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Research Article

The Impact of Financial Technology (Fintech) on Economic Growth: Evidence from Tanzania

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Abstract

This research is driven by the rapid spread of fintech, and its contributions to Tanzania's economic growth. This study uses quantitative quarterly time series data from Tanzania from 2008 to 2022. The Augmented Dicky Fuler (ADF) is used for the stationarity test, Johansen Cointegrations for the hypothesis and Cointegrations test, VAR and VECM for testing both short-run and long-run causality relationships, and Granger Causality for testing variable causality. The Ordinary Least Squares (OLS) regression model is used for parameter estimation, modelling and significance testing. The results show that the model is statistically significant and the independent variables in the regression accounted for around 89% of the overall variation in GDP. Fintech variable subscriptions have a positive impact on Tanzania's economic growth. Thus, unemployment in Tanzania may be alleviated by the growing sector of financial technology. Fintech has involved many people from all over the world, including Tanzania, and has had a positive impact on both the national economy and per capita growth. Since TTCL and ZANTEL have witnessed a sharp decline in subscriptions, the government, as a fixed-wired broadband service provider, must take the necessary steps to increase the subscriptions.

Keywords: Fintech. Economic Growth. M-Pesa. Tanzania

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1. Introduction

1.1 Background of the Study

Financial technology (Fintech) has become widely used in the twenty-first century to meet the need for new technologies to absorb existing financial difficulties and automate the delivery of financial services to individuals (Fund, 2019, Anyfantaki, 2020, WB Tanzania, 2021, Almashhadani & Almashhadani, 2023). Fintech, currently recognized as one of the fourth industrial revolutions, has lowered prices and distance between customers and financial institutions in terms of access to financial services (Shin & Choi, 2019).

Fintech was introduced in Tanzania following the successful launch of M-Pesa in Kenya in 2008, starting first with MobiPawa, followed by E-Fulusi, and finally M-Pesa in April of 2008. Initially, Tanzania established the Electronic Payment Scheme through the Bank of Tanzania (Tanzania, U. 2021, Anyfantaki, 2020,.Fund, 2019, Finscope Tanzania, 2017, Ephraim & Mhina, 2009, ATTORNEYS, n.d.). The IMF and World Bank Staff Study Report, 2019 shows that, the government investments in ICT, particularly the use of fintech, can help to overcome the ongoing barriers to the use of financial services and financial inclusion in Tanzania (Report et al., 2022).

Despite the expansion of fintech product subscriptions in Tanzania since 1990, many individuals still do not use fintech to supplement their income, and the substantial impact of fintech on economic growth remains unproven. This study addresses the issue of a lack of awareness among individuals and policymakers about the specific impact of fintech on physical value and economic growth in Tanzania.

Currently, fintech products have demonstrated widespread engagement in Tanzania, as seen by an increase in subscribers, which contributes to Tanzania's economic growth. According to the research findings, a 1% rise in revenue from fintech products, telecoms, mobile wireless broadband, and fixed wireless broadband subscribers improved Tanzania's economic growth by around 1.32%, 4.36%, and 111.77%, respectively. As a result, the fintech products utilised as independent variables in this research study had a favourable effect on Tanzania's economic growth.The research findings suggest that the police markers should give more attention to improving the availability of financial services.

2. Literature Review and Hypothesis Development

2.1 Literature Review

This section reviewed the following selected studies on fintech. Researcher used telecoms, mobile wireless broadband and fixed wireless broadband subscriptions to determine the impact of fintech on economic growth which their study results show that, fintech has a positive impact on economic growth. Findings and actual practice demonstrate the rapid growth of fintech use in Tanzania. Fintech has influenced both rural and urban regions in mobile money transactions utilizing their phones, regardless of owning or not holding bank accounts. People use their phones for making transactions (Finscope Tanzania, 2017, Tok & Heng, 2022, Song & Appiah-otoo, n.d.).

The study that was conducted in Jordan using time series data from 1990 to 2021 to investigate the impact of financial technology (FinTech) on economic growth; the autoregressive distributed lag (ARDL) was employed for cointegration test, and the vector error correction model (VECM) was used to examine both long- and short-term causality discovered that FinTech products such as the number of internet users, broadband subscriptions, and mobile cellular subscriptions were linked to an increase in economic indicators (Mugableh & Hammouri, 2022).

The research study titled "Egypt's Sustainable Development Strategy 2030" identified crowd funding payments and mobile money subscriptions as the control variables. Paying bills, sending and receiving money, and subscribing to government services are further factors. The utilization of a mobile accountant for financial transactions through mobile money is one of the independent variables in studies examining the impact of fintech on consumer happiness and financial performance in Egypt (Hussein, 2020 , Salman et al., 2021)**.**

A study conducted in Palestine to ascertain the effect of financial technology (fintech) on economic growth employed time series data from 2008 to 2021, including the number of internet users, broadband and mobile subscriptions, ATMs, and bank branches. The VECM results showed that the data on economic growth and financial development were stable at the initial differences and had both short-term and long-term causal relationships with economic growth and financial development, respectively. The ARDL test was used to test the co-integration and long-term and short-term causal relationships between variables. Fintech solutions have positively impacted the expansion of financial inclusion, which has fuelled Palestine's economic growth (Badwan & Awad, 2022).

The research uses a technology-based business model to analyse how FinTech fuelled Indonesia's economic growth from 1998 to 2018 found a strong correlation between economic growth and FinTech businesses after controlling for other important growth drivers like capital per worker, FDI, stock market development, and trade openness (Narayan, 2019, Tok & Heng, 2022). The World Bank Digital Tanzania Project, which was launched in May 2021, show Tanzania's digital financial investments have reduced rural poverty from 33.4 percent to 31.3 percent. By the end of 2020, there were over 32.3 million mobile money accounts, and in 2019, the value of digital financial transactions accounted for nearly 50% of the GDP (Tanzania,W, B 2021, Tanzania,U. 2021, Fund, 2019).

2.2 Hypothesis Development

The primary goal of this study was to determine the impact fintech on economic growth in Tanzania from 2008 to 2022. The results show that;

H_1 : Jointly the impact of fintech products, telecoms voice over IP (telecoms) subscriptions on Tanzania's economic growth is positive.

H_2 : The impact of telecoms voice over IP subscriptions on Tanzania's economic growth is positive.

H_3 : The impact of mobile wireless broadband subscriptions on Tanzania's economic growth is positive.

H_4 : The impact of fixed wireless broadband subscriptions on Tanzania's economic growth is positive.

