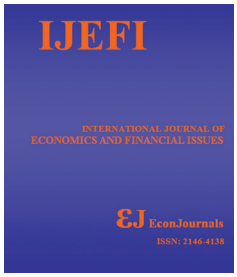

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Causal Relationship between Economic Growth and Macroeconomic Interactions

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ABSTRACT

This study examines the causal relationship between economic growth and the interplay of money supply, interest rate, and gross domestic product growth rate in Botswana, Namibia, South Africa, Zambia, and Zimbabwe using panel data from 2010 to 2024. Employing Granger causality method, the results reveal no significant causal link between economic growth and the interactions of these monetary variables. This suggests that changes in money supply, interest rates, and GDP growth rate do not predict changes in economic growth, and vice versa. The findings have important implications for policymakers, indicating a more complex relationship between economic growth and monetary variables than previously assumed. The absence of causality may imply that other factors, such as institutional or structural elements, play a more crucial role in driving economic growth in these SADC Countries.

Keywords: Inflation, Money Supply, Economic Growth, Interactions
JEL Classification: O47, O42, O430

1. INTRODUCTION

Economic growth is a fundamental objective of macroeconomic policy, profoundly impacting individual and societal well-being. It drives poverty reduction, improves living standards, and increases economic opportunities (Llena-Nozal et al., 2019, Acemoglu and Robinson, 2008). As an economy grows, new jobs are created, incomes rise, and governments can invest in essential public services like healthcare, education, and infrastructure (Barro, 1991; Agenor and Montiel, 2015).

Economic growth enables individuals to improve their economic circumstances, invest in their future, and enjoy a higher quality of life (Samli, 2010; Murgaš and Böhm, 2015). It also generates government revenue, which can fund public goods and services benefiting society (Odinakachi et al., 2021; Roşoiu, 2015). Furthermore, economic growth reduces poverty and inequality by creating opportunities for marginalized groups to participate in the economy (Labeeque and Sanaullah, 2019; Boarini et al., 2018).

Economic growth is essential for achieving sustainable development, enabling investments in sustainable infrastructure, renewable energy, and green technologies (Stern, 2020). It provides resources to address pressing social and environmental challenges, such as improving access to education and healthcare, and promoting sustainable agriculture and resource management. Understanding the determinants of economic growth is crucial for policymakers, researchers, and practitioners seeking to promote sustainable economic development and improve well-being (Llena-Nozal et al., 2019; Cristea et al., 2021). Exploring the causality relationship between economic growth and interactions of money supply, interest rate, and GDP growth rate is crucial because it helps policymakers understand the transmission mechanisms of monetary policy and its impact on economic activity. By identifying the causal links between these variables, policymakers can design more effective monetary policies to stimulate economic growth, control inflation, and maintain financial stability, ultimately informing decisions on interest rates, money supply, and other macroeconomic factors that influence economic performance.

The study investigates the causal relationship between economic growth and interactions of money supply, interest rate, and GDP growth rate in selected African countries using panel data for the period 2010-2024.

2. BACKGROUND OF THE STUDY

Economic growth has been a persistent challenge for many African countries, despite the implementation of various macroeconomic policies and strategies. Empirical evidence suggests that economic growth in Africa has been volatile and unsustainable, with many countries experiencing fluctuations in growth rates over the years (Collier and Gunning, 1999; Arbache and Page, 2010). For instance, some countries have experienced periods of rapid growth, only to be followed by sharp declines, highlighting the need for a more nuanced understanding of the determinants of economic growth in the region. Furthermore, the growth experiences of African countries have been heterogeneous, with some countries achieving sustained growth while others have struggled to achieve consistent growth (Ndulu et al., 2008).

The empirical literature has identified several factors that contribute to the challenges of achieving sustainable economic growth in Africa, including inadequate infrastructure, poor governance, and limited access to finance (Calderón and Servén, 2004; Ndulu et al., 2008). Additionally, external shocks, such as terms of trade volatility and global economic downturns, have also been shown to have a significant impact on economic growth in African countries (Collier and Gunning, 1999; Deaton, 1999). Despite the importance of understanding the determinants of economic growth, there is still limited consensus on the key drivers of growth in Africa, highlighting the need for further research in this area.

