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Promoting the Application of Econometrics

Inflation Dynamics in Zambia: Evidence from a Time-Varying Parameter Model

Noah Mutoti

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Abstract

This study investigates Zambia’s inflation dynamics through a time-varying parameter error-correction model. The results reveal that liberalization, monetary policy reform, and credibility gains progressively reshaped the transmission channels of inflation, though external volatility remained a persistent source of vulnerability. In the early 1990s, inflation was driven by unstable expectations, rapid exchange rate pass-through, and foreign price shocks, while money and output shocks were largely inert. Under monetary targeting, money growth became the dominant driver, expectations were more anchored though still volatile, and output shocks began to exert moderate influence. Exchange rate and foreign inflation shocks, initially strong, gradually moderated as reforms deepened. In the interest rate-based regime, expectations became firmly anchored, the money–inflation nexus weakened, and output shocks assumed a stabilizing role, curbing inflationary pressures. Yet exchange rate shocks re-emerged as the dominant channel, with episodes such as the 2015 depreciation and COVID-19 disruptions reigniting strong pass-through. Across regimes, inflation remained weakly mean-reverting, underscoring limited self-correction and persistent vulnerability. The policy lesson is clear: reforms reshape inflation dynamics but cannot insulate economies from external volatility. Sustained credibility, disciplined policy signaling, structural diversification, and adaptive frameworks remain indispensable for resilience and durable price stability.

1.0 Introduction

Several studies of inflation dynamics in Africa, and Zambia in particular (e.g., Mutoti et al., 2011; Mwansa, 1998), have traditionally relied on the assumption that estimated coefficients remain constant throughout the sample period. Increasingly, however, this assumption has proven untenable. Economic

relationships often evolve over time, and imposing parameter constancy risks misspecification (Hansen, 2001; Hong et al., 2023). Structural and financial reforms, for instance, frequently induce economic agents to adjust their behavior, resulting in relationships that shift rather than remain fixed (Swamy & Tavlas, 2011). Moreover, macroeconomic variables often exhibit time-varying distributions, reflecting the dynamic interplay of economic, social, and environmental factors (Wang et al., 2024). Koop and Potter (2011) caution that assuming constant parameters in linear models can be misleading, particularly in the analysis of macroeconomic and financial data. Similarly, Swamy and Tavlas (2011) emphasize that the instability of macroeconomic relationships undermines the validity of traditional econometric models premised on parameter constancy.

Since the early 1990s, Zambia—like many Sub-Saharan African economies—has undergone extensive financial and structural reforms¹ that have fundamentally reshaped its economic environment, rendering the assumption of constant parameters increasingly untenable. Departing from earlier and more recent studies (e.g., Chipili, 2021), this paper investigates Zambia’s inflation dynamics using a time-varying parameter error-correction model (TVP-ECM), following Jooste and Jhaveri (2014) and drawing on the state-space modeling tradition pioneered by Primiceri (2005), Hamilton (1994), and Kim and Nelson (1999). This approach, also employed by Kumar et al. (2012) and Hou (2019), enables the exploration of several critical questions: To what extent are the main drivers of inflation in Zambia time-varying? Did financial liberalization alter the speed and magnitude of exchange rate pass-through? How have financial reforms reshaped the nexus between money and inflation? What are the implications of time-varying inflation drivers for the effectiveness of monetary policy in this Southern African economy?

By situating these questions within a state-space framework, the paper contributes to the literature on modeling inflation in low-income, open economies. It demonstrates how financial liberalization and monetary reforms reshape inflation processes, advancing understanding of the shifting nature of inflation transmission channels. Crucially, the findings establish that the effectiveness of monetary policy is not uniform but conditional on structural and institutional factors, underscoring the need for adaptive frameworks capable of sustaining credibility and resilience in the face of shocks and reforms. In doing so, the study enriches regional debates on how time-varying dynamics shape the scope for effective policy in developing economies.

The remainder of the paper is organized as follows. Section 2 outlines the theoretical framework. Section 3 discusses the empirical results. Section 4 concludes with policy implications.