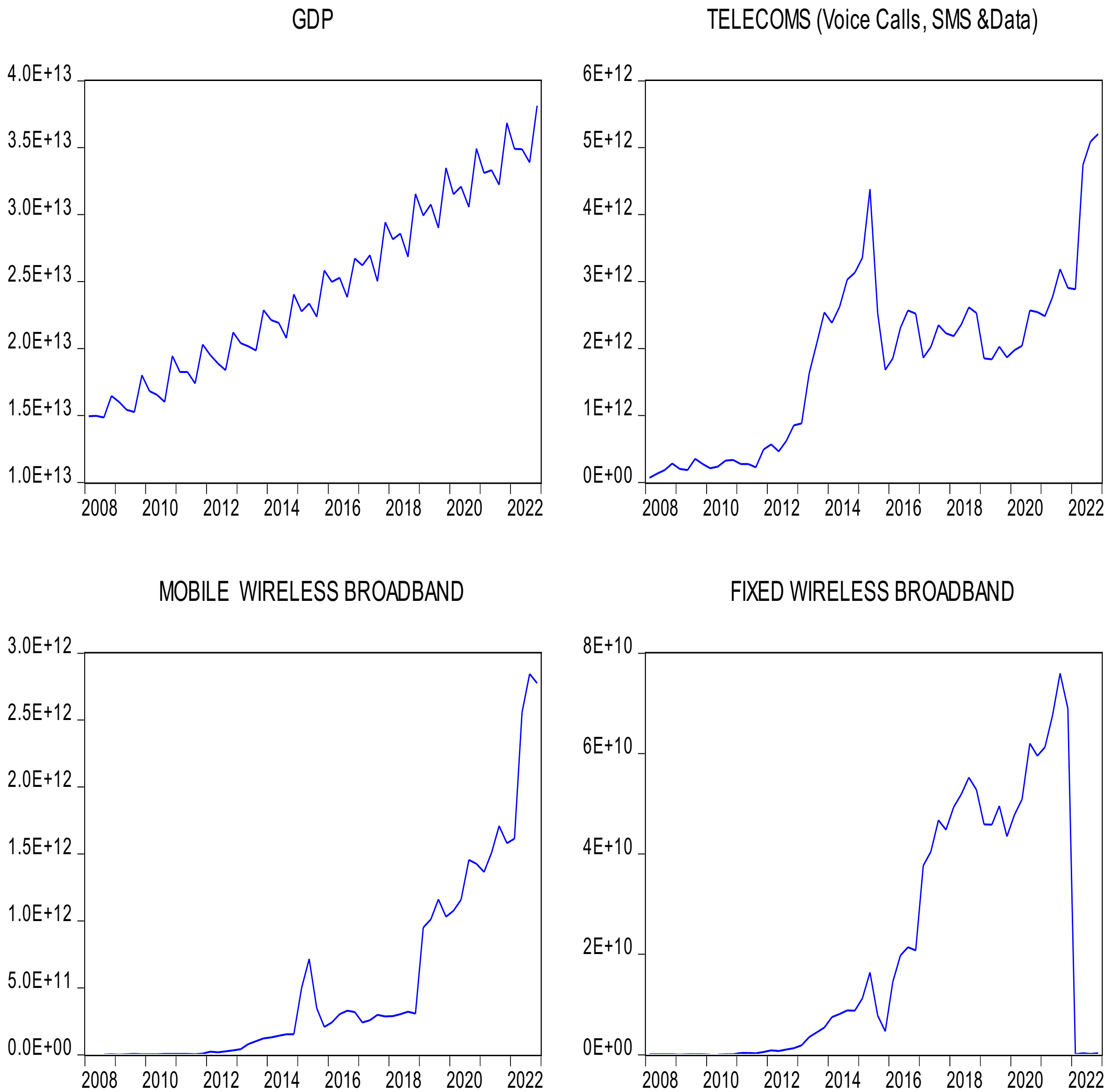
3. Data and Methodology

3.1 Data Descriptions

The data set comprises a time series data from 2008 to 2022 to make 60 observations. The study used the variable data of Gross Domestic Product (GDP) from Tanzania National Bureau of Statistics (NBS) and fintech variable data from Tanzania Communications Regulatory Authority (TCRA) to make the total revenue per user (TARPU). These data were also retrieved from; https://www.tcra.go.tz/upload/texteditor/files/telecoms%, https://www.vodacom.com> quarterly-results (Vodacom Group), and https://www.nbs.go.tz/index.php/en/census surveys/national-accounts-statistics-by subject and https://www.Vodacom.com/quarterly-Results.php.

Total value of GDP in Tanzania shillings increases from 14.95 trillion in the first quarter 2008 to 38.15trillion in the fourth quarter 2022. Revenues from telecoms increases from 69.53 billion first quarter 2008 to 5.20 trillion in the fourth quarter 2022. Mobile wireless broadband revenues increase from 2.36 billion first quarter 2008 to 2.78 trillion in the fourth quarter 2022 while total revenues from fixed wireless broadband have increased from 76.34 million in the first quarter 2008 to 68.94 billion in the fourth quarter 2021 and then dropped to 268.02 million in the fourth quarter 2022. See figure 3.1.

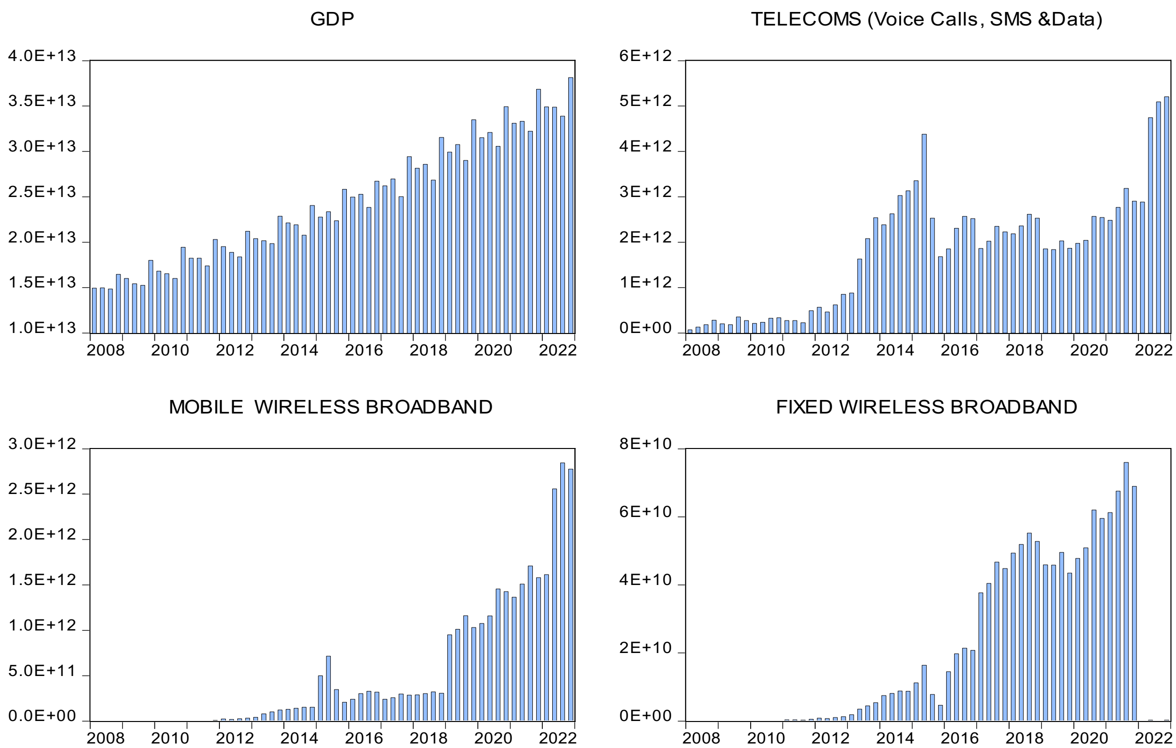
Figure 3.1: The graph represents the Total Average Revenue Tanzanian shillings at Market Price from 2008 to 2022 with base year 2005.



Source: NBS and TCRA (TCRA Tanzania, 2022,Uys & Africa, 2011)

The histogram shows the increase or decrease of the total average revenue per user per quarter (TARPU) for each quarter caused by an increase of fintech product subscriptions as indicated in figure 3.2.

Figure 3.2: The Histogram represents the total Average Revenue Tanzanian shillings at Market Price from 2008 to 2022 with base year 2005.



Source: NBS and TCRA (TCRA Tanzania, 2022,Uys & Africa, 2011).

3.2 Methodology and Model Specifications

Multiple linear regression models with grounded theory, classical estimation theory, economic theory, and putting first theory were employed in the analysis of the data. The Ordinary Least Squares (OLS) was employed for parameter coefficient estimation, hypothesis, significance, model, spurious test, correlation test, Johansen cointegration test, serial correlation test, multicollinearity test, heteroskedasticity test, VAR and VECM for both short-run and long-run causality relationships, and Granger variable causality.

Based on the fundamental research theory type, this study employed mixed research to measure and satisfy the fundamental skills required for an economist to conduct a research program while taking into account the most important economic theories and data sets for economic challenges. To assess the influence of fintech on economic growth, this study used telecoms, mobile, and fixed wireless broadband subscribers as variable factors. (Cothari, C, R. 2004, Cresswell, 2015, Pandey, 2015, Timothy C. Guetterman, 2014, Bhattarai, 2016, Elsayir, 2018, Consortium, 2023).

