MAKERERE UNIVERSITY

COLLEGE OF BUSINESS AND MANAGEMENT SCIENCES

SCHOOL OF STATISTICS AND PLANNING

TOPIC: TIME SERIES ANALYSIS OF THE RELATIONSHIP BETWEEN ACTIVE MOBILE CELLULAR SUBSCRIPTIONS AND ECONOMIC GROWTH IN UGANDA.

BY

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A DISSERTATION SUBMITTED TO THE SCHOOL OF STATISTICS AND PLANNING IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE IN QUANTITATIVE ECONOMICS OF MAKERERE UNIVERSITY.

July, 2026

DECLARATION

I, Apetu Abel, to the best of my knowledge, hereby declare that this dissertation is an original work conducted and prepared by me. Any reference to existing research, direct quotations, or paraphrasing has been properly acknowledged and cited in accordance with academic standards. This dissertation has not been previously submitted for any Degree, diploma, or other qualification at this or any other institution.

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APPROVAL

This dissertation has been submitted in partial fulfilment of the requirements for the award of the degree of Bachelor of Science in Quantitative Economics at Makerere University, with the approval of the following university Supervisor:

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DEDICATION

This dissertation is dedicated to God, who has guided and protected me throughout the pursuit of the degree.

And to my parents, who have continually provided me with moral and financial support, giving me the environment I need to concentrate on my work.

ACKNOWLEDGEMENT

I would like to extend my sincere gratitude and appreciation to all those who helped me make this study a success. Special thanks to my supervisor, Mr Byamugisha Jimrex, who has been patient and understanding throughout our conversations about the dissertation and has guided me in some parts of its development.

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LIST OF ACRONYMS

ADF- Augmented Dickey Fuller test

AIC-Akaike Information Criterion

ARDL- Autoregressive Distributed Lag

df - Degrees of Freedom

ECT- Error Correction Term

FPE-Final Prediction Error

GDP- Gross Domestic Product

HQIC-Hannan–Quinn Information Criterion

ICT- Information Communication and Technology

LL-Log-Likelihood

LR-Likelihood Ratio

MSE- Mean Squared Error

OLS- Ordinary Least Squares

P2B-Person to Business

P2P- Person to Person

SBIC- Schwarz Bayesian Information Criterion

UCC-Uganda Communications Commission

UECM - Unrestricted Error Correction Model

USSD-Unstructured Supplementary Service Data

VECM-Vector Error Correction Model

WB-World Bank

ABSTRACT

This study investigates the dynamic relationship between active mobile cellular subscriptions and economic growth in both the short and long-run for Uganda. It uses an Auto Regressive Distributed Lag (ARDL) model to carry out a time-series analysis of the variables for the period from 2001 to 2024, modeling Gross Domestic Product (GDP) as a function of active mobile cellular subscriptions, Gross Fixed Investment and total labor force(**Natural Log of variables is used**). The model satisfies classical diagnostic assumptions, showing no evidence of serial correlation or heteroskedasticity. The finite-sample bounds test confirms the existence of a stable, long-run level relationship at 5% significance. The Error Correction Term reveals a rapid adjustment, with 79.35% of short-run economic disequilibrium correcting back to the steady state trend annually. The sample yields statistically insignificant coefficients in the long-run but has a significant, delayed active mobile cellular subscriptions return in the short-run, which is a 1% increase in active mobile cellular subscriptions in the previous year leading to a 0.56% increase in economic growth in the current year. These findings suggest that active mobile cellular subscriptions do not yield instantaneous returns but require a one-year gestation period to generate economic returns.

CHAPTER ONE: INTRODUCTION

Background to the study

There is an increasing use of digital technologies in Uganda, especially after the COVID-19 outbreak, which accelerated digitalization. Mobile voice traffic remains a foundational pillar of connectivity in Uganda, undergoing significant recalibration. In 2024, telecom operators in Uganda recorded a total of 80.2 billion domestic voice minutes, representing a 12% increase compared to 2023. As of 2024, the number of unique mobile internet subscribers was 15.7 million, along with a rise in mobile internet traffic from 421.53 million GBs in 2022 to 815.88 million GBs in 2024. The use of digital services delivered through digital infrastructure has also expanded, from 25.19 million active mobile money accounts in 2022 to 32.13 million in 2024. The volume of Person to Person (P2P) mobile money transactions rose to 624.0 million transactions, valued at UGX 53.73 trillion in 2024, up from 302.96 million transactions, valued at UGX 25.02 trillion in 2022. The dominance of Person-to-Person (P2P) transactions within Uganda's mobile financial services ecosystem remains a defining characteristic, supported by the widespread accessibility of USSD channels and short codes. (Uganda Communications Commission, 2024).