2.0 Theoretical Approach

Previous studies on African inflation dynamics (e.g., Moser, 1995; Durevall & Ndung’u, 2001) have emphasized monetarist, external and excess demand theories. We adopt a similar framework but extend it by incorporating time-varying coefficients. A key distinction is drawn between traded and non-traded goods. Let ω be the share of imported goods in the overall consumer price (p_t). Then p_t fulfills

¹Financial and structural reforms include notably liberalization of interest and exchange rates, restructuring and privatization of state-owned enterprises. Trade liberalization reduced tariffs and encouraged foreign investment, while fiscal reforms strengthened discipline, transparency, and credibility. These were alongside the introduction of monetary policy regimes: the monetary targeting in 1993 (Bank of Zambia Act of 1996 formally established price stability as the central mandate) and the interest-rate policy regime in 2012 and operationalized 2014 (making policy rate the principal instrument of monetary policy).

$$p_t = \psi p_t^T + (1-\psi)p_t^{NT} \quad (1)$$

where p_t^T is domestic price of traded goods and p_t^{NT} stands for price of non-trade goods. It assumed p_t^{NT} originates from the domestic sector and is set in the money market, where demand for non-traded goods is assumed, for simplicity, to move in line with aggregate demand. It is thus determined by money market conditions

$$p_t^{NT} = \chi_t(m - p) = b_t y_t + \varepsilon_t^{md} \quad (2)$$

In (2) m_t is money, y_t is output and ε_t^{md} represents money demand shocks. For a small open economy with perfect price arbitrage, the domestic-currency price of imported goods takes the form

$$p_t^T = c_t(s_t + p_t^*) + \varepsilon_t^f \quad (3)$$

where p_t^* is foreign consumer price, s_t is the exchange rate and ε_t^f denote foreign price shocks. Substituting (2) and (3) into (1) and after some simplifications, yields a consumer price equation

$$p_t = \beta_{1t} m_t - \beta_{2t} y_t + \beta_{3t} s_t + \beta_{4t} p_t^* + v_t \quad (4)$$

The statistical model underpinning this analysis is consistent with the state-space formulation, drawing on Chin(2019) and Beck (1983), Kim and Nelson(2006) as well as Koop and Korobilis (2012). Following Botha and Saayman (2012), the study applies a TVP-ECM, with the state-space representation comprising two measurement equations: one capturing the equilibrium deviation (the error correction term) and the other describing inflation dynamics. Assuming p_t , m_t , y_t , s_t and p_t^* are cointegrated, the equilibrium deviation is cast as

$$ect_t = p_{t-1} - (\beta_{1t} m_{t-1} - \beta_{2t} y_{t-1} + \beta_{3t} s_{t-1} + \beta_{4t} p_{t-1}^*) \quad (5)$$

where $\beta_{1t}, \dots, \beta_{4t}$ are time-varying cointegration coefficients, indicating evolving long-term structural relationships. TVP-ECM inflation dynamics are then modeled as

$$\Delta p_t = \alpha_t ect_t + \sum_{j=1}^p \gamma_{1jt} \Delta m_{t-j} + \sum_{j=1}^q \gamma_{2jt} \Delta y_{t-j} + \sum_{j=1}^r \gamma_{3jt} \Delta s_{t-j} + \sum_{j=1}^m \gamma_{4jt} \Delta p_{t-j}^* + v_t \quad v_t \sim N(0, \Omega) \quad (6)$$

Here α_t are the adjusting speeds, $\gamma_{1t}, \dots, \gamma_{4t}$ are short-run elasticities and v_t are price shocks. The transition equations specify random-walk evolution of parameters

$$\alpha_t = \alpha_{t-1} + \mu_t \quad (7)$$

$$\beta_{kt} = \beta_{k,t-1} + \zeta_t, k = 1, \dots, 4 \quad (8)$$

$$\gamma_{kt} = \lambda_{kt-1} + \eta_t, k = 1, \dots, 4 \quad (9)$$

such that μ_t, ζ_t and η_t are Gaussian shocks. This formulation allows the Kalman filter to jointly estimate the evolving cointegration vector and the short-run adjustment process.

