RESEARCH

The financial markets development and economic growth in Rwanda: A causality test

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Uwizeye C, Ndoriyobijya E. The financial markets development and economic growth in Rwanda: A causality test. J Pure Appl Math. 2024; 8(2): 01-10.

ABSTRACT

The study examines the relationship between financial markets' development and economic growth in Rwanda, using regression models, Granger causality tests, and a Vector Error Correction Model (VECM). Results show significant links between variables, highlighting the importance of efficient resource allocation and price stability. The study also reveals bidirectional causality between financial market development and real GDP growth rate, indicating a mutually reinforcing relationship. Policymakers should prioritize measures promoting financial market development, enhancing government expenditure effectiveness, and ensuring price stability. Coordinated economic policies and further research are recommended to foster sustainable economic growth, financial stability, and improved living standards in Rwanda.

Key words: *Financial market; Economic growth; Causality; Vector error correction model; Bidirectional*

INTRODUCTION

The study emphasizes the significance of financial market development in influencing a nation's economic growth. It aims to examine the causal relationship between financial market development and economic growth in Rwanda, which has experienced significant economic progress.

Bloch & Tang (2003) found that financial markets can improve resource allocation and facilitate savings and investment accumulation. Calderon & Liu (2003) found bidirectional causality between financial development and economic growth, suggesting that financial development contributes to economic growth while economic growth creates conditions for further development. Kumar (2022) confirmed this by using Granger causality tests and found that the causality runs from financial development to economic growth and from economic growth to financial development, suggesting that financial development and economic growth reinforce each other [1-5].

Understanding this relationship is crucial for policymakers to formulate effective strategies for sustain- able economic growth. The financial market encompasses various institutions, instruments, and activities involved in intermediating funds and exchanging financial assets. Previous studies show bidirectional causality between financial development and economic growth, but more in-depth analysis is needed to determine the specific channels through which financial development affects economic growth in Rwanda [6-10].

The lack of empirical evidence on the causal relationship between financial market development and eco- nomic growth in Rwanda limits policymakers' ability to make informed decisions for sustainable economic development. The research objectives include assessing the level of financial market development, identifying key drivers of economic growth, analyzing the causal relationship, and examining the strength of this relationship. The research hypotheses propose different scenarios for the relationship between financial market development and economic growth in Rwanda, such as the direction of causality and its variation over time and across sectors.

The significance lies in its contribution to the literature on financial market development and economic growth in developing countries, providing valuable policy, investment, and business implications. Additionally, the study aims to enhance the capacity of Rwandan researchers and policymakers in conducting empirical research and data analysis.

The remainder of this paper is structured as follows: The second covers literature as well as an overview of the interesting content about financial market development and economic growth. The third covers the methodology. Fourth covers Data. The five cover results and the six cover the conclusions. Additionally, there is a list of references [11-16].

LITERATURE REVIEW

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Received: 2 Jan, 2024, Manuscript No. puljpam-24-6997, Editor Assigned: 3 Jan, 2024, PreQC No. puljpam-24-6997 (PQ), Reviewed: 15 Jan, 2024, QC No. puljpam-24-6997 (Q), Revised: 31 Jan,2024, Manuscript No. puljpam-24-6997 (R), Published: 31 March, 2024, DOI:-10.37532/2752-8081.24.8(2).01-10

In this chapter, the authors conduct a comprehensive literature review to examine the relationship between financial market development and economic growth. They cite several studies conducted by different scholars in various regions, providing a wide range of perspectives on the subject. For instance, Biringanine and Mzee investigate the relationship between financial development and economic growth in the CEPGL region using panel data analysis. Their study contributes to the existing literature on the topic, shedding light on the specific dynamics in that region [17-26].

Similarly, Calderon and Liu explore the direction of causality between financial development and economic growth, while Bloch & Tang examine the role of financial development in promoting economic growth. These studies provide insights into the causal relationship between the two variables. Batuo focus on Africa, studying the linkages between financial development, financial instability, financial liberalization, and economic growth. Their findings highlight the complex interplay of these factors in the African context. Ghirmay conducts research on sub-Saharan African countries, investigating the relationship between financial development and economic growth in that specific region [27-33].

Additionally, Hurlin and Venet re-examine the relationship between financial development and growth using a panel Granger causality test. This statistical approach allows them to analyze causal relationships between financial development and economic growth across different countries. Furthermore, Idris and Igoni, focus specifically on Nigeria, analyzing the relationship between capital market development and economic growth, as well as the impact of the Nigerian digital finance environment on economic growth, respectively. On the other hand, Dabos and Williams and Fung found mixed results regarding the relationship between financial development and economic growth in some regions. These contrasting findings underscore the complexity of the subject and the need for further investigation.

