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Macroeconomic Interactions, Inflation, and Exchange Rate Behaviour: A Structural Mediation Analysis

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ABSTRACT:

This study investigates whether inflation mediates the relationship between a composite macroeconomic interaction index comprising money supply, interest rates and GDP growth (the MIG index) and exchange rate dynamics in Zimbabwe, Zambia, South Africa, Namibia and Botswana. Using balanced annual panel data for 2010–2024 and a Structural Equation Modelling (SEM) mediation framework, the study finds that the MIG index is positively associated with inflation (coefficient = 42.046; $p = 0.027$) and exchange rates (coefficient = 0.332; $p = 0.039$), while inflation is positively associated with exchange rates (coefficient = 47.954; $p = 0.008$). Standardized robustness estimates confirm a statistically meaningful indirect effect of 0.140, with a bootstrapped 95% confidence interval of [0.012, 0.310]. The evidence supports partial mediation: monetary and real-sector conditions affect exchange rates directly and indirectly through domestic price pressures. Because exchange rates and inflation are jointly determined in macroeconomic systems, the results are interpreted as structural association and mediation evidence rather than definitive proof of causality. The findings imply that exchange-rate management in Southern Africa requires coordinated attention to inflation, money supply, interest-rate settings and growth conditions.

Keywords: Mediation, Inflation, Money Supply, Interest Rate, GDP.

JEL Classifications: E3, E4, and E5.

1. INTRODUCTION

The effective implementation of monetary policy is central to macroeconomic stability, particularly in emerging and developing economies where external shocks, shallow financial systems, volatile capital flows and exchange-rate pass-through often weaken conventional policy transmission. The components of the MIG index exert theoretically distinct yet interrelated effects on exchange rate behaviour. Expansion in money supply can generate inflationary pressures that erode currency value. Interest rate adjustments influence capital flows, expectations, and exchange rate appreciation or depreciation. Meanwhile, GDP growth signals macroeconomic

strength, influencing investor confidence and currency demand (Itskhoki and Mukhin, 2025). Yet these effects do not operate independently. Instead, they are embedded within a system characterized by feedback mechanisms, expectation adjustments, and dynamic interactions. Understanding these interconnected channels is essential for policymakers seeking to balance exchange rate stability, inflation control, and sustainable growth.

Inflation is particularly consequential in African and other emerging economies, where high and persistent price instability undermines competitiveness, weakens domestic currencies, and diminishes policy credibility. Exchange rate depreciation often feeds into domestic prices through import pass-

through effects, which can further destabilize macroeconomic conditions (Mazorodze, 2026). Conversely, contractionary monetary policy aimed at stabilising inflation may strengthen the currency but dampen output growth. These trade-offs underscore the complexity of macroeconomic management and highlight the need to examine inflation not merely as an outcome variable, but as a transmission mechanism linking monetary fundamentals to exchange rate performance.

From a theoretical perspective, money supply influences liquidity conditions and aggregate demand, interest rates shape borrowing costs and investment behaviour, and GDP growth reflects macroeconomic fundamentals and forward-looking expectations. The exchange rate, in turn, affects trade competitiveness, capital accumulation, fiscal sustainability, and inflation dynamics (Ha et al., 2020; Itskhoki and Mukhin, 2025). In structurally constrained African economies, these relationships are further complicated by limited financial depth, exposure to commodity price shocks, and institutional rigidities. Consequently, examining the joint interaction of these macroeconomic variables within a unified analytical framework becomes both theoretically and policy relevant.

Despite extensive evidence on bilateral links among money supply, inflation, interest rates, GDP growth and exchange rates, the literature still pays insufficient attention to their integrated transmission structure within African economies. The gap is not simply that these variables have been studied separately; it is that prior studies rarely decompose the total exchange-rate effect into direct and inflation-mediated components within the same empirical system. This paper therefore asks whether inflation operates as a transmission channel through which the combined monetary-growth environment affects exchange-rate dynamics.

The study is grounded in the monetarist framework, which emphasizes the role of monetary expansion in generating inflationary pressures that influence exchange rate behaviour. However, rather than assuming a direct and proportional relationship, this research extends the theoretical foundation by explicitly modelling inflation as an intermediary mechanism within the broader macroeconomic system. By doing so, the study captures the simultaneous interactions among money supply, interest rates, GDP growth, inflation, and exchange rates, thereby providing a more comprehensive understanding of monetary transmission in African economies. The argument is also consistent with open-economy Keynesian reasoning, in which liquidity conditions, aggregate demand and expectations interact with exchange-rate adjustment rather than moving in a simple one-way chain (Keynes, 1923).

The primary objectives of the study are twofold: first, to empirically test the mediating role of inflation in the MIG–exchange rate nexus; and second, to assess the implications of this mediation for monetary policy effectiveness in African economies. By decomposing total effects into direct and indirect components, the study contributes to the literature by offering a nuanced interpretation of macroeconomic interdependencies. The findings are expected to provide evidence-based insights for central banks seeking to improve exchange rate management, strengthen inflation control frameworks, and enhance overall macroeconomic stability.

The remainder of the paper is organized as follows. Section 2 reviews the relevant theoretical and empirical literature on the MIG index components, inflation, and exchange rate dynamics. Section 3 outlines the data, methodology, and mediation modelling approach. Section 4 presents and discusses the empirical findings, including the direct and indirect transmission paths among the key variables. Section 5 concludes with policy implications and recommendations for future research.