3.0 Empirical Approach

We utilize quarterly data spanning 1992Q1 to 2025Q4, expressed in logarithmic form. The variables comprise domestic consumer prices, measured by the consumer price index (CPI); money supply, represented by broad money; Kwacha/United States (US) dollar exchange rate; output, proxied by real gross domestic product (GDP); foreign prices, captured by the US CPI; and seasonal components, included to ensure a parsimonious model. The results reveal the shifting influence of these variables on inflation formation under policy regimes.

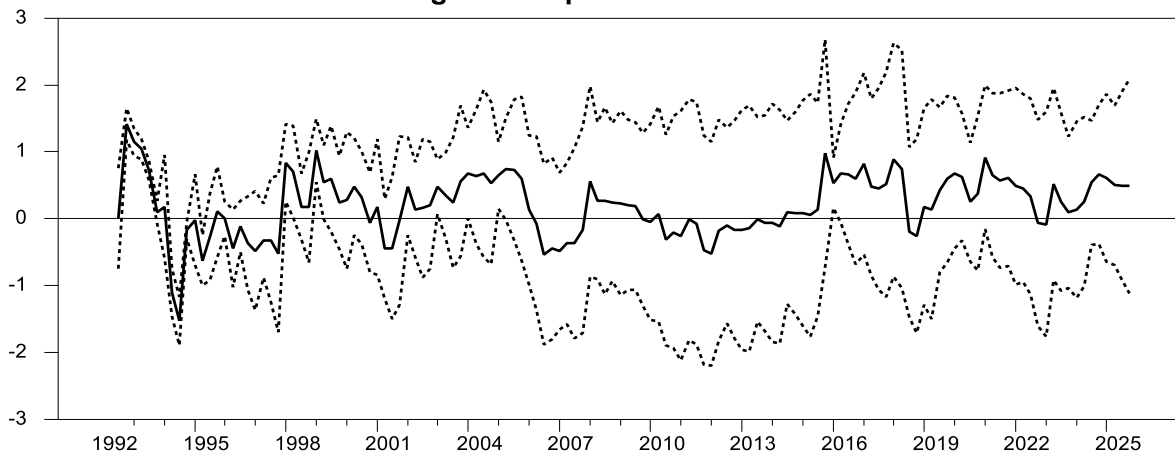
Figure 1 traces the evolving role of inflation expectations. In the early liberalization of 1990s, the expectation coefficient was highly unstable, reflecting weak institutional capacity, fiscal dominance, and the limited credibility of monetary authorities. Expectations adjusted almost one-for-one with observed CPI inflation, at times surging into triple digits, underscoring their adaptive and magnifying nature. During the monetary-targeting era (1993–2012), liberalization deepened with the removal of interest and exchange rate controls. Initially, this heightened turbulence, with the expectation coefficient spiking above **0.5** in the mid-1990s. Over time, however, reforms improved policy signaling, and by the 2000s expectations began to anchor more firmly, with coefficients moderating. Episodes such as 2007 show that shocks could still trigger heightened sensitivity, yet the magnitude was increasingly contained compared to the early liberalization phase.

With the transition to the interest rate–based policy era (2013 onwards)², expectations became even more anchored and between 2013 and 2015, the coefficient approached zero. However, episodes of uncertainty—such as the 2015–2016 depreciation and COVID-19 disruptions—temporarily reignited inertia, and inflation briefly rising to double digits. This demonstrated that while liberalization and institutional strengthening slowed and dampened expectation pressures, they did not eliminate them.

This trajectory highlights three distinct phases: unstable and adaptive expectations in the early liberalization period, progressively anchored but occasionally volatile expectations under monetary targeting, and more firmly anchored yet episodically volatile expectations in the interest rate–based regime.

²Introduction of the Policy Rate in 2012, operationalized in 2014 as the principal instrument of monetary policy. This interest rate–based framework aligned Zambia with forward-looking practices, enhancing transparency and strengthening the signalling power of monetary policy through quarterly Monetary Policy Committee meetings

Figure 1: Expected Inflation



The shifting money–inflation nexus across policy regimes is illustrated in Figure 2. In the early 1990s, money elasticity hovered just above zero, showing that monetary expansion had only a muted effect on inflation. Structural rigidities, shallow financial markets, and weak central bank credibility constrained transmission. As monetary targeting became entrenched, however, the money–inflation relationship intensified sharply. Between 2004 and 2008, elasticity peaked, meaning money growth translated almost directly into inflationary pressures. Weak anchors and elevated expectations amplified this responsiveness, leaving inflation highly vulnerable to monetary shocks.