There was a noticeable increase in the resources allocated by persons towards merchant acquisition initiatives aimed at promoting digital payments across various sectors including retail shops, fuel stations, supermarkets, and departmental stores. Consequently, this effort has led to a notable rise in Person-to-Business (P2B) transactions, increasing from UGX 203.2 million at the end of 2022 to UGX 323.5 million at the end of 2023. (Ministry of Finance, Planning and Economic Development, 2024).

Active mobile cellular subscriptions have influenced communication through voice bundles, SMS, and mobile internet connectivity. However there have been very few studies examining the relationship between economic growth and active mobile cellular subscriptions in Uganda thus the need for this study.

Problem Statement

A study concentrated on exploring the effect of ICT access index on economic growth found that ICT access has a significant effect on the economic growth of the reviewed countries. The coefficient measuring the effect of the ICT access on economic growth was positive, indicating that ICT affects economic growth of the 142 sample countries in a positive way. Furthermore, in high income counties ICT access index has the strongest effect on real GDP per capita among the others since low-income countries are affected by ICT access index less than others. Therefore, these countries can improve their overall GDP growth with policies aimed at increasing ICT availability (Farhadi et al. 2014).

Nsavyimana et al., (2025) using data from six East African countries (Burundi, Rwanda, DR Congo, Tanzania, Uganda, and Kenya) for the periods 2007 to 2021, studied the impact of mobile phones and the internet as components of ICT on economic development where results from the random effect model showed that mobile phones do not have a positive impact, though internet penetration contributes significantly to economic development.

Several studies such as the above have looked at the impact of Information communication technology and some of its components on economic growth however few have looked at the relationship between number of active mobile cellular subscriptions and economic growth in Uganda, thus the need for this study

Objectives

To determine the short-run relationship between active mobile cellular subscriptions and economic growth in Uganda.

To explore the long-run relationship between active mobile cellular subscriptions and economic growth in Uganda.

To determine the magnitude of the effect of active mobile cellular subscriptions on economic growth in Uganda.

Hypothesis

- Null: There is no short-run relationship between active mobile cellular subscriptions and economic growth.
  Alternative: A short-run relationship exists between active mobile cellular subscriptions and economic growth.

- Null: There is no long-run relationship between active mobile cellular subscriptions and economic growth.
  Alternative: A long-run relationship exists between active mobile cellular subscriptions and economic growth.

- Null: Active mobile cellular subscriptions have no effect on economic growth.
  Alternative: Active mobile cellular subscriptions have an effect on economic growth.

Significance Of the Study

On a national level this study aims to contribute to information that guides policy makers on the extent to which strengthening and supporting communication infrastructure should be done in relation to its potential positive impacts on the economic growth of Uganda.

The study also aims to contribute to filling the knowledge gap that exists relating to the relationship between communication and its relationship with economic growth of the Ugandan economy, with the hope to be used as leverage in developing mechanisms for poverty reduction in developing countries along with improving their market structures.

CHAPTER TWO: LITERATURE REVIEW

Information and Communication Technology Generally

Several studies have investigated the link between ICT and economic growth. For example, Farhadi et al. (2014) explored the effect of ICT access index on economic growth and found that ICT access has a significant effect on the economies of the reviewed countries. The coefficient measuring the effect of the ICT access on economic growth was positive, indicating that ICT positively influences economic growth of the 142 sample countries. Furthermore, in high income counties, the ICT access index has the strongest effect on real GDP per capita whereas low-income countries are less affected. Therefore, these countries can improve their overall GDP growth through policies aimed at increasing ICT availability.

Using regression models, the sector specific impact of communication technologies on economic growth was analysed. It was found that, all else being equal, an increase in the volume of services and work in the field of information and telecommunications leads to higher GDP, and an increase in the volume of digital services in the economy also leads to an increase in the GDP of Ukraine (Irtyshcheva, 2021).