2. LITERATURE REVIEW

Although monetarism traditionally posits a direct proportional relationship between money supply and price levels, empirical evidence from developing and African economies indicates that the transmission mechanism is considerably more complex. Evidence on Bangladesh and Sudan shows that changes in broad money influence macroeconomic outcomes through liquidity, inflation and exchange-rate channels (Hossain and Ibon, 2020; Mohamed, 2020). Evidence from Nigeria further shows that inflation, interest rates and exchange rates have threshold effects on growth (Oyadeyi et al., 2025). These findings challenge a mechanical monetarist interpretation and suggest that institutional quality, fiscal dominance, exchange-rate regimes and external shocks condition the strength and speed of transmission. Therefore, money supply is likely to influence exchange rates partly through its inflationary consequences, providing strong empirical justification for modelling inflation as a mediating variable within the MIG–exchange-rate framework.

Demand-side macroeconomic studies emphasise the role of interest rates, output dynamics and inflation expectations in influencing macroeconomic stability. Exchange-rate pass-through evidence shows that domestic prices respond differently depending on the source of currency movements and the credibility of policy responses (Ha et al., 2020). In African economies, inflation, interest-rate and exchange-rate thresholds also matter for growth and exchange-rate stability (Oyadeyi et al., 2025). These findings suggest a mediated pathway in which monetary and real-sector conditions influence inflation, while inflation subsequently affects exchange-rate movements. This supports the pathway: interest rates, money supply and GDP growth → inflation → exchange rates. Recent evidence on financial inclusion and monetary-policy effectiveness also shows that interest-rate channels can condition the strength of monetary transmission in developing economies (Sethy et al., 2026).

However, the extant literature predominantly estimates bilateral relationships, examining either interest rate–inflation or inflation–exchange rate linkages in isolation. Very few studies simultaneously model money supply, interest rates, and output growth within a unified empirical framework. Consequently, while indirect transmission channels are acknowledged, their joint interaction remains insufficiently explored. This study advances the literature by integrating money supply, interest rates, and GDP growth into a composite MIG framework and empirically testing inflation as the mediating mechanism linking these macroeconomic fundamentals to exchange rate dynamics in African economies.

Empirical investigations of Purchasing Power Parity in South African economies indicate weak short-run validity but stronger long-run convergence (Kisten et al., 2025). Evidence from Nigeria, Ghana, and Tanzania demonstrates that deviations from parity are corrected gradually through domestic price adjustments rather than immediate nominal exchange rate realignments (Kisten et al., 2025). Panel cointegration studies across Sub-Saharan Africa further reveal that domestic inflation differentials serve as the principal adjustment mechanism through which exchange rates respond to macroeconomic imbalances. In several cases, monetary and fiscal shocks influence real exchange rate misalignment indirectly via inflationary pressures (Alemnew & Taffesse, 2025). Thus, while PPP provides a theoretical benchmark, African evidence suggests that inflation constitutes the operative channel through which macroeconomic fundamentals affect exchange rate dynamics. This reinforces the methodological rationale for explicitly modelling inflation as an intermediary variable rather than treating it as a parallel outcome. This interpretation is consistent with classical PPP reasoning, which emphasises that price-level adjustment is central to long-run exchange-rate equilibrium (Holmes, 1967).

Empirical assessments of interest rate parity in African economies reveal persistent deviations attributable to capital controls, sovereign risk premia, shallow financial markets and structural rigidities. Evidence from South Africa and other emerging markets shows that covered and uncovered interest parity conditions are often weakened by country risk, liquidity constraints and imperfect capital mobility (Hur and Shin, 2026). In contrast, economies such as Nigeria and Ghana often exhibit substantial interest-rate–exchange-rate disconnects because market segmentation and policy credibility problems weaken arbitrage channels. Recent evidence indicates that interest-rate adjustments affect exchange rates indirectly by influencing inflation expectations and domestic price stability rather than through pure arbitrage mechanisms. Under inflation-targeting regimes, policy credibility shapes exchange rate outcomes through its effect on expected inflation, thereby establishing a mediated transmission pathway.

Long-run empirical evidence from African economies broadly supports a relationship between money supply growth and inflation, particularly in high-inflation contexts such as Zimbabwe. However, the magnitude and persistence of this relationship vary according to fiscal discipline, exchange rate arrangements, and financial sector development. Dynamic panel and structural modelling studies show that monetary expansions typically elevate domestic price levels before exerting downward pressure on exchange rates (Duan et al., 2025). Recent empirical evidence confirms that inflation functions as the primary conduit through which monetary shocks translate into currency variations. Accordingly, African empirical evidence consistently positions inflation as the transmission mechanism linking monetary aggregates to exchange rate outcomes, further validating the mediation framework adopted in this study.

Empirical estimations of the Phillips Curve in African economies suggest a modest but significant short-run trade-off between inflation and output. Studies in South Africa and Kenya indicate that inflation expectations significantly influence exchange rate pass-through and output stability.

Moreover, exchange rate depreciation has been shown to feed into domestic inflation, which subsequently affects output performance, creating a dynamic feedback loop. Emerging African analyses employing indirect-effect decomposition methods reveal that output growth influences exchange rate behaviour through inflationary pressures, particularly in commodity-dependent economies. These findings strengthen the conceptual plausibility of positioning inflation as an intermediary variable within the MIG framework.

African macroeconomic literature has traditionally relied on VAR, ARDL and panel regression approaches that estimate direct effects between variables (Jima and Makoni, 2023; Ogbonnaya and Ebubechima, 2025). While these models capture dynamic relationships, they often do not decompose total effects into direct and indirect components. Recent empirical studies increasingly adopt mediation-oriented modelling strategies and structural equation modelling (SEM) to capture complex transmission mechanisms (Sarstedt et al., 2020). Mediation analysis is therefore methodologically appropriate for this study because it enables the decomposition of total effects into direct and indirect components, allows simultaneous modelling of multiple macroeconomic predictors, explicitly tests inflation as an intervening variable and improves identification of transmission channels within structurally constrained economies.

