MIGRATION AND CROSS-BORDER PAYMENTS: ANALYZING REMITTANCE DYNAMICS IN SUB-SAHARAN AFRICA

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BIS & SARB Theme: Advancing Cross-Border Payments: Identifying Opportunities and Challenges for Sub-Saharan Africa

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ABSTRACT

In the context of growing regional integration and mobility, understanding the interplay between migration patterns and cross-border payment behaviours is becoming increasingly critical for financial inclusion and economic development in Sub-Saharan Africa. Despite the progress made in advancing cross-border payment infrastructures, significant gaps persist in the literature regarding how migration flows influence the frequency, volume, and efficiency of such payments. This study aims to investigate the impact of internal and external migration patterns on cross-border payment behaviours across Sub-Saharan African countries. In particular, the research explores the dynamics of remittance channels, digital financial adoption, and the regulatory environments shaping cross-border transactions. Employing panel data regression analysis, the study utilizes country-level data over multiple years to uncover both linear and non-linear relationships, including potential threshold effects and regional disparities. Annual data from 2004 to 2024 was sourced from various international databases. The findings are expected to offer evidence-based insights for policymakers and financial institutions to optimize cross-border payment systems while responding effectively to migratory trends in the region.

KEYWORDS: Cross-border payment, migration, remittances and panel regression analysis.

JEL CLASSIFICALION: F24, F22, F36, F65, G21, O55 and C33

INTRODUCTION

Cross-border payments are crucial to fostering financial inclusion, trade, and economic integration in Sub-Saharan Africa (SSA). As regional migration increases, the volume and frequency of remittance flows across African borders grow correspondingly. However, the traditional financial infrastructure has struggled to meet the evolving demands brought on by technological innovation, changing migration patterns, and the global push for financial inclusion. High remittance costs, fragmented regulatory frameworks, and limited interoperability among digital platforms remain key impediments (He, 2021; Domingo et al., 2023).

This study explores how migration dynamics shape cross-border payment behaviours, focusing on the opportunities for leveraging digital innovations such as mobile money, fintech, and central bank digital currencies (CBDCs). The study focuses on a few selected SSA countries namely South Africa, Nigeria, Kenya, Ghana, Ethiopia, Rwanda, Namibia and Zimbabwe. It aims to assess the transformative potential of digital financial services against the backdrop of migration flows, governance quality, and regional integration in SSA. Despite progress in mobile money and digital banking, cross-border payments remain costly and inefficient. A significant gap exists in understanding how migration patterns influence cross-border financial behaviour and how policy and infrastructure can adapt to support efficient, inclusive transactions (Buckley et al., n.d.; Agama, n.d.).

This article investigates the impact of migration patterns on cross-border payment behaviours in SSA using a quantitative panel data approach. It identifies both the barriers and drivers of efficient digital cross-border transactions, with particular attention to regulatory quality, mobile money penetration, and remittance costs. This study contributes meaningfully to both academic literature and policy discourse by illuminating how migration patterns influence financial flows and the adoption of digital payment platforms across Sub-Saharan Africa. It identifies critical regulatory and infrastructural barriers that hinder the smooth functioning of cross-border payment systems, particularly in contexts shaped by high mobility and informal remittance channels. Through data-driven analysis, the research offers actionable insights that can inform the design of targeted financial policies at both regional and national levels. Furthermore, the findings align with and support broader developmental frameworks,

including the objectives of the African Continental Free Trade Area (AfCFTA) and the United Nations Sustainable Development Goals (SDGs), especially those promoting financial inclusion, economic integration, and reduced inequalities.

Background and Problem Statement

The expansion of regional mobility, intra-African migration, and digital financial infrastructure has reshaped the dynamics of cross-border payments in Sub-Saharan Africa (SSA). Migration—whether temporary, circular, or permanent—has become a significant driver of cross-border financial transactions, particularly remittances. These payment flows play a critical role in supporting household incomes, sustaining informal businesses, and financing basic services across borders (Yendaw, 2022; L.E.O. and S., 2021). However, despite these benefits, the structural integration of migration trends into formal cross-border payment systems remains limited and uneven across SSA.

As intra-African migration increases, the financial infrastructure necessary to support secure, cost-efficient, and inclusive cross-border transactions has not kept pace. Existing cross-border payment systems are often fragmented, costly, and limited in reach—particularly for migrants sending remittances to rural or underserved regions (Beck, 2014; Domingo et al., 2023). While initiatives such as the Pan-African Payment and Settlement System (PAPSS) and the rise of mobile money platforms have improved interoperability in some corridors, a lack of regulatory harmonization and technological standardization continues to impede seamless financial flows (Buckley et al., n.d.; Domingo & Teevan, n.d.).

Furthermore, digital transformation in the region—though accelerating—is marked by persistent disparities in access, digital literacy, and trust. Studies have noted the uneven uptake of digital banking and mobile-based remittance services across demographic and geographic lines (Eyo-Udo et al., 2025). Compounded by limited access to identification systems, weak institutional frameworks, and security concerns, many migrants still rely on informal and often insecure channels to move money across borders (Ramadugu & Kadambala, n.d.; Soumaré et al., 2021).

Remittance statistics in SSA and across the World, are significantly underreported due to the existence of informal remittance transfer channels. These channels include hand-carry methods, unregistered money transfer agents, and informal traders who facilitate cross-border currency exchange outside formal financial systems. Such channels are often preferred due to lower costs, speed and the absence of documentation requirements which is usually favoured by illegal immigrants especially in contexts where formal financial access is limited or regulatory environments are restrictive (Esser & Cooper, 2019; UNCDF, 2023).

However, these informal mechanisms pose serious challenges: They distort national remittance data, undermining the accuracy of macroeconomic indicators and financial inclusion metrics. They complicate monetary policy and financial surveillance, particularly in countries with high dependence on remittance inflows. In some cases, informal traders may engage in foreign currency externalisation or money laundering, using remittance flows to clean dirty money or circumvent capital controls (Boyomo et al., 2024).

The lack of reliable data on informal remittance flows limits the ability of policymakers to design effective interventions, such as cost-reduction strategies, diaspora engagement platforms, and inclusive financial products. Addressing this gap requires a combination of regulatory reform, digital innovation, and community-based financial literacy programs to encourage formal channel adoption

Despite the forementioned challenges in remittances across the SSA there are also opportunities that exist out of the current problems which include opportunity for Central Banks of SSA to come up with an integrated financial inclusion remittance platform which can assist in converting informal remittances to formal channels. The remittance plartfom can help improve access in rural areas, lower transaction costs and increase savings through the remittance platform. It can be noted that solutions to current cross boarder challenges within SSA can help accelerate regional integration, regulatory integration and improve migration data sharing which can help in migration policies.

The emergence of cross-border payment financial technology (FinTech) and blockchain-enabled platforms offers both promise and disruption. These innovations

can potentially lower costs, enhance speed, and boost transparency in cross-border transactions (Sule et al., 2025; Agama, n.d.). Yet, the surge in fintech-led remittance solutions also raises questions about regulatory oversight, consumer protection, and the risk of excluding the most vulnerable populations, including undocumented migrants and informal sector workers (Olatunbosun et al., 2024; He, 2021). There has been huge migration in the Sub-Saharan Africa and the transfer or funds has been accelerated by development of systems like the Southern African Development Community - Real Time Gross Settlement system (SADC-RTGS).

Figure 1 powerfully illustrates the total value and volume settled since inception of the SADC-RTGS a major financial platform. The figure visually captures the system's journey from a small-scale operation in 2013 to a vital piece of regional financial infrastructure, culminating in the impressive figures cited.

