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Inflation Dynamics in Tanzania's Post-reform Period

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Abstract

This paper investigates the effect of monetary, fiscal, external and structural factors on inflation in post-reform Tanzania. Using the autoregressive distributed lag (ARDL) model, it analyses annual time-series data for the period 1980–2021, and finds inflation to be influenced by the demand side, supply side, and external factors. In the long-run, money supply, real GDP and trade openness significantly affect inflation as per theoretical predictions; whereas fiscal deficit shows an insignificant influence on inflation. In the short-run, real GDP growth, interest rate, nominal exchange rate and trade openness influence inflation negatively; thus the Romer-hypothesis holds in the short-run. Also, a structural break has no significant influence on inflation. The error correction term suggests a stable long-run equilibrium, with a speed of adjustment of about 59% per annum towards its long-run state. These results imply that low and stable inflation is predicated on tightening monetary policy and maintaining economic growth and productivity, particularly in industry and agriculture. Additionally, while targeted interest rate levels should ensure a sufficient supply of money in the productive sectors, they should guard against the crowding-out effect. Also, Tanzania should consider a timely importation of goods in short supply to ease supply-side pressure.

Keywords: *inflation dynamics, post reform, ARDL, Tanzania*

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Introduction

Tanzania started to implement policies of socialism and self-reliance in 1967, when the state took a primary role in national development programmes.[1] The nationalization of privately-owned companies and the creation and management of state enterprises was based on the belief that the state was better placed to guide the country towards sustainable development than the private sector. The financial system was also entirely owned and controlled by the state, characterized by specialization along sectoral and functional lines. In most of the cases, a designated institution was catering for a particular sector or specific function. The central bank, however, was performing multiple roles, which included the development of government parastatals and implementation of monetary policy, characterized by directed credit and foreign exchange allocation as determined by the Finance and Credit Plan introduced in the 1971/72 financial year.

From the late 1960s to the mid-1970s, the economy was characterized by relatively modest rates of growth, a reasonably stable macro-economic environment and a

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[1] Following the Arusha Declaration in 1967, all major means of production in Tanzania were nationalized, marking an orientation towards socialism and self-reliance.

sustainable resource balance. Also, inflation was not significantly different from that of Tanzania's trading partners (Lipumba, 1991). However, during the late 1970s and the early 1980s, monetary and fiscal policies proved ineffective in achieving the objectives of price stability and efficient resource allocation (van Arkadie, 1995). As a result, by the early 1980s the economy was experiencing large and unsustainable fiscal and current account deficits, excessive levels of monetary expansion, high inflation, and a sharp deterioration in savings, investment and output performance: all of which led to a severe economic crisis. For example, during the period 1980–85, the budget deficit (before grants) averaged 12% of the GDP, with borrowing from the banking system financing about 50% of it; monetary expansion averaged 31%; the inflation rate was 30.3%; and real GDP growth during the same period declined sharply to an average of 1.4%; with negative growths being recorded in 1981 and 1983 mainly due to a combination of investment cuts, a decline in capacity utilization and a distorted incentive structure (Ndulu, 1994; Kimei, 2002). The economic crisis manifested through a shortage of food and basic consumer goods, a failure by the government to provide basic services such as health and education as envisioned in the socialism philosophy, and dismal results from different development programs (van Arkadie, 1995; Lofchie, 1985; Mugala, 2004).

From 1986 the Tanzania government embarked on a comprehensive structural adjustment program supported by the International Monetary Fund (IMF), the World Bank, and other development partners. The Economic Recovery Program (ERP I) 1986/87–1988/89, and its rejoinder, ERP II (1989/90–1991/92), aimed at promoting real GDP growth, achieving a positive growth rate in real per capita income, reducing the inflation rate, and restoring a sustainable balance of payments. During the ERP II, the Foreign Exchange Act of 1992 replaced the Exchange Control Ordinance. This change was followed by other liberal policies, such as the introduction of bureaux de change in 1992; the Banking and Financial Institutions Act of 1991; the introduction of Interbank Foreign Exchange Market (IFEM); and the auctioning of treasury bills in 1993 that paved a way for market-determined exchange rates and interest rates. The Bank of Tanzania (BoT) Act of 1995 marked a policy reversal to a single primary objective of price stability, thereby enhancing the independence of the BoT and limiting the government's access to the central bank coffers. The Act enabled the BoT to adopt more efficient means of conducting monetary policy in a liberalized market environment, which included the use of indirect monetary policy instruments as well.

