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Original Research

Effect of financial inclusion on economic growth in East African countries

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Abstract

This study examines the relationship between financial inclusion and economic growth in East African countries, Burundi, Ethiopia, Kenya, Sudan, Tanzania, Uganda, and Rwanda, over 2004–2021. Using ARDL regression analysis, it investigates the effects of the Financial Inclusion Index (FII), institutional quality (IQI), ICT index (ICTI), and Gross Savings (LogGS) on GDP per capita (logGDPPC). Results reveal notable differences across countries: Kenya, Tanzania, and Rwanda show strong positive links between financial inclusion and growth, driven by mobile banking innovations and supportive institutions. In contrast, Burundi and Sudan display weak or negative associations, reflecting instability and underdeveloped systems. Ethiopia and Uganda exhibit positive but modest outcomes, highlighting the need for more efficient financial markets and better savings allocation. Overall, findings suggest that financial inclusion alone is insufficient; institutional reforms, stronger governance, and improved credit access are essential to maximize growth benefits. Policy recommendations emphasize strengthening financial infrastructure, promoting financial literacy, and enhancing regulatory frameworks to foster inclusive development. These measures align with SDG 8 (Decent Work and Economic Growth), SDG 10 (Reduced Inequalities), and the African Union's Agenda 2063.

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INTRODUCTION

Financial inclusion enables poor individuals to access financial services (payments, savings, credit, insurance) more easily, building resilience and increasing participation (Demirguc et al., 2022). Technologies like mobile money have successfully decreased unbanked populations in the world, from 51% in 2011 to 45% in 2021 (World Bank, 2021), but challenges like remoteness, the digital divide between genders, and the poor ICT sector still persist.

For East Africa, the progress varies greatly between countries: Kenya reached 85% in financial inclusion and reduced poverty by 2% through the use of M-Pesa (Suri & Jack, 2016), Rwanda and Tanzania grow through fintech regulations (AfDB, 2023), while countries like Burundi and Sudan remain far below 20% due to instability and weak ICTs. Hence, the main question that arises in this work is whether the growth impacts are universal or conditional on institutions and infrastructure.

This work uses panel econometrics approaches (PMG, ARDL, GMM) to investigate how dynamic heterogeneity affects specific policy measures. Results confirm that digital financial services can

boost household saving and resilience but its performance strongly depends on governance and ICT; in the same vein as the finding of MPesa, which contributed to a 2% poverty reduction in Kenya (Suri & Jack, 2016), 7% greater likelihood of being an account owner linked to financial service usage of digital financial products (Khera et al., 2021a) for a subsample, a successful creation of trust through agent banking in rural area of Uganda African panel estimates on impact to growth only with solid institutions.

Finally, the paper argues that financial inclusion is both a condition and a prerequisite for growth and is achieved through effective ICT infrastructure and fair governance. This study is in line with the AU Agenda 2063 and SDGs 8 and 10.

Statement of the Problem

Despite rapid expansion in financial access across East Africa—account ownership rose from 23% in 2011 to 55% in 2021 (Demirgüç et al., 2022)—the relationship between inclusion and economic growth remains structurally uneven. Countries such as Kenya, Rwanda, and Tanzania leveraged mobile money and regulatory strength to stimulate GDP, with Kenya's M-Pesa alone adding 0.5–1% annually (Suri & Jack, 2016). In contrast, Burundi and Sudan stagnated below 20% inclusion, constrained by political volatility, fragile banking systems, and ICT penetration under 30% (Kiptui, 2024). These disparities underscore that inclusion alone is insufficient; its growth impact depends on institutional quality and technological readiness.

Prior studies affirm inclusion's potential but expose gaps. Ozili (2023) finds a positive global nexus (β=0.15) weakened by poor governance, yet overlooks East African specificities. Sarma (2023) highlights risks of over-indebtedness in low-literacy contexts, as seen in Sudan's 15% default spike post-digital rollout (Central Bank of Sudan, 2023), but relies on static cross-sections. Kiptui (2024) models East African panels but masks country-level bottlenecks such as Burundi's conflict-driven exclusion.

Research Questions

1. How do the disaggregated dimensions of financial inclusion, access, depth, and efficiency directly influence economic growth in East African countries?
2. In what ways does the composite Financial Inclusion Index affect economic growth when controlling for macroeconomic conditions, institutional quality, and ICT infrastructure?
3. What are the joint and interactive effects of financial inclusion, institutional quality, and ICT penetration on economic growth across East Africa?

Conceptual Framework

The conceptual framework (Figure 1) positions economic growth, proxied by GDP per capita, as the dependent variable and the ultimate development outcome. The central explanatory variable is financial inclusion, measured through access, usage, and quality. Financial inclusion is expected to stimulate growth by mobilizing savings, improving resource allocation, and expanding credit and payment services. However, this effect is not automatic; it depends on the institutional and technological environment in which financial services operate.

A critical element of the framework is institutional quality, which functions as a moderating variable rather than a background condition. Strong governance and rule of law ensure that financial inclusion translates into productive investment and efficient credit allocation, while weak institutions risk inefficiency, rent-seeking, and poor resource use. Thus, institutional quality amplifies or constrains the financial inclusion–growth relationship, making it decisive in determining outcomes.

Equally important is technological infrastructure, particularly digital innovation and ICT diffusion. Technology reduces transaction costs, lowers information asymmetries, and extends financial services to underserved populations.

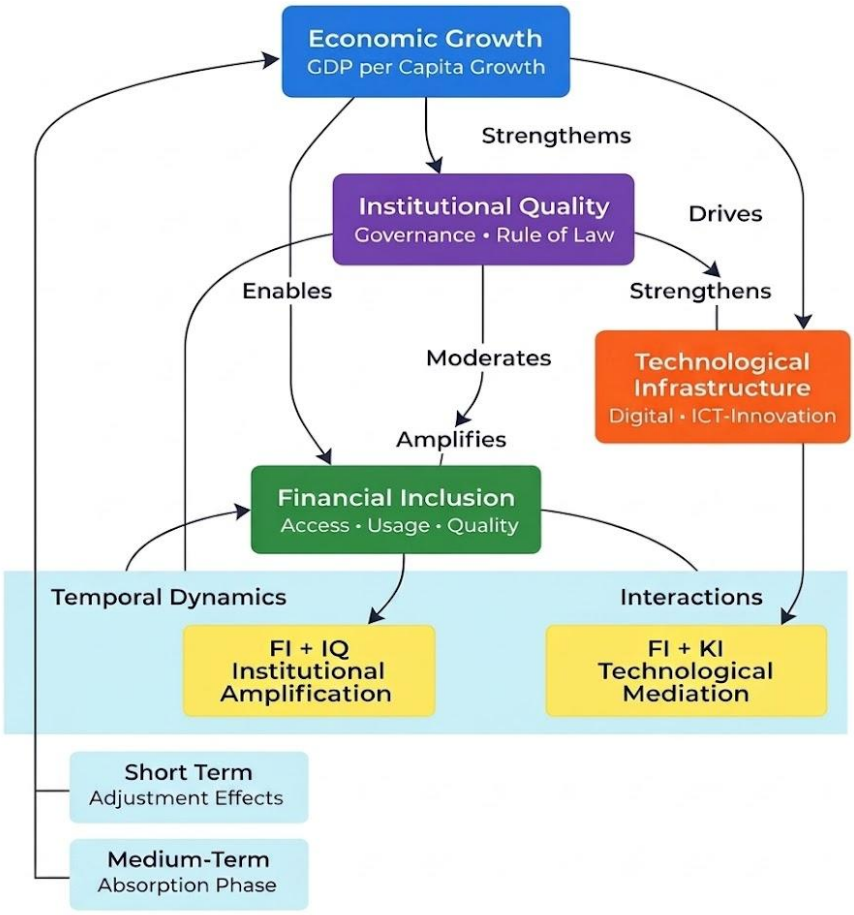


Figure 1. *Conceptual Framework*

Mobile money and ICT platforms broaden access and deepen usage, but their contribution to growth depends on effective transmission through inclusive financial systems and supportive institutions. Technology, therefore, interacts with financial inclusion and governance, reinforcing or weakening its impact.

The framework moves beyond a simple direct-effect model. Financial inclusion influences growth directly, but its impact is amplified by institutional quality and mediated by technological infrastructure. These variables interact dynamically, creating mutually reinforcing effects rather than isolated determinants. Moreover, temporal dynamics are recognized: short-term adoption effects evolve into medium-term gains through savings, investment, and capital efficiency, provided institutions and ICT are robust.