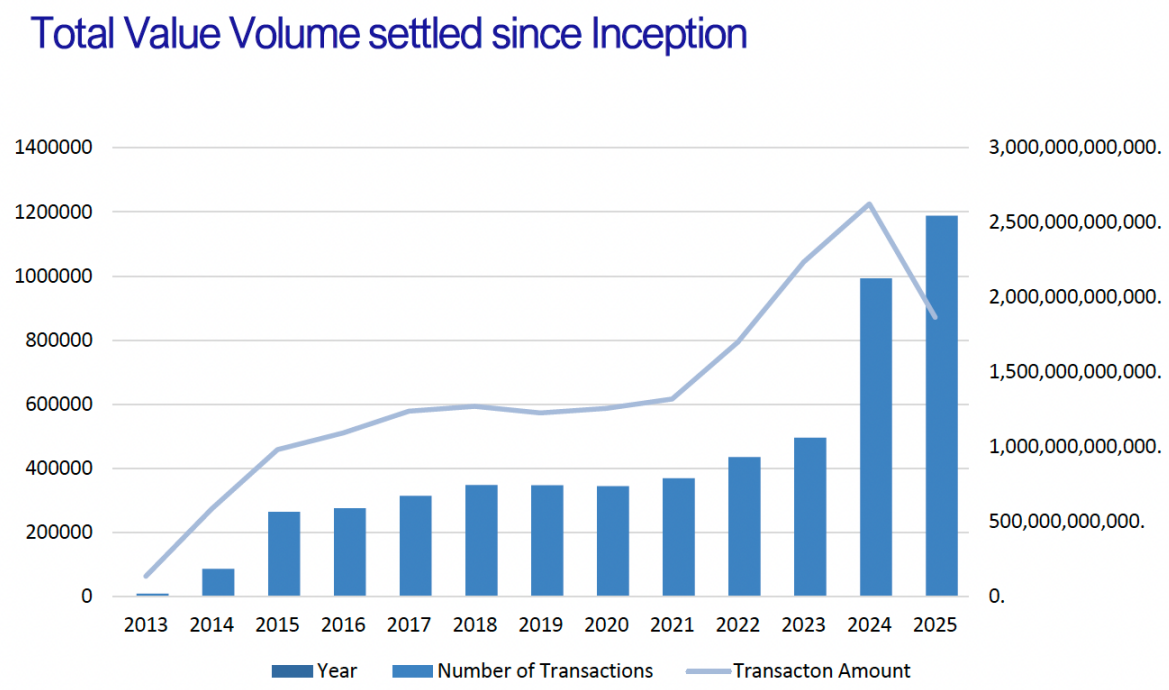

Figure 1: Total Value and Volume settled since Inception of the SADC-RTGS

The key story told by the chart is the divergence between Volume and Value growth. While the Number of Transactions (Volume) has steadily increased (left axis), the Transaction Amount (Value) (right axis) has surged dramatically, especially since 2017, heading toward a projected Trillion value mark by 2025. This steep rise in value

confirms the system's primary function as an RTGS mechanism, designed specifically for high-value, high-priority interbank and systemic payments, rather than large quantities of low-value retail transactions.

While previous research has explored digital payments, regional banking integration, and remittances in isolation, few studies have systematically analysed how evolving migration patterns influence cross-border payment behaviours at a macro-regional level. Moreover, the lack of empirical studies incorporating quantitative techniques to assess this relationship across multiple countries and over time has left policymakers with limited evidence to guide targeted reforms (Gondwe, 2023; Bamidele Oso et al., 2025).

Therefore, this study seeks to address these knowledge gaps by investigating the extent to which migration patterns—both intra- and inter-regional—affect the frequency, mode, and efficiency of cross-border payments across Sub-Saharan Africa. Employing panel data regression analysis, the study will capture the dynamic, heterogeneous effects of migration on payment behaviours, controlling for regulatory, economic, and digital infrastructure variables. This evidence is critical to inform regional strategies under the BIS initiative aimed at advancing cross-border payments and financial inclusion across SSA.

This study seeks to examine the impact of migration patterns on cross-border payment behaviours in Sub-Saharan Africa by investigating the asymmetric effects of migration across countries, estimating the threshold impacts of migration flows on the efficiency, frequency, and cost of payments, and identifying the transmission channels such as digital infrastructure, remittance platforms, and regulatory frameworks through which migration shapes cross-border payment systems.

2. LITERATURE REVIEW

This literature review explores the dynamics of migration and cross-border payments in Sub-Saharan Africa (SSA), with a focus on remittance flows and their implications for financial inclusion, economic development, and policy reform. Migration and

remittances are central to SSA's socioeconomic landscape, shaping household resilience, regional trade, and financial sector development. The review draws on theoretical frameworks such as the New Economics of Labour Migration (NELM), Transaction Cost Theory, Network Theory, and digital financial inclusion paradigms, while examining empirical evidence from mobile money innovations, fintech, blockchain, and central bank digital currencies (CBDCs). The section is comprised of the theoretical literature review, empirical literature review and analysis of reviewed literature.

Theoretical Literature Review

Migration theories provide a conceptual foundation for understanding remittance dynamics in SSA. The New Economics of Labour Migration (NELM) posits that migration decisions are household strategies to diversify risk and secure remittance inflows, which function as both an economic necessity and a resilience tool for households in developing regions (L.E.O. & S., 2021). From this perspective, remittances reduce vulnerability to economic shocks and enable long-term investments in health, education, and small businesses. Transaction Cost Theory complements this view by explaining migrant preferences for payment channels that minimize costs and maximize efficiency, particularly in regions where formal banking services remain underdeveloped. This is especially relevant in SSA, where remittance fees are among the highest globally, underscoring the importance of digital and fintech innovations for lowering costs (Agama, n.d.; Central Bank Digital Currencies in Africa, 2023).

Network Theory further enriches the theoretical understanding by highlighting how migrant communities rely on shared norms, trust, and information to adopt common financial tools. Informal migrant networks facilitate the circulation of remittances through both formal and informal channels, with cultural and social ties shaping financial behaviours (Yendaw, 2022). These networks also explain why mobile money services such as M-Pesa and interoperable platforms in East Africa achieved rapid uptake, as social learning reduced barriers to adoption (Domingo & Teevan, n.d.; Domingo, Arnold & Apiko, 2023).

Digital financial inclusion frameworks extend these migration theories by incorporating the roles of regulatory environments, technological infrastructure, and financial literacy in shaping access to cross-border financial services. According to Domingo and Teevan (n.d.), digital payment interoperability and integration across African countries are essential for reducing transaction costs and expanding financial access. Buckley et al. (n.d.) argue for regional harmonisation through a single regulatory rulebook, aligning with the African Continental Free Trade Area (AfCFTA) vision of seamless intra-African payments. Moreover, technological innovations such as blockchain and CBDCs represent extensions of Transaction Cost Theory by providing secure, transparent, and low-cost solutions for cross-border remittances (Sule et al., 2025; Eyo-Udo, Agho et al., 2025). The evolution of fintech and blockchain technologies also underpins the need for secure, transparent, and efficient transaction methods (Sule et al., 2025).

Empirical Literature Review

Empirical evidence highlights the transformative impact of digitalisation on cross-border payments in SSA. He (2021) demonstrates how global payment systems are undergoing rapid digitalisation, reshaping the efficiency and cost structures of cross-border transfers. In SSA, where remittances contribute significantly to GDP, digital channels such as mobile money and blockchain are increasingly critical. Stijns et al. (2015) and Beck (2014) trace the evolution of SSA's banking sector, emphasising how historical underinvestment and weak infrastructure created demand for mobile money systems that bypass traditional banks.

The empirical literature also highlights the rise of CBDCs and fintech in SSA. Agama (n.d.) and the CBDC report (2023) discuss the potential of digital currencies to reduce transaction costs, improve financial inclusion, and strengthen intra-African trade. However, implementation challenges remain, particularly regarding regulatory coordination and cybersecurity. Ramadugu and Kadambala (n.d.) emphasise that when properly regulated, fintech can increase remittance flows, reduce transaction times, and enhance financial inclusion. Similarly, Olatunbosun et al. (2024) examine the surge of cross-border payment firms, underscoring their role in supporting SMEs and entrepreneurship in Africa.

Mobile money has been one of the most influential innovations in SSA's remittance sector. Kirui (2020) provides evidence that mobile money platforms significantly reduce transfer costs and expand access to remittance services for rural households. Tembo and Okoro (2021) further show that mobile money penetration is strongly correlated with regional financial integration, linking remittances to broader economic growth. Empirical studies also confirm the effectiveness of blockchain in enhancing trust and efficiency in cross-border payments. Eyo-Udo, Agho et al. (2025) and Sule et al. (2025) demonstrate how blockchain-based solutions provide transparency and security, reducing fraud and ensuring transaction integrity.