Using data from 26 African countries over the period 2000–2020, it was found that ICT has been involved in many economic activities, and increasing ICT infrastructure can boost economic growth in Africa. Furthermore, the results reveal that the interaction between ICT and democracy can enhance economic growth in the continent. (Alinsato, 2024)

As shown above the contribution of ICT to economic growth has been studied in a various ways from examining whether the access to ICT has an effect, to analysing how the use of ICT in different sectors contributes to economic growth thus demonstrating some of the extent of its transformative power on the economy.

Specific Components of ICT

Most studies have focused on ICT in general, while the impact of specific ICT-technologies has been less emphasized. A few studies have taken a more focused approach, such as Gruber and Koutroumpis (2011), who used annual data from 192 countries over the period 1990 to 2007, to assess the impact of mobile telecommunications on economic growth. They found that this impact is smaller for countries with a low mobile penetration, usually low income countries. In low-income countries mobile telecommunications contribution to

annual GDP growth is 0.11%, for high income countries this is 0.20%. Increasing returns from mobile adoption also emerge when assessing the impact on productivity growth.

The results from both ARDL for short-run and error correction term with long-run cointegration relations reveal that mobile phone and internet penetration contribute to economic development in the EAC. However, only lagged values from internet penetration have a significant impact on the current situation (Nsavyimana et al., 2025).

Edquist et al. (2018) showed that mobile broadband is associated with GDP. By Introducing a dummy variable for mobile broadband in a difference-in-difference specification, they found evidence of an introductory effect. Moreover, there is a contemporaneous effect from mobile broadband penetration, though it is initially not significant once controlled for capital and labor. Furthermore, evidence suggests that mobile broadband introduction and penetration causes GDP growth rather than vice versa. A 10 percent increase in mobile broadband penetration causes a 0.6–2.8 percent increase in GDP, depending on the specification of the model. There is also a significant effect from lagged mobile broadband penetration, indicating that the full effect from mobile broadband infrastructure may take time before being properly realized.

Households in villages that received telephones between 1991 and 1993 had slightly higher incomes from wages and businesses and lower incomes from agriculture, than villages that were still without telephones in 1993. However, households living in villages that received telephones in 1993 had incomes that were slightly lower in 1991 (about 2 percent) than those that didn't recieve. But between 1991 and 1993, there were dramatic changes in income for households in villages where telephones were added. In particular, overall average household income grew 15 percent, with the largest increases in agricultural and business income. By contrast, households living in villages that did not add telephones experienced slightly lower incomes in 1993 compared with 1991 (Eggleston et al., 2002).

Discussion And Conclusion

Summing up the studies, it can be seen that ICT and some of its components have a significant effect on economic growth. Although different methods were used, Eggleston et al. (2002) and Edquist et al. (2018) found that the introduction of telecommunications has an accelerating effect on economic growth. In agreement with other authors, Gruber and Koutroumpis (2011), found that mobile telecommunications have a positive impact on

economic growth. However, using the ARDL method Nsavyimana et al. (2025) found that impact of mobile phones on economic growth is insignificant, while the impact of internet access in East African countries is significant which gives us an interesting point for futher investigation. Very few studies have isolated the number of active mobile cellular subscriptions as a distinct component of ICT, particularly in the Ugandan case, to understand its impact on economic growth.

In relation to the above an expected link is derived between variables of economic growth, active mobile cellular subscriptions, productivity and Labor as illustrated below.