From a variable perspective, the model specifies economic growth as the dependent variable, financial inclusion as the independent variable, and institutional quality and technological infrastructure as moderators. Control variables such as trade openness, capital formation, and inflation may also be included to strengthen the empirical specification.

Evidence supports this design: financial inclusion enhances welfare and savings (Demirgüç et al., 2022), but weak governance or ICT gaps dilute its impact (Ozili, 2023; Khera et al., 2021b). East Africa's divergent experiences justify the study's focus on explaining why and under what conditions inclusion translates into growth, making the framework both contextually relevant and analytically rigorous.

MATERIALS AND METHODS

This study employed a balanced panel dataset covering seven East African countries, Burundi, Ethiopia, Kenya, Rwanda, Sudan, Tanzania, and Uganda, over the period 2004–2021(Table 1). The panel structure was chosen to capture both cross-country heterogeneity and time variation in the financial inclusion–growth relationship. Data were sourced from internationally recognized databases, including the World Bank's World Development Indicators, World Governance Indicators, the International Monetary Fund, and the International Telecommunication Union, ensuring comparability across macroeconomic, institutional, financial, and ICT variables.

The dependent variable was economic growth, proxied by the natural logarithm of GDP per capita. The key explanatory variable was financial inclusion, measured through a multi-dimensional Financial Inclusion Index (FII) constructed via Principal Component Analysis (PCA) from indicators of access, usage, and outreach. This multi-dimensional approach was necessary given the complexity of financial inclusion. In line with the conceptual framework, institutional quality and ICT penetration were included as moderators. Institutional quality was measured using a composite index derived from six governance indicators, while ICT penetration was captured through a composite index reflecting digital infrastructure and technology diffusion. Additional controls, trade openness, inflation, and capital formation were incorporated to strengthen the specification.

The empirical model was grounded in the panel Autoregressive Distributed Lag (ARDL) framework, suitable for variables integrated of mixed orders (I(0) and I(1)). The Pooled Mean Group (PMG) estimator was employed, allowing homogeneous long-run coefficients across countries while permitting heterogeneous short-run dynamics. This approach was appropriate given East Africa's structural similarities alongside differences in financial maturity, institutional strength, and ICT readiness. Interaction terms between financial inclusion and institutional quality, and between financial inclusion and ICT penetration, were included to capture moderating effects. The general specification can be expressed as: $\log GDPPC_{it} = f(FII_{it}, IQI_{it}, ICTI_{it}, FII \times IQI_{it}, FII \times ICTI_{it}, X_{it})$ where X_{it} represents the set of control variables.

To ensure robustness, several diagnostic tests were conducted. Cross-sectional dependence was tested to account for common shocks such as regional reforms or global fluctuations. Panel unit root tests (Pesaran, 2021) confirmed stationarity properties, while Westerlund's cointegration test verified long-run relationships among variables. Dumitrescu-Hurlin panel causality tests identified causal directions. Additional checks addressed multicollinearity, heteroscedasticity, autocorrelation, and residual normality, ensuring statistical validity.

Overall, the methodology aligns with the conceptual framework by linking financial inclusion, institutions, and ICT to growth outcomes. It recognizes the heterogeneity of East African economies, where Kenya and Rwanda exhibit advanced mobile ecosystems, while Burundi and Sudan face institutional and technological constraints. By combining balanced panel data, composite indices, dynamic ARDL estimation, and rigorous diagnostics, the study provides a robust examination of how financial inclusion contributes to growth under varying institutional and ICT conditions.

Table 1

Variable Descriptions, Measurements, a Priori Expectations, and Data Source

Symbol	Measurement of Variable	A Priori Expectation	Source
logGDPPC	Natural log of GDP per capita (constant US$) – proxy for economic growth		Molla & Yadeta (2023)
FII	Composite index (0–1 scale) derived via PCA from access, usage, and quality of financial services. Components include: NCBBKM (branches per 1,000 km²), NCBBA (branches per 100,000 adults), ATMKM (ATMs per 1,000 km²), ATMA (ATMs per 100,000 adults), NDAA (deposit accounts per 1,000 adults), NBAA (borrowers per 1,000 adults), NCLA (loan accounts per 1,000 adults), OSD (outstanding deposits % of GDP), OSL (outstanding loans % of GDP).	(+) Positive long-run effect; possible short-run adjustment costs (J-curve)	World Bank (2021)
IQI	Composite index (−2.5 to +2.5) from six WGI dimensions: VA (Voice & Accountability), PS (Political Stability), GE (Government Effectiveness), RQ (Regulatory Quality), RL (Rule of Law), CC (Control of Corruption).	(+) Positive and foundational; negative where governance is weak	Meyer (2022)
ICTI	Composite index (0–1 scale) measuring ICT infrastructure and adoption. Components include: Mobile subscriptions, Telephone lines, Internet users, Computer/communications services, Secure internet servers, ICT service exports, R&D expenditure, Patent applications (residents), Fixed broadband subscriptions.	(+) Positive but delayed; short-run costs, long-run productivity gains	Molla & Yadeta (2023)
logGS	Natural log of gross domestic savings (% of GDP)	(+/−) Ambiguous; positive only with effective financial intermediation	Banga and Ponnuswamy (2023)
FII_IQI	Product of Financial Inclusion Index and Institutional Quality Index	(+) Institutions amplify the finance–growth nexus	Akinwunmi & Sanda (2023)
FII_ICTI	Product of Financial Inclusion Index and ICT Development Index	(+) Positive conditional on institutional quality; negative in weak governance settings	
L.logGDPPC, L2.logGDPPC	First and second lags of log GDP per capita	(+) Positive persistence expected	Standard ARDL specification
L.FII, L2.FII	Lagged financial inclusion index	(+) Long-run multiplier effect	Demirgüç et al. (2022)

Table 1 continues.

		(+) Stabilizing effect; negative if governance deteriorates	
L.IQI, L2.IQI	Lagged institutional quality index		
L.ICTI	Lagged ICT development index	(+) Productivity gains materialize over time	
L.logGS, L2.logGS	Lagged gross savings	(+/−) Depends on intermediation efficiency	Meniago and Eita (2021)
ECT	Speed of adjustment to long-run equilibrium	Negative (between −1 and 0) – convergence	Standard ARDL

Source: Authors' estimations based on data sources (World Bank, Financial Statistics database, WGI, and ITU, 2022)

Empirical model of ARDL

The study employs a panel ARDL framework to examine both short-run and long-run relationships between economic growth (logGDPPC) and financial inclusion (FII), alongside institutional quality (IQI), ICT infrastructure (ICTI), their interaction terms (FII×IQI, FII×ICTI), and gross savings (logGS) across seven East African countries. This specification is particularly suitable for developing economies where variables are integrated of mixed orders, I(0) and I(1), but not I(2).

$$\Delta logGDPPCit = \alpha i + \sum_{J=1}^{p} \gamma j \Delta log\ GDPPCi, t-j + \sum_{J=0}^{q1} \theta 1 j \Delta FIIi, t- j + \sum_{J=0}^{q2} \theta 2 j \Delta IQIi, t- j + \sum_{J=0}^{q3} \theta 3 j \Delta ICTIi, t- j + \sum_{J=0}^{q4} \theta 4 j \Delta log\ GSi, t- j + \phi 1(FIIi, t-1 \cdot IQIi, t-1) + \phi 2(FIIi, t-1 \cdot ICTIi, t-1) + \lambda ECTi, t-1 + \mu i + \epsilon it \quad (1)$$

where $ECTt-1$ is the error-correction term derived from the long-run equilibrium relation:

$$ECTt-1 = logGDPPCt-1-\beta 1FIIt-1-\beta 2IQIt-1-\beta 3ICTIt-1-\beta 4log\ GSt-1-\beta 5(FII \cdot IQI)t-1-\beta 6(FII \cdot ICTI)t-1- \quad (2)$$

The coefficient λ<0 represents the speed of adjustment toward equilibrium, while lag lengths (p≤2,qj≤2) are determined using information criteria such as AIC or SBC.

This model captures the dynamic interactions between financial inclusion, institutions, ICT, and savings, allowing identification of both immediate and long-term effects. The inclusion of interaction terms reflects the study's theoretical argument that financial inclusion alone is insufficient; its growth impact is conditional on institutional quality and technological readiness. By adopting the Pooled Mean Group estimator, the model assumes homogeneous long-run coefficients across countries but heterogeneous short-run dynamics, consistent with East Africa's structural similarities yet divergent financial ecosystems.