Over time, as reforms deepened and the central bank strengthened its credibility, elasticity declined. By 2011, the sensitivity of inflation to money shocks had diminished markedly. In the subsequent interest rate–based regime, the coefficient stabilized around zero, signaling that money growth ceased to be a dominant driver of inflation. These findings suggest that monetary reforms progressively weakened the money–inflation nexus. What began as a muted relationship intensified under weak anchors, but reforms and credibility gains eventually eroded the nexus, leaving money growth largely unpronounced to inflation dynamics in the interest rate era

Figure 2: Money

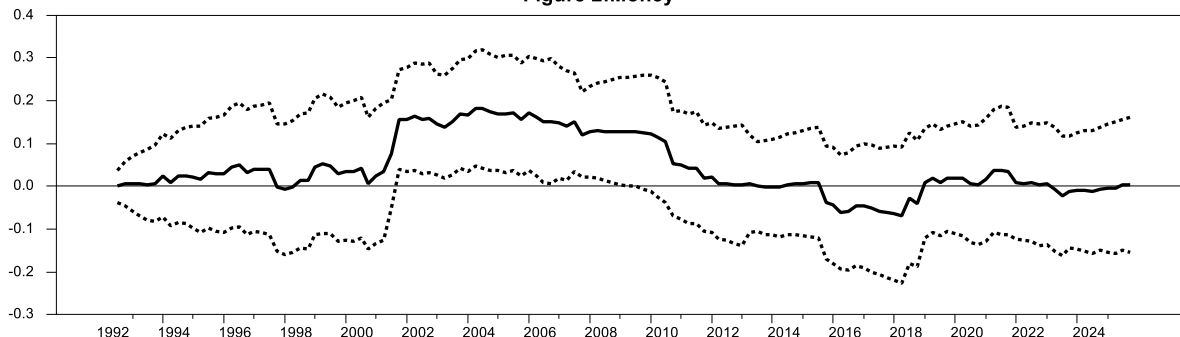
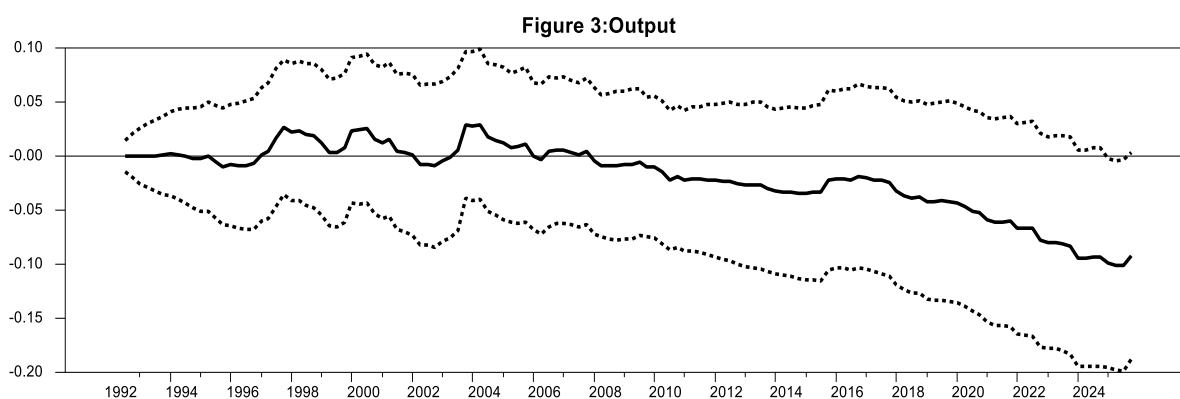


Figure 3 highlights the time-varying influence of output shocks on Zambia’s inflation dynamics. In the early liberalization period, output elasticity hovered around zero, indicating that supply shocks had little impact on inflation. Transitional inertia and structural rigidities muted the responsiveness of

prices to real-side developments. Under monetary targeting, as reforms deepened, the coefficient turned positive, showing that output shocks began to exert a discernible—though not dominant— influence. The supply–inflation link strengthened moderately, reflecting an economy becoming more responsive to real-side conditions.