This study makes a novel contribution to the existing literature on economic growth in the SADC region by examining the causal relationship between economic growth and the interactions of money supply, interest rate, and GDP growth rate in five selected African countries, namely Botswana, Namibia, South Africa, Zambia, and Zimbabwe, using panel data from 2010 to 2024, thereby providing new insights into the dynamics of monetary policy transmission in the region and informing evidence-based policy decisions that can help policymakers design more effective strategies to stimulate economic growth, control inflation, and maintain financial stability in the SADC region.

The African continent has experienced varied economic growth rates over the past few decades, with some countries making progress while others continue to face significant development challenges, including poverty, inequality, and limited economic opportunities. Economic growth is crucial for addressing these challenges and improving African citizens' well-being (Acemoglu and Robinson, 2019; Easterly, 2002). Various factors have influenced economic growth in Africa, including natural resource endowments, institutional quality, and global economic trends (Collier and Gunning, 1999; Epo and Nochi, 2020).

Moreover, economic growth enables governments to invest in essential public services like healthcare, education, and infrastructure, critical for human development. Despite its importance, the factors driving economic growth in Africa remain poorly understood. Existing studies have identified potential determinants, including institutional quality, human capital, and infrastructure (Alonso and Garcimartín, 2013).

Notably, previous studies have neglected the impact of macroeconomic variables and their interactions on economic growth. This study bridges this knowledge gap by investigating the causal effects of key macroeconomic variables, including money supply, interest rates, unemployment, and exchange rate, as well as their interactions, on economic growth in selected African countries, thereby providing a more comprehensive understanding of the drivers of economic growth in these nations.

Guided by the neoclassical growth model (Solow, 1999), this study will analyze relationships between macroeconomic variables and economic growth, identifying potential policy implications for sustainable economic development in selected African countries.

3. LITERATURE REVIEW

Economic growth can be measured using various indicators, including Gross Domestic Product (GDP), GDP per capita, GDP growth rate, and real GDP. These measures offer distinct perspectives on economic growth, each with its strengths and limitations. National income and value added are also used to capture specific aspects of economic activity. Economic growth theories, including classical, neoclassical, and endogenous growth models, seek to explain the drivers of economic development. These theories converge on the importance of factors like capital accumulation, labor, and technological progress in fostering economic growth (Cvetanović et al., 2019; Sredojević et al., 2016). However, they diverge in their approaches and assumptions, with neoclassical theory attributing technological progress to external factors (Romer, 1989) and endogenous growth theory emphasizing internal factors like human capital and knowledge (Lucas, 1988; Aghion and Howitt, 2021).

While economic growth theories originated in developed nations, their applicability to developing countries is limited due to differences in institutional contexts and development stages (Ocampo, 2003). Nevertheless, these theories can provide valuable insights if adapted to the unique challenges and opportunities of developing countries. Economists are now stressing the need for context-specific theories, highlighting the role of institutional factors, human capabilities, and freedoms in promoting economic growth (Okunlola and Ayetigbo, 2022; Serbina et al., 2024).

Despite extensive research on economic growth, few studies have examined the causal effect of interactions between macroeconomic variables, particularly in developing nations. Recent studies have overlooked the influence of the interaction between money supply, interest rate, and GDP growth rate on economic growth, warranting further investigation to inform effective economic growth strategies in developing nations. Researchers like Khan and Senhadji (2001), Loayza and Ranciere (2006), and more recent authors have emphasized the role of macroeconomic

variables, but the specific interplay between these variables remains underexplored.

4. MATERIALS AND METHODS

This study uses panel Granger causality tests to explore the causal relationship between economic growth and the interactions of money supply, interest rate, and growth rate in five Southern African countries (Botswana, Namibia, South Africa, Zambia, and Zimbabwe) from 2010 to 2024. The panel data setting allows for examination of dynamic relationships, accounting for cross-sectional and temporal variations.

The countries were selected through purposive sampling based on data availability and economic significance. Annual macroeconomic data from the World Economic Forum's datasets were utilized. While the sampling approach was non-random, the selected countries represent diverse economic profiles.

The analysis reveals skewness in economic growth and the interaction term between monetary variables, indicating occasional periods of rapid growth or slowdowns. Positive skewness suggests significant economic booms, while negative skewness implies more frequent economic instability due to policy misalignments or external shocks.