Yendaw (2022) provides a migration-specific perspective, analysing how informal migrant networks shape cross-border financial behaviours among itinerant immigrant retailers in Ghana. This highlights the coexistence of formal and informal systems, where trust, culture, and regulatory gaps drive reliance on informal remittance methods. Gondwe (2023) explores regulatory dimensions, showing how bank regulation and cross-border banking influence monetary transmission in SSA, which has implications for remittance stability and integration into formal systems. Soumaré et al. (2021) complement this by discussing capital market developments and innovations that underpin financial deepening in SSA.

Analysis of Reviewed Literature

The literature reviewed reveals a dynamic and evolving landscape of migration and cross-border payments in SSA. Theoretically, migration is framed as both an economic and social phenomenon, where remittances serve household resilience functions while being shaped by transaction costs, social networks, and regulatory frameworks. Empirical studies provide rich insights into the role of digital technologies, with mobile money and blockchain demonstrating transformative effects on cost, trust, and accessibility. Yet, several gaps persist.

First, while technological innovations are widely acknowledged, disparities in regulatory quality, financial literacy, and infrastructure remain significant obstacles. Soumaré et al. (2021) and Gondwe (2023) underscore that without stronger regulatory

frameworks, the benefits of digital remittance channels may be unevenly distributed, potentially exacerbating financial exclusion. Second, there is limited empirical evidence that captures the behavioural dimensions of migrant remitters. Although Yendaw (2022) highlights informal networks, panel data and longitudinal analyses remain scarce in exploring how migration stocks interact with payment system usage.

Third, while CBDCs and fintech solutions are promising, their real-world applications remain underexplored. Agama (n.d.) and the CBDC report (2023) outline opportunities but highlight unresolved challenges in implementation. Furthermore, while blockchain solutions are supported in experimental studies (Sule et al., 2025; Eyo-Udo, Agho et al., 2025), there is insufficient evidence on how these technologies interact with existing mobile money ecosystems and user adoption patterns. Additionally, the literature rarely addresses how gender, education, and employment status shape remittance behaviours in digital contexts.

In summary, while significant progress has been made in theorising and documenting the role of remittances and digital payments in SSA, important research gaps remain. Future studies should examine how migration flows, regulatory environments, and mobile access jointly influence remittance behaviours. Panel datasets, behavioural analyses, and mixed-methods approaches could help bridge these gaps, providing a deeper understanding of how technological, social, and institutional dynamics intersect in shaping the remittance landscape of SSA.

3. METHODOLOGY

The study adopts a quantitative panel data approach across selected SSA countries from 2004 to 2024. Data is available on the databases like the World Bank Bilateral Remittance Matrix, IMF Financial Access Survey, GSMA Mobile Money Metrics and the World Governance Indicators. Data collected is yearly for all countries in the SSA.

Variables, Data and Data Sources

Stylised notations/expected signs and source of the data to be employed in the study are presented in Table 1. Annual Data has already been collected for Sub-Saharan economies for 20 years. The sources of data are shown below and a sample of data for one country is shown in Appendix section.

Table 1: Stylised Notations, Expected Signs and Data Sources

VARIABLE	NOTATION	EXPECTED SIGN	SOURCE
Dependent Variable			
Cross-border payments (remittance per capita or mobile cross-border transfer volume)	CBP		World Bank Bilateral Remittance Matrix
Independent Variable(s)			
Migration stock (% of population)	MS	-/+	Global Finance Development Database.
Financial access	FA	+	IMF Financial Access Survey.
Mobile penetration rate	MPT	+	GSMA Mobile Money Metrics.
Cost to send (% of amount sent)	CTS	-	World Bank Bilateral Remittance Matrix.
Regulatory Quality	RQ	+	WGI
Macroeconomic Variable (s)			
Inflation	INFL	-/+	WDI
Gross Domestic Product per Capita	GDP pc	+	WDI
Exchange rate volatility	REER	+	WDI

Source: Authors' Construct, 2025

Econometric Approach

To rigorously assess the impact of migration patterns on cross-border payment behaviours in Sub-Saharan Africa, the study employs a robust panel data econometric framework. Initially, unit root tests—specifically the Levin-Lin-Chu (LLC) and Im-Pesaran-Shin (IPS) tests—will be conducted to assess the stationarity properties of the panel variables. This step ensures that the data do not exhibit non-stationary trends that could bias regression estimates. To detect multicollinearity among the independent variables, the Variance Inflation Factor (VIF) will be calculated. This allows for the identification of redundant predictors that could distort the model's explanatory power.

The main estimation strategy will involve panel regression models using both Fixed Effects (FE) and Random Effects (RE) specifications. The choice between these models will be guided by the Hausman test, which assesses whether the unique errors are correlated with the regressors, thereby determining the most consistent and efficient estimator for the dataset. The study will further use Machine Learning (ML) techniques, after determining factors that influence cross border payments, ML techniques will be applied for forecasting purposes.

Model Specification

$$y_{it} = \alpha + \beta_{1-5} x_{it} + \beta_{6-8} z_{it} + \epsilon_{it} \quad [1]$$

Where y represents Cross-border payments (remittance per capita or mobile cross-border transfer volume) at time t and country i; x denotes Migration stock as percentage of population, Regulatory quality index, Financial access index, Mobile penetration rate and Cost to send as a percentage (%) of amount sent; and z represent GDP per capita, Exchange rate volatility and Inflation rate.

$$DependentVariable_{it} = \alpha + \beta_{1-5} ExplanatoryVariables_{it} + \beta_{6-8} ControlVariables_{it} + \epsilon_{it} \quad [2]$$

$$CrossBorderPayments_{it} = \alpha + \beta_1 Migration_{it} + \beta_2 RequlatoryQuality_{it} + \beta_3 Mobile_{it} + \beta_4 Cost_{it} + \beta_5 FinancialAccess_{it} + \beta_6 GDP\ per\ capita_{it} + \beta_7 Exchange\ rate\ volatility_{it} + \beta_8 Inflation\ rate_{it} + \epsilon_{it} \quad [3]$$

Diagnostic Tests

To validate the reliability of the regression results, several diagnostic tests will be performed. The Wooldridge test will be used to check for serial correlation within panels, while the Breusch-Pagan test will help identify the presence of heteroskedasticity in the residuals. Cross-sectional dependence, which may arise due to economic interlinkages across Sub-Saharan countries, will be assessed using the Pesaran CD test. Lastly, the Shapiro-Wilk test will be applied to examine the normality of residuals, ensuring that the error terms meet the assumptions of classical linear regression. Together, these diagnostic procedures strengthen the robustness and credibility of the empirical findings. This article offers a foundational blueprint for advancing cross-border payments in SSA by aligning digital financial solutions with real-world migration trends and challenges.

4. FINDINGS AND ANALYSIS

This section illustrates the results and the analysis of the results.

Summary descriptive statistics

Table 1: Summary descriptive statistics

Variable	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
CBP	7.02	8.75	0.00	31.49	1.15	2.80
MS	1.96	1.44	0.25	5.77	1.02	3.65
FAI	0.25	0.21	0.01	0.82	1.50	4.18
MPT	57.94	52.63	0.00	226.00	1.26	4.36
CTS	7.22	3.28	1.42	15.02	0.82	2.83
RQ	0.83	10.95	-2.20	90.4	7.72	61.08
INFL	47.68	234.24	-72.73	2,156.03	7.58	62.81
GDPC	2,641.55	1,970.14	340.74	8,646.06	1.32	3.77
REER	5.34e+07	5.99e+08	0.90	6.72e+09	11.09	124.01

The mean statistic of 7.02 for cross-border payments (CBP) measured by remittances per capita show that the annual remittances received by individuals in the selected African countries averaged US$7.02 billion over the period from 2004 to 2024.

In terms of migration stock (MS), the mean statistic of 1.96 suggest that about 2% of the population in selected African countries migrate to foreign countries on an annual basis.

The financial access index (FAI) showed the mean score 0.25 ranging from 0.01 and 0.82 as indicated by the minimum and maximum scores. The mean index of 0.25 demonstrate low levels of financial access among African economies.

As also shown in Table 1, the average mobile penetration rate for the African countries has been approximately 57.9% for the period from 2004 to 2024. This suggests moderate mobile penetration rate in Africa.

Furthermore, the mean score of 7.22, the minimum and maximum values of 1.42 and 15.02 for CTS, respectively show that the average cost of sending remittances to African countries is approximately US$7.22. The cheapest destination costing about US$1.42 whilst the most expensive destination costs about US$15.02.