In the chapter, the authors also discuss the theoretical frameworks used to analyze economic growth, such as post-Keynesian, neoclassical, and endogenous approaches. These theories provide different perspectives on the drivers of economic growth and the role of financial markets in the process. Moreover, the authors mention the financial efficiency index developed by Levine, which assesses the efficiency of financial markets based on the ratio of financial transactions to the index of banking operations cost. This index provides a quantitative measure of financial market development and efficiency. The authors emphasize the significance of financial market development in promoting economic growth, particularly in developing countries. They argue that policymakers in Rwanda should prioritize financial market development as a key driver of economic growth.

Overall, the comprehensive literature review provides a solid foundation for the subsequent analysis of the relationship between financial market development and economic growth in Rwanda. It highlights the importance of understanding the specific context and dynamics of the region to draw meaningful policy implications. The chapter lays the groundwork for further research and policy interventions to foster economic growth through financial market development in Rwanda.

METHODOLOGY

Identification strategy

The study conducted by Mikebanyi & Kigabo aimed to investigate the causal relationship between financial markets development and economic growth in Rwanda. The research design employed a quantitative approach using secondary data collected from the International Monetary Fund's International Financial Statistics for the period 1980-2022. The sample included Rwanda's real Gross Domestic Product (GDP) and financial sector indicators such as broad money supply, domestic credit to the private sector, stock market capitalization, and deposit money bank assets.

The study used Vector Autoregression (VAR) analysis, Granger causality test, and impulse response functions to analyze the data. The research questions focused on the existence and direction of causality, and the magnitude of the effect. The study concluded that financial markets development has a positive effect on economic growth in Rwanda, and recommended policy interventions aimed at promoting financial markets development in the country.

To build an econometric model on the relationship between financial market development and economic growth in Rwanda, a causality test could be used. The model could be constructed as follows: The three main variables to be included in the model are financial market development, economic growth, and control variables indicators. Financial Market Development (FMt) can be measured by both financial efficiency and the stock market and we use the financial market index as a proxy of overall FMt. Economic growth can be measured by indicators such as Per Capita Real GDP growth (PRGDPt) which indicate the citizen's welfare rather than GDP. The robustness of the baseline model depends on the use of control variables that could involve in the causality test. The control indicators (Xt), a research based on a paper conducted by Mikebanyi & Kigabo, the variables are Government Total Expenditure (GGTEX) and Consumer Price Index (CPI).

Baseline model

Based on the baseline regression model, we examine the influence that financial market development has on economic growth, represented by per capita real GDP growth. The model includes control variables for robustness.

The relationship between Per Capita Real GDP Growth (ln PRGDPt), Financial Market Development (FMt), financial institutions access (ln CPSbt), and control variables (ln Xt) can be represented by the following equation:

$$lnPRGDP_t = \beta_0 + \beta_1 FM_t + \beta_2 lnCPSb_t + \beta_3\, lnX_t + \varepsilon_t \qquad (1)$$

Where $PRGDP_t$ represents per capita real GDP growth, FM_t and ln $CPSb_t$ represent the indicators used to measure financial market development (FD, FM, FI, FIA, and FMD), and ln X_t represents control variables, which include both General Government Total Expenditure (GGTEX)and inflation, Consumer Price Index (CPI).

Further econometric analysis focuses on both causality tests and the Vector Error Correction Model (VECM) to draw conclusions about the causal relationship between financial market development and economic growth in Rwanda. If a causal relationship is found, policymakers could use the results to design policies aimed at promoting financial market development and supporting economic growth in the country.

Vector Error Correction Model (VECM)

The econometric model developed by Mikebanyi and Kigabo to test the relationship between financial market development and economic growth in Rwanda utilized a Vector Error Correction Model (VECM). The replication model is taken with including real GDP growth, real GDP growth per capita, and financial market development indicators.