To ensure the reliability and accuracy of the regression results, the study conducted diagnostic tests for normality, heteroscedasticity, multicollinearity, and unit root to verify the absence of bias and confirm the validity of the findings. Equation 1 was then employed to test for causality from the interactions of money supply, interest rate, and GDP growth rate to economic growth.

$$\blacktriangle EG_{it} = \S_1 + \sum_{k=1}^{p} \beta_{i,k} \blacktriangle EG_{i,t-k} + \sum_{k=1}^{p} \Upsilon_{i,k} \blacktriangle MIG_{i,t-k} + \varepsilon_{i,t} \quad (1)$$

The variables are defined as follows: EG represents Economic Growth, MIG is the Money Supply-Interest Rate-GDP Growth Rate Index, ε is the error term capturing random shocks, t denotes the time period, i represents the country index in the sample, $\S_1$ is the country-specific fixed effects, and β and Ɏ are the coefficients to be estimated, ▲ denotes the change in each variable, with p being the lag length.

To examine the causal relationship from the interactions of money supply, interest rate, and GDP growth rate to economic growth, the study utilized Equation 2.

$$\blacktriangle MIG_{it} = \wp_1 + \sum_{k=1}^{p} \theta_{i,k} \blacktriangle MIG_{i,t-k} + \sum_{k=1}^{p} \varnothing_{i,k} \blacktriangle EG_{i,t-k} + V_{i,t} \quad (2)$$

Where: $\wp_1$ is the country-specific fixed effects, and θ and Ø are the coefficients to be estimated. Other variables are as previously defined.

4.1. Measurement of Variables

Economic growth, measured as the percentage change in Gross Domestic Product (GDP), represents the expansion of a country's economy (Kuznets, 1971). It is a crucial indicator of a nation's economic performance and standard of living (Barro, 1991). Economic growth reflects the increase in production and consumption of goods and services, leading to improved living standards and reduced poverty (Hess, 2016). Understanding its determinants is vital for policymakers to formulate effective strategies for sustainable development.

Money supply refers to the total amount of money circulating in an economy, including currency in circulation and bank deposits (Friedman and Schwartz, 1965). Measured using monetary aggregates like M2 (Mishkin and Eakins, 2019), money supply affects inflation, interest rates, and economic activity (Taylor, 1995). An increase in money supply can stimulate economic growth by increasing aggregate demand, but excessive money supply can lead to inflation (Romer, 1989). Central banks use monetary policy tools to regulate money supply and achieve macroeconomic objectives.

Interest rate, measured as the cost of borrowing or the return on savings, influences consumption, investment, and savings decisions (Fisher, 1930). Interest rates affect the cost of capital, influencing investment and economic growth (Taylor, 1995). Low interest rates can stimulate economic activity by increasing borrowing and spending, while high interest rates can reduce borrowing and spending, curbing inflation (Romer, 1989). Central banks use interest rates as a monetary policy tool to regulate economic activity and control inflation.

The interaction variable, measured using the multiplicative approach, captures the combined effect of money supply, interest rate, and GDP growth rate. This approach provides a nuanced understanding of how these variables interact and influence each other, crucial for informing monetary policy design. By incorporating this interaction term, the study can better capture the contextual influence of these variables on the economy, ultimately providing more robust and policy-relevant insights.

5. RESULTS PRESENTATION AND ANALYSIS

This section presents the study results. The descriptive statistics are presented in Table 1.

The economic growth rate data exhibits a mean of 5.969 and a median of 4.080, indicating a growth trend with potential skewness. The standard deviation of 9.405 reveals significant variability, with growth rates ranging from −8.1 to 60.900. The data is positively skewed (4.185), suggesting occasional periods of rapid growth that pull the mean above the median. The fat tails (kurtosis of 23.141) indicate frequent extreme growth rates, and the Jarque-Bera test strongly rejects normality (P = 0.000). The MIG Index data exhibits a mean of 0.369 and a median of 0.200, with positive skewness (2.844) indicating significant asymmetry and potential extreme events.

The Jarque-Bera test results (P = 0.571) indicate that the data follows a normal distribution, as the null hypothesis of normality cannot be rejected. This suggests that parametric tests can be reliably used for further analysis.

The heteroscedasticity test results indicate that the variance is constant (homoscedastic), as evidenced by: P = 0.6 (>0.05, failing to reject the null hypothesis of homoscedasticity) and the t-value (4.014) is likely a test statistic, but without further context, the P-value is more crucial for interpretation (Table 2). The non-significant P-value (0.6) suggests that there is no evidence of heteroscedasticity, meaning the variance of the residuals is constant across different levels of the independent variable(s). This satisfies a key assumption of many regression models, indicating reliable estimates.