Although previous African studies consistently report significant relationships between money supply, inflation, interest rates, GDP growth, and exchange rates, their empirical conclusions are often inconsistent regarding the magnitude, direction and persistence of these effects. VAR and ARDL studies generally identify dynamic short-run interactions but treat macroeconomic variables as separate regressors, whereas panel regression studies primarily estimate average direct effects without examining whether inflation functions as a transmission mechanism. Consequently, these approaches provide limited insight into how multiple macroeconomic forces jointly influence exchange-rate behaviour. By constructing the composite MIG index and embedding it within a structural mediation framework, the present study advances beyond conventional modelling by simultaneously capturing the combined macroeconomic environment and decomposing its total effect on exchange rates into direct and inflation-mediated components. This integrated perspective represents a methodological contribution to African macroeconomic research where such composite interaction measures remain largely unexplored.

3. METHODOLOGY

3.1. Research Design and Data Structure

The empirical design uses a balanced country-year panel for five Southern African economies: Zimbabwe, Botswana, South Africa, Namibia and Zambia. These countries were selected because they combine data availability with meaningful institutional variation in exchange-rate arrangements, monetary-policy frameworks, inflation histories and exposure to external shocks. The sample is therefore not presented as statistically representative of the whole African continent. Instead, it is treated as an analytically relevant Southern African panel that permits structured testing of the proposed mediation

mechanism under diverse macroeconomic conditions. This clarification is important because the findings are most defensible for comparable Southern African and emerging-market settings rather than for all African economies without qualification.

The study employed annual macroeconomic data for all selected countries, spanning the period 2010–2024. Data were extracted from the World Bank’s World Development Indicators database, which provides standardised, reliable, and internationally comparable time-series data for key macroeconomic variables such as money supply, interest rates, GDP growth, inflation, and exchange rates. The annual frequency ensures consistency across countries while capturing meaningful year-on-year variations in economic activity, monetary conditions, and exchange rate movements. Using annual data also mitigates issues related to short-term volatility or seasonal fluctuations that could obscure underlying macroeconomic trends. Furthermore, the World Bank database offers well-documented methodologies for data collection and calculation, ensuring transparency and comparability, which is particularly important for panel data analysis spanning multiple countries over time. This approach allows the study to examine both temporal dynamics within countries and cross-country heterogeneity, providing a robust foundation for testing the mediation role of inflation in the MIG index–exchange rate nexus. The dataset is therefore traceable to a standardised international source (World Bank, 2025).

3.2. Model Specification and Mediation Framework

The study models the mediation effect using three structural equations. Equation (1) estimates the direct effect of the MIG index on exchange rates:

$$\text{Exchange Rate}_{it} = \beta_1 + \beta_2 \text{MIG}_{it} + \varepsilon_{it} \quad (1)$$

Equation (2) examines the effect of the MIG index on inflation and is specified as:

$$\text{Inflation}_{it} = \beta_3 + \beta_4 \text{MIG}_{it} + U_{it} \quad (2)$$

Equation (3) captures the proposed mediation pathway, where inflation transmits part of the association between the MIG index and exchange rates. The indirect effect is calculated as the product of the MIG-to-inflation and inflation-to-exchange-rate coefficients, while the total effect is the sum of direct and indirect paths. The direction $\text{MIG} \rightarrow \text{Inflation} \rightarrow \text{Exchange Rate}$ is theoretically motivated by monetary-transmission and purchasing-power arguments, but the study acknowledges that exchange-rate depreciation may also feed back into inflation through import-price pass-through. For this reason, the mediation results are interpreted as a theoretically ordered transmission test rather than as proof that feedback from exchange rates to inflation is absent.

$$\text{Exchange Rate}_{it} = \beta_5 + \beta_6 \text{MIG}_{it} + \beta_7 \text{Inflation}_{it} + V_{it} \quad (3)$$

In Equations (1–3), the dependent variable $\text{Exchange Rate}_{it}$ represents the value of the domestic currency relative to a foreign currency for country i at time t , while Inflation_{it} denotes the annual percentage change in the Consumer Price Index (CPI), capturing the general price level in the economy. The independent variable MIG Index_{it} is a composite index of money supply, interest rates, and GDP growth, designed to

reflect the combined effect of key macroeconomic fundamentals on exchange rate dynamics. The coefficients β_2 and β_6 measure the direct effects of the MIG index on exchange rates, β_4 captures the effect of the MIG index on inflation, and β_7 represents the effect of inflation on exchange rates in the mediation equation. The indirect effect is $\beta_4 \times \beta_7$, while the total effect is $\beta_6 + (\beta_4 \times \beta_7)$. The intercept terms β_1 , β_3 and β_5 represent the expected values of the dependent variables when all predictors are zero, while the error terms ε_{it} , U_{it} and V_{it} account for unexplained variation, including measurement errors, omitted variables and stochastic shocks.

3.3. Justification for Structural Equation Modelling (SEM)

The study employed SEM because it provides a system-based framework for estimating direct and indirect relationships within one coherent mediation structure. This is useful when the objective is not merely to estimate separate bilateral coefficients, but to decompose the total MIG–exchange-rate association into a direct path and an indirect path operating through inflation. Nevertheless, the use of SEM is interpreted conservatively because the panel contains 75 country-year observations. The model is deliberately parsimonious, with a limited number of observed variables and structural paths, to reduce the risk of over-parameterization. The SEM results are therefore supplemented with stationarity, cointegration, multicollinearity, heteroscedasticity, endogeneity and bootstrapping checks. Panel ARDL, panel VAR, PMG, FMOLS, DOLS and GMM approaches remain useful alternatives for future work, especially where the objective is dynamic forecasting, long-run elasticity estimation or stronger causal identification rather than mediation decomposition.