Moreover, the government instituted reforms in budgetary management procedures, such as widening the tax base and improving tax administration. The Tanzania Revenue Authority (TRA) Act was passed in 1995. In 1996, the TRA became operational and introduced the value added tax (VAT) in 1998. On the expenditure side, the government adopted a cash budget system in 1996 to enhance spending discipline, whereby cash releases to government ministries, departments and agencies (MDAs) were limited to cash availability. Also, all payments were centralized at the Ministry of Finance. In the financial year 1997/98, the government introduced public expenditure reviews to facilitate a comprehensive assessment of public financial management (PFM).

In Tanzania, supply side shocks dominated the overall inflation, where the headline inflation follows closely (or tracks) the food inflation. The positive agriculture shocks derive down the Consumer Price Index (CPI) and vice versa, owing to a large weight of food component in the CPI basket, which makes inflation susceptible to weather variations. Controlling inflation, however, has been a challenge in Tanzania because the supply-side shocks also reduce the ability of monetary policy to influence inflation in the short-run. Additionally, the relationship between money and inflation over time is ordinarily weak, at least in countries with low to moderate inflation (IMF, 2014). This weak relationship limits the role of money targeting regimes in delivering low and stable inflation; as well as managing inflation expectations, commonly in Sub-Saharan Africa. Due to reform measures, inflation decelerated from an average of 31.2% between 1987 and 1991 to 21.9% in 1992. It reversed to 33.3% in 1994 due to a heavy devaluation of the Tanzanian shilling. Thereafter, it declined to 27.4% in 1995, and reached a single digit of 7.9% in 1999. During the period 2000–2005, headline inflation remained stable around the policy target of 5%. After 2005, it took an upward trend, reaching 12.1% in 2009 (Adam et al., 2012). The inflation increased further to 16% in 2012, before declining to 5.6% in 2015 and 4.3% in the period 2016–2021.

High and volatile inflation rates have diverse social, political and economic consequences on the economy, thereby adversely affecting both businesses and consumers. Also, they cause instability and inefficiency, create uncertainty about future relative prices, and undermine the competitiveness of the export sector. Hence, price stability—as defined by a low and stable inflation—is a prerequisite for financial stability and economic growth. Thus, this paper investigated the supply side factors, demand shocks, as well as external influences on price developments in Tanzania for the period 1980–2021, which spans the post-reform period.

Section 2 presents the trend in selected macroeconomic variables in Tanzania to show the interrelationship between inflation, money, output and exchange rate. Section 3 reviews the literature on inflation, with a view to underscoring its theoretical basis and unearthing its determinants. Section 4 presents the methodology of the study, whereas section 5 presents and discusses the findings of the study. Section 6 covers the main conclusions and implications of the study.

Trends in Selected Macroeconomic Variables in Tanzania

This section presents and discusses trends in selected macroeconomic variables (as summarised in Table 1 and Figure 1). In the period 1980–2021, budget deficits were highly exogenous, as the Bank of Tanzania monetized the deficits routinely; hence, the monetary policy was subordinate to fiscal policy. Consequently, liquidity expanded and exerted an upward pressure on prices, especially during the late 1970s to the early 1990s. As Table 1 shows, the extended broad money (M3) growth 17.2% in 1980–1984[2] rose to 33.2% in the period 1990–94. The M3 decreased to an annual average rate of 14.9% in the period 1995–1999, with the lowest growth rate being 11% in 1997.

[2] The highest recorded rate of growth in broad money (46.9%) was in 1979 during the war with Idi Amin.

Table 1: Selected Macroeconomic Indicators for Tanzania (1980–2021)

Period	Real GDP Growth	Growth in Money Supply (M3)	Inflation Rate	Official Exchange Rate per USD*	BoP Deficit as % of GDP	Budget Deficit as % of GDP**
1980–1984	0.8	17.2	29.7	10.93	-0.8	-7.9
1985–1989	3.7	30.9	31.3	93.85	-6.2	-3.0
1990–1994	2.5	33.2	28.9	337.14	-8.4	-1.5
1995–1999	4.0	14.9	17.2	649.78	-3.8	-1.1
2000–2004	6.6	17.9	4.6	960.49	1.2	-0.9
2005–2009	7.0	24.6	9.5	1,230.56	1.0	-4.1
2010–2014	6.7	16.1	11.4	1,579.12	0.4	-4.3
2015–2021	6.2	10.1	4.3	2,246.4	0.8	-2.5

Note: *Period average, **After grants

Sources: BoT (2016) and Quarterly Report (various issues)

As well, inflation also decelerated to an average of 14.9% in the period 1995–1999, and recorded a single digit of 7.9% in 1999 for the first time since 1978. However, in the period 2005–2009, M3 increased to 24.6%; and then decelerated to 16.1% in 2010–2014; and even further to 10.1% in the period 2015–2021. Inflation increased as well to 9.5% in the period 2005–2009; increased further to 11.4% in the period 2010–2014, and then declined to 4.3% in 2015–2021, thereby depicting a similar trend with M3. Notably, a significant fall in inflation since 1995 is explained by tight fiscal and monetary policies adopted by the government since the mid-1990s.