The Pearson Correlation Matrix reveals a strong positive correlation (0.86) between Economic Growth (EG) and the interaction variable (MIG), indicating that as MIG increases, EG tends to increase strongly, suggesting a significant association between economic growth and the interaction of money supply, interest rate, and GDP growth rate (Table 3).

The Pearson correlation matrix reveals relatively low multicollinearity among most variables, with coefficients below 0.8 (Table 4).

Both the MIG Index and Economic growth are stationary at level (I[0]), as revealed by the PP Fisher test, making them suitable for Granger causality testing without requiring differencing, allowing for direct examination of causal relationships between the two variables.

The study's unit root tests using the Phillips-Perron approach revealed that both Economic Growth (EG) and the interaction variable (MIG) are stationary at level, with highly significant probability values (0.0000). This indicates that the variables do not have a unit root and are suitable for further analysis without requiring differencing (Table 5).

Table 1: Descriptive statistics results

Statistic	EG	MIG
Mean	5.969	0.369
Median	4.080	0.200
Maximum	60.900	2.800
Minimum	−8.100	−0.370
Standard deviation	9.405	0.511
Skewness	4.185	2.844
Kurtosis	23.141	12.259
Jarque-Bera	1486.598	369.037
Probability	0	0.000
Observations	75	75

Source: Author's compilations (2025)

Table 2: Heteroscedasticity results

Statistic	Value
P-value	0.6123
T-value	4.014

Source: Author's compilations (2025)

Table 3: Results for Pearson correlation matrix

Variable	EG	MIG
EG	1.00	
MIG	0.86	1.00

Source: Author's compilations (2025)

The Johansen cointegration test results confirm a long-run relationship between the variables, as evidenced by the highly significant Panel PP statistic (−4.327, P = 0.000) and Panel ADF statistic (−2.354, P = 0.010) (Table 6). This suggests that the variables tend to move together over time, justifying the use of error correction models to examine short-run and long-run dynamics.

The Granger causality test results indicate that neither the MIG Index nor Economic Growth (EG) Granger causes the other, as evidenced by the probabilities (0.3305 and 0.2676) exceeding the typical significance level of 0.05 (Table 7). This suggests that past values of one variable do not provide significant information to predict future values of the other, implying that their relationship may be influenced by other factors or is more complex than captured by this analysis.

The absence of Granger causality between the MIG Index and economic growth suggests that the relationship between these two variables is more complex than a simple causal link, arising from factors such as other macroeconomic variables, non-linear relationships, or structural breaks in the economy. Policymakers need to consider these complexities when designing policies related to monetary aggregates and economic growth.

Given this complexity and the limited predictive power of the MIG Index, policymakers may need to explore alternative policy instruments, such as interest rates, reserve requirements, government spending, or taxation, to achieve their economic growth objectives. This approach can help develop a more comprehensive strategy for promoting economic growth and stability.

Moreover, policymakers must consider the specific economic context and other relevant factors when designing policies. This contextual understanding can help develop more effective policies that account for the unique characteristics of the economy and the

Table 4: Pearson Likert scale

Pearson Likert scale	Descriptor
0.00-0.19	Very weak correlation
0.20-0.39	Weak correlation
0.40-0.59	Moderate correlation
0.60-0.79	Strong correlation
0.80-1.00	Very strong correlation

Source: Author's compilations (2025)

Table 5: Unit root test results

Variable	Probability	Level of stationarity
EG	0.0000	At level
MIG	0.0000	At level

Source: Author's compilations (2025)

Table 6: Cointegration test results

Panel statistic	Statistics	Probability	Weighted statistics	Probability
Panel PP statistics	−4.327	0.000	−3.758	0.0001
Panel ADF statistics	−2.354	0.010	−2.277	0.0114

Source: Author's compilations (2025)

Table 7: Granger causality stacked test results

Null Hypothesis:	Obs	F-Statistic	Prob.
MIG does not Granger Cause EG	65	1.127741...	0.33052...
EG does not Granger Cause MIG		1.347475...	0.26764...

Source: Author's compilations (2025)

specific challenges it faces, ultimately leading to more informed decisions that promote economic growth and stability.