Cross-sectional dependency test

Table 2: Cross-sectional dependence test results

Variable	**CD-test**	**p-value**	**Average joint T**	**Mean ρ**	**Mean abs(ρ)**
CBP	9.41	0.000	21.00	0.53	0.53
MS	0.55	0.585	21.00	0.03	0.59
FAI	8.59	0.000	21.00	0.48	0.50
MPT	14.52	0.000	21.00	0.82	0.82
CTS	11.42	0.000	21.00	0.64	0.64
RQ	4.21	0.000	21.00	0.24	0.43
INFL	5.03	0.000	21.00	0.28	0.35

GDPC	7.81	0.000	21.00	0.44	0.46
REER	9.35	0.000	21.00	0.53	0.65

The results of the Pesaran cross-sectional dependence test presented in Table 2 show that all the variables except for migration stock (MS) had p-values less than 0.05. This indicates strong existence of cross-sectional dependence in the panel dataset. In the presence of cross-sectional dependence, traditional models (FE, RE and pooled OLS) which assume independence across panels may yield biased or misleading estimates leading to incorrect inferences.

Unit root tests

Given the presence of cross-sectional dependence, traditional panel unit root tests become inefficient. Hence, second-generation panel unit root tests that is, the Pesaran's cross-sectional augmented dickey-fuller (CADF) was undertaken to account for cross-sectional dependence. The results are presented in Table 3.

Table 3: CADF 2nd generation unit toot tests

Variable	**Level**		**1st difference**		**2nd difference**	
	Constant	*Constant + Trend*	*Constant*	*Constant + Trend*	*Constant*	*Constant + Trend*
CBP	-1.62	-1.31	-2.09	2.72	-3.69***	-3.83***
MS	-0.70	-0.67	-1.01	-1.77	-2.92***	-3.02***
FAI	-1.64	-2.06	-2.37	-2.65	-4.14***	-4.10***
MPT	-1.26	-2.08	-2.27	-2.20	-3.43***	-3.51***
CTS	-0.48	-1.84	-2.95***	-2.81	-4.82***	-4.74***
RQ	-1.44	-2.85	-3.40***	-3.57***		
INFL	-3.12***	-3.48***				
GDPC	-1.62	-2.62	-3.04***	-3.02***		
REER	1.17	-0.02	-0.35	-0.96	-1.69	-1.91
logREER	0.31	-2.03	-2.04	-2.48	-3.29***	-3.19***

Note: *** significant at the 5% level, ** significant at the 10% level

As shown in Table 3, except for inflation rate (INF) which was stationary at level, all the other variables contained unit roots at level and became stationary after differencing. Two variables namely GDPC and RQ became stationary after first differencing whilst CBP, MS, FAI, MPT and CTS became stationary after second differencing. Surprisingly, the variable for real exchange rate volatility (REER) remained containing unit root units even after second differencing such that it was log-transformed to address the non-stationarity as recommended by Green (2018). This log-transformed consequently became stationary after second differencing as shown in Table 3.

Multicollinearity test

The multicollinearity test was undertaken using the VIF method. The results are reported in Table 4.

Table 4: Multicollinearity test results: Variance Inflation Factor

Variable	**VIF**	**1/VIF**
dFAI	5.11	0.20
dMS	3.14	0.32
dGDPC	2.95	0.34
dMPT	1.97	0.51
INFL	1.42	0.70
dRQ	1.41	0.71
dlog_REER	1.32	0.76
dCTS	1.3	0.77
Mean VIF	2.33	

The results in Table 4 show VIF values for all the predictor variables which ranged from 1.3 to 5.11 whilst the mean VIF was 2.33. The VIF values are below the maximum threshold of 10 demonstrating absence of multicollinearity in the panel model.

Test for normality

Test for normality of the residuals or errors was done using the joint test for normality with results reported in Table 5.

Table 5: Test for normality results

	Observed coefficient	Bootstrap std. err.	Z	P>|z|	Normal-based [95% conf. interval]
Skewness_e	8.16	10.15	0.8	0.421	-11.72 - 28.04
Kurtosis_e	99.67	94.14	1.06	0.290	-84.83 - 284.18
Skewness_u	0.25	3.66	0.07	0.950	-6.92 - 7.42
Kurtosis_u	-23.61	14.26	-1.66	0.098	-51.55 - 4.33
Joint test for Normality on e: chi2(2) = 1.77 Prob > chi2 = 0.4131					
Joint test for Normality on u: chi2(2) = 2.75 Prob > chi2 = 0.2531					

The results for the joint skewness and kurtosis tests in Table 5 demonstrate that neither the residuals (e) nor the disturbance random term (u) deviate from normal distribution as the p-values are greater than 0.05. For the error term [$Chi^2(2) = 1.77$, $p = 0.4131>0.05$), the null hypothesis cannot be rejected implying the residuals (e) were approximately normally distributed. Hence, no violation of normality assumption. These findings confirm validity of the inferences and estimation of robust panel regression estimates.

Wooldridge test for serial correlation

The study further conducted the Wooldridge test for serial correlation. The results are reported Table 6.

Table 6: Woodridge test results for autocorrelation in panel data

Null Hypothesis (H0)	**F-statistic**	**Prob > F**	**Decision at 5% level**
No first-order autocorrelation	F (1, 5) = 77.30	0.0003	Reject H0 (evidence of autocorrelation)

The results in Table 6 [F(1, 5) = 77.30, p-value (Prob > F) = 0.000] where the p-value is less than 0.05 results in the null hypothesis of no first-order autocorrelation being rejected implying strong evidence of first-order serial correlation in panel data errors. The findings suggest that present values of the residuals are highly correlated with past values. This further implies that the traditional FE and RE estimators may produce

biased and inefficient estimates supporting the choice of robust estimators such as the Driscoll–Kraay standard errors.

Heteroscedasticity test

Furthermore, test for heteroskedasticity was done using the Modified Wald test with the results reported in Table 7.

Table 7: Modified Wald test for groupwise heteroskedasticity

Null Hypothesis (H_0): $\sigma(i)^2 = \sigma^2$ for all i	
Chi² (6)	210.67
Prob > chi²	0.0000

The results of the heteroskedasticity test [Chi²(6) = 210.67, p-value = 0.000 (<0.05)] suggest that the null hypothesis can be rejected implying strong evidence of heteroskedasticity in panel data. This means the error variance is not constant across the cross-sectional units (six countries). Hence, invalidating the traditional FE and RE models and strongly supporting the choice of the Driscoll–Kraay standard errors technique.

Test for linearity

Linearity was examined using component-plus-residual (ACPR) plots. The partial plots confirm linearity between each predictor variable and the dependent variable. The linearity test results are shown in appendix section.

Hausman test results

To determine the most appropriate estimator, the Hausman test was undertaken. The results are reported in Table 8.

Table 8: Hausman test results

Chi² (8)	**19.03**
p-value (Prob > chi²)	**0.0147**

The results of the Hausman test [Chi²(8) = 19.03, Prob > chi² = 0.0147 < 0.05] suggest the rejection of the null hypothesis at 5% significance level. The rejection implies that there are systematic differences between the RE and FE coefficients such that the FE model is the most appropriate.

Fixed Effects Panel Regression Model Results and Discussion

The Driscoll-Kraay robust standard errors fixed effects (FE) or random effects (RE) models are suitable due to their ability to address cross-sectional dependence, heteroscedasticity and serial correlation in panel data (Driscoll and Kraay, 1998). The results of the Driscoll-Kraay standard errors FE model are presented in Table 9.

Table 9: Fixed effects panel regression with Driscoll-Kraay standard errors results

Variable	Coefficient	Std. Error	t-Statistic	p-Value	95% Confidence Interval
dMS	-3.472	0.754	-4.60	0.000***	[-5.045, -1.898]
dFAI	8.892	4.003	2.22	0.038***	[0.542, 17.241]
dMPT	0.076	0.010	7.60	0.000***	[0.055, 0.097]
dCTS	0.248	0.136	1.83	0.083**	[-0.035, 0.532]
dRQ	-0.009	0.011	-0.82	0.420	[-0.031, 0.013]
INFL	0.001	0.001	1.58	0.129	[-0.0004, 0.003]
dGDPC	0.001	0.0004	2.40	0.026***	[0.0001, 0.0019]
dlog_REER	0.231	0.129	1.79	0.088**	[-0.038, 0.500]
Constant	1.775	1.599	1.11	0.280	[-1.561, 5.111]

R-squared = 0.63; F(8, 20) = 95.73; Prob > F = 0.000

Note: *** significant at the 5% level, ** significant at the 10% level

The results of the FE regression with Driscoll-Kraay standard errors showing the R-squared of 0.63 mean that about 63% of the variations in remittances send to African economies are explained by factors such as cost to send, migration stock, financial access, regulatory quality and mobile penetration rate. The overall panel model was statistically significant as demonstrated by the F-statistic of 95.73 and the p-value of 0.000.