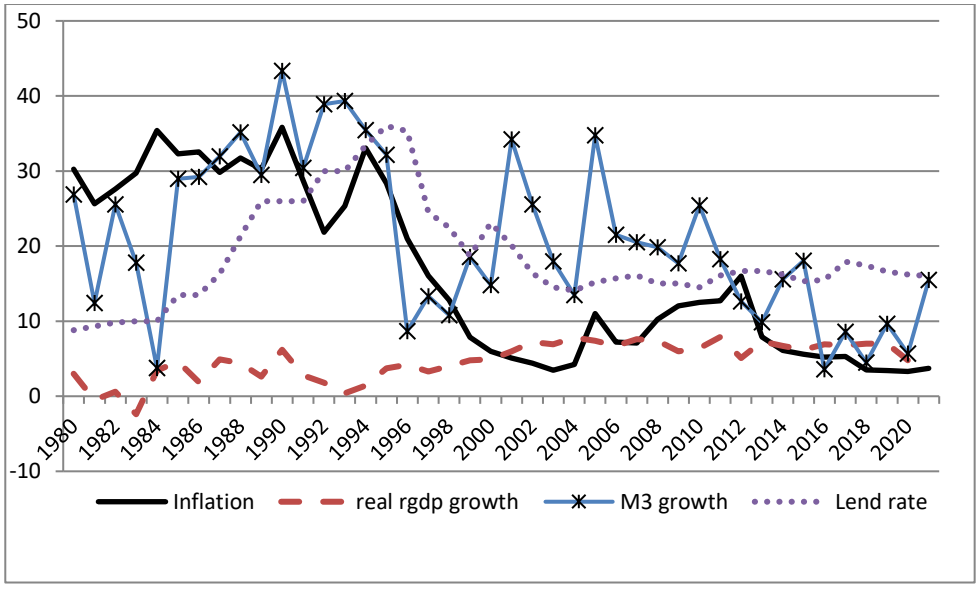

Figure 1: Trends in Money Supply, Real GDP Growth and Prices in Tanzania (1980–2021)

In the period 1993–2005 the government attempted to finance fiscal deficits by auctioning treasury bills (T-Bills). Despite the auction of T-bills reducing inflation significantly, however it led to very high interest rates, which enticed commercial banks to lend to the government rather than to the private productive sectors of the economy, thereby crowding out the private sector. The average medium term (3–5years) lending rate also indicates a declining trend from the mid-1990s through to the 2021 (Figure 1).

The post-reform period was marked by improvement in the performance of the economy. Economic activities grew at an average rate of 3.5% in the period 1985–89, as contrasted to 0.9% in the period 1980–1984. However, they declined to 2.5% in 1990–94, but picked up to 4.1% in the period 1995–99, and further to 6.6% in the period 2000–2004. Real GDP growth averaged 6.9% from 2005–2019; but declined to 4.8% and 4.9% in 2020 and 2021, respectively, due to the COVID-19 pandemic.

It may be summarised that inflation in Tanzania in the period 1980–2021 was characterized by supply shocks, high monetary growth, and external shocks. Notably, the episodes of high rates of inflation show to coincide with the episodes of large external and fiscal deficits, which indicates that the measures taken to address the deficits tended to fuel inflation. The official exchange rate movements seem to be related with inflation too, possibly through imports. The official depreciation of the currency indicates to have had a budgetary impact due to revaluation, which increased foreign debt services in local currency denomination, thereby burdening the fiscal deficit.

Literature Review

Theoretical Literature Review

The causes of inflation and remedial actions are hinged on three theoretical underpinnings, namely, the traditional demand-pull and cost-push factors and structuralism.[3] The demand-pull view asserts that price compensates for excess aggregate demand in both goods and factor markets (Mankiw, 2012). The sources of excess aggregate demand include loose monetary policy and/or fiscal policy, or a change in private spending behaviour, which lead to a shift in the aggregate demand curve. The classical theory of inflation relates price levels to the quantity of money and production of goods and services, assuming there is full employment of resources in the economy, whereas money supply is exogenously determined by the central bank. In the extreme is the monetarist school's interpretation of inflation, which maintains that:

> … inflation is always and everywhere a monetary phenomenon. …historically, substantial changes in prices have always occurred together with substantial changes in the quantity of money relative to output (Friedman, 1966).

[3] In practice, it is not always easy to decompose the observed inflation into demand-pull and cost-push components. The process is dynamic and the shocks to prices are mixed and inertia in inflation may also cause future inflation.