Figure 1

1. Illustration Of the Expected Relationship Between Variables

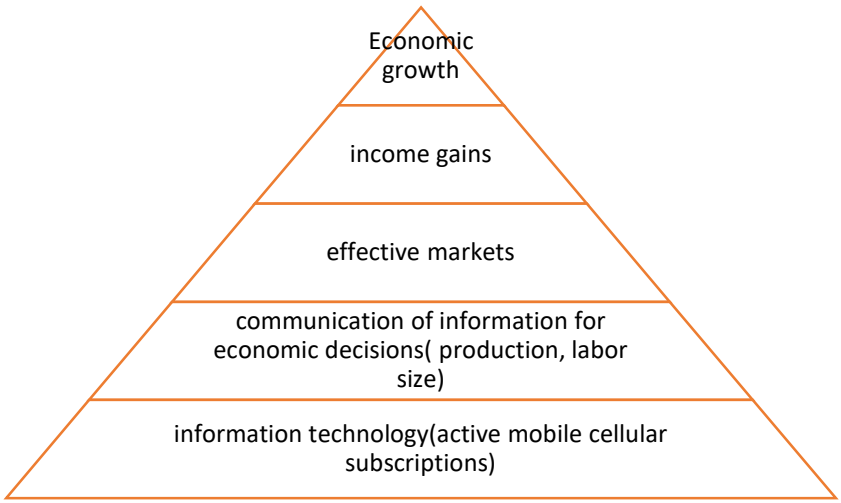


Figure 1, Illustrates how mobile cellular subscriptions can enhance communication that boosts incomes and ultimately leads to economic growth. Through cellular subscriptions individuals gain the ability to disseminate information to isolated, information deprived areas. Those receiving this information both producers and consumers, are better able to participate in effective markets. The immediate consequence should be income gains for participants, and improved capacity to spend their incomes. Over the long-term, enhanced access to information should enable producers to significantly improve their investment and Labor employment practices. Such improvement lay the foundation for economic growth. This study builds bases on these insights to investigate the impact of mobile cellular adoption on economic growth.

CHAPTER THREE: METHODOLOGY

Summary

The study is a timeseries analysis that uses ARDL (Auto Regressive Distributed Lag) to explore relationship between active mobile cellular subscriptions and economic growth. The analysis is carried out using STATA statistical package.

Source of data

The data set used in this study comprises of annual time series data over the period of 2001-2024 for active mobile cellular subscriptions, Gross Fixed Investment, Total Labor Force and GDP in Uganda. The data of active mobile cellular subscriptions is taken from communication indicators of the International Telecommunication Union (ITU) whereas data relating to Gross Fixed Investment, Total Labor Force and GDP is obtained from the World Bank (WB) data base.

Theoretical Framework

The model applied in this paper is based on the framework of the neoclassical production function. The production function framework relates output to labor, capital, intermediate inputs and factor of productivity. Assuming an augmented Cobb-Douglas production function, we have the following equation:

$Y = A * K^{\alpha} * L^{\beta}$

Where Y is aggregated production (GDP), K is physical capital, L is Labor and A is factor of productivity/ Technology.

Mathematical Model

A mathematical model is developed to explore the relationship between economic growth and active mobile cellular subscriptions, **Natural Log values are used** as shown below.

Economic growth = F (active mobile cellular subscriptions, Gross Fixed Investment, Total Labor Force)

$$\ln(\text{gdp})_t = \beta_0 + \beta_1 \ln(\text{mobile})_t + \beta_2 \ln(\text{invest})_t + \beta_3 \ln(\text{labour})_t + \epsilon_i$$

Where gdp is Gross Domestic Product, mobile is active mobile cellular subscriptions, invest is Gross Fixed Investment, labor is total Labor force and ϵ_t is the error term. The time period is t, β represents the output elasticity of each input.

Gross Fixed Investment includes acquisitions less disposals of fixed assets during the accounting period, including certain specified expenditures on services that add to the value of non-produced assets.

Labor force comprises people ages 15 and older who supply labor for the production of goods and services during a specified period. It includes people who are currently employed and people who are unemployed but seeking work as well as first-time job-seekers.

Due to their similarities in definition with the model variables the representation used is Gross Fixed Investment as physical capital and Total Labor Force as Labor, are directly included in the standard Cobb-Douglas function.

According to the International Telecommunication Union, mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the public switched telephone network (PSTN) using cellular technology. The indicator includes (and is split into) the number of postpaid subscriptions, and the number of active prepaid accounts (i.e. that have been used during the last three months).

Data Analysis and Model Specification

The analytical framework follows the ARDL, bounds testing approach (Pesaran et al., 2001) because it the most suitable for small sample sizes and can estimate both short term immediate impact of active mobile cellular subscriptions and the long-run structural growth equilibrium.