Six independent variables were found to have significant impacts at 5% and 10% levels of significant whilst regulatory quality (RQ) and inflation rate (INFL) were statistically insignificant. The discussion of the variables found statistically significant is provided hereunder:

Migration stock (MS) was found to have a negative significant impact on remittances (B = -3.47; t = -4.60, p < 0.05). The results mean that a percent increase in migration

stock can lead to about 3.47% decline in remittances inflows in African economies and vice-versa. The results revealed that migration stock has significant negative impacts on cross-border payments. These results infer that increase in the stock of migrants from SSA countries can significantly reduce remittance inflows into the countries and vice-versa. Although most of the previous empirical studies (Hor and Pheang, 2017) confirmed a positive relationship whilst theories such as the New Economics of Labour Migration (NELM) model support a positive relationship (Mannan and Fredericks, 2015), the negative impact found in this study was also expected.

The plausible explanation for the negative impact can be linked to the theory of migration stages also known as the international migration cycle. According to this cycle, the effects of migration on remittances varies by stages of migration where in the third stage, migration can significantly reduce remittance flows (Bondarenko, 2023). Hence, the findings of the present study could reflect the third stage of migration. Citing the international migration cycle, Bondarenko (2023) argued that in the third stage of migration, migrants will be in the process of "naturalization" within foreign (host) countries such that they often invite their entire families resulting in increased migration stock but reduced remittances in home countries. In support, Ziesemer (2009) also confirmed that migration can have S-shaped effects on remittances such that international migration can have both negative and positive effects. The research by Islam and Rokonuzzaman (2023) also found that countries such as Botswana had the lowest average number of migrants but having the highest inflow of remittances supporting the negative impact of migration on remittances. However, scholars such as Tabit and Moussir (2016) found that migrant stock to have insignificant influence on remittances.

Furthermore, financial access index (FAI) was found to have significant positive impacts on remittance flows (B = 8.89; t = 2.22, p < 0.05). These results mean that financial access and remittances are strongly correlated suggesting that a percent improved in financial access can significantly increase remittances inflows into African economies by about 8.9%. From the findings, increased financial access (financial inclusion) can boost cross-border payments in the form of remittances. The results demonstrate that increased financial access through enhanced financial inclusion can potentially transform cross-border payment systems making them accessible to the majority leading to increased remittance flows. The findings support Tembo and Okoro

(2021) that financial access can lead to increased cross-border remittances. In the context of South Africa, Makina (2013) also found a significant positive interplay between financial access and remittances. The research by Chuc et al. (2022) done in the context of both developing and developed economies established that increased financial access, that is, financial inclusion has significant growth-enhancing effects on remittances. In contrast, the research by Anarfo et al. (2020) revealed a reverse causality between financial inclusion and migrant remittances in SSA.

Mobile penetration rate (MPT) was found to have significant positive impacts on remittances send to African countries (B = 0.08; $t = 7.60$, $p < 0.05$). The results show that an increase in mobile penetration rate by 1% can significantly lead to increase in remittance inflows by approximately 0.08%. The findings infer that increased mobile penetration rate can foster digital financial inclusion ultimately resulting in increased cross-border payments through digital payment platforms. Mobile money penetration can foster increase usage of cross-border payment platforms making them more efficient, cost-effective and convenient leading to increased remittances into SSA countries. In other words, mobile penetration can foster increased usage of FinTechs which significantly reduce processing times and transaction costs ultimately driving cross-border payments in the form of remittances.

The findings corroborate the findings by He (2021) that digitalisation of global payment systems through mobile penetration increases cross-border transfers. In addition, the results align with the study by Ramadugu and Kadambala (2024) which underscored the important role of FinTechs in shaping and enhancing remittance flows. The results further confirm the findings of other previous studies by Kirui (2020) and Tembo and Okoro (2021) which found significant positive association between mobile money penetration and remittances. The findings also align with the findings by Chang and Benson (2023) that mobile financial services adoption is a key determinant for remittances.

In addition, although a negative sign was expected, cost to send (CTS) was found to have significant positive impacts on remittance flows into the African economies (B = 0.25; $t = 1.83$, $p < 0.10$). The results show that a percentage increase in cost of sending remittances can increase remittance flows by about 0.25%. The results imply that increased transaction costs increase remittance flows into SSA economies. These

findings suggesting a positive impact tend to be counterintuitive contradicting with most of the findings from extant literature. For instance, several previous empirical studies such as Aycinena et al. (2010), Ahmed and Martínez-Zarzoso (2016), Kakhkharov et al. (2017) and Ahmed et al. (2021) found significant negative effects of transaction costs on remittance flows.

The positive effect implies that cross-border payments in the form of remittances can be cost-inelastic as also suggested by Gibson et al. (2006). This is because migrants remitting funds for basic services such as hospital fees and school fees are likely to be cost-inelastic such that remittances increase even when sending costs increase. The findings support the conclusions by Aycinena et al. (2010) that increase in remittances cannot only be due to affordable transaction fees but the motives and frequency of remitting. The other explanation to the positive effect is that increase in transaction costs can be driven by inflation and higher exchange rate (currency depreciation) in home countries making remaining families more vulnerable prompting migrants to regularly remit more funds as also argued by and Kpodar and Imam (2024).

GDP per capita (GDPC) was also found to have positive impacts on remittance flows (B = 0.001; t = 1.58, p < 0.05). However, based on the magnitude of the coefficient, it can be inferred that the impacts of GDP per capita on remittance flows is negligible (small). Besides, the positive impact reflects that higher GDP per capita implies higher income among migrants such that they are more capable of remitting more to home countries. In the context of home countries, increased GDP capita imply improving standards of living which translate to higher costs of living prompting migrants to remit more. The results support the findings by Gurira (2024) that GDP is among the macroeconomic factors that encourage remittance inflows. Hor and Pheang (2017) confirmed GDP is a significant determinant for remittance inflows. Similarly, Tabit and Moussir (2016) found that GDP has significant positive effects on remittances. The findings further confirm the altruistic hypothesis that decisions to remit are related with income and welfare (Hor and Pheang, 2017).

Furthermore, exchange rate volatility (REER) as expected was found to have significant positive impacts on remittances (B = 0.23; t = 1.79, p < 0.10). The findings mean that a percent increase in exchange rate volatility can significantly increase

remittances by approximately 0.0023%. In real terms, a unit increase in the real exchange rate in home country (currency depreciation) can significantly increase volumes of cross-border remittances by approximately US$0.0023 million (US$2,310) per capita per annum. In line with *priori* expectations, exchange rate volatility was found having significant positive impacts on cross-border payments. The findings suggest that exchange rate instability in the receiving SSA countries can prompt migrants to remit more funds in order to improve wellbeing of families or households. This is because exchange rate volatility or instability can result in higher cost of living for households resulting in them demanding more remittances leading to increased cross-border payments. In other words, exchange rate instability can hamper the welfare of remaining households or families leading to the necessity of migrants remitting more funds. As supported by Tabit and Moussir (2016), in times of economic recession characterised by unstable exchange rate results in migrants remitting more money to their families.