Thus, a permanent increase in money growth leads to an equal increase in the rate of inflation in the long-run. On the other hand, Keynesian economists assert that the inflationary gap (i.e., excess of aggregate demand over aggregate supply) accounts to an increase in money supply, government expenditure, or a reduction in taxes when the economy is already at a full employment level.

In contrast, the cost-push view of inflation emphasizes instead autonomous increase in some important input prices, such as nominal wage rate, rental rate, profit rate, energy prices, interest rate, higher import prices, among other input prices, which fuel inflation through their impact on the cost of production (Frisch, 1990). The cost-push theory maintains that an increase in the price of the factors of production and/or super profits would increase the cost of production, and thus cause inflation. It is argued that 'big labour' or trade unions that pressurize for hikes in nominal wage rate without increasing productivity, or 'big business' inclination to demand super profits, account for inflationary conditions.

Structuralism focuses on structural rigidities and supply-side constraints as sources of inflation, especially in less developed countries (LDCs).[4] Such rigidities include inelastic food supply relative to demand, deficiencies in transport and raw materials, uncalled-for inefficiencies in investment due to mismanagement and corruption, constraints in the import capacity due to limited foreign exchange, which exacerbate response to weak structure (Prebisch, 1961; Cardoso, 1981; Agenor & Montiel, 1996). The reason in support of the argument is the existence of structural rigidities or bottlenecks—such as economic, institutional and socio-political barriers—which hinder output expansion in these economies. According to Argy (1970), the widely used structural hypotheses in empirical studies include the demand-shift, export instability, agricultural bottlenecks, and foreign exchange scarcity hypotheses. Whereas some analysts consider that the structuralist school explains inflation only in LDCs, the monetarist view applies in both developed and developing countries.

The Romer hypothesis, however, contends that more open economies or trade liberalization tend to have a low rate of inflation since trade openness unlocks the supply side constraints (Romer, 1993; Cooke, 2010). Yet, Terra (1998) found that the inverse relationship between inflation and trade openness was vivid in highly indebted countries in Latin America, and insignificant among OECD countries. Rogoff (2003) postulates that open economies are less prone to supply shocks, but quickly pay the price of high inflation in the case of expansionary policy when the exchange rate is freely determined in the market.

Since Harberger's (1963) work, the monetarist model has provided a theoretical framework for various empirical studies in analysing inflation in developing countries. However, studies by Parkin (1977), Rwegasira (1976), Khan and Knight (1981), Sain (1982), Tegen (1985), and London (1989), among many others, affirm

[4] The main views on structuralism are well captured in Seers (1962).

that the characterization of inflation as fundamentally a monetary phenomenon, especially in developing countries, is unsatisfactory. Many of these studies suggest that a modified monetarist model that takes into account the prevailing conditions would successfully capture the main elements of inflation in developing economies, in contrast to the simple Harberger framework.

Empirical Literature Review

This study reviews the empirical literature on the determinants of inflation in various African countries, since many African economies have similar characteristics, which justifies comparability of the results from the studies. Chhibber et al. (1989) examined the effect on inflation of monetary and structural factors in Zimbabwe, and found monetary growth, foreign prices, exchange rate, interest rates, unit labour costs and real output were significant determinants of inflation. Using a similar model, Chhibber and Shafik (1990) found growth in money supply and parallel market exchange rate to explain the inflationary process in Ghana. Among the factors found to be statistically insignificant was the official exchange rate. However, Canetti and Greene (1991) found the exchange rate movement and monetary growth to explain the inflationary trend in a sample of 10 SSA countries. Engwaikhide et al. (1994) found that inflation trended upward with money supply expansion in Nigeria. In addition, they found inflation to be more mirrored by the black market exchange rate; while the official exchange rate was found to exert a significant influence on inflation when lagged by one-year. Andersson and Sjo's (2000) study on Zambia found a combination of money supply and exchange rate factors to Granger cause price levels. In the Democratic Republic of Congo (DRC), Nachega (2005) found a strong and statistically significant long-run relationship between budget deficits and seigniorage.

In Kenya, various studies found that monetary variables exert upward pressure on prices in the short-run (Ndung'u, 1994; Duravell & Ndung'u, 2001); whereas exchange rate, foreign prices, and terms of trade were found to have long-run effects on inflation (Sichei & Wambua, 2011; Kiganda 2015). In addition, inertial was found to impact on inflation positively (Duravell & Ndung'u, 2001; Sichei & Wambua, 2011). Kiganda (2015) found the causality to be from money supply to inflation, thereby validating the monetarist theory of inflation. In Ethiopia, Kahssay (2017) found long-run positive effects of broad money supply growth on the consumer price index (CPI); and the CPI was found to decrease with higher imports and gross national savings. Bane (2018) found that factors that were driving inflation included money supply, real interest rate, and structural factors such as shocks to agriculture.