3.4. Addressing Endogeneity

Macroeconomic variables are prone to endogeneity due to simultaneity, reverse causality and omitted variables, especially between exchange rates and inflation. The study therefore avoids presenting SEM as a complete solution to endogeneity. SEM is used to estimate the theoretically specified mediation structure, while the control-function test is used as a diagnostic check on whether residual endogeneity is evident in the estimated paths. Unlike conventional studies that examine money supply, interest rates, or GDP growth independently, this study introduces the composite MIG index, which captures their joint macroeconomic interaction within a single analytical framework. This integrated measure provides a more comprehensive representation of the monetary and real-sector environment, allowing the mediation mechanism to be evaluated more effectively than traditional single-variable approaches. This interpretation is reinforced by robustness checks using M2, individual MIG components, standardised coefficients and bootstrapped confidence intervals.

3.5. Variable Measurement and MIG Index Construction

The study includes three key variables. $\text{Exchange Rate}_{it}$ is measured as local currency units per US dollar and reflects external competitiveness and the domestic price of foreign currency. Inflation_{it} is measured as the annual percentage change in the consumer price index and captures the general

movement in domestic prices. The MIG Index_{it} is a composite measure of money supply growth, interest rates and GDP growth. Before aggregation, the components are treated to ensure comparable scale and direction so that the index captures a common macroeconomic-pressure signal rather than mechanical differences in units of measurement. The index is calculated as a geometric mean because the theoretical mechanism is multiplicative: monetary expansion, interest-rate conditions and output growth interact jointly rather than contributing only additively to inflation and exchange-rate pressure.

$$\text{MIG Index}_{it} = [\text{Money Supply}_{it} \times \text{Interest Rate}_{it} \times \text{GDP Growth}_{it}]^{1/3} \quad (4)$$

The use of a composite MIG index is conceptually justified because money supply, interest rates and GDP growth jointly describe the monetary and real-sector environment in which exchange rates adjust. The index is not intended to imply that the three variables are economically identical. Rather, it is used as a compact measure of their combined macroeconomic stance. To address the risk that aggregation may conceal individual-variable effects, the study treats the MIG index as the main mediation construct and uses robustness checks based on alternative monetary proxies and individual components. This approach balances parsimony with transparency and reduces the risk that the composite measure becomes a statistical black box.

3.6. Diagnostic Tests and Data Treatment

To ensure the robustness and reliability of the findings, a comprehensive set of diagnostic tests was conducted. Outliers were first identified using Z-scores as a screening device, while non-stationarity was addressed separately through first differencing where required. This distinction is important: differencing is primarily a treatment for non-stationarity, not a pure outlier-correction technique. The analysis therefore treats extreme observations cautiously and relies on transformed series, residual diagnostics, robustness checks and bootstrapped confidence intervals to reduce the influence of unusual country-year observations. Stationarity was assessed using panel unit-root tests; normality was evaluated using the Jarque-Bera test; cross-sectional dependence was tested using Pesaran CD, Friedman, Frees and Breusch-Pagan LM tests; multicollinearity was examined through the Pearson correlation matrix; cointegration was tested with the Kao residual method; and heteroscedasticity was evaluated using Breusch-Pagan and White tests.

The diagnostic outcomes directly informed the empirical modelling strategy. Variables found to be non-stationary were transformed through first differencing before estimation, while the absence of significant cross-sectional dependence supported estimation using the specified SEM without additional corrections for common cross-sectional shocks. The absence of severe heteroscedasticity and multicollinearity indicated that the estimated standard errors and structural coefficients were unlikely to be materially biased. Evidence of long-run cointegration further justified modelling the structural relationships among the variables, whereas bootstrapping was employed to improve the reliability of mediation estimates given the relatively small sample and the presence of non-normal macroeconomic data.

3.7. Model Fit Evaluation

The adequacy of the SEM model was assessed using multiple fit indices. The Chi-square (χ^2) statistic evaluates overall fit, with a non-significant p-value indicating that the model-implied covariance matrix does not differ significantly from the observed covariance matrix. CFI and TLI values close to or above 0.90 indicate acceptable incremental fit, while RMSEA values below 0.05 and SRMR values below 0.08 indicate good absolute fit. Because the CFI in this study is below the conventional 0.90 threshold, the model is interpreted as broadly acceptable rather than excellent. This conservative interpretation is appropriate because mediation models are sensitive to distributional assumptions, sample size and specification errors; fit assessment is therefore read alongside robustness checks and coefficient stability.

4. RESULTS PRESENTATION AND ANALYSIS

Table 1. Descriptive statistics results.

Statistic	GDPG R	INFL	EXR	MS	INT R	MIG
Mean	5.969	24.812	65.260	0.58 2	0.127	0.369
Median	4.080	5.710	13.250	0.55 0	0.110	0.200
Maximum	60.900	667.400	373.33 0	1.05 0	0.350	2.800
Minimum	-8.100	-2.430	2.540	0.21 0	0.040	-0.370
Std. Dev.	9.405	86.912	124.87 0	0.22 9	0.069	0.511
Skewness	4.185	6.016	1.962	0.28 1	1.799	2.844
Kurtosis	23.141	42.301	4.901	1.96 2	5.956	12.259
Jarque-Bera	1486.59 8	5279.03 6	59.406	4.35 3	67.75 8	369.03 7
Probability	0	0.000	0.054	0.11 3	0.000	0.000
Observations	75	75	75	75	75	75

Source: Researchers' Computations (2026)

The GDP growth rate shows a mean of 5.97% and a median of 4.08%, indicating that most African economies in the sample are experiencing positive growth (Table 1). However, the standard deviation of 9.41% and extreme range (-8.1% to 60.9%) highlight substantial volatility in growth performance. Positive skewness (4.19) and high kurtosis (23.14) indicate that some countries experience extreme growth episodes, while many operate closer to modest growth rates. Statistically, the Jarque-Bera test rejects normality ($p = 0.000$), confirming that growth rates are not symmetrically distributed.