3.3 Regression Model

The multiple regression model was employed to determine the impact of fintech on the economic growth measured in GDP;

$y_1 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon_1$

Where; β_0 is the constant variable

β_1 is the impact of i unit increase in X_1 on the dependent variable y_1 other variables X_2 and X_3 remains constant.

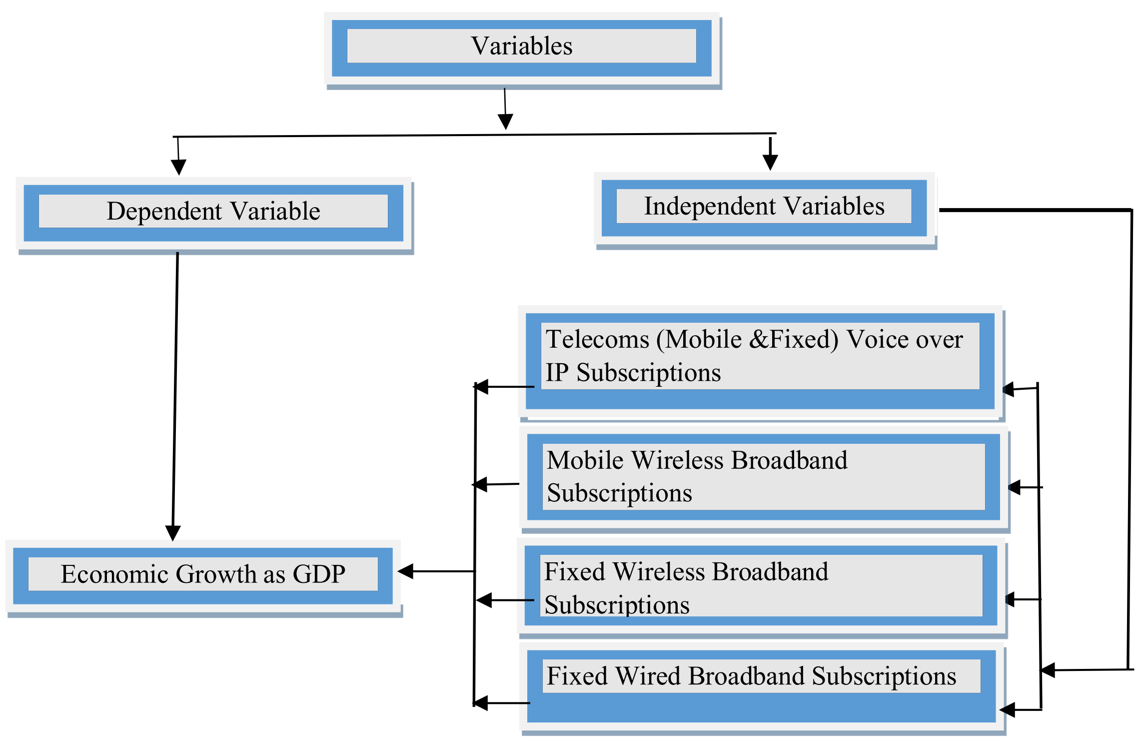
$\beta_1, \dots, \beta_3$ are the regression coefficients

Stochastic Error (ε) is the term that is added to the econometric model for the introduction of all variations $\boldsymbol{y_1}$ that have not been explained by the included variables $\boldsymbol{X_s}$**.** These independent variables are telecoms(X_1), mobile wireless broadband (X_2) and fixed wireless broadband (X_3) and Dependent variable as the Economic Growth (y) (Wooldridge, n.d. , B- & Degrees, n.d., Studenmund, A, H. 2016, Pampaka, M, Elliot, M, Tranmer, M and Murphy, 2020).

Conceptual Framework

The figure illustrates how the fintech variable relates and used in this study.

Figure 4. 3: Research Conceptual Framework



The variables in this research study and other literature show that all subscriptions to telephone voice over IP services known as telecoms (mobile and fixed), mobile broadband services, and fixed broadband services are fintech products, and fintech is a type of information and communication technology (ICT**)** (TCRA Tanzania, 2022)**.** The number of fintech products which include internet user's (mobile and fixed broadband, mobile communications) is the ICT product (Kireyeva & Kredina, 2021).

This study used a fundamental research theory and a mixed research design with quarterly time series data spanning 2008 to 2022. Grounded theory, classical theory, economic theory, and putting theory were employed. The study's goal is to demonstrate a significant impact of financial technology on economic growth as measured by Gross Domestic Product (GDP) in order to minimise bias in research.

4. Results and Discussions

4.1 Results

The goal of this research was to determine how Tanzania's GDP, a measure of economic growth, is affected by financial technology (Fintech). The results reveal that for every one unit increase in telecoms, mobile wireless broadband, and fixed wireless broadband subscriptions, assuming other variables remain constant, GDP increased by 1.323402, 4.363050, and 111.7728, respectively. This means that a 1% rise in telecoms, mobile wireless broadband, and fixed wireless broadband boosts Tanzania's economic growth by almost 1.3%, 4.4%, and 111.8%, respectively. The theories and results uncovered in this study were developed and interpreted using the following reference books (Studenmund, 2016, Diebold, 2019, Fahrmeir and Kneib, 2013,Wooldridge, 2016, Watson, n.d. , Gujarati, 2009, Davidson & Mackinnon, 2021).

4.2 Regression Analysis

4.2.1 The Ordinary Least Square Model (OLS) Results

Hypothesis:

H_0: Independent variable has no impact on the economic growth measured in GDP.

H_A: Independent variable has an impact on the economic growth measured in GDP.

Rule of Thumb:

If the $t - \text{statistic} \geq |2.0000|$:Variable is statistically significant

If the $\text{Prob} - \text{Value of } t - \text{statistic} < 0.05$:Reject the null hypothesis

If the $\text{Prob} - \text{Value of } t - \text{statistic} > 0.05$: Do not reject the null hypothesis

If the $\text{Prob}(F - \text{Statistic}) = 0.000000$: Model is jointly significant

If the $R^2 - \text{ value} < \text{Durbin} - \text{Watson Statistic value}$: The model is non-spurious, the value of R^2 indicates how much the variation in dependent variables is explained by independent variables and the goodness of fit of the data.

Table 4.1: GDP Against Independent Variable by OLS Regression Analysis Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TELECOMS	1.323402	0.344706	3.839218	0.0003
MOBILE__WIRELESS	4.363050	0.631469	6.909366	0.0000
FIXED_WIRELESS	111.7728	13.53816	8.256127	0.0000
C	1.74E+13	5.50E+11	31.66569	0.0000

R-squared	0.885652	Mean dependent var	2.44E+13
Adjusted R-squared	0.879526	S.D. dependent var	6.63E+12
S.E. of regression	2.30E+12	Akaike info criterion	59.83159
Sum squared resid	2.97E+26	Schwarz criterion	59.97121
Log likelihood	-1790.948	Hannan-Quinn criter.	59.88620
F-statistic	144.5774	Durbin-Watson stat	1.635864
Prob(F-statistic)	0.000000		

The data reveal that all P-values less than 0.05 lead the researcher to reject the null hypothesis. The P(F-Statistic) = 0.00000 indicates that the model is statistically significant. Additionally, the R-squared value of 0.885652 is smaller than Durbin-Watson's value of 1.635864, indicating that the model is not spurious. Forecasting can thus be done using the regression results. The t-statistic value ≥|2.0000| indicates that all variables are statistically significant and can predict the dependent variable.

The independent variable in the regression explains nearly 89% of the total variation in GDP, and the model has a best fit of roughly the same proportion. As a result, the regression model is valid, and the independent variables have an impact on Tanzanian economic growth as measured in GDP.