With the transition to the interest rate–based policy era, the coefficient turned negative and declined steadily, signaling that output shocks became increasingly important in curbing inflationary pressures. Viewed in its entirety, this trajectory underscores how structural reforms progressively reoriented the supply side–inflation nexus: muted and inert in the early liberalization period, moderately inflationary under monetary targeting, and ultimately stabilizing and disinflationary in the interest rate era. In effect, reforms transformed output shocks from marginal influences into a key stabilizing force, illustrating how credibility and institutional strengthening can reshape the real-side contribution to price stability.



The results outlined in Figure 4 suggests that liberalization and monetary reforms the speed and magnitude of exchange-rate pass-through. In the early 1990s, the pass-through coefficient was high, with exchange-rate shocks translating almost immediately into domestic inflation that surged into triple digits. This reflected weak policy credibility, unstable expectations, and structural dependence on imports, making transmission rapid and forceful.

During the monetary-targeting era, liberalization initially heightened vulnerability. Around 2006, the elasticity rose markedly, showing that the magnitude of pass-through intensified and inflation’s responsiveness to external volatility was amplified. Yet as reforms matured and credibility improved, the coefficient moderated by 2007, indicating that the channel had slowed and weakened. Exchange-rate effects remained present, but their force was increasingly contained compared to the early liberalization phase. In the interest rate–based policy regime, episodes such as the 2015 depreciation reignited strong pass-through, momentarily pushing inflation into double digits. Similarly, COVID-19 disruptions underscored the persistence of external vulnerability, even under strengthened institutions.

The evidence delineates three phases: pronounced transmission in the early liberalization period, intensified but later moderated vulnerability under monetary targeting, and a re-emergence of the exchange rate as the dominant channel in the interest rate–based regime. Liberalization therefore reshaped the dynamics of pass-through by progressively reducing its speed and magnitude, though never eliminating its capacity to destabilize inflation during episodes of external shocks.

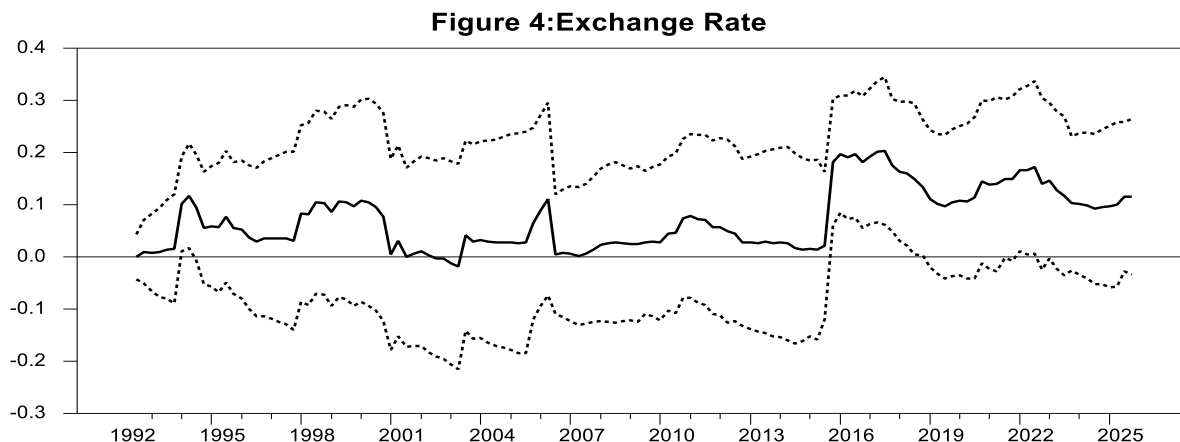


Figure 5 traces the evolving role of foreign inflation shocks in Zambia's price dynamics. In the early 1990s, financial and trade liberalization exposed the economy to external volatility, with the foreign inflation coefficient high and unstable. Pronounced effects in the mid-1990s coincided with global commodity price fluctuations and the turbulence of liberalization, underscoring the vulnerability of domestic inflation to external shocks.