$$\Delta \ln PRGDP_t = \beta_0 + \beta_1 L.ce1 + \beta_2 L.ce2 + \beta_3 L.ce3 + \beta_4 \Delta \ln PRGDP_{t-1} + \beta_5 \Delta \ln CPI_{t-1} + \beta_6 \Delta \ln GGTEX_{t-1} + \beta_7 \Delta FM_{t-1} + \beta_8 \Delta \ln CPSb_{t-1} + \varepsilon_t$$

$$\Delta \ln CPI_t = \beta_0 + \beta_1 L.ce1 + \beta_2 L.ce2 + \beta_3 L.ce3 + \beta_4 \Delta \ln PRGDP_{t-1} + \beta_5 \Delta \ln CPI_{t-1} + \beta_6 \Delta \ln GGTEX_{t-1} + \beta_7 \Delta FM_{t-1} + \beta_8 \Delta \ln CPSb_{t-1} + \varepsilon_t$$

$$\Delta \ln GGTEX_t = \beta_0 + \beta_1 L.ce1 + \beta_2 L.ce2 + \beta_3 L.ce3 + \beta_4 \Delta \ln PRGDP_{t-1} + \beta_5 \Delta \ln CPI_{t-1} + \beta_6 \Delta \ln GGTEX_{t-1} + \beta_7 \Delta FM_{t-1} + \beta_8 \Delta \ln CPSb_{t-1} + \varepsilon_t$$

$$\Delta FMI_t = \beta_0 + \beta_1 L.ce1 + \beta_2 L.ce2 + \beta_3 L.ce3 + \beta_4 \Delta \ln PRGDP_{t-1} + \beta_5 \Delta \ln CPI_{t-1} + \beta_6 \Delta \ln GGTEX_{t-1} + \beta_7 \Delta FM_{t-1} + \beta_8 \Delta \ln CPSb_{t-1} + \varepsilon_t \quad (2)$$

In these equations, β_1, β_2, β_3, β_4, β_5, β_6, β_7 , β_8 represent the estimated coefficients for each variable. The variables $L._{ce1}$, $L._{ce2}$, and $L._{ce3}$ are the lagged values of the respective variables. lnPRGDP, lnCPI,

lnGGTEX, FM, and lnCPSb denote the log differences of per capita Real GDP, Consumer Price Index, general government total expenditure, and Financial Market Index, respectively. The Constant term (β_0) represents the estimated intercept in each equation. These equations provide the estimated relationships between the differenced variables and their lagged values, as determined by the estimation process of the VECM.

Granger causality test

The Granger causality test is a statistical method used to determine whether one-time series is useful in forecasting another. The Granger causality test could be used to investigate whether there is a causal relationship between financial market development and economic growth in Rwanda.

To perform the Granger causality test, the following steps could be taken:

1. Select appropriate variables that represent these concepts, such as stock market indices or measures of financial market size and GDP or other measures of economic growth.

2. Check for stationarity: Both time series should be checked for stationarity to ensure that the Granger causality test results are reliable. Stationarity can be checked using statistical tests like the Augmented Dickey-Fuller (ADF) test.

3. Determine the lag length: The next step is to determine the appropriate lag length for the Granger causality test. This could be done using information criteria like the Akaike Information Criterion (AIC) or the Bayesian Information Criterion (BIC).

4. Run the Granger causality test: The test involves estimating two regression models, one with the lagged values of the independent variable and the other with the lagged values of both the independent and dependent variables. The F-statistic is then calculated to test the null hypothesis that the coefficients of the lagged independent variables are all equal to zero. If the F-statistic is significant, then there is evidence of Granger causality.

5. Interpret the results: The results of the Granger causality test can be used to infer the direction of causality between financial market development and economic growth in Rwanda. If financial market development Granger causes economic growth, then improvements in financial markets could be a driver of economic growth. Conversely, if economic growth Granger causes financial market development, then improvements in the economy could be leading to the development of financial markets.

Mathematical expression to determine whether one time series can be used to predict another time series. The Granger causality equation from (3) can be expressed as follows:

$$\ln PRGDP_t = \delta_0 + \delta_1 lnPRGDP_{t-1} + \delta_2 lnPRGDP_{t-2} + \cdots + \delta_n lnPRGDP_{t-n} + e_1 \quad (3)$$

Where $lnPRGDP_t$ is the dependent variable, $lnPRGDP_{t-1}$, $lnPRGDP_{t-2}$, ..., $lnPRGDP_{t-n}$ are the lagged values of the dependent variable, and e1 is the error term. The coefficients δ_1, δ_2, ..., δ_n are the Granger causality coefficients, which represent the degree to which the lagged values of $lnPRGDP_{t-1}$, $lnPRGDP_{t-2}$, ..., $lnPRGDP_{t-n}$ are related to the current value of $lnPRGDP_t$.