General Empirical Unrestricted Error Correction Model (UECM)

The relationship is modelled as below:

$$\Delta \ln gdp_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta \ln gdp_{t-i} + \sum_{j=0}^{q1} \beta_{2j} \Delta \ln mobile_{t-j} + \sum_{k=0}^{q2} \beta_{3k} \Delta \ln invest_{t-k} + \sum_{m=0}^{q3} \beta_{4m} \Delta \ln labor_{t-m} + \lambda_1 \ln gdp_{t-1} + \lambda_2 \ln mobile_{t-1} + \lambda_3 \ln invest_{t-1} + \lambda_4 \ln labor_{t-1} + \epsilon_t$$

Where:

gdp_t is Gross Domestic Product at time t

$mobile_t$ is number of active mobile cellular subscriptions at time t

$invest_t$ is Gross Fixed Investment at time t

$labor_t$ is Total Labor force at time t

Δ is first difference operator tracking short-run changes

p is the optimal lag length for the dependent variable

q1, q2, q3 are the optimal lag lengths for the respective independent variables

ϵ_t is a structurally independent white noise error term

λ_1 to λ_4 are long-run level multipliers used to calculate bounds test

β_1 to β_4 are short-run dynamic error response multipliers

Estimation Procedure

1. Unit root testing. Using Augmented Dickey Fuller (ADF)
2. Lag selection using BIC for optimal lag length
3. Bounds test to check for long-run relationship
4. Estimate long-run levels and short-run dynamics
5. Diagnostic checks; Bruesch Godfrey for autocorrelation, Breusch-Pagan test for Heteroskedasticity, CUSUMQ and CUSUM tests are used to check for stability of the model.

Limitations Of the study

This study on the relationship between active mobile cellular subscriptions and economic growth is limited by several factors that focus the scope of the research and define its boundaries. These limitations are essential to provide clarity to the extent of the research and to acknowledge the limitations within which the study operates.

Firstly, this study is set from the year 2001 to the 2024, a period that captures the rapid acceleration of digital communication technologies and their integration into the economic

fabric of Uganda. This timeframe allows for the examination of the effects of mature mobile communication on economic growth however acknowledges that the sample size is small which may have vulnerabilities to small sample bias and may not capture long-run trends smoothly.

Secondly, the study is geographically confined to Uganda. While digital communication is a global phenomenon, this study focuses on Uganda to provide an analysis within a single, cohesive economic and regulatory environment. This ensures that the findings are relevant to the specific context of Uganda economic policies, infrastructure, and market dynamics.

Thirdly, this study is restricted to just two control variables due to degree of freedom constraints therefore may be missing key constraints like institutional quality and active mobile cellular subscriptions may not fully capture the economic effects of communication.

Additionally, the methodological limitation of this study involves the use of secondary data sources, including peer-reviewed articles, industry reports, and government publications. The study does not include primary data collection, such as surveys or interviews, which limits the scope to the analysis of existing literature and data.

Finally, the study is limited by its focus on the economic aspects of digital communication. While acknowledging Economic growth may itself stimulate communication expansion.

Ethical Considerations

This study relies exclusively on publicly available, aggregated secondary macroeconomic data and strict adherence to research ethics is maintained regarding data integrity and transparency.

CHAPTER FOUR: RESULTS AND DISCUSSION

Unit Root Test

The Augmented Dickey Fuller test is used to check for stationarity and the results are as follows:

Table 1

1. Stationarity Test Results

Difference	gdp	mobile	labor	invest
P-value at I(0)	.4941	.0003	.9579	.0439
P-value at I(1)	.0082	-	.0000	-

According to the results mobile and invest are stationary at I(0) while gdp and labor are stationary at I(1) at a 5% level of significance.

BIC Results

Due to the small size of the sample SBIC is used to determine the appropriate lag length, the lowest value of SBIC is chosen which is -8.5366 therefore the optimal lag length is 2 as shown below.

Table 2

2. Lag Determination

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	30.675	-	-	-	7.1e-07	2.808	2.774	2.609
1	101.782	142.21	16	.000	2.3e-09	8.609	8.440	7.614
2	134.098	64.631	16	.000	5.4e-10	10.326	10.023*	8.537*
3	150.487	32.779*	16	.008	1.3e-09	10.367*	9.930	7.782
4	-	-	16	-	2.5e-43*	-	-	-

Note. Endogenous variables: Natural Log values of *dgdp* (Differenced gdp), mobile (Active mobile cellular subscriptions), invest (Gross Fixed Investment), dlabor (Differenced total labor). Exogenous variable: _cons. Number of observations (N) = 19. Sample period: 2006 – 2024. LL = log-likelihood; LR = likelihood ratio; df = degrees of freedom; FPE = final prediction error; AIC = Akaike information criterion; HQIC = Hannan–Quinn information criterion; SBIC = Schwarz Bayesian information criterion. *Indicates lag order selected by the criterion.