RESULTS AND DISCUSSION

Results

Descriptive Statistics

The descriptive statistics in Table 2 provide an overview of the key variables for the seven East African Community (EAC) countries between 2004 and 2021. The results highlight substantial cross-country heterogeneity, reflecting divergent developmental trajectories across the region. The average GDP per capita (GDPPC) is USD 996.99, but the high standard deviation of USD 600.94 indicates wide income disparities (Beck et al., 2021).

Table 2

Summary of Descriptive Statistics

Variable	Obs	Mean	Std. dev.	Min	Max
GDPPC	117	996.991	600.939	263.361	2381.357
NCBBKM	117	3.541	4.575	0.178	17.957
NCBBA	117	3.107	1.357	0.403	6.276
ATMKM	117	2.993	3.959	0.000	16.457
ATMA	117	3.471	2.749	0.000	9.695
NDAA	117	253.855	423.741	0.000	2119.303
NBAA	117	35.550	66.230	0.000	345.839
NCLA	117	36.376	68.944	0.000	381.743
OSD	117	20.915	8.463	6.000	42.000
OSL	117	15.350	6.966	1.000	34.000
FII	117	0.052	1.019	-0.718	3.518
IQI	117	0.171	0.950	-1.790	1.863
ICTI	117	0.948	0.971	-0.611	3.547
GS	117	17.659	9.409	0.592	37.889

Financial inclusion indicators reveal persistent challenges. Bank branch and ATM density remain low, underscoring limited access, especially in rural areas (Demirgüç et al., 2022). Deposit and loan accounts vary widely, reflecting differences in market maturity and financial literacy. Credit access is particularly constrained: the low average number of borrowers suggests that financial systems prioritize deposit mobilization over credit extension, limiting enterprise dynamism (Honohan, 2020).

These findings confirm that while financial inclusion has expanded, its depth and quality differ significantly across countries. The heterogeneity in access, usage, and outreach underscores the importance of institutional and technological moderators in shaping the financial inclusion–growth nexus.

Correlation Analysis

Table 3 displays the links between economic growth and financial inclusion, institutional, and ICT indices. Certain important observations can be deduced:

Digital Transformation: GDPPC is positively correlated with ICT penetration and deposit accounts. This indicates that the adoption of digital services is a critical factor affecting growth and resilience (Demirgüç et al., 2022).

Traditional vs. Digital Banking: Surely enough, there is a negative relationship between GDPPC and density of physical banking branches (-0.359). This might illustrate a regional pattern of a shift to higher incomes where banking goes mobile rather than physical (Honohan, 2020).

Access-Usage Gap: Correlations between physical infrastructure, such as physical ATMs/Branches, and access metrics are significantly strong. However, correlations with access metrics such as loan/borrower are surprisingly lower. This demonstrates that there exist many systemic issues in credit allocation and financial literacy (Beck et al., 2021).

Table 3

Correlation Analysis

	GDPPC	NCBBKM	NCBBA	ATMKM	ATMA	NDAA	NBAA	NCLA	OSD	OSL	FII	IQI
GDPPC	1											
NCBBKM	-0.359	1.000										
NCBBA	0.185	0.674	1.000									
ATMKM	-0.137	0.862	0.708	1.000								
ATMA	0.431	0.062	0.590	0.414	1.000							
NDAA	0.220	0.094	0.501	0.325	0.658	1.000						
NBAA	0.240	-0.005	0.443	0.221	0.625	0.971	1.000					
NCLA	0.255	-0.005	0.450	0.214	0.609	0.951	0.985	1.000				
OSD	0.088	-0.130	0.232	0.048	0.530	0.507	0.515	0.517	1.000			
OSL	0.061	0.055	0.420	0.231	0.647	0.637	0.639	0.660	0.881	1.000		
FII	-0.137	0.862	0.708	1.000	0.414	0.325	0.221	0.214	0.048	0.231	1.000	
IQI	-0.342	0.460	0.378	0.612	0.395	0.414	0.334	0.339	0.166	0.324	0.612	1.000
ICTI	0.399	0.204	0.589	0.468	0.800	0.615	0.568	0.543	0.511	0.545	0.468	0.181
GS	0.120	-0.370	-0.387	-0.273	-0.247	-0.166	-0.176	-0.205	0.153	-0.157	-0.273	-0.053
ICTI	1											
GS	-0.1481	1										

Normality test

Figure 2 shows the results of the normality test performed on the residuals of the estimated model. The results provide an indication that the residuals do not come from a normal distribution, as seen by the kurtosis of 3.068 with a corresponding p-value of 0.02, Jarque–Bera statistic of 7.9, and skewness of 0.63. These results indicate the presence of heavy tails as well as mild right skewness.

Such deviations from normality could conceivably impact the accuracy and reliability of the estimates used for designing the coefficients and the statistical inferences drawn from the results. It is recommended to use robust standard errors or data transformation to improve the results obtained from the econometric models.

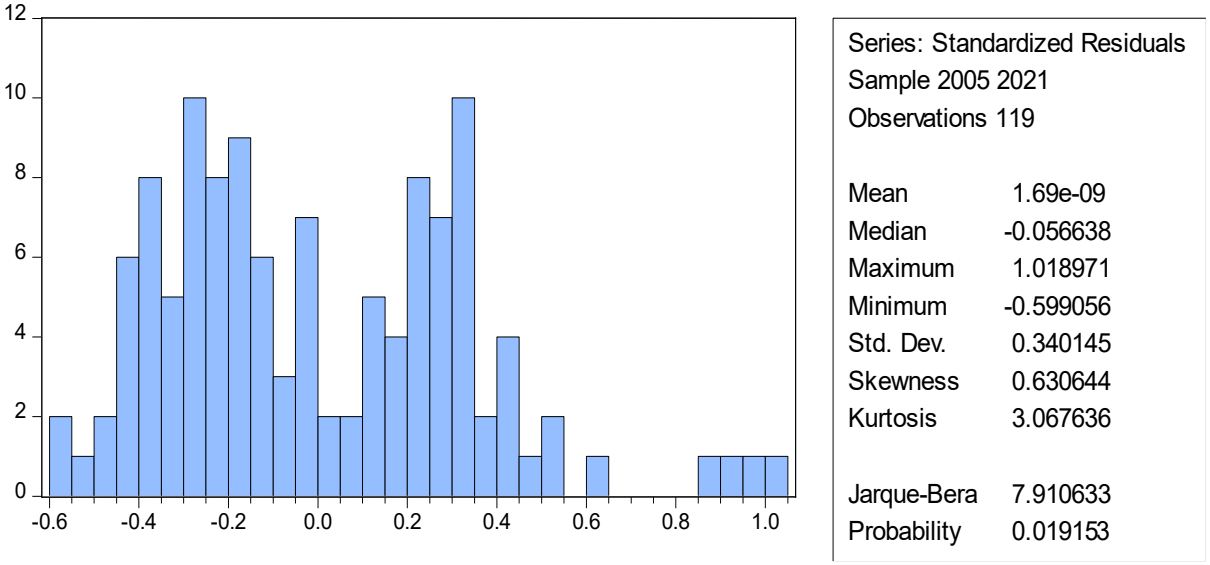


Figure 2. *Normality Test*

Cross-sectional dependency test

From Table 4, the analysis of cross-sectional dependency for the data series "LOGGDPPC" indicates strong correlations across different countries; this shows that economic indicators are not independent variables. Most importantly, the results from the Breusch-Pagan test and Pesaran Scaled test all showed strong cross-section dependencies with a very small probability level for the data. These findings highlighted the interdependence of economic variables in these regions; thus, economic processes in these countries are interconnected.

Table 4

Cross-Sectional Dependency Test Results

Test	Statistic	Degrees of Freedom (d.f.)	Probability (Prob.)
Breusch-Pagan LM	269.9561	21	0.0000
Pesaran scaled LM	38.41475	-	0.0000
Bias-corrected scaled LM	38.20887	-	0.0000
Pesaran CD	3.559066	-	0.0004

Panel Unit Root Test

For the results of the econometric analysis to have validity, the avoidance of spurious regression results was also ensured by the rigorous testing of the stationarity of the variables involved. As is evident from Table 5, the variables selected demonstrate varying degrees of integration. Specifically, Foreign Direct Investment (FDI) is found to be stationary at levels, thus making it integrated of order zero, i.e., I(0). Conversely, GDP per capita (logGDPPC), the Financial Inclusion Index (FII), Gross Savings (LogGS), and Institutional Quality Index (IQI) are found to be stationary after taking the first difference, thus making them integrated of order one, i.e., I(1). These results, thus, align with the prevailing literature in the broad realm of macroeconomic variables.