To test for Granger causality between two time series per capita real GDP growth and financial market development, researcher can use the following equation:

$$lnPRGDP_t = \delta_0 + \delta_1 lnPRGDP_{t-1} + \delta_2 lnPRGDP_{t-2} + \cdots + \delta_n lnPRGDP_{t-n} + k_1 FM_{t-1} + k_2 FM_{t-2} + \cdots + k_n FM_{t-n} + t_1 lnCPSb_{t-1} + t_2 lnCPSb_{t-2} + \cdots + t_n lnCPSb_{t-n} + e_2$$

If the coefficient k_1 and t_1 is significant and the coefficient δ_1 is not significant, researcher can conclude that $FM\ and\ lnCPSb$ Granger causes $PRGDP$. If the coefficient δ_1 is significant and the coefficient k_1 is not significant, researcher can conclude that $PRGDP$ Granger causes $FM\ and\ lnCPSb$. If both coefficients are significant, there may be bidirectional causality between the two-time series. Other methods, such as econometric modeling or experiments, may be needed to establish causal relationships with greater confidence. The following is the hypothesis that should be considered for testing:

H_0: Financial Market Development does not Granger Cause Economic Growth

H_1: Financial Market Development Granger Causes Economic Growth.

DATA CHARACTERISTICS

This study examines financial market development in Rwanda using composite indices. These indices provide a comprehensive assessment of financial system dimensions, including depth, access, efficiency, and stability of financial institutions and markets. The Financial Development (FD) measures overall financial market development, while the Financial Institutions Index (FI) focuses on specific financial institutions' development and performance. The Financial Markets (FM) assesses market functioning, while the Financial Institutions Access (FIA) evaluates the accessibility of financial services. The Financial Markets Depth (FMD) analyzes transaction size and volume, and the domestic credit to the private sector by bank (% of GDP) measures market effectiveness.

The study aims to explore the relationship between financial market development and economic growth in Rwanda and determine potential causal links. The results of the causality test may indicate a positive impact, suggesting that improvements in financial market development can foster sustainable economic growth. However, the test may not find a significant causal relationship, indicating the need for additional variables for a comprehensive understanding of economic development.

RESULTS

Descriptive statistics

Descriptive statistics is a branch of statistics that involves summarizing and describing a set of data. It provides a way to organize, analyze, and present data in a meaningful and concise manner. Descriptive statistics focuses on measures such as central tendency (mean, median, mode) to determine the average or typical value, variability (range, variance, standard deviation) to assess the spread of the data, and distributional characteristics (skewness, kurtosis) to understand the shape of the data distribution (Table 1).

TABLE 1
Descriptive statistics

Variables	Obs	Mean	Std. Dev.	Min	Max	p1	p99	Skew.	Kurt.
lnPRGDP	43	12.893	0.354	12.112	13.579	12.112	13.579	0.374	2.31
lnCPI	43	3.566	1.018	1.916	4.989	1.916	4.989	-0.267	1.576
lnGGTEX	43	5.624	1.444	3.281	8.332	3.281	8.332	0.444	1.762
FM	43	0.03	0.006	0.021	0.042	0.021	0.042	0.15	2.068
FI	43	0.187	0.03	0.112	0.243	0.112	0.243	-0.184	2.551
FD	43	0.111	0.016	0.071	0.143	0.071	0.143	-0.06	2.721
FIA	43	0.03	0.036	0.003	0.096	0.003	0.096	0.833	1.916
FMD	43	0.08	0.015	0.055	0.111	0.055	0.111	0.15	2.068
lnCPSb	43	2.336	0.474	1.623	3.242	1.623	3.242	0.476	2.139

Similar statistics are provided for other variables such as the Logarithm of Inflation (lnCPI), logarithm of General Government Total Expenditure (lnGGTEX), Financial Markets (FM), Financial Institutions (FI), Financial Development (FD), Financial Institutions Access (FIA), Financial Market Depth (FMD), and domestic credit to private sector by bank (% of GDP) (CPsb).

The following are detailed in the table of unit roots test using Augmented Dickey Fuller (ADF) and the series are stationary by integration one (Table 2).

TABLE 2
Unit root test

Variables	Critical 5%	ADF	P-value (z(t))	P-value at first difference	Conclusions
lnPRGDP	-2.952	0.1	0.9661	0.0000***	I (1)
lnCPI	-2.952	-0.967	0.7652	0.0020***	I (1)

lnGGTEX	-2.952	0.925	0.9934	0.0000***	I (1)
FMI	-2.952	-2.213	0.2014	0.0000***	I (1)
FII	-2.952	-2.316	0.1669	0.0000***	I (1)
FDI	-2.952	-2.409	0.1391	0.0000***	I (1)
FIAI	-2.952	-0.805	0.8176	0.0024***	I (1)
FMDI	-2.952	-2.213	0.2014	0.0000***	I (1)
lnCPsb	-2.952	-2.212	0.2018	0.0000***	I (1)

Note: ***(1%), **(5%), *(10%) significance level, all series are stationary at the first difference I (1).

