in both the 25th and 50th quantile but non-significant in the 25th quantile and significant in the 50th quantile. It is positive and significant in the 75th quantile. This implies that FDI stimulates human development in the 75th quantile while reducing human development in the 50th quantile. This may be due to the fact that foreign direct investment enhances human development more significantly in countries with a high level of human development, as it leads to increased income and investment,

compared to countries with lower levels of human development and lower income.

4.3: Quantile Regression Normality Tests

Table 5: Shapiro-Wilk, Shapiro-Francia and Skewness Tests

Variables	Shapiro-Wilk test	Shapiro-Francia test	Skewness/Kurtosis
HDI	6.822(0.00000)	6.345(0.00001)	40.46 (0.0000)
Remittance	11.150(0.00000)	10.278(0.00001)	(0.0000)
Internet use	9.117(0.00000)	8.459 (0.00001)	63.65 (0.0000)
MPS	5.671(0.00000)	5.260 (0.00001)	21.40 (0.0000)
FDI	12.681(0.00000)	11.782 (0.00001)	(0.0000)
GDPPC	9.716(0.00000)	9.121 (0.00001)	(0.0000)

Note: HDI = Human development index; MPS = Mobile phone subscription; FDI = Foreign direct investment; GDPPC = GDP per capita. The numbers in brackets are the probability values.
Source: Authors Computation (2024).

To validate the use of the quantile regression in the study, the Shapiro-Wilk and Shapiro-Francia tests are carried out as depicted in Table 5, the results of Shapiro-Wilk and Shapiro-Francia tests show that all the variables are statistically significant, which revealed that our variables are not normally distributed. Koenker and Bassett (1978) demonstrate that quantile regression does not require a normal distribution assumption for the target variable. However, to validate the panel quantile regression results, Wald tests and Markov Chain Monte Carlo (MCMC) diagnostics are conducted to assess data quality. As presented in Table 3, the Wald tests are significant at the 5% level, and MCMC diagnostics indicate that most data observations closely approximate the target distribution. Additionally, the study includes linear predictions and their standard errors after each result to confirm prediction accuracy, with supporting graphs shown in Figures 1 and 2.

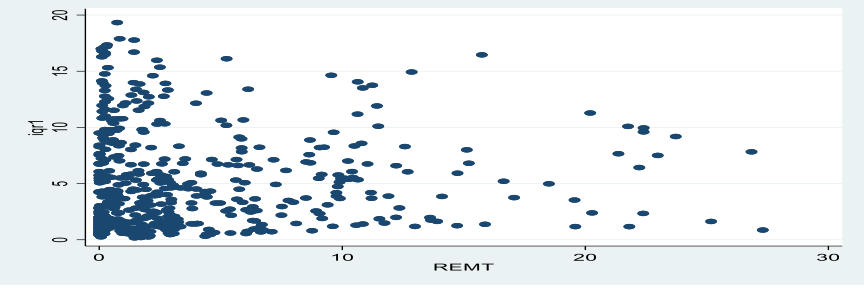

Figure 1: IQEG for the Lower and the Upper Quartile of REMT
Source: Authors Computation (2024).

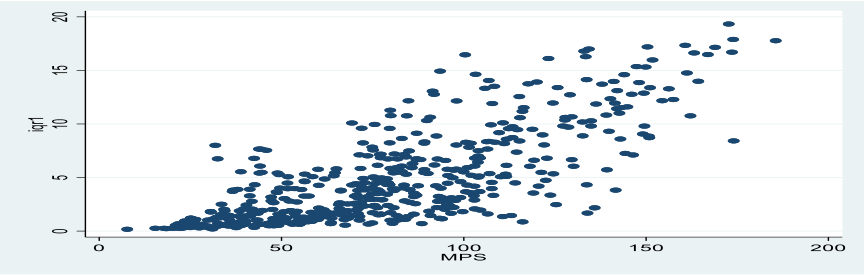

Figure 2: IQEG for the Lower and the Upper Quartile of MPS
Source: Authors Computation (2024).

Figures 1 and 2 showed that positive coefficient for the explanatory variables (remittance and mobile phone subscription) means that increases in remittances and digitalization means increases in the inter-quartile range and therefore in human development in SSA.

4.4 Discussion of Findings

The result of the study found that remittances have positive effect on human development in SSA and the effect is stronger in countries at the 50th quantile (middle) HDI level. The result finding showing positive effect of remittance on human development aligns with that of (Delessa*et al.* 2024; Ikpesu, 2024; Kamalu *et al.* 2022; Kamalu & Ibrahim, 2022) who found that remittances improve economic growth and human development. However, the results do not tally with the findings of Bibi and Ali (2021) who found remittance transfers have non-significant impact on human development in the selected developing countries. The result of the study also revealed that mobile phone subscription and internet use, indicators of digital technology have positive effect on human development in SSA, with the effect substantial in countries at the high (75th quantile) HDI level. The positive effect of digital technology on human development agrees with the findings of (Jemiluyi& Keke, 2023) who reported significant positive relationship between digital innovations, remittance inflows and growth in SSA.

In addition, the study found that digitalization serves as a substitute for remittance in improving human development in both the lower and middle HDI countries in SSA. This result did not align with that of Muhammed (2021) who showed that the interaction between institutions and remittances enhances human development. However, the interaction is stronger in the middle HDI (50th) quantile group than in the 25th and 75th quantile levels, implying.

Generally, the results revealed noticeable variations across the 25th, 50th and 75th levels in the effect of remittance inflow and internet use on human development. The effect of remittance inflow and the interaction between remittance and internet use are stronger in countries in the middle (50th) HDI

level, while the effect of digitalization is stronger in countries in the higher (75^{th}) HDI level. This may be attributed to the fact that, majority of the SSA countries are in the lower middle HDI levels in global ranking and thus, have made more efforts in improving remittance inflows. Digital innovation is stronger in the higher HDI level, which implies that countries at high HDI levels have embraced digital economy in improving their human development.

5. Conclusion and Recommendations

The study examines the combined effect of remittance inflow and digital technology on human development, using a panel data of 45 SSA countries from 2010 to 2022. Based on the analysis, the study concludes that elevating digital technology to ease remittance transfers is vital for meeting the SDG 10.C targets of reduction in cost of remittance transfers and improvement in the human development in SSA ravaged by high poverty rate. Moreover, the findings of the study have policy implications. Policy makers in SSA have to provide the enabling infrastructural environment that will encourage the needed advancement in digital technology and reduce the cost of remittance transfers and encourage migrant remittance inflows into the region. This includes SSA countries connecting their digital payment systems to regional and international digital systems, the influence of this will imply easy remittance transfers with eventual reduction in income disparities that are mainly useful for equitable human development in all parts of SSA.

Moreover, to boost personal remittance inflow from abroad for improvement in human development index amidst advancement in digital technologies, Sub-Saharan African countries should introduce consumer oriented digital platforms for remittance services which should be adequately protected. This will be followed by improvements in the financial and payment system digital infrastructures that are accessible to the Diasporas and the domestic receivers, thereby boosting remittance inflows across Sub-Saharan Africa, which will lead to improvement in living standard.

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