5. CONCLUSION & RECOMMENDATION

This study investigated the impact of internal and external migration patterns on cross-border payment behaviours across Sub-Saharan African countries. Specifically, the research examined the dynamics of remittance channels, digital financial adoption and the regulatory environments shaping cross-border transactions. Panel data regression analysis was employed utilizing country-level data for the period spanning from 2004 to 2024. The study confirmed the interplay between cross-border payments (remittances) and migration which offers developing economies in Africa a pathway for sustainable socio-economic development. The findings lead to the conclusion that transaction costs are not only determinants for cross-border payments but also migration stock, financial access, macroeconomic instability particularly exchange rate volatility, income level (GDP per capita) and mobile money penetration. The findings imply that policymakers and regulatory authorities such as central banks must not only focus on regulating transaction fees as a way to attract and stimulate cross-border remittances but also implement initiatives and policies that promote increased adoption of FinTechs such as mobile money services and financial inclusion. This can provide migrants with the opportunity to harness their personal savings into the mainstream home economies. In addition, the findings call for policy direction towards

removal or relaxing of barriers to cross-border remittances such as work permits, travel documents and proof of residence as pre-requisites for remitting money from host to home countries. The study further recommends national governments in partnership with financial sector institutions to increasingly invest in digital infrastructure to permit increased mobile money penetration and adoption of FinTechs by the majority. This will ultimately promote increased cross-border remittances within the African region and stimulate economic growth. In other words, investments in digital infrastructure can promote increased financial access through usage of FinTechs which in turn significantly reduce transaction costs and enhance convenience leading to increased remittances.

The study therefore recommends Central Banks in Sub Saharan Africa to develop a coordinated send and receive remittance platform which enables migrants and residents of all countries to be able to send/receive remittance funds. The remittance platform should provide access through various channels which include mobile money and digital platforms. These platforms should be created and made accessible at a cheaper cost than those of traditional remittance platforms. The study recommends that in order to deal with informal remittances the recommended remittance platform should allow for lite KYC onboarding which allows for legal and illegal migrants to be onboard smoothly so that informal remittances can be converted into the formal channel. This will allow previously unaccounted remittances to be formally recorded and help to minimize informal remittances which sometimes expose financial systems to money laundering, financing of terrorism and corruption. However there will be need for threshold to be set for different amounts of remittance to allow for tax exemptions and low fees depending on the level amount which an individual want to send and level of KYC provided.

In a nutshell, this empirical research not only contributes to the limited extant literature on migration and cross-border remittances in the context of African developing economies but also make significant contributions to policy and practice. The study's findings add to the existing scholarly debate regarding the nexus between remittances and migration. The findings may contribute to the development of new migration-remittance nexus theories or modification of existing theories such as the New Economics of Labor Migration (NELM). Besides the potential contributions to theory,

practice and policy, the research had its own limitations. Hence, further analyses are necessary to further validate the present findings. Given data availability, future studies may consider including a large sample of African countries to enhance generalizability of findings. Other key determinants of cross-border remittances such as political (in)stability and real interest rates may be considered in modelling the impacts of migration on cross-border payments.

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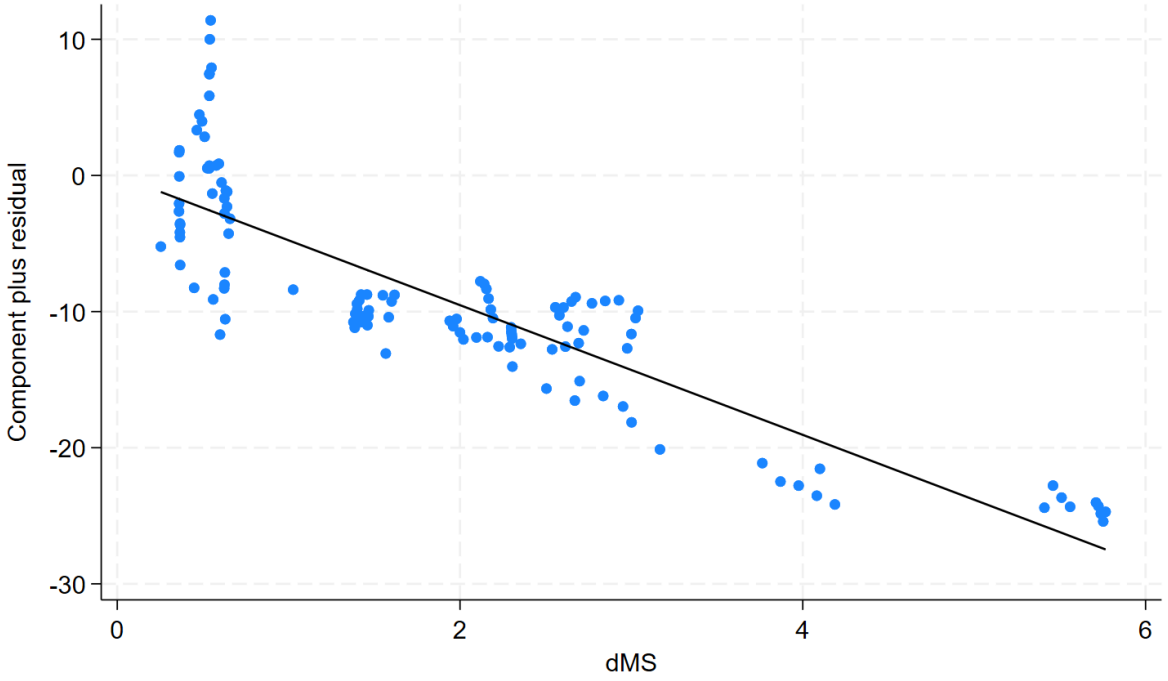
APPENDIX

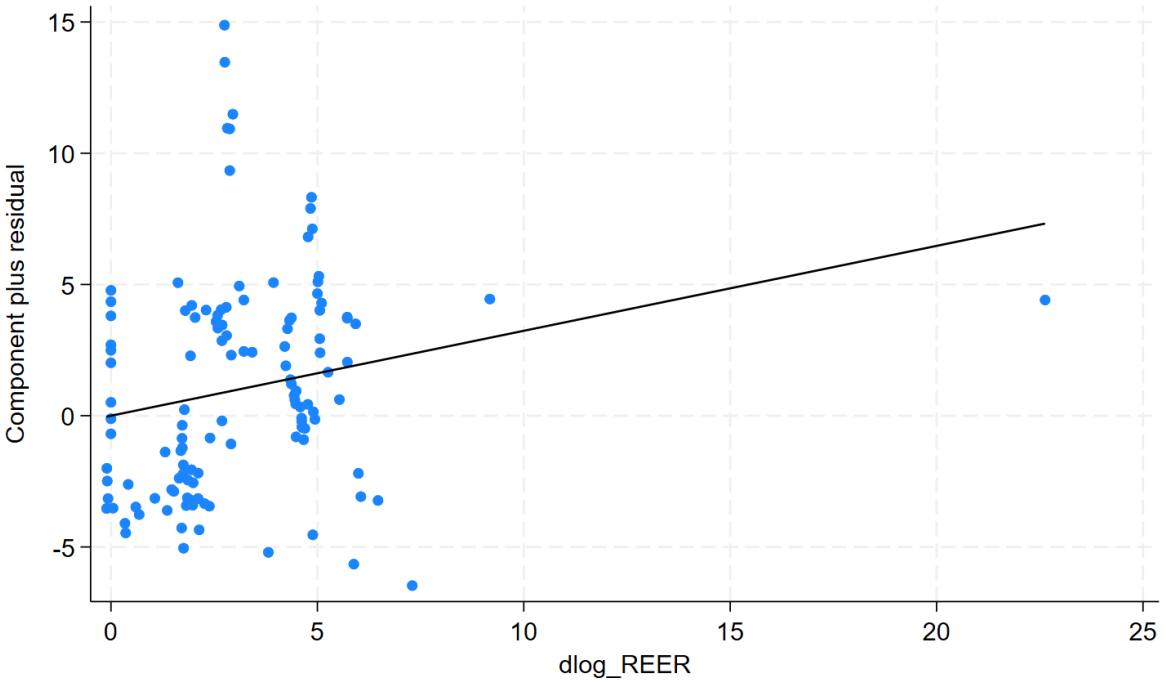
Country	Year	CBP (US$)	MS (%of population)	FA (ATM/100000adults)	FA (CBR/100000dults)	MPT (Mobile cellular subscriptions)	CTS (Cost to send remittances (%))	RQ (Estimate)	INFL (cpi%)	GDPpc (US$)
Kenya	2004	3340700000,00	0,25	2,55	3,66	7640000,00	5,00	-0,57	11,27	991,26
Kenya	2005	5017300000,00	0,37	3,22	3,67	13600000,00	5,10	-0,45	4,87	1104,80
South Africa	2004	468117772,17	2,31	28,51	4,57	20800000,00	6,11	0,69	-0,69	5221,46
South Africa	2005	613577432,38	2,50	23,98	6,83	34000000,00	6,17	0,72	2,06	5836,88

Linear Test Results



The graph above depicts trends represented by three distinct curves, which likely correspond to different variables under investigation (e.g., remittance inflows, transaction costs, and migration flows). The x-axis represents the progression of time (or a categorical variable such as countries or regions), while the y-axis measures the magnitude of each variable. The upward movements in the curves suggest increasing values, such as higher remittance volumes or greater adoption of digital payment platforms, while downward movements indicate declines, potentially in costs or migration intensity.