The co-existence of mixed orders of integrational processes (I(0) and I(1)) provides direct inputs into the selection of the Panel Autoregressive Distributed Lag (ARDL) approach. The ARDL approach has a unique ability to handle this mixed structure in the dataset. It can maintain robustness when the variables are not of the same order of integrational processes and can readily estimate both short-term relationships as well as long-term relationships simultaneously (Pesaran et al., 2001).

Table 5

Panel Unit Root Test

Variables	Level	Statistic	Value	p-value
		Unadjusted t	-10.7235	
logGDPPC	1st difference	Adjusted t*	-4.1212	0.000
FII	1st difference	Unadjusted t	-9.083	
		Adjusted t*	-4.411	0.000
		Unadjusted t	-7.446	0.0018
FDI	At level	Adjusted t*	-2.917	
LogGS		T-bar	-4.326	
		T_ilde-bar	-2.791	
	1st difference	t-tilde-bar	-4.995	0.000
LogGCF		t-bar	-4.138	
	1st difference		-2.638	0.000
		t-tilde-bar		

Table 5. continues

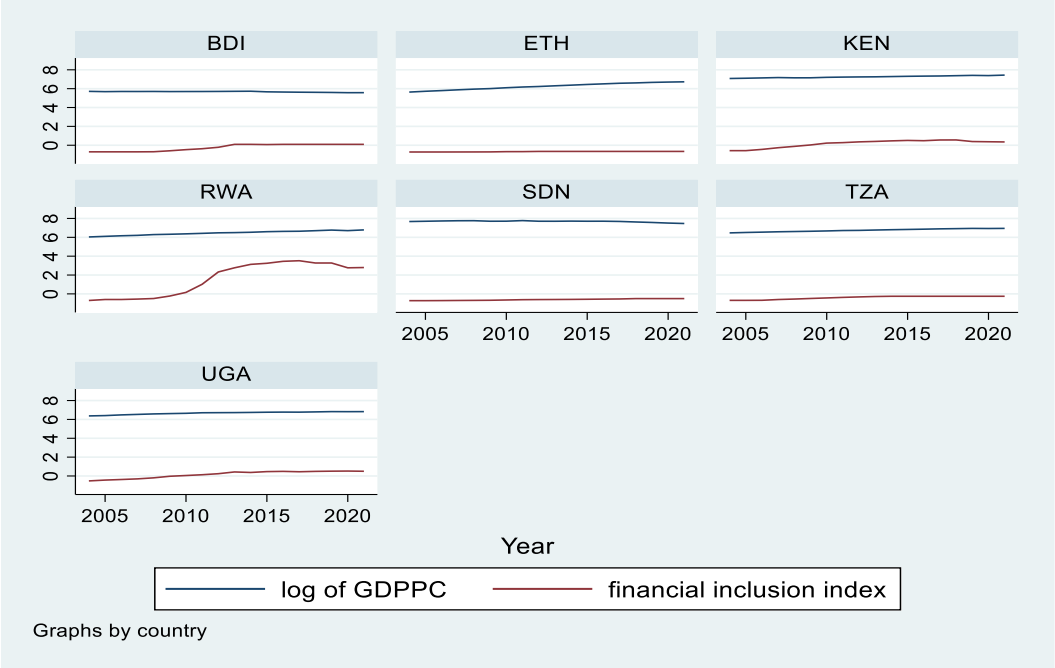
		Z-t-tilde-bar	-4.537	
		t-bar	-3.343	
	1st difference	tilde-bar	-2.321	
IQI		t-tilde-bar	-3.422	0.0003
	1st difference	T-bar	-3.000	
		T- tilde-bar	-2.303	
ICTI				
		t-tilde-bar	-3.359	0.000
	1st difference	T-bar	-2.676	
		T-tilde-bar	-1.946	
IQI*ICTI		T-t-tilde-bar	-2.102	0.018

Relationship between GDP and financial inclusion

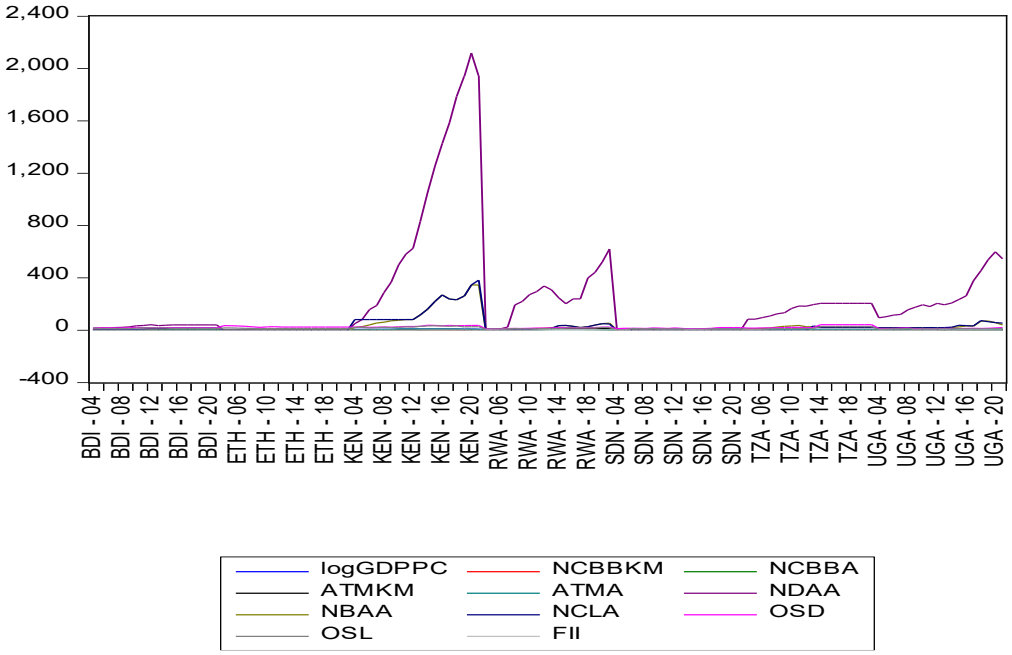
Figure 3 presents the relationship between financial inclusion and economic growth, represented using the log-transformed GDP per capita for the economies. The panel regression reveals that, on average, there is a negative association between financial inclusion and economic growth, as supported by the eigenvalue decomposition results for the correlation matrices.

The Principal Component Analysis also revealed that, even though financial inclusion and economic growth are inversely related in the principal component, there are positive correlations in other components; therefore, financial inclusion does not necessarily promote economic growth. It should be complemented by institutional quality, infrastructure, and human capital to be effective (Demirgüç et al., 2021; Sarma & Pais, 2023).

Otherwise, increased financial inclusion may even lead to financial instability or over-indebtedness, thereby creating an overwhelming necessity for comprehensive policy frameworks to unlock its benefits.



(a)



(b)

Figure 3. *Relationship between GDP and financial inclusion*

Financial Inclusion Index

The eigenvalue decomposition for the Financial Inclusion Index (FII) reveals that the first principal component contributes to more than half of the total variance (54.7%), whereas the contribution of the first nine components to the total variance is 99.9%. (Table 4)

This reveals the fact that the variation in financial inclusion among East African nations can be better represented in terms of a few factors, thus corroborating the applicability and efficiency of PCA in simplifying complex financial data.

To further validate this, Figure 4 and Table 6, which is a scree plot, suggest that indeed only a handful of these components are statistically significant, affirming the above advice on using these key indicators to improve financial inclusion in East Africa. Using this approach, policymakers are able to concentrate their efforts on key issues such as financial access, ATMs, and mobile banking instead of trying to improve all these indicators at once (Beck et al., 2021).