Bounds Test Results

To examine the long-run relationship among the variables the ARDL bounds testing approach was implemented and the results are as shown below:

Table 3

3. Bounds Test Results

Statistic	Value	10% Bound		5% Bound		1% Bound	
		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F-statistic	9.814***	3.219	4.566	4.100	5.707	6.461	8.739
t-Statistic	-5.072***	-2.578	-3.489	-2.992	-3.977	-3.892	-5.041

The above was obtained under Case 3(unrestricted constant and no trend) assuming natural log of GDP as dependent variable. Number of variables = 3, N=21. Finite sample critical values and approximate p-values are obtained from Kripfganz and Schneider (2020). I(0) indicates lower bound where variables are stationary at level. I(1) indicates upper bound where variables are stationary at first difference.

(***p < .01) for both I(0) and I(1) bounds Approximate p-values: I(0) = .002, I(1) = .006 for F-statistic; Approximate p values: I(0) = .001, I(1) = .010 for t-statistic.

Because calculated F-statistic (9.814) is greater than the 1% upper bound I(1) critical value (8.739) and the t-statistic (-5.072) is more negative than the 1% upper bound critical value

(-5.041), the null hypothesis of no levels relationship is rejected. This confirms a robust long-run cointegrating relationship among the variables at a 1% significance level.

Estimate Of Long-Run Levels and Short-Run Dynamics

Table 4

4. ARDL Regression Results

Variable	Coefficient	Standard Error	t-statistic	P-value
Long-run Dynamics (LR)				
ln(mobile)	-.069	.075	-0.91	.376
ln(invest)	.303	.233	1.30	.215
ln(labor)	.360	.388	0.93	.368
Short-run Dynamics (SR)				
Δ ln(mobile)	-.115	.103	-1.11	.284
Δ ln(mobile) ($L1$)	.562	.108	5.20	.000
constant	-4.588	2.959	-1.55	.143
Adjustment term (ADJ)				
ECT_{t-1} (dgdpL1)	-.794***	.156	-5.07	.000
Model Diagnostics				
Observations (N)	21			
R^2	.810			
Adjusted R^2	.729			
Root MSE	.080			

Note. The dependent variable is the Natural logarithm of the first difference I(1) of GDP ($\Delta \ln(gdp)$). Optimal lag selection ARDL (1, 2, 0, 0) determined via Bayesian Information Criterion (BIC). Δ denotes first-difference operator L1 denotes the first lag.

The R-squared value of 0.810 implies that approximately 81% of the variation in economic growth is explained by the model which suggests that active mobile cellular subscriptions have an impact on economic growth, this finding is in line with Gruber and Koutroumpis (2011) where it was found that there are increasing returns on production from telecommunication connectivity. The Error Correction term of -0.794 is statistically significant since 0.0000<0.05 therefore there is a stable and co-integrated relationship between the variables therefore if economic shock pushes the system out of its long-run steady state, 79.35% of that disequilibrium corrects itself within a year back toward the long-term trend thus a rapid recovery speed.

In the long-run, none of the independent variables are statistically significant at a 5% level, since all their p-values are greater than 0.05 therefore active mobile cellular subscriptions do not show a statistically verifiable impact on economic growth in the long-run under this model.

However, in the short-run, the model identifies a significant dynamic occurring with a one-year delay as shown by the lagged effect whose coefficient is 0.562 with a p-value of 0.0000 which means there is a clear time lag before active mobile cellular subscription affects the economy. A 1% increase in active mobile cellular subscriptions from the previous year generates a 0.56% surge in economic growth in the current year. This result is in agreement with the finding on average a 10 percent increase of mobile broadband adoption causes a 0.6–2.8 percent increase in economic growth depending on the model specifications (Edquist et al., 2018).