According to the Augmented Dicky Fuller data testing judgement criteria, if the R-squared value is greater than Durbin-Watson Statistics Value, then the data is non-stationary, spurious, and therefore cannot be used for forecasting. The results of the Augmented Dicky-Fuller test at the first difference level with constant indicate that the data is stationary, the model is non-spurious, statistically significant, and adequate for forecasting (Studenmund, 2016, Diebold, 2019, Wooldridge, 2016, Gujarati, 2009, Watson, n.d.).

Table 4.2 Standard VAR Optimal Lag Order Test Results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-6199.603	NA	1.10e+93	225.5856	225.7315	225.6420
1	-6000.554	361.9073	1.41e+90	218.9292	219.6592	219.2115
2	-5969.981	51.13983	8.41e+89	218.3993	219.7132	218.9074
3	-5960.410	14.61805	1.09e+90	218.6331	220.5309	219.3670
4	-5875.319	117.5799*	9.26e+88*	216.1207*	218.6025*	217.0804*
5	-5859.477	19.58678	1.01e+89	216.1264	219.1922	217.3120

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The AIC, SC, HQ, FPE and LR all indicate the optimal lag order selection criteria is 4. Akaike (AIC) optimal decision criteria under VAR lag order selection criteria is 4.

4.3 The Multiple Linear Regression Estimated Model by OLS

GDP= (1.7429) + 1.3234*telecoms + 4.3631*mobile wireless + 111.7728*fixed wireless + 2.302

The estimation results reveal that GDP, as a factor indicator of economic growth, would be equal to 1.7429 if the intercept coefficients of telecom subscriptions, mobile wireless broadband, and fixed wireless broadband subscriptions were all zero. The telecom industry's slope coefficient is positive; hence, it has a positive impact on economic growth. The findings suggest that, when other variables are held constant, a one-point increase in the telecoms industry boosts GDP growth by almost 1.3234. The results show that mobile wireless has an effect on the GDP growth rate of 4.3631 for every 1 increase in mobile wireless, while other variables stay constant. When all variables are held constant, a one-point increase in fixed wireless broadband subscriptions increases GDP growth by about 111.7728.

4.4 Data Correlation Test Results

The results suggest that there are positive relationships between independent and dependent variables. The diagonal correlation matrix results' coefficient of 1.000000 attests to the existence of high correlation between the variables themselves (Studenmund, 2016, Fahrmei and Kneib, 2013, Davidson & Mackinnon, 2021).

Table 4.3 Correlation Matrix

	GDP	TELECOMS	MOBILE__WIRELESS	FIXED_WIRELESS
GDP	1.000000	0.768409	0.835408	0.699017
TELECOMS	0.768409	1.000000	0.743362	0.372721
MOBILE__WIRELESS	0.835408	0.743362	1.000000	0.401439
FIXED_WIRELESS	0.699017	0.372721	0.401439	1.000000

4.5 Hypotheses Test

The Johansen Cointegration Unit Root Test and the Augmented Dicky Fuller Test (ADF) results show stationarity at first difference level with a constant. The VAR and VECM were used to test the causality short-run and long-run variable relationship.

4.5.1 Hypothesis Test Results Based on Variable Stationarity Test

Decision Criterion:

If the ADF $(t - \text{statistic}) <$ P-Value of 0.05 critical value; The data is not stationary

If the ADF $(t - \text{statistic}) >$ P-Value of 0.05 critical value; The data is stationary

Hypothesis:

H_0: Data is not stationary and H_A: Data is stationary

Rule of Thumb:

The ADF $(t - \text{statistic}) <$ P-value of 0.05 is the critical value and the absolute $t - \text{statistic} >$ Absolute $t - \text{statistic}$ of the critical value 0.05. The results show that, the series is stationary and statistically significant at the first difference level with constant. Therefore, the researcher has rejected the null.

4.5.2 Hypothesis Test Results based on calculated t-Statistic.

Null Hypothesis Test based on the calculated t-statistic value against the critical value 0.05 (5% level of Significance).

4.5.2.1 The Estimated Multiple Linear Regression Model

GDP= (1.742857) +1.323402*telecoms+4.363051*mobilewireless+111.772778*fixed wireless+ 2.302

Hypothesis Statement:

H_0 : A Variable has no impact on the economic Growth

H_A : A Variable has an impact on the economic Growth

Decision Rule:

Reject H_0 : If $|t_k| > t_c$

Reject H_0: If t_k also has the sign implied by H_A and Vice versa.

$t_k = \text{Calculated } t - \text{value}$

$t_c = \text{Critical } t - \text{value}$

General Decision Rule based on calculated t-value against t-critical value;

Reject H_0; If the $|t_k| > t_c$

Do not Reject H_0: If the t_k sign is the same as the sign of the coefficient implied by H_A.

The calculated t-value is given by;

$$t_k = \frac{\hat{\beta}_k}{S.E(\hat{\beta}_k)},$$

Where; $\hat{\beta}_k$ – the estimated regression coefficient of the kth variable

$S.E(\hat{\beta}_k)$ – the estimated standard error of β_k

First Null Hypothesis test

H_0: Telecoms (Telephone Voice over IP) Subscriptions has no impact on the economic Growth in Tanzania

$Telecoms_k$ = (1.742857) + 1.323402*telecoms + 2.302
(0.344706)
$t_k = 3.8392$ and $t_c = 0.05$

The $t_k > t_c$; Therefore, Researcher has rejected the null hypothesis.

Second Null Hypothesis test

H_0: Mobile Wireless Broadband Subscriptions has no impact on the economic growth in Tanzania

The estimated model for Mobile wireless broadband subscriptions is measured by mobile wireless broadband revenues.

$Mobwls_k$ = (1.742857) + 4.363051*mobwls + 2.302
(0.631469)
$t_k = 6.9094$ and $t_c = 0.05$

The $t_k > t_c$; Therefore, Researcher has rejected the null hypothesis

Third Null Hypothesis test

H_0: Fixed Wireless Broadband Subscriptions has no impact on the economic growth in Tanzania

The estimated model for fixed wireless broadband subscriptions is measured by fixed wireless broadband revenues.

$Fixedbwls_k$ = (1.742857) + 111.772778*fixedbwls + 2.302e+12
(13.53816)
$t_k = 8.2561$ and $t_c = 0.05$

The $t_k > t_c$; Therefore, Researcher has rejected the null hypothesis.

Generally, the R-squared and adjusted R-squared values in OLS Regression model indicates almost equal to 0.885652 and 0.879526 respectively.

Decision Rule

The Adjusted R^2 determined the strength of the Regression Model.

The models indicates that, all independent variables account for 88.5% of the variation in the dependent variable (GDP). Therefore, the selected regression model was an excellent best-fit model.

4.6 Regression Model Decision based on F-Test Results

H_0: Financial Technology (Fintech) has no impact on the economic growth in Tanzania

F-Test used to test the overall significance

Reject H_0: If $F > F_C$

Do no Reject H_0: If $F \leq F_C$

F is calculated;

$$F = \frac{(ESS)/K}{(RSS)/(N-K-1)}$$

$ESS -$ Explained Sum of Squares
$RSS -$ Residual Sum of Squares
$K -$ Total number of independent variables
$N -$ Total number of observations in the sample

NOTE: $RSS_M \geq RSS$

$R^2 = \frac{ESS}{TSS}$; and $R^2 = 1 - \frac{RSS}{TSS}$ where; $TSS = RSS + ESS$

$ESS = \frac{R^2(RSS)}{1-R^2}$;

where; $R^2 = R -$ Squared

$TSS =$ Total Sum of ESS and RSS

Now;

$$ESS = \frac{0.885652(2.97E+26)}{1-0.885652},$$

$$= \frac{0.885652(2.97x10^{26})}{1-0.885652},$$

$$= 2.300334453x10^{27},$$

$$F = \frac{(2.300334453x10^{27})/3}{(2.97x10^{26})/(60-3-1)}$$

$$= \frac{7.667781509x10^{26}}{5.303571429x10^{24}}$$

$= \mathbf{144.5776985}$

Since, $F_k = 144.5776985$

$F_C = 144.5774$

$F_c -$ F(Statistic) from the regression results table

$F_k > F_c$; Series is significant. Null hypothesis (H_0) has rejected.