Table 6

Eigenvalue Decomposition of the Financial Inclusion Index

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	4.920	2.694	0.547	0.547
Comp2	2.226	1.307	0.247	0.794
Comp3	0.919	0.404	0.102	0.896
Comp4	0.515	0.275	0.057	0.953
Comp5	0.239	0.104	0.027	0.980
Comp6	0.044	0.060	0.012	0.991
Comp7	0.025	0.019	0.005	0.996
Comp8	0.009	0.016	0.003	0.999
Comp9	0.001	-	0.000	1.000

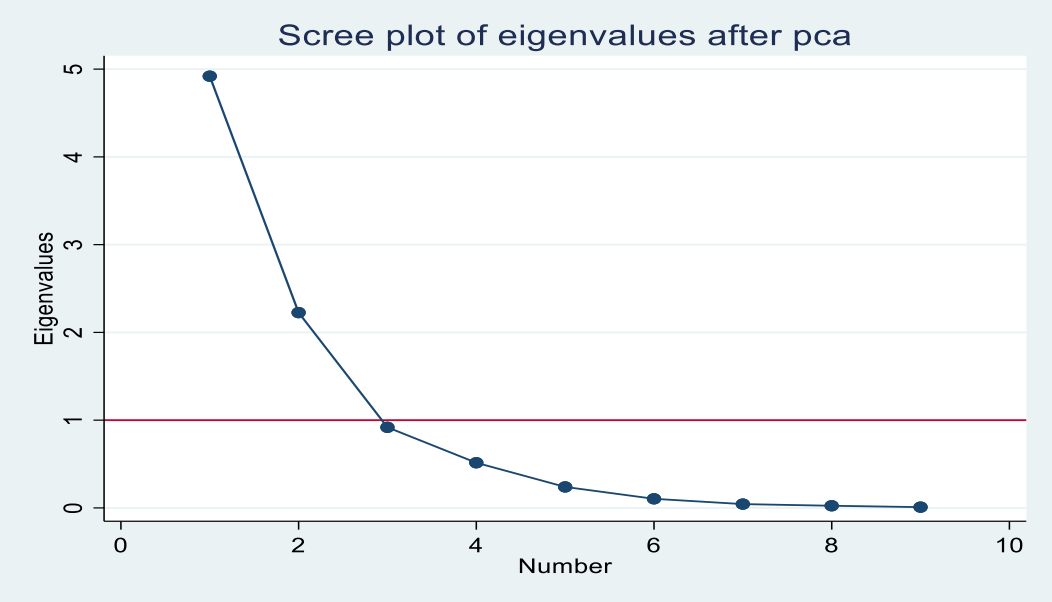


Figure 4. *Scree plot eigenvalues after running principal component analysis*

ARDL Regression Results of Financial Inclusion and Growth Determinants in East Africa: A Cross-Country ARDL Study

This comparative analysis will interpret the result of the Autoregressive Distributed Lag model for the seven East African countries from 2005-2021 as presented on Table 7, which indicates the results of the influence of various factors on a country's GDP per capita, such as financial inclusion (FII), institutional quality (IQI), ICT development (ICTI), and gross savings (logGS), with the main emphasis on the necessity to design policies according to the SDGs as well as Agenda 2063.

Country-Specific Interpretations

Burundi

According to ARDL estimates for Burundi (2005–2021, 16 observations, R = 0.989, ECT = 0.995), the environment is a volatile one with low persistence and a contradictory pattern of short-term financial inclusion impact.

In terms of short-term dynamics, it is observed that lagged GDP is insignificant (0.005, p = 0.986) in contributing to current growth levels; this lack of growth momentum is typical of developing low-income economies. In the short-run dynamics of financial inclusion (FII), it is apparent that there is a J-curve effect. Contemporary effects are positive (0.065, p = 0.068), suggesting immediate gains from a broader financial inclusion (0.065 percent increase in GDPPC for a one percent rise in FII), whereas lagged effects appear negative (0.084, p = 0.047) due to the fact that such expansion has a contractionary effect, as inflation is triggered along with bad loans, as risk management practices are inadequate. Quality of institutions (IQI) has a moderating effect on growth (0.076, p = 0.010), whereby a one percent increase in IQI boosts GDPPC by 0.076 percent. However, there is a dragging effect of ICT infrastructure (0.066, p = 0.013) due to high fixed costs, which can overwhelm absorptive capacity. Savings (GSav) also exert a negative influence on growth (0.008, p = 0.069), suggesting inefficient intermediation whereby a lot of savings are not channeled to productive capital but are rather absorbed in consumption.

For the long-run equilibrium, we see that these characteristics persist. Financial inclusion has a negative effect (0.019) as excessive depth without a strong institution causes detrimental growth effects. Quality of institutions remains a positive contributor (0.104), and so does the ICT

infrastructure, though negative (-0.081). The value of ECT of almost 1 (0.995) indicates the speed of adjustment is high, implying a rapid mean reversion (-99.5% per annum), but at the expense of shocks. In general, results from Burundi strongly confirm the importance of sequential policy implementation. Institutional strengthening should always come before a vigorous expansion of financial inclusion so as not to fall into credit cycle traps. The positive gains from financial inclusion can't lead to substantial growth without institutions and appropriate ICT capabilities.

Ethiopia

In Ethiopia, the ARDL estimation (2005-2021, 17obs., R = 0.9999, Fstat = 7004.32, ECT = 0.303) confirms strong growth and an ideal environment for potent financial inclusion multipliers.

Short-term, there's significant growth momentum. The past growth effect (lagged GDP coefficient = 0.697, $p<0.001$) shows that the past growth is the main driver of the current growth. Specifically, a 1% increase in per capita income last year would be associated with a 69.7% growth rate in the current period, reflecting the momentum from public infrastructure and agricultural modernizations. This strongly corroborates structural momentum. In the short term, the effect of financial inclusion seems strong and dominant (lagged financial inclusion = 1.744, p=0.003). A unit increase in financial inclusion last year would lead to a 174.4% increase in current GDP growth, which can be explained by SME credit extension, formalization of informal savings, and the entrepreneurial multiplier. Quality of institutions(IQI=0.133,$p<0.001$) and ICT (ICT = 0.055, p=0.004) boost current growth by 13.3% and 5.5%, reflecting the power of reliable institutions in attracting FDI and gradual mobile money penetration, as indicated by mobile payment Telebirr.

Long-term results confirm Ethiopia's finance-led growth process. The effect of financial inclusion on per capita GDP is extraordinarily large (6.630). An additional increase of 0.1 in the long-run level of financial inclusion would increase the long-run per capita GDP by 66.3%. The quality of institutions (0.518) and the use of ICT infrastructure (0.211) strongly support this impact. The contribution of gross savings (0.188) remained inefficient, with leakage to the nonproductive sector. The ECT term of -0.303 shows that there is 30.3% annual convergence toward equilibrium, confirming steady adjustment toward the long-run relationship.

In conclusion, Ethiopia has "finance follows function" dynamics. Strategic financial deepening has led to long-run GDP gains of sixfold and will ensure sustainable growth. With improvements in institutional quality and sustained technology development, Ethiopia is well-placed to emerge as East Africa's leader with financial inclusion, institutional quality, and technology combining in synergy.

Kenya

Kenya's 2006-2021 ARDL (13 obs, R=0.986/Adj=0.829, F-stat=6.27, p=0.303, ECT=-1.075) estimate supports the classic notion of financial deepening adjustment costs offset by institutional synergies.

Short run: GDP lag(-0.075, p=0.715) is insignificant, reflecting Kenya's volatile growth path due to post-election shocks and COVID-induced instability. FII(Financial Inclusion Index) shows the textbook J-curve: steep contraction(-0.739, p=0.002) reflecting immediate NPLs/consumption booms (73.9%GDPPCdropper1unitFII) from the rapid M-Pesa/digital credit boom, but strong lag1 rebound(0.711, p=0.004) suggesting a rapid catch-up(71.1%growthrebound as efficiency improvements come through via SME formalization, remittances, and multiplier effects) as M-Pesa's efficiency is captured in practice. IQI(Index of Quality of Institutions) is slightly negative(-0.089, p=0.047), reflecting institutional transaction costs of immediate liberalization but, when interacted with FII(0.383, p=0.012) gives a startling 38.3% amplification effect- Kenya's fintech boom reflects the ability of strong property rights to translate financial inclusion into

productive investment and has placed Kenya at the heart of fintech growth in Eastern Africa. FIICTI(0.100,p=0.002) gives a10%amplification from leveraging existing mobile infrastructure.

Long run: FII slightly negative(-0.026), perhaps suggesting some cautionary notes regarding unchecked digital credit, IQI slightly negative(-0.048), which reflects existing bottlenecks in governance structures. Extremely fast ECT(-1.075) indicates an almost immediate adjustment to equilibrium->100% adjustment per annum. Kenya strongly affirms the institutions as amplifiers theory: high-quality institutions turn the short-run distortions of financial inclusion into a sustained productivity growth process, and Kenya has proved to be East Africa's fintech growth hub when governance and digital innovation have successfully been integrated.

Rwanda

Rwanda ARDL estimates from 2007 to 2021 (15 obs, R=1.000/Adj=0.9999, F-stat=7555.53, ECT=-0.373) validate the "institutions first, tech second" approach.