Diagnostic Tests

To confirm the statistical reliability and validity of the ARDL estimates, post estimation diagnostic checks are conducted on residuals, specifically Breusch-Godfrey LM test for autocorrelation and Breusch-Pagan/ Cook-Weisberg test for heteroskedasticity.

The results are as shown below

Table 5

5. Diagnostic Test Results

Diagnostic Test	Statistic	df	p-value
Breusch-Godfrey LM test for autocorrelation.	$X^2 = 0.708$	1	.400
Breusch-Pagan/ Cook-Weisberg test for heteroskedasticity.	$X^2 = 1.720$	1	.190

In evaluating the null hypothesis of no residual serial correlation up to lag 1, the results show that there is no serial correlation between error terms since the P value (0.4) of the Breusch Godfrey test is greater than the significance level (0.05) therefore we fail to reject its null hypothesis and conclude that residuals are free from first-order autocorrelation which suggests that the ARDL model successfully captured the system's underlying dynamics.

For the evaluation of the null hypothesis of homoskedasticity (constant variance among the error terms) the Breusch-Pagan test resulting statistic (1.720) yielded a p-value of .190 which is greater than the significance level of .05 therefore we also fail to reject the null hypothesis hence the model is homoscedastic and spread of errors is stable over time thus aligned to Ordinary Least Squares (OLS) assumptions.

The above diagnostic tests tell us that the model is statistically robust which implies that the regression coefficients are unbiased and standard errors are reliable for valid statistical inference.

The stability of the model is checked using CUSUM and CUSUMQ plots as shown below

To evaluate the structural stability of long-run and short-run coefficients, the Cumulative Sum of Squares (CUSUMQ) test was applied to the residuals. As illustrated in figure 2, the CUSUM squared statistic generally remains within the critical bounds at a 5% significance level confirming overall stability across the studied period.

Figure 2

2. CUSUM Squared Plot for ARDL Model Stability

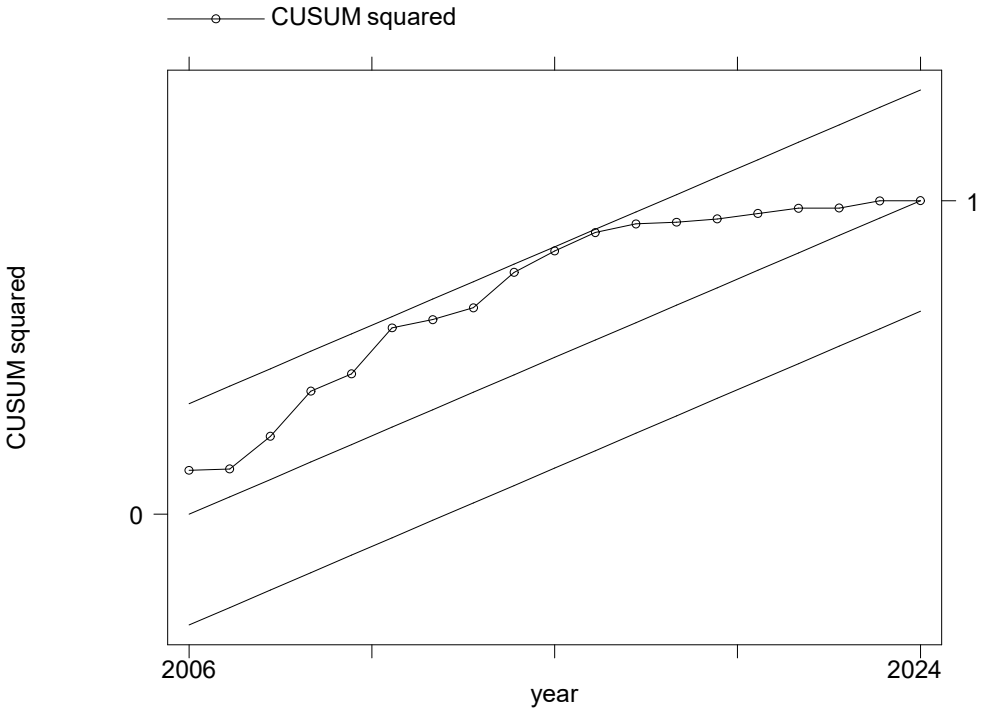
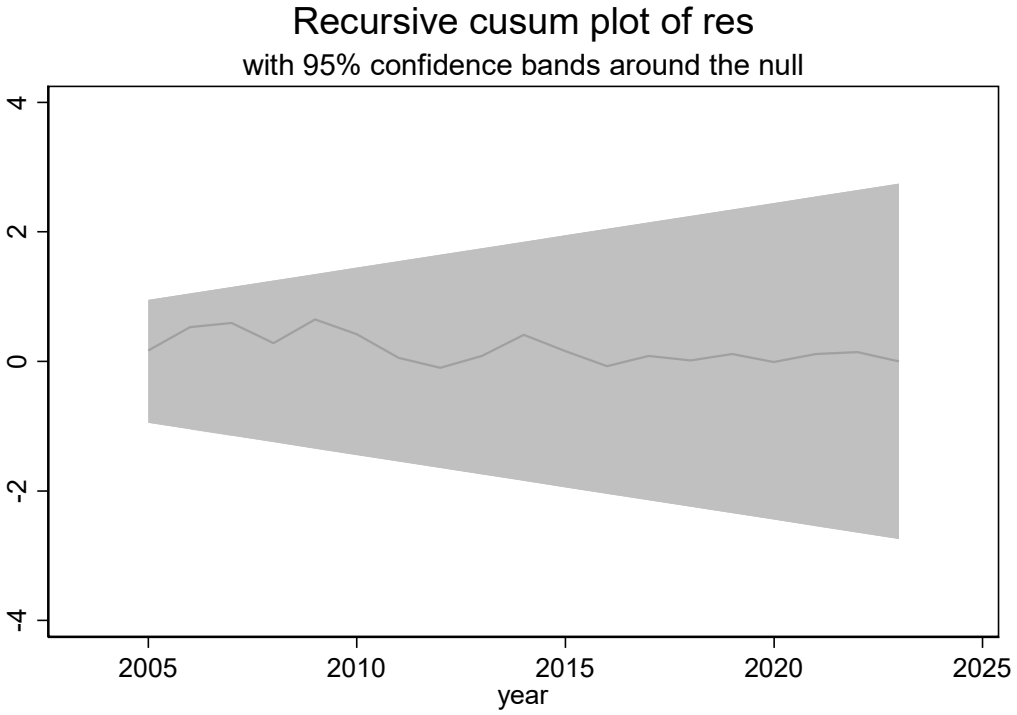