Economically, this suggests that while average growth appears healthy, policymakers must be alert to exceptional booms or sharp contractions that could destabilize inflation, employment, and exchange rate dynamics. Volatile growth also complicates fiscal planning and debt management, as revenue expectations may fluctuate sharply. The findings reinforce the need for counter-cyclical policies and structural reforms to mitigate growth shocks.

The inflation rate demonstrates even greater variability, with a mean of 24.81% but a median of only 5.71%, highlighting the presence of extreme outliers due to episodes of hyperinflation in countries such as Zimbabwe. The standard deviation of 86.91%, maximum of 667.4%, positive skewness (6.02), and extreme kurtosis (42.30) indicate heavy-tailed distributions, with rare but severe inflationary spikes. Jarque-Bera strongly rejects normality ($p = 0.000$). Economically, this volatility erodes purchasing power, disproportionately affecting low- and middle-income households, while undermining investor confidence. High inflation also complicates monetary policy calibration; central banks may face trade-offs between stabilising prices and supporting growth. Persistent inflationary shocks can exacerbate exchange rate depreciation, reduce competitiveness, and trigger capital flight, highlighting the importance of inflation targeting and credible policy communication.

Exchange rates exhibit substantial asymmetry, with a mean of 65.26 and a median of 13.25, indicating large deviations from central tendencies due to extreme depreciation events. Standard deviation of 124.87, positive skewness (1.96), and leptokurtosis (4.90) confirm that exchange rates frequently experience extreme movements. Jarque-Bera p -value (0.054) marginally rejects normality. Economically, such volatility affects import prices, export competitiveness, and capital inflows. Rapid depreciation can trigger imported inflation, while excessive appreciation may undermine export growth. Policymakers in emerging African economies must therefore stabilize exchange rates to support both trade balance and inflation control, using interventions such as managed float regimes or monetary policy coordination.

Money supply growth (M3) shows relative stability, with a mean of 0.582 and SD of 0.229, skewness 0.28, and platykurtic distribution (1.96). Jarque-Bera ($p = 0.113$) fails to reject normality. Economically, this stability provides a predictable anchor for monetary policy, allowing central banks to focus on controlling inflation and influencing exchange rates. In contrast to volatile GDP growth and inflation, a stable money supply enables measured adjustments in interest rates and liquidity to dampen macroeconomic shocks.

Interest rates reveal a mean of 0.127 and SD of 0.069, but high skewness (1.80) and leptokurtosis (5.96), with Jarque-Bera strongly rejecting normality ($p = 0.000$), indicate occasional spikes. Economically, these variations reflect country-specific risk premiums, monetary tightening, or responses to inflationary pressures. Interest rate fluctuations affect borrowing costs, investment decisions, and capital inflows. In economies with shallow financial markets, sudden interest rate increases can reduce credit availability, slow growth, and influence exchange rate stability, emphasising the importance of careful interest rate management.

Finally, the MIG Index, a composite of money supply, interest rates, and GDP growth, shows a mean of 0.369 and SD of 0.511, with high skewness (2.84) and kurtosis (12.26), and Jarque-Bera $p = 0.000$. Economically, the MIG index captures periods when combined macroeconomic pressures exert extreme influence on exchange rates. Its non-normality reflects systemic shocks where simultaneous changes in money supply, interest rates, and growth interact to either stabilize or destabilize exchange rates. The MIG Index provides policymakers with a holistic metric, integrating multiple macroeconomic channels to assess potential inflationary pressures and exchange rate risks, thereby supporting more effective, coordinated policy interventions compared to isolated variable analysis.

Table 2. Outlier detection using the Z-score method.

Variable	Outlier Criterion	Treatment	Outcome
INFLATION	Yes: $ Z \geq 2$ detected	First differenced/transformed	Data transformed
MONEY SUPPLY	Yes: $ Z \geq 2$ detected	First differenced/transformed	Data transformed
EXCHANGE RATE	Yes: $ Z \geq 2$ detected	First differenced/transformed	Data transformed
INTEREST RATE	Yes: $ Z \geq 2$ detected	First differenced/transformed	Data transformed
GDPGR	Yes: $ Z \geq 2$ detected	First differenced/transformed	Data transformed
MIG INDEX	Yes: $ Z \geq 2$ detected	First differenced/transformed	Data transformed

Source: Researchers' Computations (2026).

As shown in Table 2, the Z-score method detected outliers in inflation, money supply, exchange rate, interest rate, GDP growth and the MIG index, with $|Z|$ values of at least 2. These outliers could distort the estimates if left untreated. The affected variables were therefore transformed using a first-differencing approach to reduce the influence of extreme observations and improve the robustness of the analysis.

Table 3. Jarque-Bera normality test.

Test	χ^2 value	p value
Jarque-Bera test	7.638	0.651

Source: Researchers' Computations (2026).

The Jarque-Bera test ($\chi^2 = 7.638$, $p = 0.651$) indicates that the transformed data are normally distributed, as the p -value is not significant, failing to reject the null hypothesis of normality (Table 3).