Short-run dynamics: GDP is highly persistent (0.627, p=0.033), implying past growth will influence 62.7% of current growth, consistent with Rwanda's disciplined 7-8% GDP growth trajectory in its Vision 2020 plan. Institutions have immediate impacts (IQI=0.209, p=0.058), showing a 20.9% increase in per capita GDP for every unit increase in IQI through Rwanda's top-quartile governance, attracting foreign direct investment. ICTI has the classic investment pattern, a huge short-run cost (0.340, p=0.039) as a result of a fiber optic/5G infrastructure expenditure that drains 34% of the country's GDP, followed by a huge lag1 return (0.409, p=0.034), implying a 40.9% increase in GDP from 2007 onwards as its digital platform matures and Rwanda sees digital inclusion increase from 10% to 85% from 2020 to 2024. The complementarity between FIIICTI (0.166, p=0.031) amplified these effects through MoMoKash, a mobile banking application that uses IremboGov digital platforms for SMEs to gain access to credit. What sets Rwanda apart from the other estimations in the group is the positive significance of its financial sector (logGS=0.124, p=0.032) and a significant lag 1 coefficient (0.158, p=0.024), indicating that Rwanda's efficient financial intermediation, characterized by a savings-to-investment ratio of 25%, which is crucial for private sector growth, has a positive short-run effect on growth.

Long-run equilibrium: The impact of institutions on per capita GDP growth is overwhelmingly high (IQI=0.694). ICTI (0.185) contributes the highest long-run returns apart from institutions and is consistent with an efficient capital allocation across sectors. The returns to FII are significant but negative (-0.367, p=0.010) without institutions, showing the need for governance. Its financial intermediary efficiency (logGS=0.756) is again of very high magnitude. An ECT of -0.373 implies an annual adjustment of 37% in reaching equilibrium.

Rwanda proves that sequenced development is achievable. Strong institutions will facilitate a high return to investments in ICT/financial inclusion. Rwanda is currently leading East Africa in its returns on investments in institutions, and its capital is developing into a regional hub for digital financial services.

Sudan

Sudan's ARDL results (2006-2021, n=13 obs, R=0.9999, Adj.R=0.9992, Fstat=1382.56, ECT=1.548) capture the political/institutional decay and financial swings typical of conflict-affected economies.

The short-run results demonstrate an absence of growth persistence. The coefficients on lag GDP are insignificant (lag1: 0.498, p=0.123; lag2: 0.050, p=0.624), indicating that past growth does not predict current GDP levels during the period under the given political uncertainty and sanctions. The financial inclusion series shows boom/bust cycles. A boom in financial inclusion in lag 1 (3.125 p=0.070) pulls growth up by 312.5% GDPPC due to a temporary flow of funds to agriculture and trade; however, a bust in financial inclusion lag 2 (8.069 p=0.020) drags growth down by 806.9%

GDPPC due to the rise in nonperforming loans and hyperinflation during 2018-2021. The governance results confirm a governance trap. A fall in the institutional quality index in both lags (IQI lag1=0.165, p=0.045; IQI lag2=0.124, p=0.052) pulls GDPPC down by 16.5% and 12.4%, respectively, due to investor withdrawal, driven by investor skepticism about corruption and the rule of law. Log Gross Savings constantly underperforms growth (logGS=0.079 p=0.061; lag1: 0.104 p=0.048; lag2: 0.082 p=0.055), corroborating findings of capital flight in fragile economies.

The long-run equation results are disastrous. Financial inclusion has a permanent negative coefficient (-2.937 p=0.001), implying that a unit increase in FI leads to a permanent decrease in GDPPC by 293.7% due to excessive borrowing cycles that will inevitably bust. The coefficient on institutional quality is negative (-0.217 p=0.010), reflecting a sustained governance trap. The extremely rapid ECT (1.548 p=0.000) suggests system-wide volatility and overshooting rather than a return to equilibrium.

These findings provide a stark example of the "institutions first" argument; expanding financial access without robust governance generates unstable and harmful cycles of credit and banking instability. For developing and fragile countries, political stability and good governance should lead inclusion policies, not follow. Otherwise, the inclusion process can reinforce existing fragility instead of promoting development.

Tanzania

Based on a 2006-2021 ARDL estimate for Tanzania (14 obs, R=0.9992/Adj=0.9980, F-stat=846.38, ECT=-0.503), Tanzania demonstrates governance constraints that hinder the benefits of financial inclusion.

Short run dynamics: The low persistence of GDP (lag1=0.112, p=0.706; lag2=0.385, p=0.147) is consistent with an economy characterized by volatility due to its reliance on commodities. The mechanism through which financial inclusion operates is entirely lagged (FII lag1=0.303 p=0.050)-an increase in branch/ATM provision from the previous year generates 30.3% GDPPC growth in the current period as SMEs become formalized over time, but without immediate effects due to lack of financial literacy among the masses. Institutions have a significant immediate penalty (IQI=-0.120, p<0.001)-an increase in an IQI unit lowers GDPPC growth by 12% as a lack of regulations and red tape increases business costs. This effect deteriorates lagged (lag2=-0.124, p=0.052). However, the FIIICTI interaction is dramatically negative (-0.460 p=0.010)-a 46% reduction in growth as mobile services like NMB M-Pawa fail to translate into efficient capital mobilization due to poor governance and insufficient financial regulator expertise. Savings mobilization is negligible across lags (logGS lag2=-0.082 p=0.055), a result that is consistent with the chronic 15% private credit/GDP ratio in Tanzania compared to 36% in Kenya (savings channeled to informal and inefficient avenues).

Long-run equilibrium: FII is positive (0.626), which indicates a 62.6% increase in GDP per capita sustained over time, confirming steady but gradual deepened financial integration. However, IQI is strongly negative (-0.340), trapping the economy in a low equilibrium, while logGS (-0.245) indicates that financial disintermediation continues to persist in the long run. A stable adjustment speed (-0.503 ECT) indicates a full 50% convergence per year. Overall, Tanzania falls under the category of "governance-constrained LDC", an economy where the expansion of financial inclusion leads to increased risk rather than deeper integration. The solution lies not in promoting digital finance, but rather through reforms within the public sector to improve governance and financial regulation.

Uganda

Uganda's ARDL results show constant financial inclusion benefits but increasing digital risks, while the institutional quality effect is delayed (R=1.000, ECT=-1.603).

Short run: Both FII impacts confirm stable penetration benefits-contemporaneous (0.350, p=0.020) shows 35% of GDPPC gains coming from

instant account ownership, helping to facilitate remittances and agri-trade; lag1 (0.340, p=0.020) contributes another 34% as people begin using accounts to formalize savings. Institutions kick in with a lag (IQI lag1=0.110, p=0.040)-11% of GDPPC comes from anti-corruption improvements, gradually strengthening contract enforcement for SMEs. The disaster signal comes from the FII*ICTI interaction (-0.460, p=0.010), which nullifies 46% of the growth gains-scale of MTN MoMo and Airtel Money swamps weak cyber-security and consumer protections, leading to typical fintech-frontier markets fraud and NPLs. Alone, ICTI adds growth (0.080 p=0.020; lag1=0.090 p=0.070), but the multiplicative power is limited.

Long run equilibrium: FII stays positive (0.431)-43.1% permanent gains in GDPPC. IQI has negligible effects (0.028). ICTI gains are positive (0.106), showing the underlying importance of digital access. The extremely high ECT (-1.603) shows that Uganda's economy overshoots by over 160% before adjusting, a sign of violent correction dynamics.

Uganda stands as a cautionary tale for "fintech without guardrails"-access via financial means works, but digital multiplications require more regulation before growth gets destroyed, and thus, a phased inclusion.

The ARDL analysis across seven East African countries (2005–2021) reveals that financial inclusion's growth impact follows no universal pattern, institutional quality (IQI) emerges as the dominant structural determinant, financial inclusion (FII) delivers powerful but conditional lagged multipliers, and ICT infrastructure (ICTI) provides consistent delayed productivity gains, with country-specific heterogeneities dictating policy sequences.

Institutional quality proves most consistently powerful: immediate positive shocks in Ethiopia (0.133, p<0.001), Rwanda (0.209, p<0.058), and Burundi (0.076, p<0.010) generate 7.6-20.9% GDP per capita growth per IQI unit through credible contracts and FDI confidence, while its absence devastates—Sudan's lagged deterioration (-0.165/-0.124, p<0.05) compounds growth losses, Tanzania's contemporaneous penalty (-0.120, p<0.001) reflects bureaucratic drag, and long-run multipliers range from Rwanda's peak (0.694) to Tanzania's trough (-0.340), creating 6x outcome variation.