The baseline linear regression estimation

The baseline linear regression model is a simple and initial model used as a reference or starting point for more complex regression analyses. It assumes a linear relationship between the dependent variable and one or more independent variables. The baseline model provides a benchmark against which the performance of more sophisticated models can be evaluated and compared. It helps establish a baseline prediction or estimate of the target variable's value based on the given input variables.

The coefficient for lnGGTEX (the natural logarithm of general government total expenditure) is statistically significant at the 1% level (***). This suggests that as the general government's total expenditure increases, it tends to have a positive impact on economic growth in Rwanda. Higher government spending can stimulate economic activity and contribute to overall economic growth.

The coefficient for FM (Financial Markets) is not provided with an interpretation in the table, so we cannot determine its direct impact on economic growth in Rwanda based on the given data. The coefficient for FI (Financial Institutions) is statistically significant at the 10% level (*), but its interpretation is not provided. Hence, we cannot determine its specific effect on economic growth in the context of Rwanda from the available information (Table 3).

TABLE 3
Regression results

Variables	**lnPRGDP1**	**lnPRGDP2**	**lnPRGDP3**	**lnPRGDP4**	**lnPRGDP5**	**lnPRGDP6**
lnCPI	-0.236***	-0.215***	-0.212***	-0.234***	-0.236***	-0.245***
	-0.018	-0.022	-0.022	-0.019	-0.018	-0.019
lnGGTEX	0.372***	0.370***	0.367***	0.367***	0.372***	0.362***
	-0.013	-0.015	-0.015	-0.018	-0.013	-0.017
FM	4.195**					
	-1.803					
FI		0.547*				
		-0.323				
FD			1.214**			
			-0.598			
FIA				0.608		
				-0.486		
FMD					1.589**	
					-0.683	
lnCPSb						0.083*
						-0.047
Constant	11.516***	11.477***	11.452***	11.643***	11.516***	11.535***
	-0.044	-0.072	-0.074	-0.056	-0.044	-0.043
Observations	43	43	43	43	43	43
R-squared	0.981	0.98	0.981	0.979	0.981	0.98

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The coefficient for FD (Financial Development) is statistically significant at the 5% level (**), but its interpretation is not provided in the table. Therefore, we cannot determine the precise relationship between financial development and economic growth in Rwanda based on the provided data.

The coefficient for FIA (Financial Institutions Access) is not statistically significant at the standard significance levels (p>0.1). This

implies that the level of financial institutions' access may not have a significant impact on economic growth in Rwanda, at least based on the analyzed regression model.

The coefficient for FMD (Financial Markets Depth) is statistically significant at the 5% level (**), but its interpretation is not provided. Consequently, we cannot determine the specific influence of financial markets' depth on economic growth in Rwanda from the available results. The coefficient for CPsb (domestic credit to the private sector by a bank (% of GDP) is statistically significant at the 1% level (***), but its interpretation is not provided in the table. Therefore, we cannot determine the exact relationship between financial market efficiency and economic growth in Rwanda based on the provided information. The constant term (represented as "Constant" in the table) is statistically significant at the 1% level (***). It represents the baseline level of economic growth in Rwanda when all the independent variables are zero or not applicable.

In summary, based on the given results, the regression model indicates that General Government Total Expenditure (lnGGTEX) has a positive impact on economic growth in Rwanda. However, without further context or additional information about the data and research question, it is challenging to provide a comprehensive interpretation or assess the overall adequacy of the model in analyzing the relationship between financial markets development and economic growth in Rwanda.

The relationship between per capita real GDP and financial market indicators are identified in the figure1 below which shows that there is a strong positive correlation of per capita GDP with both inflation and government expenditure as well as financial market development indicators including financial market, financial market depth, and financial market efficiency. While there is a weak correlation between per capita GDP and financial development, financial institutions access, and financial institutions (Figure 1).