Figure 3

3. CUSUM Plot for ARDL Model Stability



The standard cumulative sum (CUSUM) test was also carried out as shown in figure 3 where the recursive CUSUM statistic of remains entirely with in the 95% confidence boundaries throughout the same period and the line does not cross or approach the critical limits at any point in the studied period which suggests that the mean of the structural coefficients is completely stable thus implies that the model does not suffer from systematic parameter drift or structural instability.

The results suggest that the independent variables that is active mobile cellular subscriptions, gross fixed investment and total labor do not have a significant effect on economic growth in the long-run though the short-run effect is significant, this may be due to the small sample size or the high degree of multicollinearity among developing macro-aggregates, standard errors may be inflated which reduces the statistical power required to isolate individual long-run multipliers even though the overall relationship is cointegrated.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

Using an ARDL (1,2,0,0) framework, from 2001 to 2024 (t=24), the model accounts for 72.9% of the variance in economic growth, the error correction term is negative (-0.7935) and highly significant($p<0.01$) thus verifying a stable cointegrating equilibrium where 79.35% of deviations correct annually. Though the long-run impacts of active mobile cellular subscriptions, gross fixed investment and Total Labor Force are statistically insignificant, a highly significant short-run lagged effect is observed where a 1% increase in active mobile cellular subscriptions from the previous year generates a 0.56% surge in economic growth in the current year thus demonstrating a delayed active mobile cellular return.

However further studies are warranted on the interactions between active mobile cellular subscriptions and the production system in influencing economic growth, and they could:

- employ quarterly data to increase observations,
- investigate sector-specific effects of active mobile cellular subscriptions, and

examine causality using techniques such as VECM or Granger causality tests.

policy implications of the study

Policies or shocks affecting mobile cellular subscriptions may not have a predictable long-term effect on the economic growth however short-run effects are significant therefore investment in strengthening connectivity infrastructure in regards to active mobile cellular subscriptions can boost economic growth in the short-term.

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