Table 4. Panel stationarity test results

Variables	Individual Unit Root Process						Order Of In- tegration
	Levels			1 st Difference			
	Lm, Pesaran & Shin W-Stat	ADF-Fisher Chi-Square	PP-Fisher Chi-Square	Lm, Pesaran & Shin W-Stat	ADF-Fisher Chi-Square	PP-Fisher Chi- Square	
MS	0.965	0.966	0.467	0.017	0.024	0.000	I (1)
EXR	0.922	0.949	0.858	0.003	0.005	0.000	I (1)
GDP	0.061	0.071	0.000	-	-	-	I (0)
INTR	0.751	0.841	0.882	0.010	0.011	0.001	I (1)
INF	0.017	0.017	0.035	-	-	-	I (0)
MIG	0.145	0.111	0.000	-	0.000	0.000	I(0) and I(1)

Source: Researchers' Computations (2026).

This diverse set of integration orders supports the use of a system-based SEM framework after appropriate data treatment, because the empirical interest lies in the simultaneous direct and indirect relationships among the variables rather than in isolated single-equation effects.

Table 5. Cross-sectional dependence test results.

Test	Statistic	P-value
Pesaran's CD	0.897	0.569
Friedman's	1.751	0.421
Frees'	0.825	0.323
Breusch-Pagan LM	Chi squared = 0.358	0.648

Source: Researchers' Computations (2026).

The absence of significant cross-sectional dependence supports the use of the specified SEM because the estimates are less likely to be distorted by unmodelled common shocks across the five countries.

Table 6. Pearson correlation matrix for multicollinearity assessment.

Variable	INFL	GDPGR	MS	INTR	EXR	MIG
INFL	1.00	-	-	-	-	-
GDPGR	-0.03	1.00	-	-	-	-
MS	0.11	-0.13	1.00	-	-	-
INTR	0.56	-0.06	-0.15	1.00	-	-
EXR	0.28	0.03	-0.05	0.76	1.00	-
MIG	0.25	0.86	0.02	0.31	0.25	1.00

Source: Researchers' Computations (2026).

These correlations are therefore acknowledged as a potential diagnostic concern, but the SEM specification, fit indices and robustness checks provide additional evidence on whether the estimates remain stable.

Table 7. SEM model-fit diagnostic results.

Fit Index	Value
Chi Squared (χ^2)	5.321 (p=0.618)
CFI	0.865
RMSEA	0.029 (CI: 0.019-0.047)
SRMR	0.035
TLI	0.925

Source: Researchers' Computations (2026).

The Chi-square (χ^2) value of 5.321 with a p-value of 0.618 indicates that the model-implied covariance matrix does not differ significantly from the observed covariance matrix (Table 7). The RMSEA value of 0.029 is below the conventional 0.05 threshold, while the SRMR value of 0.035 is also comfortably below 0.08. The TLI value of 0.925 indicates acceptable incremental fit. The CFI value of 0.865 is below the preferred 0.90 threshold, so the model should be described as broadly acceptable rather than excellent. Taken together, the diagnostics support the adequacy of the SEM model, but the CFI result should be acknowledged transparently to avoid overclaiming.

Table 8. Kao panel cointegration test.

Kao Cointegration Test		
Test	Statistic	P-Value
Augmented Dickey-Fuller t	2.651	0.025

Source: Researchers' Computations (2026).

The Kao cointegration test is significant (p = 0.025), indicating a long-run equilibrium relationship among money supply, exchange rates, GDP growth, interest rates, inflation and the MIG index (Table 8). This result reduces concern that the estimated relationships are purely spurious. It also supports the modelling strategy because the variables exhibit meaningful long-run co-movement despite short-run fluctuations. The

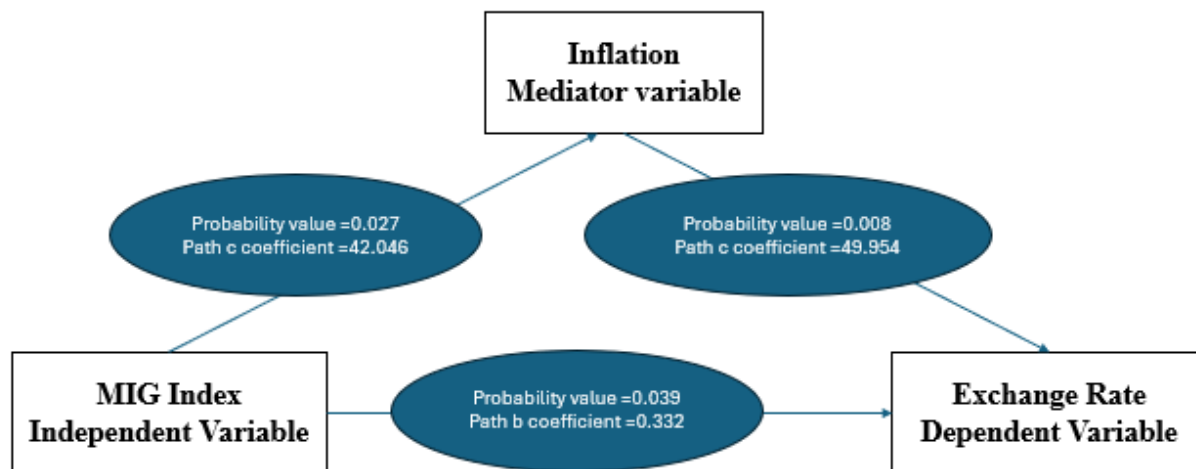


Fig. (1). SEM Path Diagram.

Source: Researchers' Computations (2026).

SEM results should nevertheless be interpreted together with the stationarity, endogeneity and robustness tests because cointegration alone does not establish causality.

Table 9. Heteroscedasticity test results.