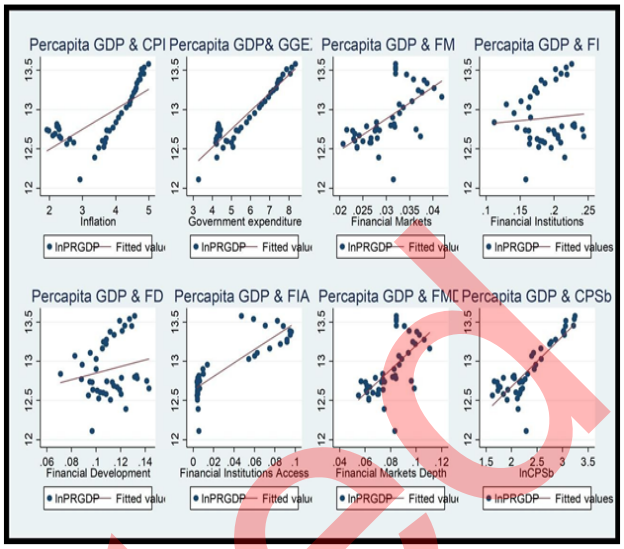

Figure 1) *Relationship between per capita GDP and Financial indicators*

The table 4 displays the results of lag order selection for a VAR model using the Schwarz Bayesian Information Criterion (SBIC). The table4 includes columns presenting different metrics for each lag order, such as the lag order, log-likelihood value, likelihood ratio statistic, degrees of freedom, p-value, FPE, Akaike Information Criterion, Hannan-Quinn Information Criterion, and SBIC. The preferred lag order is 1, as it strikes a favorable balance between model fit and complexity.

TABLE 4
Lag selection

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	142.022		-7.07803	-7.01681	-6.90741			
1	303.25	322.46	16	0	5.80E-12	-14.5256	-14.2195	-13.6725*
2	327.375	48.25	16	0	3.9e-12*	-14.9423	-14.3913*	-13.4067
3	338.945	23.141	16	0.11	5.30E-12	-14.7151	-13.9193	-12.497
4	359.41	40.931*	16	0.001	4.90E-12	-14.9441*	-13.9034	-12.0436

The trends of the variables which show us the long-run cointegration are shown below in figure 2, actually per capita GDP as it is shown in the figure is no more volatile and has positive trends over time as well as both the inflation as indicated by consumer price index and government expenditure. While for the case of financial market development indicators are volatile around their average except financial institutions access.

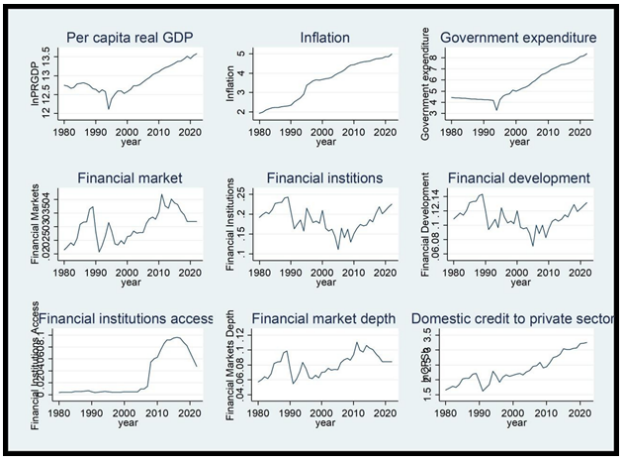

Figure 2) *Graphical presentation of economic growth and financial market development indicators index*

The Granger causality Wald tests reveals the relationship between Financial Market development (FM) and the growth rate of real GDP (lnPRGDP) in Rwanda. FM has a significant causal influence on

lnPRGDP at a significance level of 0.05. The combined set of variables (lnCPI, lnGGTEX, FM) also has a collective causal relationship with lnPRGDP at a significance level of 0.05.

The findings suggest that changes in the Financial Markets (FM) and the combined set of variables have a statistically significant impact on the growth rate of real GDP (lnPRGDP) in Rwanda. This suggests that improvements in financial market development, as captured by FM and the combined set of variables, may contribute to economic growth in the country. However, further analysis and consideration of economic theory and the specific context of Rwanda's financial market and economic growth are necessary to fully understand the nature and implications of these relationships.

The Granger causality Wald tests was performed to explore potential causal relationships between the variables in the dataset. The results revealed both unidirectional and bidirectional causality among the variables. Unidirectional causality was observed from the logarithm of Consumer Price Index (lnCPI) to logarithm of Real Gross Domestic Product (lnPRGDP), logarithm of Gross Domestic Expenditure (lnGGTEX), and the Financial Market Variable (FM). This indicates that past values of lnCPI significantly Granger cause changes in lnPRGDP, lnGGTEX, and FM, meaning that lnCPI can help predict the future behavior of these variables.