A study by the AfDB (2012) on the East African economies revealed that the main driver of short-run inflation in Ethiopia and Uganda was a surge in money supply; whereas in Kenya and Tanzania the drivers were oil prices and money growth. The study further found that more inflationary pressures in Ethiopia resulted from deficit monetization; whereas in Kenya and Uganda the growth in private sector

credit was the main source of pressure on aggregate demand. The same study found that the effect of world food prices on inflation was relatively low in Tanzania; but high in Uganda and Ethiopia.

A study on inflation drivers in SSA by Nguyen et al. (2015) revealed that: (i) inflation was driven mainly by domestic supply shocks, but declined as SSA integrated more with the global economy; (ii) global oil and food shocks, as well as inflation spill-overs from other countries pushed up domestic prices; and (iii) regional and global demand shocks were increasing, thereby signalling a rise in global inflation. Furthermore, the study found that the contribution of exchange rate and monetary variable shocks to inflation had diminished over time in SSA, owing partly to the improvements in monetary policy frameworks in many countries in the region; including a greater use of market-based instruments, more clarity and transparency in monetary objectives and instruments, as well as the adoption of market-based exchange rates.

Dridi and Nguyen (2018) investigated inflation convergence in the five East African countries of Kenya, Tanzania, Uganda, Rwanda and Burundi. The study found that factors behind the EAC regional convergence include similarities in shocks affecting the EAC countries, similar foreign factors that drive inflation in the region, as well as low and less volatile inflation from the EAC trading partners since the early 1990s. An additional favourable factor was a greater use of market-based instruments, aligned with clear and transparent monetary objectives, instruments and exchange rate flexibility.

In Tanzania, many of the empirical studies on inflation have found significant determinants of inflation to include monetary and structural factors. Money supply growth is the most common significant determinant of inflation in these studies (Loxley, 1972; Rwegasira, 1976; Hyuha & Osoro, 1982; Salimano, 1990; Kilindo, 1992; Lipumba, 1991). As for other factors, Hyuha and Osoro (1982) found that the growth rate of CPI was negatively related to the growth rate of real income and the rate of interest (borrowing); Ndulu and Hyuha (1989) found that the nominal exchange rate adjustment exerted a negligible impact on inflation in Tanzania; while Doriye (1990) found exchange rate adjustment to be one of the factors that fuelled inflation in Tanzania and other LDCs. Structural factors that were found to fuel inflationary pressures in Tanzania include a decline in productivity, production and efficiency that is accompanied by excessive money supply, monetization of the budget deficit, excess demand for food, imported inflation, a series of devaluations, and an increase in interest rates (Curry, 1978; Ndyeshobola, 1980).

Ndulu (1997) found a strong evidence of inflation inertia in Tanzania owing to the lack of credibility, but found real GDP growth to have a dampening effect on inflation. Laryea and Sumaila (2001) found that monetary factors influenced inflation in Tanzania in both the short- and the long-run, whereas output fluctuations and depreciation of the exchange rate had lesser effects. Rutasitara (2004) observed

inflation drivers in Tanzania to include monetary, fiscal and structural factors; as well as imported inflation and regime change from controlled (suppressed inflation) to market-based economy with full pass-through to prices. Solomon and Wet (2004) found the causal link between budget deficit to inflation and monetization of budget deficit as the main source of inflationary pressures in Tanzania.

Mwase (2006) asserted that exchange rate pass-through to inflation in Tanzania had been weak since the late 1990s, which implies that the observed currency depreciation had less impact on domestic prices. However, the study cautioned that a decline in pass-through does not mean that exchange rate fluctuations are not as significant in explaining macroeconomic fluctuations in Tanzania. Ndanshau (2009) found that monetary factors did not fully explain inflation in Tanzania; instead, output growth and exchange rate exert a relatively stronger influence on inflation. Also, Ndanshau and Nyasebwa (2012) found a weak relationship between inflation and budget deficits for the period 1980–2010.

Adam et al. (2012) found that money growth and the stance of monetary policy matter for stable inflation in both the long- and the short-run. Supply-side factors—driven by both domestic agricultural supply shocks and the pass-through from world prices for food and fuel—play a major role in pushing up headline inflation in Tanzania. The pass-through was found to be stronger with a rise in world prices than with world-price fall; and food imports were found to respond rapidly to domestic production shortfalls. However, the capacity to export surplus food was much more muted, such that market adjustment tends to occur through falling prices, other things being equal. Mtui (2015) revealed that real GDP growth and nominal exchange rate depreciation were statistically significant with correct sign, while budget deficit was significant with a negative sign in the long-run, contrary to theoretical predictions. The lack of significant positive effect of budget deficit on inflation in Tanzania is consistent with the studies by Ndanshau and Nyasebwa (2012).