Comparing the three curves provides insight into the dynamic interactions between migration and cross-border payment systems. For example, one curve could show how migration flows influence remittance volumes, another might illustrate changes in transaction costs, and the third could represent adoption of digital platforms. The intersections between the curves highlight critical points where migration patterns begin to affect payment efficiency or where regulatory and technological factors alter cross-border payment behaviours. Overall, the graph illustrates that migration patterns and remittance behaviours are not uniform but vary across time (or regions), reflecting the asymmetric, threshold-based, and channel-dependent effects identified in the research objectives. Similar graphs are shown below for other variables.


Component plus residual
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0
-5
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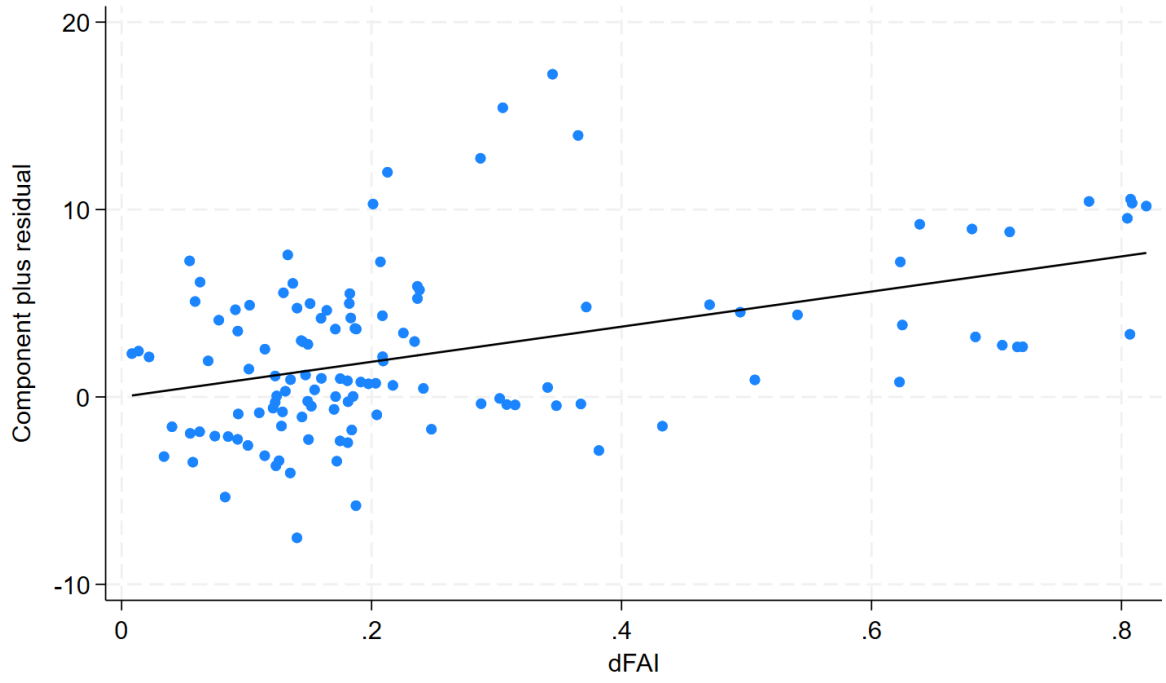
15
20
25
dlog_REER


Component plus residual
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-10
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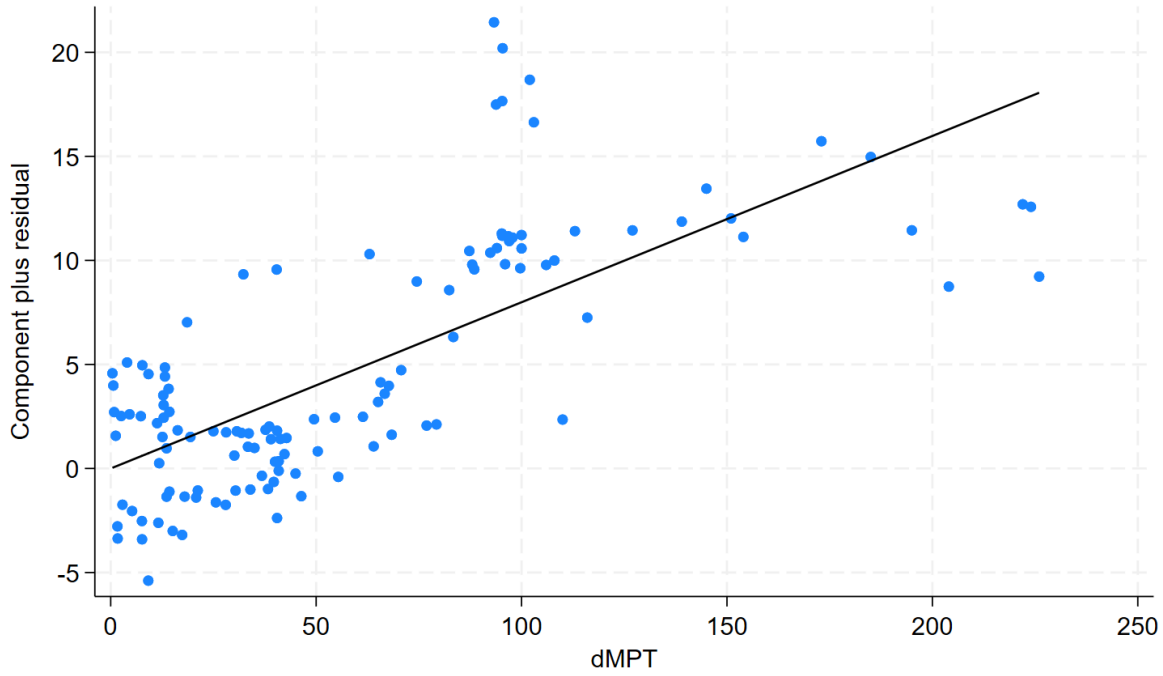
.4
.6
.8
dFAI


Component plus residual
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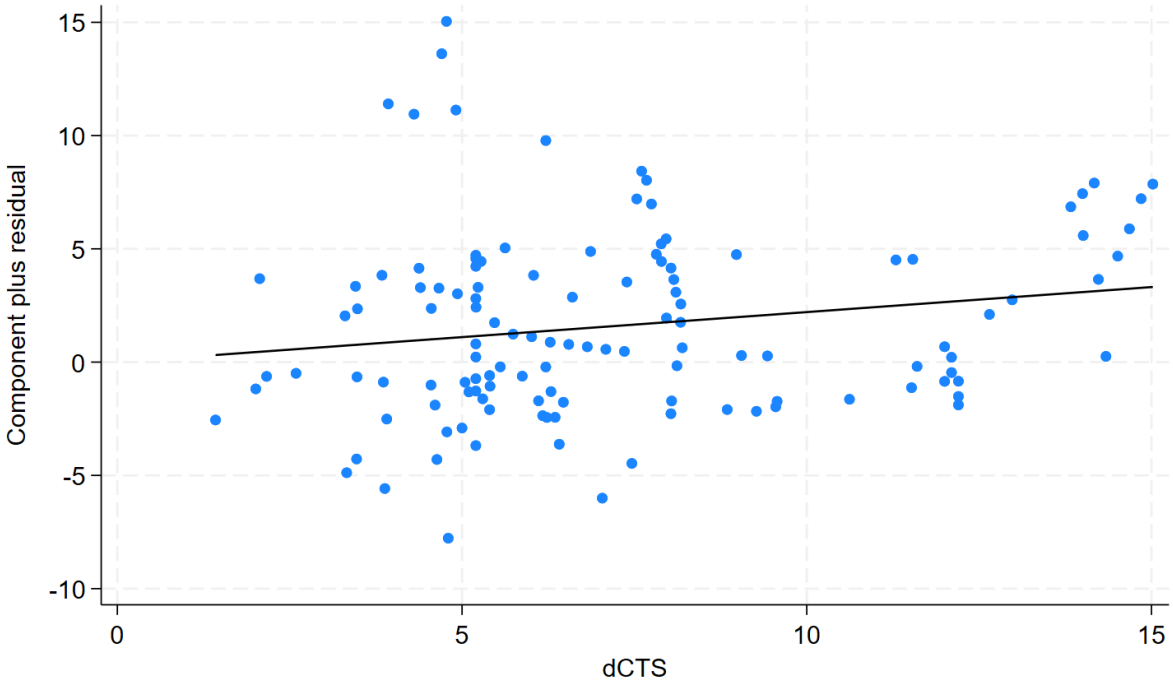
0
-5
0
50
100
150
200
250
dMPT