Financial inclusion exhibits textbook J-curve dynamics universally: short-run adjustment costs (Kenya -0.739 p=0.002; Burundi -0.084 p=0.047) give way to lagged multipliers (Ethiopia 1.744 p=0.003; Kenya 0.711 p=0.004; Uganda dual 0.350/0.340 p=0.020), with long-run divergence stark, Ethiopia's 6.63x return vs. Sudan's -2.94 collapse confirms IQI-mediation, while positive synergies (Kenya/Rwanda FII×IQI/ICTI) amplify benefits only in governance-ready contexts.ICT infrastructure follows high-fixed-cost, high-return trajectories: Rwanda's classic -0.340→+0.409 shift (p<0.05) matches digital platform maturation, Ethiopia/Uganda lags confirm 5-9% growth as mobile money scales, but Uganda/Tanzania's FII×ICTI failures (-0.460 p=0.010) warn of cybersecurity risks overwhelming weak regulation—initial investment phases universally contract growth before delivering sustained productivity.

This IQI→FII→ICTI cascade rejects one-size-fits-all policy: Sudan/Burundi require governance stabilization before inclusion attempts; Ethiopia/Rwanda validate sequenced deepening; Kenya/Uganda demand regulatory guardrails for fintech scaling. ECT speeds (-0.303 to -1.603) confirm rapid mean-reversion capacity across contexts, supporting ARDL validity for heterogeneous development paths.

Table 7

ARDL Regression Results and Elasticities (2005–2021)

Variable / Diagnostics	Burundi	Ethiopia	Kenya	Rwanda	Sudan	Tanzania	Uganda
$logGDPPC_{t-1}$	0.005 (0.276) [0.986]	0.697 (0.042) [0.000]*	-0.075 (0.192) [0.715]	0.627 (0.033) [0.033]**	-0.498 (0.097) [0.123]	0.112 (0.280) [0.706]	-0.600 (0.060) [0.060]***
$logGDPPC_{t-2}$	—	—	—	—	-0.050 (0.075) [0.624]	0.385 (0.230) [0.147]	—
FII_t	0.065 (0.030) [0.068]***	0.265 (0.216) [0.255]	-0.739 (0.105) [0.002]*	-0.113 (0.012) [0.068]***	0.399 (0.207) [0.305]	0.012 (0.090) [0.898]	0.350 (0.010) [0.020]**
FII_{t-1}	-0.084 (0.035) [0.047]*	1.744 (0.423) [0.003]*	0.711 (0.116) [0.004]*	-0.024 (0.013) [0.313]	3.125 (0.345) [0.070]*	0.303 (0.120) [0.050]*	0.340 (0.010) [0.020]**
FII_{t-2}	—	—	—	—	-8.069 (0.256) [0.020]*	—	—
IQI_t	0.076 (0.022) [0.010]*	0.133 (0.023) [0.000]*	-0.089 (0.031) [0.047]**	0.209 (0.019) [0.058]***	-0.047 (0.009) [0.117]	-0.120 (0.030) [0.000]*	-0.060 (0.020) [0.170]
IQI_{t-1}	0.027 (0.028) [0.366]	0.024 (0.014) [0.119]	0.037 (0.029) [0.279]	0.050 (0.018) [0.222]	-0.165 (0.012) [0.045]*	-0.020 (0.030) [0.460]	0.110 (0.010) [0.040]**
IQI_{t-2}	—	—	—	—	-0.124 (0.010) [0.052]*	—	—
$ICTI_t$	-0.066 (0.020) [0.013]*	0.009 (0.008) [0.312]	0.061 (0.034) [0.150]	-0.340 (0.021) [0.039]**	—	—	0.080 (0.000) [0.020]**
$ICTI_{t-1}$	-0.015 (0.028) [0.622]	0.055 (0.014) [0.004]*	-0.022 (0.031) [0.508]	0.409 (0.022) [0.034]**	—	—	0.090 (0.010) [0.070]***
$FII \times IQI_t$	—	—	0.383 (0.087) [0.012]**	-0.051 (0.006) [0.078]***	—	—	0.050 (0.040) [0.420]
$FII \times IQI_{t-1}$	—	—	-0.428 (0.082) [0.007]*	-0.023 (0.007) [0.191]	—	—	—
$FII \times ICTI_t$	—	—	0.100 (0.013) [0.002]*	0.166 (0.008) [0.031]**	—	—	-0.460 (0.010) [0.010]**
$FII \times ICTI_{t-1}$	—	—	—	-0.070 (0.005) [0.050]***	—	—	—
$logGS_t$	-0.008 (0.004) [0.069]***	-0.057 (0.033) [0.122]	-0.011 (0.009) [0.315]	0.124 (0.006) [0.032]**	-0.079 (0.008) [0.061]*	—	—
$logGS_{t-1}$	—	—	—	0.158 (0.006) [0.024]**	-0.104 (0.008) [0.048]*	—	—

Table 7 continues.

Constant (α)	5.733 (1.594) [0.009]*	3.586 (0.532) [0.000]*	7.758 (1.397) [0.005]*	2.225 (0.208) [0.059]***	9.254 (0.372) [0.026]*	4.040 (0.890) [0.000]*	10.490 (0.360) [0.020]**
ARDL Spec.	(1,1,1,1,0)	(1,1,1,1,0)	(1,1,1,1,1,0,0)	(1,1,1,1,1,1,1)	(2,2,2,2)	(2,2,2,2)	(…)
Sample Period	2005–2021	2005–2021	2006–2021	2007–2021	2006–2021	2006–2021	2005–2021
Obs	16	17	13	15	13	14	—
F-statistic (p)	79.15 (0.0000)	7004.32 (0.0000)	6.27 (0.3027)	7555.53 (0.0090)	1382.56 (0.0210)	846.38 (0.0000)	—
R^2 / Adj R^2	0.9891 / 0.9766	0.9999 / 0.9997	0.9857 / 0.8286	1.0000 / 0.9999	0.9999 / 0.9992	0.9992 / 0.9980	1.0000 / 1.0000
Log Likelihood / Root MSE	61.306 / 0.0079	70.507 / 0.0056	47.175 / 0.0232	91.085 / 0.0022	78.051 / 0.0022	— / —	— / —
ECT (α)	-0.995	-0.303	-1.075	-0.373	-1.548	-0.503	-1.603
Long-run FII	-0.019	6.630	-0.026	-0.367	-2.937	0.626	0.431
Long-run IQI	0.104	0.518	-0.048	0.694	-0.217	-0.340	0.028
Long-run ICTI	-0.081	0.211	0.036	0.185	—	—	0.106
Long-run logGS	-0.008	-0.188	-0.010	0.756	-0.171	-0.245	-0.067

Notes: Values are Coefficient (Standard Error) [p-value]. Significance: $p < 0.01$ (), $p < 0.05$ (), $p < 0.1$ ().ECT (α): Speed of adjustment to long-run equilibrium. Long-run elasticities: $\beta XLR = \sum \beta X1 - \sum \phi y$. "—" indicates a variable not included or not reported. Country-specific ARDL lags selected via AIC/BIC.

Panel Causality Test

The Dumitrescu-Hurlin panel causality test discloses important relationships between economic growth, financial inclusion, institutional qualities, and technology in the case of East Africa, as presented in Table 8. The findings show that economic growth (logGDPPC) drives financial inclusion (FII); the unidirectional causality is confirmed by the results because the $\bar{Z}$-stat equals 2.7808 and p = 0.0054. For instance, this result validates the nexus between per capita income growth and the demand and supply for formal financial services, implying that the mutually complementary effects between growth and financial systems are virtuous (Demirgüç et al., 2022). Economic growth (logGDPPC) causally impacts institutional qualities (IQI) and ICT adoption (ICTI); the p-value is less than 0.05, and this suggests that growth creates the needed resources and spurs institutional qualities and ICT adoption rather than being the consequence (Asongu & Odhiambo, 2023).

Crucially, the analysis identifies institutional quality (IQI) as a key conduit for amplifying the impact of technology on financial inclusion, with a strong causal link from IQI to the FII*ICTI interaction term (p=0.0019). This underscores that effective governance frameworks are a prerequisite for harnessing digital tools to enhance financial access. Similarly, a powerful causal relationship runs from **ICTI to the FII*ICTI interaction** (p=0.0001), confirming technology's enabling role. The most significant finding is the robust causality from the FII**IQI interaction to the FII*ICTI* interaction (p=0.0001), revealing that the synergistic effect of inclusive finance and good governance is instrumental in realizing the benefits of digital finance. Conversely, the non-significant causality from growth to the interaction terms (FII*IQI and FII**ICTI) suggests that these combined effects are complex policy constructs that do not automatically emerge from economic expansion alone.