4.7 Johansen Cointegration Results

Johansen Cointegration checks whether cointegration exists in order to ascertain whether or not the variables converge over the long term and have a relationship when cointegrated, or not in order to reject or fail to reject the null hypothesis.

Hypothesis
H_0: There is no cointegration and H_A: There is cointegration

Rule of Thumb.
If Trace Statistic value $<$ Calculated critical value: There is no cointergrartion
If Trace Statistic value $>$ Calculated critical value: There is cointegration and
If Max $-$ Eigen Statistic value $<$ Calculated critical value: No cointegration
If Max $-$ Eigen Statistic value $>$ Calculated critical value: There is cointegration

Table 4.4: Johansen Cointegration Variables Test Results at Lag interval 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.404830	44.01218	47.85613	0.1097
At most 1	0.144832	13.91546	29.79707	0.8454
At most 2	0.071574	4.840921	15.49471	0.8255
At most 3	0.009157	0.533577	3.841466	0.4651

Trace test indicates no cointegration at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.404830	30.09672	27.58434	0.0233
At most 1	0.144832	9.074540	21.13162	0.8264
At most 2	0.071574	4.307343	14.26460	0.8256
At most 3	0.009157	0.533577	3.841466	0.4651

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

However, Johansen Cointegration null hypothesis decision rule can also be stated as;

$\mathbf{H_O}$: There is no long-run (no level) relationship among the series in the model

$\mathbf{H_A}$: There is a long-run (level) relationship among the series in the model

Johansen Cointegration Decision criteria use the Trace statistic against critical value or Max-Eigen Statistic against the critical value.

Decision Criteria

There is no cointegration equation at the 0.05 level, indicating that the variables in the series model do not have a long-term relationship, and the null hypothesis is not rejected. Cointegration at the 0.05 level indicates the presence of a long-term relationship between the variables in the series model. Consequently, the null hypothesis has been rejected.

The VECM was used for the long-run relationship test, and the VAR was used for the short-run relationship test, based on the Max-Eigen statistic values. The findings indicate a weak long-term association for some variables and a strong long-run relationship for the same variables. The results, however, show a long-term chance of returning to the equilibrium line.

Table 4.5. VAR Residual Serial Correlation LM Tests Results

Null hypothesis: No serial correlation at lag h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	14.20270	16	0.5836	0.887515	(16, 128.9)	0.5847
2	41.71137	16	0.0004	2.894028	(16, 128.9)	0.0004
3	10.94009	16	0.8132	0.675358	(16, 128.9)	0.8138

Null hypothesis: No serial correlation at lags 1 to h

Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	14.20270	16	0.5836	0.887515	(16, 128.9)	0.5847
2	109.3158	32	0.0000	4.467497	(32, 141.7)	0.0000
3	139.0402	48	0.0000	3.985081	(48, 133.0)	0.0000

*Edgeworth expansion corrected likelihood ratio statistic.

Hypothesis: H_0: Series has no serial correlation and H_A: Series has a serial correlation
Rule of Thumb.
If the Prob -value > 0.05 critical value: Series has no serial correlation
If the Prob -value < 0.05 critical value: Series has a serial correlation
The results table indicates no serial correlation. Therefore, series is free from serial correlation.

4.8 VAR Estimates Out Put of the Variance Decomposition on each equation

The variance decomposition result and the impact of each variable, either alone or in combination, across both short- and long-term time periods are displayed in the VAR Decomposition table within the VAR estimate.

Table 4.6.: VAR Estimates Main Variance Variable Decomposition Results

Variance Decomposition of GDP:

Period	S.E.	GDP	TELECOMS	MOBILE__WIRELESS	FIXED_WIRELESS
1	1.53E+12	100.0000	0.000000	0.000000	0.000000
2	1.59E+12	94.61883	0.409143	0.193344	4.778681
3	1.84E+12	85.42830	4.675867	1.808116	8.087722
4	1.93E+12	81.45408	8.023567	2.475979	8.046371
5	2.10E+12	80.07647	10.20729	2.702074	7.014161
6	2.20E+12	78.34563	12.16194	2.937730	6.554702
7	2.32E+12	76.65268	14.00590	3.254776	6.086647
8	2.43E+12	74.92050	15.80109	3.594797	5.683611
9	2.55E+12	73.57253	17.29060	3.901151	5.235721
10	2.66E+12	72.31306	18.62988	4.204920	4.852142

Variance Decomposition of TELECOMS:

Period	S.E.	GDP	TELECOMS	MOBILE__WIRELESS	FIXED_WIRELESS
1	3.72E+11	0.588831	99.41117	0.000000	0.000000
2	5.50E+11	0.441333	83.91841	1.400411	14.23985
3	6.86E+11	3.740751	66.82641	3.149467	26.28338
4	7.60E+11	4.125341	61.45852	3.821501	30.59464
5	8.12E+11	4.580917	60.13942	3.535560	31.74411
6	8.61E+11	4.600446	59.18889	3.149548	33.06112
7	9.11E+11	4.911458	57.65171	2.837770	34.59906
8	9.55E+11	5.122910	56.26726	2.679150	35.93068
9	9.95E+11	5.383790	55.19294	2.720941	36.70233
10	1.03E+12	5.618885	54.32435	2.961321	37.09544

Variance Decomposition of MOBILE__WIRELESS:

Period	S.E.	GDP	TELECOMS	MOBILE__WIRELESS	FIXED_WIRELESS
1	1.26E+11	0.938593	18.46486	80.59655	0.000000
2	2.08E+11	1.586618	13.77215	54.90673	29.73450
3	2.66E+11	3.020591	10.81784	44.47244	41.68913
4	3.00E+11	2.987767	10.76361	44.99237	41.25625
5	3.27E+11	2.917874	11.54846	47.71399	37.81967
6	3.50E+11	3.239000	12.01222	49.95236	34.79642
7	3.69E+11	4.091661	12.05498	51.65116	32.20220
8	3.85E+11	5.195839	11.93208	53.10562	29.76645
9	4.00E+11	6.472476	11.74893	54.18369	27.59491
10	4.14E+11	7.927485	11.51957	54.73757	25.81537

Variance Decomposition of FIXED_WIRELESS:

Period	S.E.	GDP	TELECOMS	MOBILE__WIRELESS	FIXED_WIRELESS
1	9.59E+09	0.000309	0.507380	0.732385	98.75993
2	1.35E+10	0.190695	0.279163	0.455373	99.07477
3	1.58E+10	4.636819	1.380227	0.736694	93.24626
4	1.79E+10	6.817840	2.965327	1.662148	88.55469
5	1.98E+10	7.814336	3.493671	2.322879	86.36911
6	2.12E+10	8.126452	3.527670	2.949127	85.39675
7	2.23E+10	8.622780	3.444750	3.729092	84.20338
8	2.30E+10	9.023932	3.343623	4.664046	82.96840
9	2.36E+10	9.345448	3.224203	5.622476	81.80787
10	2.40E+10	9.556272	3.117147	6.554885	80.77170