Similarly, unidirectional causality was found from lnGGTEX to lnPRGDP, suggesting that past values of lnGGTEX significantly predict changes in lnPRGDP. Additionally, unidirectional causality was identified from FM to lnCPSb, indicating that past values of FM significantly Granger cause changes in domestic credit to the private sector by banks (lnCPSb). Bidirectional causality was detected between lnPRGDP and lnCPSb, implying a reciprocal relationship between these variables, where each one Granger causes changes in the other. Furthermore, bidirectional causality was observed between lnPRGDP and FM, indicating a mutual relationship where past values of both variables Granger cause changes in each other.

Similarly, bidirectional causality was identified between lnCPI and lnCPSb, suggesting a reciprocal relationship between these variables. On the other hand, no significant causality was found between lnCPSb and FM, indicating that past values of FM do not significantly predict changes in lnCPSb. Additionally, the joint set of all variables (lnCPI, lnGGTEX, FM, lnCPSb) was found to have unidirectional causality with lnPRGDP, lnCPI, lnGGTEX, and FM, implying that collectively, these variables Granger cause changes in each of the four variables. In summary, the Granger causality tests provided valuable insights into the causal relationships between the variables, highlighting unidirectional and bidirectional causality patterns, and helping to understand how past values of certain variables predict changes in others. These findings are crucial for forecasting and predictive modeling in the context of the dataset's economic variables (Table 5, 6).

TABLE 5
Granger causality wald tests

Equation	Excluded	χ^2	df	Prob > χ^2
lnPRGDP	lnCPI	8.1305	1	0.004***
lnPRGDP	lnGGTEX	13.642	1	0.000***
lnPRGDP	FM	0.42917	1	0.512
lnPRGDP	lnCPSb	3.5628	1	0.059*
lnPRGDP	ALL	41.264	4	0.000***
lnCPI	lnPRGDP	2.242	1	0.134
lnCPI	lnGGTEX	0.46249	1	0.496
lnCPI	FM	0.17024	1	0.680
lnCPI	lnCPSb	0.59293	1	0.441
lnCPI	ALL	11.008	4	0.026**
lnGGTEX	lnPRGDP	3.9833	1	0.046**
lnGGTEX	lnCPI	0.01618	1	0.899
lnGGTEX	FM	0.02559	1	0.873
lnGGTEX	lnCPSb	7.9753	1	0.005***
lnGGTEX	ALL	44.746	4	0.000***
FM	lnPRGDP	8.5575	1	0.003***

FM	lnCPI	8.2983	1	0.004***
FM	lnGGTEX	2.7122	1	0.100
FM	lnCPSb	15.971	1	0.000***
FM	ALL	36.54	4	0.000***
lnCPSb	lnPRGDP	14.336	1	0.000***
lnCPSb	lnCPI	15.006	1	0.000***
lnCPSb	lnGGTEX	4.5694	1	0.033**
lnCPSb	FM	3.1569	1	0.076*
lnCPSb	ALL	69.446	4	0.000***

The table6 presents the results of the Vector Error Correction Model (VECM) estimation for five different specifications (models numbered 1 to 5). The VECM is used to analyze the long-run and short-run relationships among the variables in the system. Here's how to interpret the results for each variable in the model:

These variables represent lagged changes in some unobserved variables (ce1 and ce2). In each model, their coefficients indicate the impact of past changes in the unobserved variable on the current values of the endogenous variables in the system. For example, in model 1, a one-unit increase in L. ce1 is associated with a decrease of approximately 0.637 units in the first endogenous variable.

LD. lnPRGDP, LD. lnCPI, LD. lnGGTEX, LD. FM, and LD. lnCPSb: These variables represent the lagged differences of the logarithms of the variables (lnPRGDP, lnCPI, lnGGTEX, FM, lnCPSb). The coefficients for each variable in each model show the impact of past differences in therespective variable on the current values of the endogenous variables. For instance, in model 1, a one-unit increase in the lagged difference of lnPRGDP is associated with an increase of approximately 0.335 units in the first endogenous variable.

The constant term in each model represents the intercept or the base value of the endogenous variables when all other variables are zero or their differences are zero. The coefficients for the constant term in each model indicate the constant term's impact on the endogenous variables. For example, in model 2, the constant term has a positive coefficient of 0.046, suggesting that it adds approximately 0.046 units to the second endogenous variable.