Test	t value	p value
Breusch-Pagan Test	1.374	0.238
White test	2.631	0.305

Source: Researchers' Computations (2026)

The Breusch-Pagan test ($p = 0.238$) and White test ($p = 0.305$) do not reject the null hypothesis of homoscedasticity (Table 9). This suggests that the residual variance is sufficiently stable across the fitted values, supporting reliable inference from the reported standard errors and test statistics.

Table 10. Control-function endogeneity test results.

Path	Coefficient	Standard Error	Z	P value
MIG→Inflation	0.421	0.192	2.18	0.029
MIG residuals→Inflation	0.076	0.118	0.64	0.522

Exchange rate equation.

Path	Coefficient	Standard Error	Z	P value
Inflation → Exchange rate	0.332	0.164	2.02	0.043
Inflation residual→ Exchange rate	0.091	0.137	0.66	0.508
MIG→ Exchange rate	0.480	0.280	1.72	0.086

MIG residual → Exchange rate	0.058	0.145	0.40	0.689
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Source: Researchers' computations (2026).

The insignificant residual terms reduce concern about endogeneity bias, although they do not by themselves prove causality; the mediation interpretation remains theory-driven and supported by robustness checks.

The path diagram illustrates the hypothesised mediation structure among the MIG index, inflation and exchange rates (Fig. 1). The MIG index has a positive direct association with exchange rates (coefficient = 0.332, $p = 0.039$). It also has a positive association with inflation (coefficient = 42.046, $p = 0.027$), while inflation is positively associated with exchange rates (coefficient = 47.954, $p = 0.008$). The diagram therefore supports the interpretation that inflation transmits part of the effect of the MIG index to exchange rate movements, while a direct MIG–exchange-rate channel remains present.

Table 11. Structural equation modelling results

Direction of Effect	Coefficient	Standard Error	Z-Value	Probability
MIG Index to inflation	42.046	19.023	2.21	0.027
Inflation to Exchange rate	47.954	17.438	2.75	0.008
MIG Index to Exchange rate	0.332	0.161	2.06	0.039

Source: Researchers' Computations (2026).

The SEM results reported in Table 11 reveal statistically meaningful relationships among the MIG index, inflation and exchange rates. The unstandardised coefficients are large because the variables are measured on different original scales, particularly inflation and the exchange rate. For that reason,

the substantive interpretation should rely primarily on the direction, statistical significance and standardised robustness estimates rather than on the raw coefficient magnitudes alone. The MIG index significantly influences inflation (coefficient = 42.046, $p = 0.027$), inflation significantly influences exchange rates (coefficient = 47.954, $p = 0.008$), and the MIG index also directly affects exchange rates (coefficient = 0.332, $p = 0.039$). These results support partial mediation, but the economic size of the relationship is best evaluated through the standardised estimates and bootstrapped indirect effect reported in Table 13.

These results are consistent with established macroeconomic theory. The MIG–inflation relationship aligns with monetarist and demand-pull arguments that liquidity conditions, interest-rate settings and output growth influence domestic prices (Friedman, 1968; Phillips, 1958). The inflation–exchange-rate nexus is consistent with purchasing power parity and exchange-rate pass-through arguments, which predict that inflation differentials and import-price channels affect currency values (Fisher, 1911; Ha et al., 2020). The direct effect of the MIG index on exchange rates is also consistent with open-economy portfolio-balance arguments, where changes in monetary conditions and growth prospects affect investor demand for domestic-currency assets (Itskhoki and Mukhin, 2025).

The mechanism through which the MIG index affects inflation is likely to operate through demand-side and expectations channels. Monetary expansion, lower real interest rates and stronger output growth can raise aggregate demand and inflation expectations. Inflation can then contribute to currency depreciation by reducing purchasing power and increasing import costs (Ha et al., 2020; Mazorodze, 2026). The direct MIG–exchange-rate channel may reflect investor responses to domestic monetary conditions, interest-rate differentials and growth prospects, which affect demand for domestic currency independently of contemporaneous inflation.

This study contributes to the literature by explicitly modelling the combined effect of money supply, interest rates and GDP growth as a composite macroeconomic index rather than treating the three variables as isolated predictors. This approach is useful because the three variables operate jointly in monetary transmission. The mediation framework further adds value by distinguishing direct MIG effects on exchange rates from indirect effects transmitted through inflation, which is often overlooked in bilateral VAR, ARDL and panel-regression studies.

The findings are broadly consistent with studies showing that monetary conditions, inflation and exchange rates are strongly connected in emerging economies (Ha et al., 2020; Itskhoki and Mukhin, 2025; Oyadeyi et al., 2025). The study advances this evidence by showing that inflation is not merely an additional macroeconomic outcome but a transmission channel through which monetary and real-sector conditions influence exchange rates. This helps explain why studies that test only direct money-supply or interest-rate effects often produce mixed results: part of the effect may pass through inflation before appearing in exchange-rate movements.

The findings carry policy implications, but these should be stated cautiously because the empirical design identifies structural associations rather than definitive causal effects. The results suggest that exchange-rate management cannot be separated from inflation control, monetary conditions and growth dynamics. Central banks should therefore monitor the joint movement of money supply, interest rates and output growth because their interaction may affect both inflation and currency pressure. However, the results should not be read as implying that a single policy instrument can mechanically stabilise the exchange rate. Policy responses should be country-specific and should consider credibility, fiscal dominance, reserve adequacy, exchange-rate regime, import dependence and financial-market depth.

Table 12. Standardised mediation robustness results.

Variable	Coefficient	Standard Error	Z Statistic	Probability
MIG to inflation	42.046	19.282	2.181	0.029
From inflation to exchange rate	0.332	0.164	2.021	0.043
From MIG Index to Exchange rate	0.480	0.280	1.715	0.086

Source: Researchers' Computations (2026).