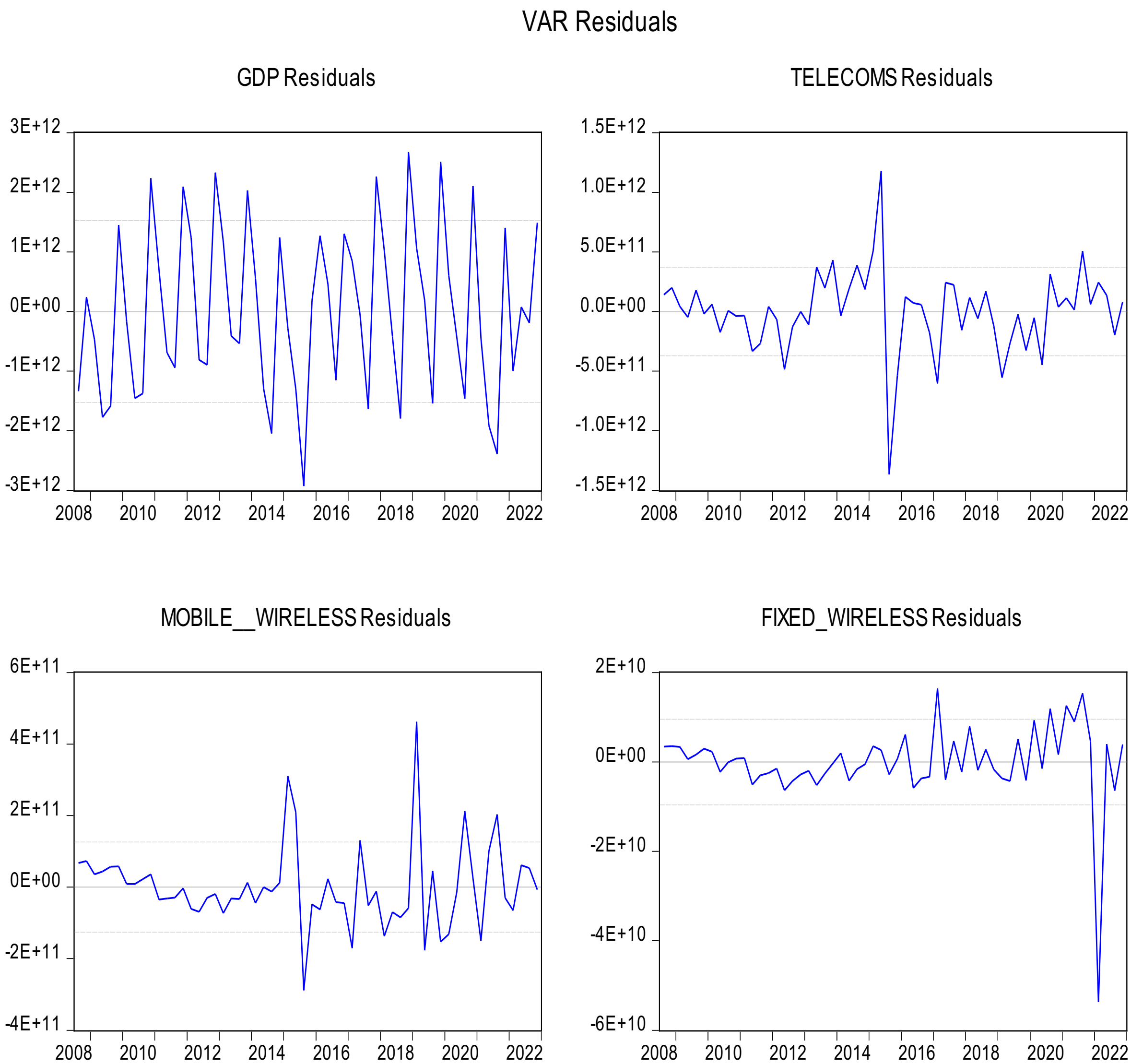
Cholesky Ordering: GDP TELECOMS MOBILE__WIRELESS FIXED_WIRELESS

Short-run and long-run influences of the variables estimated for the current 10 years.

Variance Decomposition influences of GDP, Telecoms, Mobile wireless broadband, and fixed wireless against itself or other Variables.

In short-run GDP, telecoms, mobile wireless broadband and fixed wireless broadband, and have a strong influence by themselves, ranging from 100%, 99.4%, 80.6%, and 98.8% in average at the first year to the influence of about 72.3%, 54.3%, 54.8%, and 80.8% in the long run at the tenth year. However, in short run all variables have shown a very weak influence on other variables.

Figure 4.3: VAR Residual Graphical Residual Test



The VAR Residual Graph Test shows the stationarity of the variable is in the model since the blue line is almost within the boundary ± 2.

4.9: Vector Error Correccion Model (VECM) Estimation Results

Hypothesis:
H_0: The variable coefficient is not significant if the $|t - \text{statistic}| < 2.00$
H_A: The variable coefficient is significant if the $|t - \text{statistics}| > 2.00$

Rule of Thumb:
If the $|t - \text{statistic}| > 2.00$ and Prob -Value < 0.05 critical value: Reject null hypothesis
If the $|t - \text{statistic}| < 2.00$ and Prob -Value > 0.05 critical value: Do not reject null hypothesis.

Table 4.7: Vector Error Correction Estimation Results

D(GDP) is the Dependent Variable
D(GDP) = C(1)*(GDP(-1) - 1.66695575351*TELECOMS(-1) -

4.56897473984*MOBILE__WIRELESS(-1) - 116.222332334
*FIXED_WIRELESS(-1) - 1.66261769551E+13) + C(2)*D(GDP(-1)) +
C(3)*D(TELECOMS(-1)) + C(4)*D(MOBILE__WIRELESS(-1)) + C(5)
*D(FIXED_WIRELESS(-1)) + C(6)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.419738	0.112721	-3.723680	0.0005
C(2)	-0.439038	0.116724	-3.761328	0.0004
C(3)	-0.567872	0.560386	-1.013359	0.3156
C(4)	-1.172579	1.441767	-0.813293	0.4198
C(5)	-13.60145	22.31818	-0.609434	0.5449
C(6)	6.50E+11	2.08E+11	3.120999	0.0029
R-squared	0.511732	Mean dependent var		4.00E+11
Adjusted R-squared	0.464783	S.D. dependent var		2.03E+12
S.E. of regression	1.49E+12	Akaike info criterion		58.99083
Sum squared resid	1.15E+26	Schwarz criterion		59.20398
Log likelihood	-1704.734	Hannan-Quinn criter.		59.07385
F-statistic	10.89976	Durbin-Watson stat		2.003250
Prob(F-statistic)	0.000000			

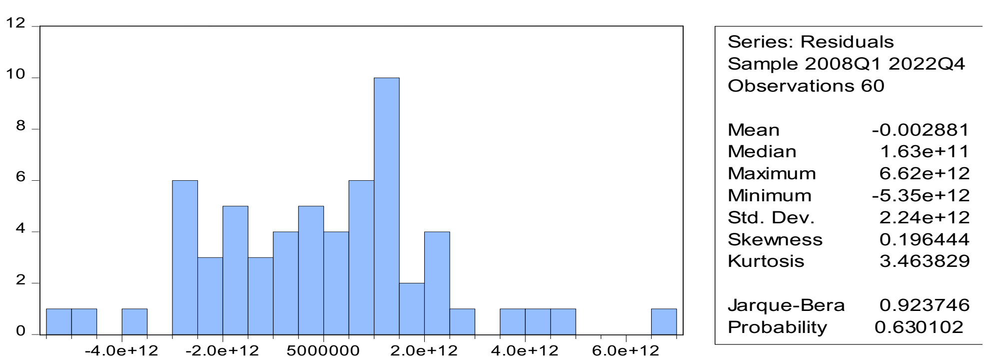
Decision criteria

Variables with $|\text{t} - \text{Statistic}| > 2.00$ and $\text{Prob} - \text{Value} < 0.05$, tell researcher that the coefficient variable is statistically significant and has rejected the null. Jointly, variable coefficients are statistically significant since P(F-Statistic) = 0.000000.

A positive sign on the Coefficients (C) of the VECM long-run relationship estimates of the CointEqn1 of the estimated standard VAR above indicates a movement of the variable away from the equilibrium, whereas a negative sign and significant indicates long-run causality between the independent and dependent variables. However, the negative sign denotes the variables' long-term capacity to return to the equilibrium line.

4.10: Graphical Normality Series Test Results

Figure 4.4: Normality Test basing on Ordinary Least Square Method (OLS)



Hypothesis:

H_0: The series is not normal distributed and H_A: The series is normal distributed

Rule of Thumb

If the Jarque-Bera P-value > 0.05 level of significance, reject the null (H_O) and series is normal distributed. The probability value of the Jarque-Bera is greater than 0.05 level of significance. These imply that the series is normally distributed. Therefore, the researcher has rejected the null.