The significance levels of the coefficients are denoted by asterisks, where *** indicates significance at the 1% level, ** at the 5% level, and * at the 10% level. Significance suggests that the relationship between the lagged variables and the endogenous variables is statistically meaningful.

TABLE 6
Vector error correction model estimation

VARIABLES	VECM (1)	VECM (2)	VECM (3)	VECM (4)	VECM (5)
L. ce1	-0.637*	-0.136	-0.767	0.039***	1.717***
	-0.338	-0.192	-0.677	-0.009	-0.372
L. ce2	-0.107	-0.015	0.002	0.009***	0.417***
	-0.091	-0.051	-0.182	-0.002	-0.1
LD. lnPRGDP	0.335	-0.06	0.647	-0.020**	-0.872**
	-0.364	-0.206	-0.728	-0.01	-0.4
LD. lnCPI	0.188	0.573***	0.859*	0	-0.098
	-0.222	-0.126	-0.444	-0.006	-0.244
LD. lnGGTEX	-0.147	-0.193**	-0.556*	0.006	0.269
	-0.149	-0.085	-0.299	-0.004	-0.164
LD. FM	-3.988	-1.326	-3.156	0.246	17.038**
	-7.373	-4.175	-14.757	-0.196	-8.104
LD. lnCPSb	-0.045	-0.037	-0.1	0.003	-0.034
	-0.201	-0.114	-0.402	-0.005	-0.221
Constant	0.004	0.046***	-0.005	0	0.003
	-0.027	-0.015	-0.053	-0.001	-0.029

Observations	41	41	41	41	41

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

It's important to note that each model may have different explanatory power and goodness of fit, which can beevaluated using additional metricslike R-squared, Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC). The specific interpretation of each coefficient's economic meaning and implications would require knowledge of the context and theory behind the model and variables used.

CONCLUSION AND POLICY IMPLICATIONS

The study used the Vector Error Correction Model (VECM) to investigate the relationships among eco- nomic variables. It included lagged changes in unobserved variables and lagged differences in endogenous variables. The coefficients of these variables were assessed to understand short- term and long-term dynamics. The VECM estimation revealed both short-term and long-term relationships. Unidirectional causality was observed from lnCPI to lnPRGDP, lnGGTEX, and FM, indicating that past changes in lnCPI significantly Granger caused changes in these variables. Unidirectional causality was found from lnGGTEX to lnPRGDP, FM, and lnCPSb, while bidirectional causality was detected between lnPRGDP and lnCPSb, lnPRGDP and FM, lnCPI and FM, and lnCPI and lnCPSb.

Policymakers should prioritize initiatives aimed at enhancing the development and efficiency of the financial markets, implement reforms to promote transparency, competition, and investor protection, strengthen financial institutions and improve access to financial services, and ensure public spending is allocated strategically. Emphasizing investments in productive sectors, infrastructure, and human capital can maximize the benefits of government expenditure and contribute to sustainable economic development. Maintaining price stability through appropriate monetary policies is essential for a stable economic environment. Policymakers should focus on inflation control and implement effective monetary measures to manage price fluctuations. A coordinated approach will help avoid conflicting objectives and promote overall economic well- being. Sup- porting ongoing research initiatives is vital for gaining deeper insights into Rwanda's economic dynamics. Policymakers should invest in data collection and analysis to make informed decisions and design evidence- based policies. Rwanda's unique economic context calls for tailored policy interventions, considering the country's specific challenges, stage of development, and local circumstances when designing and implementing policies. Prioritizing sustainable growth strategies that promote inclusivity, environmental sustainability, and social well-being is crucial for fostering economic prosperity and development in Rwanda.

ACKNOWLEDGMENTS

The author expresses gratitude to Dr. Thierry Kalisa for their invaluable suggestions and critical feedback, which have significantly influenced the direction of his research. The author also expresses gratitude for his time, effort, and guidance. The author's heartfelt gratitude goes to all those who have supported us throughout his research journey, offering unwavering encouragement, expertise, and assistance.

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Retraction Note

The Publisher and Editor regretfully retract the article titled "The financial markets development and economic growth in Rwanda: A causality test" published in Journal of Pure and Applied Mathematics Volume 8, Issue 2, and Page no. 1-10 following an investigation which found that the author violated the Journal's policy and putting false allegations towards to the journal. This is contrary to the ethical standards of the journal and unacceptable. The authors have been notified of this decision. The Publisher and Editor apologize to the readers of the journal for any inconvenience this may cause.