The robustness results in Table 12 are consistent with the main SEM findings but should be read as standardised diagnostic evidence rather than as a direct replacement for the unstandardised SEM estimates in Table 11. The MIG index remains positively associated with inflation, inflation remains positively associated with exchange rates, and the direct MIG–exchange-rate path becomes weaker after accounting for inflation. This pattern supports partial mediation: inflation explains an important part of the MIG–exchange-rate relationship, while other direct channels remain possible. The marginal p -value for the direct path ($p = 0.086$) also shows why the conclusion should be framed cautiously as partial mediation evidence rather than as a strong causal claim.

The study employed SEM to examine whether inflation mediates the relationship between the MIG Index and exchange rates. Standardized coefficients were calculated to allow comparison across variables measured on different scales. To assess the significance of mediation, bootstrapping with 5,000 resamples was performed, generating bias-corrected confidence intervals for indirect effects. Bootstrapping is particularly appropriate in this context due to the small number of countries and the non-normality of macroeconomic variables, as it does not rely on normality assumptions. Additionally, the analysis was stratified across the five countries to verify the consistency of the mediation effect. This is important because mediation estimates can be sensitive to non-normality and model misspecification, especially in small samples (Liu et al., 2025).

The SEM results indicate that the MIG index significantly influences inflation, with a standardized coefficient of 0.421 (SE = 0.192, $Z = 2.18$, $p = 0.029$), and the 95% bootstrapped confidence interval [0.056, 0.742] confirms robustness (Table

Table 13. Standardised mediation robustness results and bootstrapped confidence intervals.

Path	Standardized Coefficient	Standard Error	Z statistic	P value	95% CI Bootstrapped	Indirect Effect
MIG → Inflation	0.421	0.192	2.18	0.029	[0.056, 0.742]	-
Inflation → Exchange rate	0.332	0.164	2.02	0.043	[0.042, 0.622]	-
MIG → Exchange rate (Direct)	0.480	0.280	1.72	0.086	[-0.065, 0.990]	-
MIG → inflation → Exchange rate	0.140	-	-	-	[0.012, 0.310]	0.140

Source: Researchers' computations (2026).

13). Inflation significantly affects exchange rates (standardized coefficient = 0.332, SE = 0.164, Z = 2.02, p = 0.043, 95% CI [0.042, 0.622]), indicating that higher inflationary pressure is associated with currency depreciation. The direct effect of the MIG index on exchange rates is positive but marginally insignificant (0.480, SE = 0.280, Z = 1.72, p = 0.086, 95% CI [-0.065, 0.990]), suggesting that much of the MIG index's influence operates indirectly through inflation. The indirect effect is 0.140, with a bootstrapped 95% CI of [0.012, 0.310], confirming statistically meaningful mediation.

Bootstrapping was employed to estimate the mediation effect of inflation in the MIG index–exchange-rate nexus across the five-country panel, resampling the balanced dataset 5,000 times with replacement to generate empirical distributions of direct, indirect and total effects. This approach is appropriate given the small number of countries, non-normality and high variability of macroeconomic variables such as inflation, GDP growth and exchange rates. It reduces reliance on parametric normality assumptions and limits the influence of single extreme observations. Nevertheless, bootstrapping does not remove the need for country-specific interpretation: Zimbabwe's inflation history, South Africa's deeper financial markets, Namibia's currency arrangement, Botswana's resource-linked structure and Zambia's external-sector exposure mean that the average panel result should be treated as a regional tendency rather than a uniform national effect.

5. CONCLUSION AND RECOMMENDATIONS

The SEM results provide evidence of a coherent transmission structure among the MIG index, inflation and exchange rates in the selected Southern African economies. The evidence indicates that the combined monetary-growth environment is associated with inflationary pressure and exchange-rate movements. However, the results are best interpreted as mediation evidence within a theory-guided panel SEM framework, not as conclusive proof of one-way causality.

Inflation significantly influences exchange rates, confirming that domestic price pressures are an important channel through which the MIG index affects currency movements. The evidence supports partial mediation because both the indirect path through inflation and the direct MIG–exchange-rate path matter. This means that policymakers should not treat inflation, growth, interest rates and exchange rates as separate policy targets; they are part of one transmission system.

The findings have important policy implications for Southern African monetary authorities by demonstrating that exchange-rate stability is influenced by the joint interaction of money supply, interest rates, GDP growth and inflation rather than by isolated policy instruments. Nevertheless, the conclusions should be interpreted in light of the study's limitations, including the relatively small regional sample, the use of a composite index, and the constraints associated with observational panel data. Future research should extend the analysis to larger African panels, compare the mediation framework with alternative dynamic econometric approaches, and examine whether the transmission mechanism differs across monetary policy regimes, exchange-rate systems and periods of macroeconomic instability.

5.1. LIMITATIONS AND FUTURE RESEARCH

The study has four important limitations. First, the sample is restricted to five Southern African countries and 75 country-year observations, which limits the statistical power of SEM and restricts generalisation beyond comparable economies. Second, the MIG index is a useful parsimonious construct, but aggregation may conceal heterogeneous effects of money supply, interest rates and GDP growth. Third, although endogeneity diagnostics are reported, the absence of strong external instruments means that the estimates should not be interpreted as definitive causal effects. Fourth, the mediation direction is theory-driven even though exchange-rate depreciation may also feed back into inflation through import-price pass-through.

Future research should extend the sample, test country-specific heterogeneity, compare SEM results with panel ARDL, panel VAR, PMG, FMOLS, DOLS and dynamic panel GMM estimators, and evaluate whether the mediation effect changes across exchange-rate regimes, inflation-targeting frameworks and periods of macroeconomic stress.

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