4.11: Residual Diagnostics of Serial Correlation LM Test Results

Hypothesis: H_0: There is no serial correlation and H_A: There is serial correlation

Decision Rule; If $P - \text{value correspondind to Obs } R^2 > 0.05$; Reject the null hypothesis.

Table 4.8: Residual Diagnostic Serial Correlation LM Test Results

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.386351	Prob. F(2,54)	0.2587
Obs*R-squared	2.930319	Prob. Chi-Square(2)	0.2310

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TELECOMS	0.056754	0.348017	0.163078	0.8711
MOBILE__WIRELES S	-0.046574	0.627782	-0.074188	0.9411
FIXED_WIRELESS	0.998750	13.51684	0.073889	0.9414
C	-9.21E+10	5.63E+11	-0.163707	0.8706
RESID(-1)	0.193942	0.135924	1.426840	0.1594
RESID(-2)	-0.155582	0.143278	-1.085875	0.2824

R-squared	0.048839	Mean dependent var	-0.002881
Adjusted R-squared	-0.039232	S.D. dependent var	2.24E+12
S.E. of regression	2.29E+12	Akaike info criterion	59.84818
Sum squared resid	2.82E+26	Schwarz criterion	60.05762
Log likelihood	-1789.446	Hannan-Quinn criter.	59.93010
F-statistic	0.554540	Durbin-Watson stat	1.972490
Prob(F-statistic)	0.734185		

The data has yielded a legitimate and dependable conclusion that may be used for forecasting, as evidenced by the probability of Chi-Square (2) = 0.2310 being greater than the 0.05 level of significance. The series is therefore free from serial correlation. Thus, the researcher was unable to reject the null.

4.12: Residual Diagnostic Heteroskedasticity Test Results

Hypothesis: H_0: There is no Heteroskedasticity and H_A: There is Heteroskedasticity

Decision Rule; If $P-$ value correspondind to $\text{Obs}.R^2 > 0.05$; Reject the null hypothesis.

Table 4.9: Residual Diagnostic Heteroskedasticity Test Results

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.448292	Prob. F(3,56)	0.2385
Obs*R-squared	4.320045	Prob. Chi-Square(3)	0.2289
Scaled explained SS	4.635989	Prob. Chi-Square(3)	0.2005

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.08E+24	1.85E+24	1.662276	0.1020
TELECOMS	4.55E+11	1.16E+12	0.392617	0.6961
MOBILE__WIRELES S	2.36E+12	2.12E+12	1.113818	0.2701
FIXED_WIRELESS	-1.03E+13	4.55E+13	-0.226580	0.8216

R-squared	0.072001	Mean dependent var	4.94E+24
Adjusted R-squared	0.022286	S.D. dependent var	7.83E+24
S.E. of regression	7.74E+24	Akaike info criterion	117.5190
Sum squared resid	3.35E+51	Schwarz criterion	117.6586
Log likelihood	-3521.569	Hannan-Quinn criter.	117.5736
F-statistic	1.448292	Durbin-Watson stat	2.457548
Prob(F-statistic)	0.238526		

The probability Chi-Square (3) = 0.2289 of the Obs.R-squared is greater than the 0.05 level of significance. This indicates that the series is free from heteroskedasticity. The researcher has failed to rejected the null hypothesis. Also indicates that, the series has produced linear, unbiased, and efficient results because the variance of the error term and that of the OLS estimator are unbiased. Therefore, the series has produced a realistic conclusion and also be used for forecasting.

4.13. Multicollinearity Results by OLS Regression

The multicollinearity rule of thumb states that, there is no multicollinearity between independent variables "if the centred variance inflation factor (VIF) = 1". There is a moderate correlation but not enough severity to justify the corrective measure if $1 < \text{VIF} \leq 5$. " Corrective action should be taken if $5 < \text{VIF} \leq 10$''. A VIF of more than 10 denotes a critical degree of multicollinearity, which suggests that, the variables are highly correlated and the coefficients are poorly estimated, casting doubt on the P-values.

Table 4.10: The Centred Variance Inflation Factor (VIF) for Multicollinearity Test Results

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
TELECOMS	0.118822	6.805649	2.268444
MOBILE__WIRELESS	0.398753	3.578651	2.328567
FIXED_WIRELESS	183.2818	2.081741	1.209913
C	3.03E+23	3.430721	NA

Thus, all variables have an uncentered VIF of less than 10, with the exception of telecommunications, which has a VIF of 6.805649. Nonetheless, the standardised variable indicates that multicollinearity has been resolved, as the centred variance inflation factor (VIF) is less than 5.

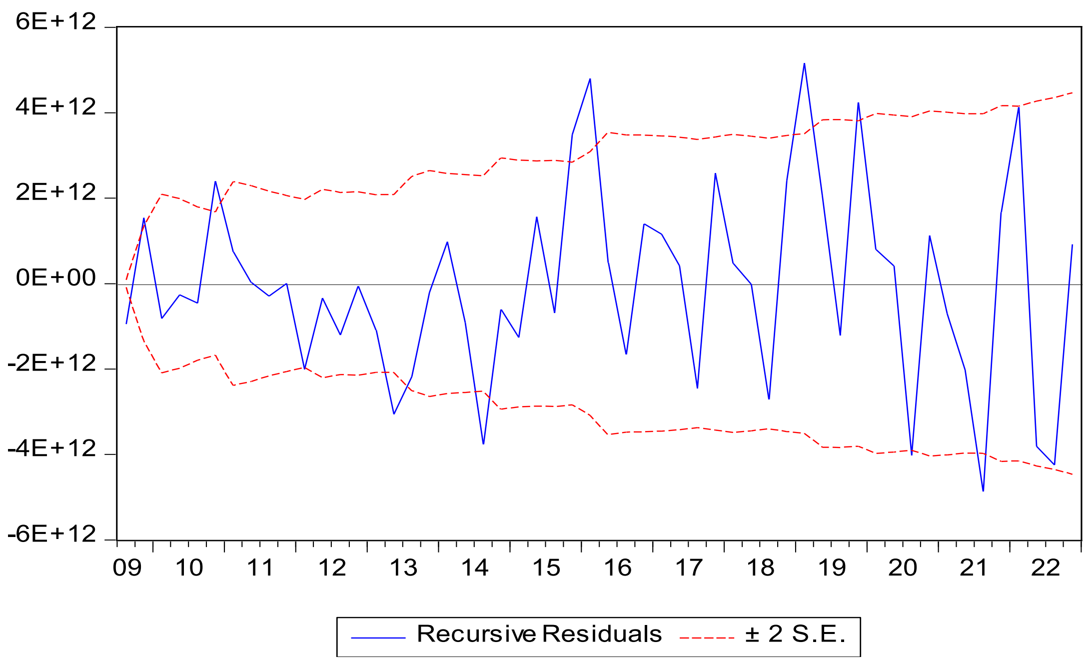
4.14: Regression Model Stability Test

4.14.1 Recursive Diagnostic Estimate Test

The diagnostics recursive estimates decision criteria states that, "If the recursive residual line is relying in between the red lines, which makes the boundaries, like lying between ± 2, 5% level of significance, then the Regression Analysis model is stable.