Studies have employed a panel Granger causality test to investigate the relationship between innovation, financial development, and economic growth, finding mixed results that indicate a complex relationship between financial development and economic growth (Wesiah and Onyekwere, 2021). In order to ascertain the relationships between innovation, financial development, and economic growth in 49 European nations between 1961 and 2014, Pradhan et al. (2018) used panel unit root and panel cointegration tests. The findings imply that the three series have a cointegrating relationship. Financial development and innovation are both long-term causes of economic growth, according to an estimated vector error-correction model. Using a panel VAR technique, Mtar and Belazreg (2021) investigated the causal association between innovation, financial development, and economic growth for 27 OECD nations between 2001 and 2016. The results showed a unidirectional causal relationship between financial development and economic growth. The neutrality hypothesis is validated between financial development and economic growth, between financial development and innovation, and between innovation and economic growth. Creation of financing for innovation via the patent guarantee deposit. In high-income OECD nations, Guloglu and Tekin (2012) investigated potential causal relationships between R&D spending, innovation, and economic growth. By using the GMM and panel fixed effects methods to estimate a trivariate panel vector autoregressive (VAR) model, they used both pairwise and multivariate causal linkages. The findings of the bivariate panel causality test indicate that while technological innovations Granger cause economic growth, as assumed by endogenous growth theory, R&D expenditures Granger cause innovation as assessed by the number of triadic patents. There is also a reverse causal relationship between innovation and economic growth, meaning that the rate of technical advancement is accelerated by the rate of output increase. The multivariate causality tests also show that while an increase in national output and R&D intensity jointly Granger-cause technical change, market size and innovation rate together Granger-cause R&D activity. These results imply that the "technology-push" and "demand-pull" models of innovation are equally plausible.

Studies by various authors contradict the findings on the relationship between economic indicators and growth. Studies have also established that traditional indicators like GDP distort reality in today's service-oriented economy. It has also been established that there is an asymmetric relationship between corruption control and economic policy uncertainty in European countries, implying strong institutions promote long-term growth Olabisi and Effiong, (2023). Found a significant relationship between socio-economic indicators and economic growth in

Table 8: Pairwise Dumitrescu Hurlin causality robustness test

Pairwise Dumitrescu Hurlin Panel Causality Tests
Date: 06/28/25 Time: 15:32
Sample: 2010 2024
Lags: 2

Null Hypothesis:	W-Stat.	Zbar-Stat.	Prob.
MIG does not homogeneously cause EG	4.3655...	1.007298...	0.31379...
EG does not homogeneously cause MIG	3.2243...	0.330644...	0.74091...

Source: Author's compilations (2025)

Nigeria and South Africa. King and Levine (1993) showed that financial development is correlated with faster economic growth, suggesting finance leads growth, and implying policymakers should prioritize financial development.

The Dumitrescu Hurlin Panel Causality Test results confirm no Granger causality between MIG and EG in either direction, with probabilities of 0.3138 and 0.7409 exceeding the 0.05 significance level (Table 8). This indicates that past values of one variable do not provide significant predictive information for future values of the other. These findings support the stacked causality test results, providing robust evidence of the lack of causal relationship between MIG and EG.

6. CONCLUSION AND RECOMMENDATIONS

The empirical findings suggest that the variables MIG and EG are causally independent, implying that the dynamics of one variable do not Granger-cause the other. This absence of a predictive relationship indicates that policymakers cannot rely solely on MIG to forecast or influence economic growth, necessitating a more nuanced approach to macroeconomic policy formulation that incorporates a broader set of indicators.

Policymakers should consider a broader set of indicators beyond MIG to inform economic growth policies, exploring alternative predictors such as fiscal policy indicators, institutional factors, or global economic trends. A nuanced approach to policy formulation is recommended, taking into account the unique characteristics of the economy and regularly monitoring and analyzing multiple variables to better understand the drivers of economic growth and make informed decisions.

The study's findings may have limited generalizability to all African countries or regions. Future research could consider alternative sampling methods or expand the sample to enhance broader applicability. Future research directions could explore non-linear relationships between MIG and EG, incorporate additional macroeconomic variables, conduct country-specific studies, investigate long-term relationships, and perform comparative analyses across countries or regions. These avenues can provide a more comprehensive understanding of the relationship between MIG and EG, informing more effective policy decisions and addressing the limitations of the current study.

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