In the recent years, Cheti and Ilembo (2021) found a positive relationship between inflation, money supply (M3), and exchange rate; whereas GDP growth was found to reduce inflation. Mwankema and Luvanda (2022) used quarterly time series data and found a U-shaped relationship between inflation rise and fiscal deficit at 2.69% deficit to GDP ratio, beyond which the fiscal deficit tended to push up the CPI. Mbowe and Mpango (2023) found that low inflation was pro-growth; however, the inflation rate above 7% was found to harm economic growth.

To sum up, the empirical studies on inflation in Tanzania have shown that there are differences in their findings and conclusions. The differences emanate from the determinants of inflation used in the studies, the period they cover, and the varied methodological approaches taken. Thus, our understanding of inflation in Tanzania is still moot, which calls for a further inquiry. In addition, some gaps still remain. For example, Romer's (1993) trade openness hypothesis has not been given sufficient

attention, despite Tanzania being highly dependent on imports. Furthermore, very few studies have examined the determinants of inflation in Tanzania in the post-reform period. Thus, this study was motivated by the need to continue with the identification of elements that contribute to price developments in Tanzania, particularly those that have played a vital part in the post-reform period.

Methodology

Empirical Model

The used model in this study is based on the monetarist model of inflation, which presumes that there exists a stable and well-defined money demand function of the following form:

$$\frac{M}{P_t} = f(y_t r_t) \qquad (1)$$

where the real money balance ($^{M}/_{P}$) is positively related to real income (y_t), but inversely related to the rate of return on money (r_t) (London, 1989).

However, Tanzania is a small open economy. Hence, the basic monetarist model is re-casted to include the exchange rate exr_t, trade openness to_t, and a dummy variable (D_{91}), which reflect the financial sector reforms since the early 1990s after the enactment of the Banking and Financial Institutions Act in 1995, and the budget deficit component (bd_t). Thus, the modified inflation model is expressed as:

$$\frac{M}{P_t} = f(y_t, r_t, exr_t, bd_t, to_t, D_{91}) \qquad (2)$$

By invoking natural log transformation, equation (2) gives a log-linear long-run equation:

$$lnP_t = \beta_0 + \beta_1 lny_t + \beta_2 m_t + \beta_3 lnr_t + \beta_4 lnexr_t + \beta_5 lnbd_t + \beta_6 lnto_{t_t} + D_{91} + \varepsilon_t \qquad (3)$$

where *ln* is the log form, β_0 indicates the intercept of the model, $\beta_1 \ldots \beta_6$ represent the parameters of the explanatory variables, and ε_t is the error term.

Equation 3 includes the demand pull, cost push and structural factors that explain the sources of inflation in Tanzania, as variously used in the empirical literature.

Estimation Techniques

The study invokes an auto-regressive distributed lag (ARDL) to capture the dynamics of how inflation adjusts to changes in the explanatory variables, whereby the lags of order p and q of dependent and independent variables, respectively, enter the right-hand side of the equation to be estimated. ARDL mitigates any contemporaneous causation from the dependent to the independent variables that might bias the estimates; it has strong and efficient results with small sample sizes, and it is the best

when the variables are integrated of order zero (I(0)) and one (I(1)) only (Pesaran et al., 2001). The ARDL model from equation 3 is expressed as:

$$\begin{aligned}\Delta lnP_t = {} & \alpha + \beta_1 \sum_{i=1}^{p} \Delta ln\,(p_{t-i}) + \beta_2 \sum_{i=0}^{q} \Delta ln\,(y_{t-i}) + \beta_3 \sum_{i=0}^{q} \Delta ln\,(r_{t-i}) \\ & + \beta_4 \sum_{i=0}^{q} \Delta ln\,(m_{t-i}) + \beta_5 \sum_{i=0}^{q} \Delta ln\,(bd_{t-i}) + \beta_6 \sum_{i=0}^{q} \Delta ln\,(exr_{t-i}) \\ & + \beta_7 \sum_{i=0}^{q} \Delta ln\,(to_{t-i}) + \emptyset_1\, ln(P_{t-i}) + \emptyset_2 ln(y_{t-i}) + \emptyset_3 ln\,(r_{t-i}) \\ & + \emptyset_4 ln(m_{t-i}) + \emptyset_5 ln(bd_{t-i}) + \emptyset_6\, ln(exr_{t-i}) + + \emptyset_7 ln(to_{t-i}) \\ & + D_{91} + \varepsilon_t \qquad (4)\end{aligned}$$

where Δ represents the difference operator, α is the intercept, $\beta_1 \ldots \beta_7$ are the coefficients measuring short-run relationships, and $\emptyset_1 \ldots \emptyset_7$ are long-run coefficients with optimal lag length based on the Schwarz-Bayesian criterion (SBC).