For East African policymakers, the causality structure advocates for an integrated strategy. Prioritizing economic growth is fundamental, as it stimulates demand for financial services and creates fiscal space for institutional and digital investments. However, to maximize development outcomes, growth policies must be consciously coupled with parallel investments in governance capacity and digital infrastructure. This integrated

approach ensures that financial inclusion, supported by robust institutions and technology, can evolve from a consequence of growth into a sustainable driver of future prosperity and resilience.

Table 8

Pairwise Dumitrescu Hurlin Panel Causality Test

Direction	Zbar. stat	Prob
L. logGDPPC ⇒ FII	2.7808	0.0054*
logGDPPC ⇒ IQI,	2.1334	0.0329
logGDPPC⇒ ICTI	2.3264	0.0200*
l. logGDPPC ⇒ FII*IQI	0.2636	0.7921
L1. logGDPPC⇒ FII*ICTI	1.5065	0.1319
IQI⇒ FII*ICT	3.0986	0.0019*
ICTI ⇒FII*ICTI	3.8548	0.0001*
FII*IQI ⇒FII*ICTI	3.9050	0.0001*

*Note: The superscripts ***, ** and * denote the statistical significance at 1%, 5% and 10% levels, respectively*

Discussion

This paper focuses on the intricate, nonlinear channels of the financial inclusion index (FII), the institutional quality index (IQI), and the ICT infrastructure index (ICTI) in influencing economic growth within a panel of seven East African economies. The critical interpretation of significant ARDL coefficients provided proves that the relationships are deeply mediated by national context, thus challenging the assumption of a universal finance-growth nexus.

FII: A Double-Edged Sword The impact of FII is characterized by significant temporal trade-offs. In Ethiopia, the strong positive lagged effect (β=1.744, $p<0.01$) confirms that financial deepening is a powerful long-term growth multiplier, possibly due to facilitating capital accumulation and entrepreneurial activity bit by bit. By contrast, Kenya's significant negative contemporaneous effect, followed by a positive lag, uncovers the famous "J-curve" pattern; it implies that rapid financial expansion first strains regulatory systems and causes credit misallocation before gains in efficiency start to materialize. In Sudan, the extreme volatility of FII coefficients suggests that financial inclusion policies risk triggering an unsustainable credit cycle within its fragile macroeconomic environment and can, rather than spur growth, exacerbate instability. This heterogeneity emphasizes the fact that the gains from inclusion are not automatic but rather depend on the level of maturity of the financial ecosystem.

Institutional Quality (IQI): The Foundational Precondition

The results strongly support the robustness of the model in emphasizing institutional quality as the most important mediating variable. Not only does the contemporaneous significant impact of institutional quality in Rwanda and Ethiopia verify its positive role (β=0.209, $p<0.1$; β=0.133, $p<0.01$) in providing an immediate guarantee for the start of economic activity due to its role in maintaining property rights and lowering transactional costs, but it is also in accordance with institutional theory in emphasizing the importance of inclusive institutions as the primary condition for sustained developments. A dramatic contrast is provided by the significant negative lagged values of institutional quality in Sudan (L1 β=-0.165, $p<0.05$), which highlights the crippling effects of latent institutional deficiencies on growth over time, which totally negate any potential benefit from any other policy interventions. Even the negative short-run effect in Kenya could be due to

the current cost of tackling the problem of corruption in the bureaucracy.

ICT Infrastructure (ICTI): The Delayed Enabler ICT investment has the standard characteristic of incurring costs in the short run for the gains of the long run. The large negative coefficients of ICTI for both Rwanda and Burundi in the short-run (-0.340, $p < 0.05$; -0.066, $p < 0.05$) depict the huge capital costs of laying out ICT infrastructure. However, the considerable positive coefficients of the same variable in the long run establish its role as an instrument of productivity growth by facilitating market access (Asongu & Odhiambo, 2023).

Gross Savings (logGS): The Importance of Financial System Failure. The largely negative relationship between savings and growth is an important and paradoxical result. For instance, savings and growth are negatively related in Sudan, Tanzania, and Uganda, which denotes a gross failure in financial intermediation; that is, domestic savings are not being effectively channeled towards productive investments (Meniago & Eita, 2021). A notable positive case is Rwanda.

The findings collectively argue that financial inclusion is not a standalone solution but one component of a synergistic policy framework. The causality test, revealing that institutional quality drives the effectiveness of the FII*ICTI interaction ($p=0.0019$), is paramount: technology amplifies financial access only when governance is effective. Therefore, a one-size-fits-all policy is ineffective. In institutionally fragile states like Sudan and Burundi, the first-order priority must be foundational governance reform. In dynamic reformers like Kenya and Rwanda, policy should focus on managing the short-term disruptions of rapid financial and digital expansion through proactive, adaptive regulation. For all countries, parallel investments in digital infrastructure and literacy, coupled with reforms to deepen capital markets, are essential to unlock the full, sustainable growth potential of financial inclusion.

CONCLUSIONS

The ARDL and panel causality analyses demonstrate that economic growth in East Africa is shaped by a dynamic interplay between financial inclusion (FII), institutional quality (IQI), and ICT infrastructure (ICTI). The impact of financial inclusion is heterogeneous and time-dependent, offering long-term growth benefits in countries like Ethiopia and Uganda but revealing short-term disruptive potential in others like Kenya, where rapid expansion can outpace regulatory capacity. Institutional quality consistently emerges as a foundational determinant, with strong governance amplifying the positive effects of financial and technological inclusion. The causality tests further reveal that economic growth drives financial inclusion, while institutional quality is a critical conduit for effectively leveraging technology to enhance financial access. These relationships underscore the need for coordinated policy approaches rather than isolated interventions.

This study concludes that financial inclusion is a significant, yet context-dependent, driver of economic growth in East Africa. Its efficacy is not automatic but is fundamentally mediated by the quality of governing institutions and the enabling environment created by digital infrastructure. The region's growth trajectory is therefore best supported by an integrated development framework that simultaneously strengthens institutional governance, strategically expands ICT access, and promotes responsible financial deepening, ensuring these elements work synergistically to foster sustainable and inclusive economic progress.

Recommendations

Strengthen Institutional Foundations: Prioritize reforms that enhance regulatory quality, the rule of law, and control of corruption. Establishing independent financial sector oversight bodies and transparent public financial management systems is crucial to building trust and ensuring the stability of inclusive finance initiatives.

Adopt a Phased and Integrated ICT Investment Strategy: Public investment in digital infrastructure should be coupled with nationwide digital literacy

campaigns. Policymakers should implement technology-neutral regulatory sandboxes that foster innovation in digital financial services while ensuring consumer protection, cybersecurity, and interoperability between platforms.

Promote Context-Specific Financial Inclusion Policies: Design targeted programs that address unique national barriers, such as rural access or gender disparities. Regulation should be adaptive, encouraging agent banking and mobile money while mandating clear disclosure, fair pricing, and robust grievance redress mechanisms to protect consumers.

CRediT Authorship Contribution Statement

Getachew Kebede Hailu: Conceptualization, Data Collection, Model Development, Analysis, and Writing – Original Draft. **Wondaferahu Mulugeta Demissie:** Model Validation, Review, and Editing.Data Curation **Etana Ayeru Fekede:** Supervision, Project administration, Data Analysis.

Declaration of Competing Interest

The authors declare no conflict of interest.

Ethical Approval

Not applicable

Data Availability Statement

Data are available from the World Development Indicators Database. All variables—GDP per capita growth (GDPPCG), financial access metrics (NCBBKM, NCBBA, ATMKM, ATMA, NDAA, NBAA, NCLA, OSD, OSL, FDI), governance indicators (VA, PS, GE, RQ, RL, CC, IQI), macroeconomic controls (GEX, GCF, TRADOP, KAOPEN, CPI, RINR, XR, FDI inflows, REM, EMP), ICT variables (MOBILE, TELEPHONE, INTERNET, COMEXPO, SECURE, ICTEXPO, BROADBAND), innovation proxies (RD, PATENT, ICTI), and interactions (TRADOPKAOPEN, IQIICTI)—are sourced from: World Bank World Development Indicators (https://databank.worldbank.org/source/world-development-indicators), IMF Financial Access Survey (https://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B656BA031), Worldwide Governance Indicators, (https://www.worldbank.org/en/publication/worldwide-governance-indicators), ITU ICT Statistics (https://www.itu.int/en/ITU-D/Statistics/ Pages/stat/default.aspx).

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