Component plus residual
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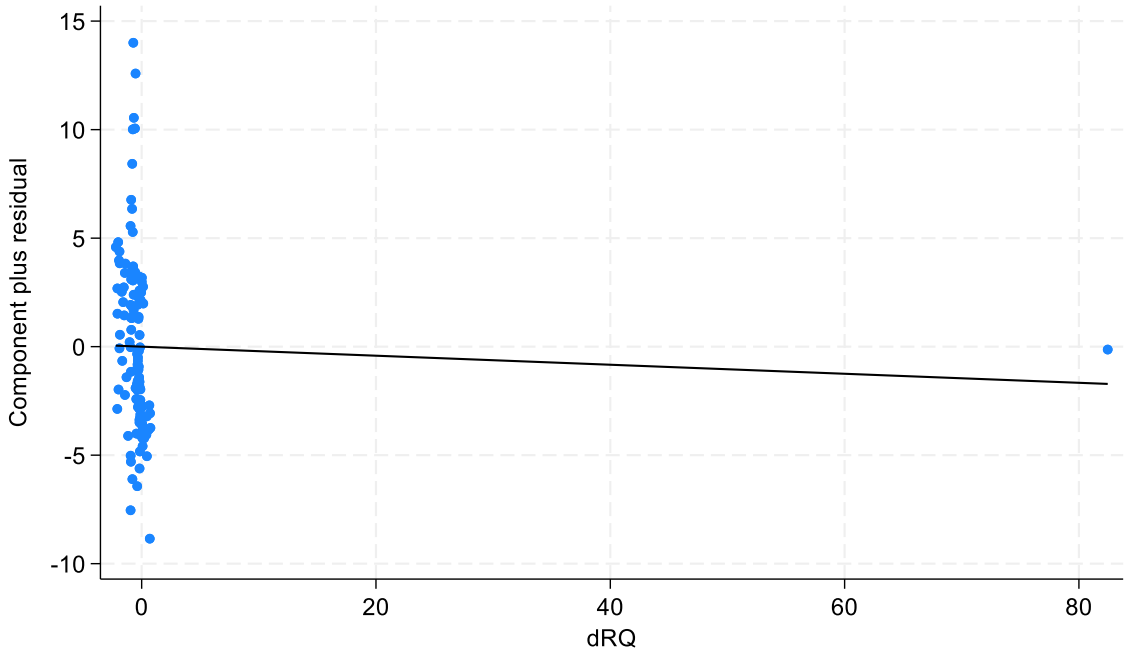
dCTS


Component plus residual
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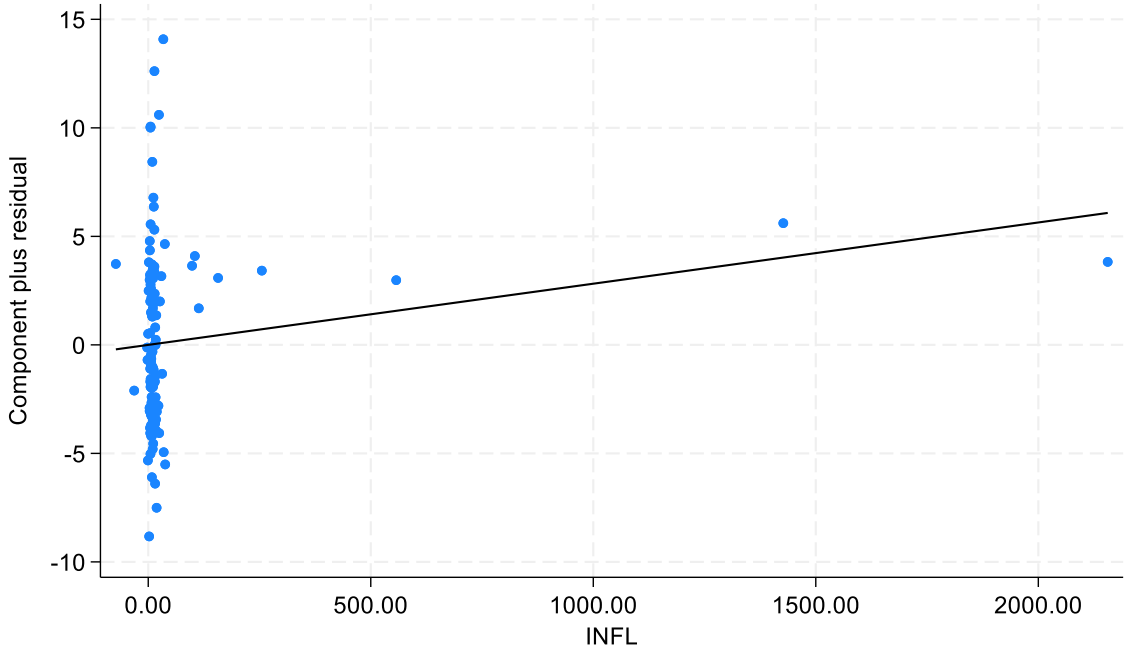
80
dRQ


Component plus residual
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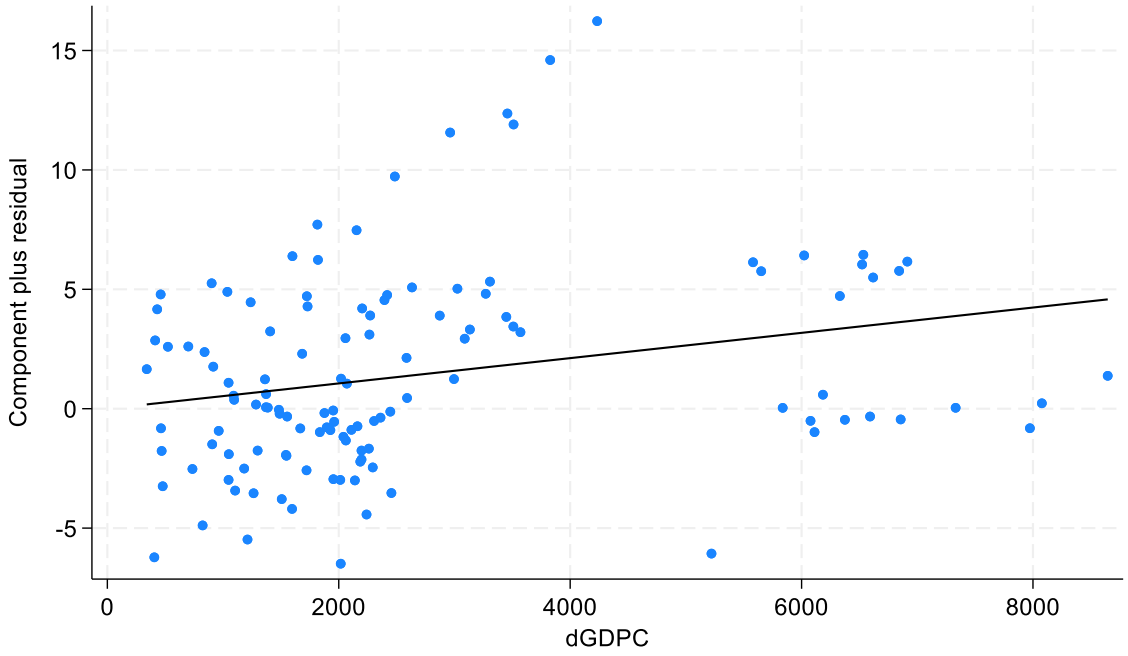
500.00
1000.00
1500.00
2000.00
INFL


Component plus residual
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-5
0
2000
4000
6000
8000
dGDPC