During the monetary-targeting era, the impact of foreign inflation shocks intensified again around 2001, driven by surges in global oil and food prices. Yet as monetary reforms deepened and credibility improved, the elasticity moderated significantly. Between 2006 and 2015, the coefficient hovered close to zero, marking a substantial reduction in the persistence of imported inflation. In the subsequent interest rate-based policy regime, the coefficient continued to fluctuate but remained positive, underscoring that foreign price shocks—particularly commodity surges in oil markets—still exerted a measurable influence on domestic inflation.

Taken together, the evidence points to three phases: heightened vulnerability in the early liberalization period, moderation under monetary targeting, and a more contained but still relevant channel in the interest rate-based regime. Financial liberalization thus reshaped the dynamics of foreign price transmission by progressively reducing its speed and magnitude. Initially, liberalization amplified volatility and intensified shocks; later, as reforms matured and credibility strengthened, transmission became slower, less persistent, and more contained—though never fully eliminated.

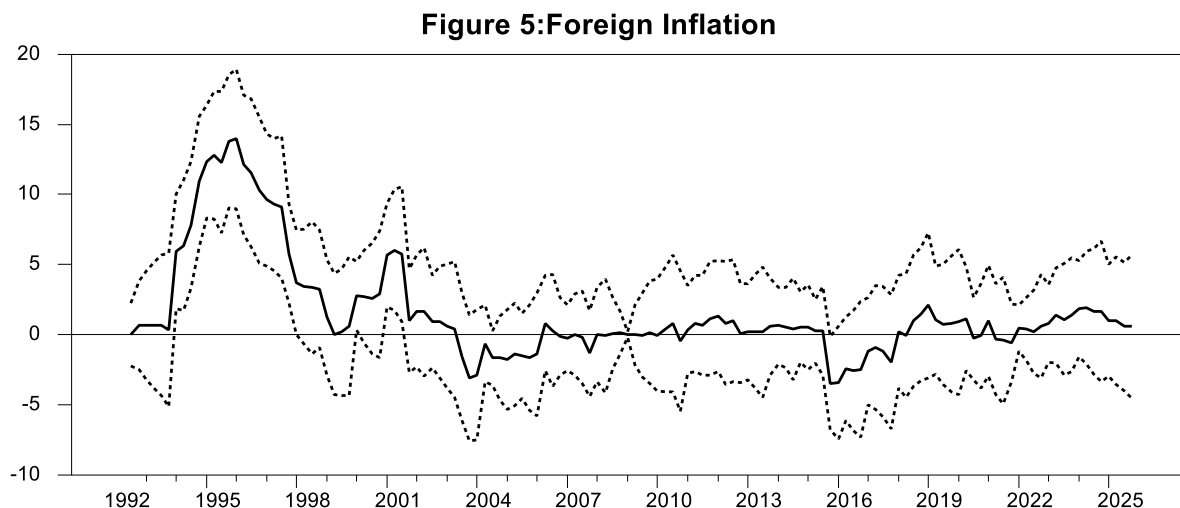
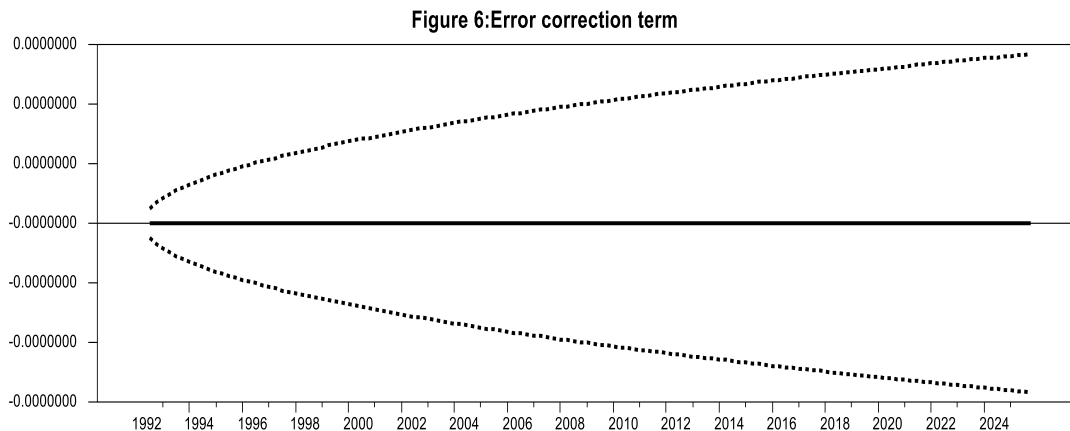


Figure 6 demonstrates that Zambia's inflation dynamics have been only weakly mean-reverting, even during periods when inflation was contained within single digits. This pattern highlights the limited self-correcting capacity of the inflation process, suggesting that shocks tend to persist rather than dissipate naturally. The findings underscore the critical role of credible policy frameworks in strengthening expectation management and enhancing resilience against recurrent disturbances.