After uncovering the presence of co-integration by the F-statistics or the Wald statistic, the long-run ARDL between inflation and its determinants is estimated from the following equation:

$$\begin{aligned}lnP_t = {} & \gamma + \sum_{i=1}^{j} \beta_{1i}\, P_{t-i} + \sum_{i=0}^{k} \beta_{2i} y_{t-i} + \sum_{i=0}^{l} \beta_{3i} r_{t-i} + \sum_{i=0}^{m} \beta_{4i} m_{t-i} \\ & + \sum_{i=0}^{n} \beta_{5i} bd_{t-i} + \sum_{i=0}^{o} \beta_{6i} exr_{t-i} + \sum_{i=0}^{p} \beta_{7i} to_{t-i} + D_{91} + \mu_t \qquad (5)\end{aligned}$$

where the terms j, k, l, m, n, o and p represent different lag lengths, and μ_t is an error term.

The short-run coefficient from the error correction model (ECM) of the ARDL model is as in equation 6:

$$\begin{aligned}\Delta P_t = {} & \gamma + \sum_{i=1}^{a} \delta_1\, \Delta p_{t-i} + \sum_{i=0}^{b} \delta_2 \Delta y_{t-i} + \sum_{i=0}^{c} \delta_3 \Delta r_{t-i} + \sum_{i=0}^{d} \delta_4 \Delta m_{t-i} \\ & + \sum_{j=0}^{e} \delta_5 \Delta bd_{t-i} + \sum_{i=0}^{f} \delta_6 \Delta exr_{t-i} + \sum_{i=0}^{g} \delta_7 \Delta to_{t-i} + \lambda \mathrm{ect}_{t-1} + D_{91} + \varepsilon_t \qquad (6)\end{aligned}$$

where, a, b, c, d, e, f and g are different lag length; λect_{t-1} is the error correction term derived from the long-run equilibrium relation; and λ represents the speed of adjustment.

The Data

The study uses secondary annual data for the period 1980–2021 on the variables of interest. The data set were extracted from the publications and online databases of the respective institutions. Specifically, data on inflation and real GDP growth were obtained from the National Bureau of Statistics (NBS); whereas extended broad money supply (M3), nominal exchange rate, lending interest rate, budget deficit, and trade openness (sum of exports and imports) were sourced from the Bank of Tanzania (BoT).

Model Estimation, Results and Discussion

Time Series Properties of the Data

Descriptive Statistics

The descriptive statistics for the data are presented in Table 2. The standard deviations indicate that nominal exchange rate, inflation, money supply and trade openness were relatively more volatile than other variables in the model.

Table 2: Descriptive Statistics of the Raw Variables

	infl	***rgdp***	***m3***	***r***	***nexr***	***bd***	***to***
Mean	16.48	4.76	20.94	18.60	952.99	-4.51	31.53
Maximum	35.83	7.90	43.32	36.00	2298.5	-11.4	55.29
Minimum	3.30	-2.40	3.59	8.80	7.22	0.3	17.22
Std. Dev	11.50	2.49	10.76	6.88	777.25	2.83	10.29
Skewness	0.337	-0.88	0.22	1.001	0.41	0.23	0.46
Kurtosis	1.48	3.19	2.04	3.34	3.146	2.27	2.34
Jarque-Bera	6.88	5.71	2.99	7.56	4.57	1.75	2.02
Prob.	0.03	0.05	0.22	0.02	0.10	0.42	0.36
Observations	42	42	42	42	42	42	42

Source: Author estimates

Changes in trade openness and the money supply showed more or less similar variability. Inflation, money supply, fiscal deficit and openness are flat-shaped given the kurtosis of less than 3 (platykurtic), while other series were peaked – i.e., kurtosis exceeds 3. The Jarque-Bera test results revealed that only money supply, nominal exchange rate, fiscal deficit, and trade openness are normally distributed (probability>0.05). Overall, the summary statistics indicate that only inflation, money supply, and fiscal deficit have skewness close to zero; which suggests that these variables are normally distributed.

Unit Root Test Results

The ADF test results reported in Table 3 show that the nominal exchange rate *(lnnexr)* and trade openness *(to)* were integrated of order I(0), i.e., they were stationary at level; whereas inflation, real GDP growth, and money supply, interest rate and fiscal deficit were integrated of Order I(1). These orders of integration (not higher than one I(1)) allow for the application of the ARDL.