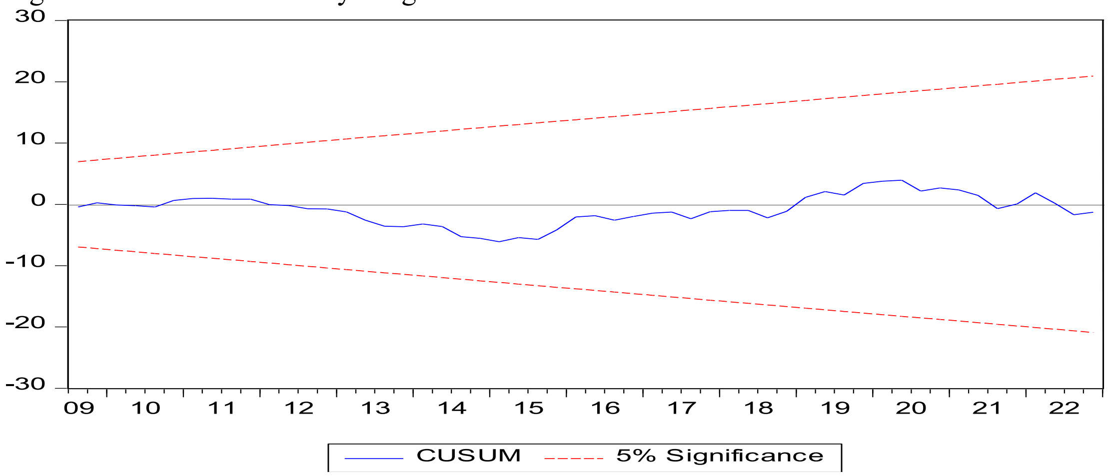
3.16.2: Recursive Diagnostic Stability Graphical Test

Figure 4.5: Stability test by Recursive Diagnostics Estimates Test



The recursive residual line almost lying in between the boundaries, means is between ±2 S.E, hence is stable.

Figure 4.6: CUSUM Stability Diagnostics Test



The CUSUM Residual line completely lying in between the boundaries, which represents 5% the level of significance, hence the regression model is stable.

4.15: GRANGER CAUSALITY

Granger causality deals with the circumstances in which one series variable precedes or leads another and is extremely useful for forecasting purposes and testing the null hypothesis.

Hypothesis.

$H_{0:}$ Variable X does not granger cause Y and $H_{A:}$ Variable X granger cause Y

Rule of thumb

If the P-value of the VAR Granger causality is less than 0.05, Variable X granger causes Y

If the P-value of the VAR Granger causality is greater than 0.05, variable X does not granger causes Y

Decision criteria

If the $\text{Prob} - \text{value} < 0.05$; Reject the null hypothesis

If the $\text{Prob} - \text{value} > 0.05$; Do not reject the null hypothesis

Table 4-11: VAR Granger Causality/Block Exogeneity Wald Test Results

Dependent variable: GDP

Excluded	Chi-sq	df	Prob.
TELECOMS	6.398126	2	0.0408
MOBILE__WIRELESS	7.581336	2	0.0226
FIXED_WIRELESS	7.480505	2	0.0237
All	15.31337	6	0.0180

Dependent variable: TELECOMS

Excluded	Chi-sq	df	Prob.
GDP	17.38340	2	0.0002
MOBILE__WIRELESS	4.554986	2	0.1025
FIXED_WIRELESS	23.29164	2	0.0000
All	36.84132	6	0.0000

Dependent variable: MOBILE__WIRELESS

Excluded	Chi-sq	df	Prob.
GDP	10.48640	2	0.0053
TELECOMS	3.538562	2	0.1705
FIXED_WIRELESS	46.39360	2	0.0000
All	59.83372	6	0.0000

Dependent variable: FIXED_WIRELESS

Excluded	Chi-sq	df	Prob.
GDP	7.957324	2	0.0187
TELECOMS	1.332124	2	0.5137
MOBILE__WIRELESS	6.895174	2	0.0318
All	10.06632	6	0.1219

The independent variables have a P-value of less than 0.05, indicating that the variable causes GDP. This suggests that causality exists and the researcher has rejected the null hypothesis, or vice versa. All independent variables work together to create GDP, suggesting a causal link between independent variables X and dependent variable Y.

5.0 DISCUSSION OF THE FINDINGS

5.1 Overview of the Diagnostic Test Findings

The study encoded, processed, and evaluated data using E-VIEWS 10. Ordinary least squares with multiple linear regression were used for parameter estimation, hypothesis testing, significance testing, model and spurious testing, and stationarity testing using Augmented Dicky-Fuller (ADF) and Johansen cointegration for the causality long-run relationship test and Granger for the variable causality test. The standardised centred variable aimed at resolving the presence of multicollinearity reduced VIF to less than 5, indicating that multicollinearity has been addressed. The combined results reveal that the series is statistically significant, the null hypothesis was rejected, and the stability test results show that the data was stable enough to yield valid conclusions.

4.2 Discussion Regarding Study's Objectives

The average revenue per user (ARPU) was estimated from the total weighted average tariffs (WAT) which was estimated from the industrial average tariffs (IAT) to make a total income.

The control variables were mobile money transfers, automated teller machines (ATMs), crowdfunding for items such as employee salary payments, and real estate tax payments made by banks and the government (Finscope Tanzania, 2017, Tanzania, W, B. 2021, Report, 2021).

H_1: The Telecoms Subscriptions has an impact on Tanzania's Economic Growth

Telecoms undertaken as a variable factor indicator of Telephone voice over IP subscriptions has a positive impact on Tanzania's economic growth. Findings suggests that, a 1 unit increase in telecoms, when other variables remain constant, increased GDP by 1.32340180767. This implies that, a 1% increase in telecoms increases GDP by approximately 1.3%.

H_2: The Mobile Wireless Broadband Subscriptions has an impact on Tanzania's Economic Growth.

According to TCRA data for June 2022, more than 33 million Tanzanians own phones, whether they are regular or smartphones. According to this analysis, every one-unit increase in mobile wireless broadband subscribers enhances GDP by 4.36305046652. This means that a 1% increase in mobile wireless broadband increases GDP by approximately 4.4%.

H_3: The Fixed Wireless Broadband Subscriptions Have an Impact on Tanzania's Economic Growth

The number of fixed wireless broadband subscriptions has grown in recent years. The fixed wireless broadband is the high-speed internet access (via a TCP/IP connection) with a downstream speed of at least 256 kbit/s. Findings show that, when all variables are held constant, each unit increase in fixed wireless broadband increases GDP by 111.772777605. This suggests that a 1% increase in fixed wireless broadband increases GDP by approximately 111.8%.

5. SUMMARY AND CONCLUSSIONS

5.1 Summary of Findings

This research study's test findings are nearly identical, which is consistent with the approach used to address the study's research problem. According to the influence of fintech on Tanzania's economic growth, a 1% rise in fintech products, telecoms, mobile wireless broadband, and fixed wireless broadband revenues in Tanzanian shillings increases Tanzania's economic growth by about 1.32%, 4.36%, and 111.77%. This means that a 10% increase in fintech products, telecoms, mobile wireless broadband, and fixed wireless broadband revenue in Tanzanian shillings increases Tanzania's economic growth by approximately 13.2%, 43.6%, and 1117.7%, respectively.

Despite an increase in subscribers in 2019, this study shows that consumers have switched from fixed wireless broadband to mobile wireless broadband as a result of their usage of mobile phones, specifically smartphones. In addition to carefully scrutinising the purchase price, fixed wireless facilities should be made more widely available in order to accommodate a greater number of customers. Since TTCL and ZANTEL have witnessed a sharp decline in subscriptions, the government, as a fixed-wired broadband service provider, must take the necessary steps to increase the subscriptions.

5.2 Conclusion and Recommendations

Tanzania's issue of unemployment may be alleviated by the growing sector of financial technology. Fintech has involved many people from all over the world, including Tanzania, and has had a positive impact on both the national economy and per capita growth. Internet memberships climbed to 31.1 million, telecom subscribers from 56.2 million to 58.1 million, and mobile money users from 37.4 million to 39.59 million. The increases indicate a positive impact on Tanzania's economic growth. (TCRA Tanzania, 2022).

The study shows that fintech is a broad field, and other research should be conducted to determine other fintech gains for national economic growth. Due to time and data constraints, this study does not include all fintech products. The next research study may include subscriptions to mobile money, online TV, online broadcasting services, satellite broadband, fibre-to-the-home or building, postal and courier services, and software product business subscriptions.

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