In particular, weak mean-reversion implies that inflation stability cannot be assumed: without firm policy anchors, temporary shocks risk becoming entrenched. Sustained credibility, consistent signaling, and disciplined monetary management are therefore essential to reinforce the adjustment mechanism and prevent inflation from drifting upward in response to external or domestic volatility.



4.0 Conclusions and Policy Implications

Zambia's inflation dynamics reveal a striking evolution across monetary policy regimes, as evidenced by the time-varying parameter error-correction model. In the early 1990s, inflation was driven primarily by unstable expectations, rapid exchange rate pass-through, and external price shocks, while money growth exerted only a muted influence due to structural rigidities and shallow financial markets. Output shocks were similarly inert, underscoring transitional inertia and weak responsiveness of the real economy.

With the adoption of monetary targeting, the hierarchy of inflation drivers shifted. Money growth emerged as a dominant force, as excess liquidity translated directly into inflationary pressures. Exchange rate shocks intensified, particularly around 2007, when external volatility and structural adjustments amplified pass-through. Foreign inflation shocks, such as surges in oil and food prices, reinforced this vulnerability, while expectations—though progressively anchored—continued to magnify instability during episodes of stress. Over time, however, as reforms deepened and institutional credibility strengthened, the impact of money growth and exchange shocks moderated, contributing to a downward trend in inflation. Output shocks began to exert a moderate influence, signaling the economy's growing responsiveness to real-side developments.

The transition to the interest rate-based regime reshaped the inflation process once again. Money growth ceased to be a dominant driver, as improved signaling and institutional discipline stabilized its elasticity around zero, eroding its inflationary effect. Expectations became more firmly anchored, though episodic shocks such as the COVID-19 disruptions reignited inertia. Output shocks assumed a stabilizing role, curbing inflationary pressures as credible frameworks amplified the influence of real-side developments. Yet exchange rate shocks re-emerged as the dominant channel, with episodes such as the 2015 depreciation rekindling strong pass-through effects.

These findings highlight that Zambia's inflation drivers are profoundly time-varying, with reforms reshaping their speed, magnitude, and persistence. Across regimes, inflation dynamics remained

weakly mean-reverting, underscoring limited self-correction and persistent vulnerability. Financial liberalization altered the pace and intensity of exchange rate pass-through, making it less continuous but still episodically forceful. The money–inflation nexus was reshaped by credibility: from muted responsiveness in the early 1990s, to intensified vulnerability under monetary targeting, and finally to near irrelevance under the interest rate regime. Output shocks, once inert, evolved into a stabilizing force as reforms deepened, underscoring the growing importance of real-side developments in shaping inflation outcomes.

We draw the following policy lessons. The weak mean reversion of inflation implies that shocks tend to persist, necessitating continuous reinforcement of credibility and disciplined signaling. The shifting dominance of transmission channels illustrates that reforms can moderate volatility but cannot insulate the economy from large external disturbances. Monetary policy must therefore remain adaptive, resilient, and forward-looking—flexible enough to absorb external volatility while sufficiently robust to prevent temporary shocks from becoming entrenched. For Zambia and other Southern African economies, the lesson is unambiguous: reforms reshape inflation dynamics, but their durability rests on sustained credibility, consistent communication, and institutional discipline. Periods of apparent stability must not breed complacency, for the drivers of inflation are inherently time-varying, and policy effectiveness hinges on anticipating and managing their shifts. Ultimately, the effectiveness of monetary policy in this regional context depends on its capacity to adapt to evolving dynamics, sustain credibility, and reinforce resilience against recurrent shocks.

5.0 References

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