Table 3: ADF Unit Root Test

Variable		With intercept & no trend		With intercept & trend	
		Level	*1st Difference*	*Level*	*1st Difference*
Inflation	*lninfl*	-0.896	-5.078***	-2.294	-5.078***
Real GDP growth	*lnrgdp*	-2.250	-5.428***	-2.9`99	-5.361***
Money supply growth	*lnm3*	-1.899	-4.794***	-2.594	-4.746***
Lending interest rate	*r*	-2.255	-3.035**	-2.380	-3.340**
Nominal exchange rate	*lnnexr*	-3.911***		-1.794	-4.442***
Fiscal deficit	*bd*	-2.668	-6.680***	-2.773	-6.644***
Trade openness	*lnto*	-4.137***		-3.790 **	

Note: *** p<0.01, ** p<0.05, * p<0.1

Source: Author estimates

ARDL Cointegration Test

The study used the ARDL bound test approach to examine the presence of cointegration among the series, the results of which are summarized in Table 4. The F-statistic (7.241) is greater than the upper bound I(1) at a 1% level of significance. Thus, the null hypothesis is rejected in favour of the alternative hypothesis, that is, accepting the existence of a long-run relationship (cointegration) between the variables in the model.

Table 4: ARDL Bounds Cointegration Test Results

Null Hypothesis: No Cointegration Exists				
Level of Significance	**I(0)**	**I(1)**	**Wald Test (F-statistic)**	**Decision**
1%	3.41	4.68		
5%	2.62	3.79	7.241*	Cointegrated
10%	2.26	3.35		

Note: * denotes statistical significance at a 1% level

Source: The author estimates.

The existence of co-integration (long-run relationship) between inflation and its explanatory variables warrants the estimation of long-run coefficients and short-run dynamic parameters.

Long-run and Short-run Multipliers

Analysis of Long Run Coefficients of ARDL

The findings from the long-run ARDL are summarized in Table 5. All the variables were expressed in natural logarithm except lending interest rate (*r*) and budget deficit (*bd*). The coefficients for real GDP growth, money supply, and interest rate are statistically significant and are signed rightly, in line with the economic theory. However, the nominal exchange rate and trade openness are statistically significant with the opposite sign, while fiscal deficit is insignificant with the right positive sign. The coefficient for real GDP growth is negative (-2.76), and statistically significant at a 10% level. This means that, holding other factors constant, a 1% growth in real GDP reduces inflation by 2.8%.

The negative coefficient for real output implies that the supply side factors play a part in dampening inflation in Tanzania. This is also in line with the structuralism theory, which asserts that supply-side constraints are the main sources of inflation, especially in developing countries. The coefficient of money supply (M3) was positive (0.069), and statistically significant at 10% level. This shows that a 1% growth rate of money supply increases inflation by 0.07 basis points, *ceteris paribus*, which is in line with the monetarist view that growth in money supply pushes up prices.

Table 5: Estimated Static Long Run ARDL Model (3, 3, 0, 1, 2, 1, 3) Based on AIC
(Dependent variable = inflation (lninf))

Variable	Coefficient	Standard Error	t-statistics	p-value
Constant	7.444***	2.339	3.18	0.006
lnrgdp	-2.767*	1.442	-1,92	0.074
lnm3	0.069*	0,034	2.04	0.059
r	-0.028*	0.146	-1.92	0.074
lnnexr	-1.835***	0.409	-4.49	0.000
bd	0.089	0.068	1.31	0.209
lnto	3.203***	0.909	3.52	0.003
R2 = 0.7446	F-statistic	1.256	Prob (F-statistic)	0.0159

Note: *** p<0.01, ** p<0.05, * p<0.1
Source: Author's estimates

The interest rate has a negative coefficient (-0.028), and is statistically significant at 10% level, which implies that a positive interest rate shock dampens inflation. Thus, other factors held constant, a 1% increase in interest rate (contractionary monetary policy) lowers the price level by 0.03 basis points. The coefficient of trade openness is positive (3.203), and statistically significant at 1% level, contrary to Romer's (1993) hypothesis that open economies tend to have lower inflation: instead, the openness accelerated prices in Tanzania in the long-run. This could be due to imported inflation, given that the country is import dependent. The fiscal deficit coefficient is positive (0.089), which is in line with the theoretical expectation, but is not statistically significant. The structural break, captured by a dummy variable, was found to exert no influence on inflation in the country; hence, the results have not been reported.

Short-Run Inflation Dynamics

Given the long-run association between the variables, the study estimated the error correction model (ECM) to examine the behaviour of inflation in the short-run; the results of which are summarized in Table 6. The lagged error correction term has a negative coefficient (-0.585), and is highly significant; suggesting a convergence with the speed of 59% per annum to restore the long-run equilibrium following a shock in the short-run. The coefficient of inflation is negative and statistically significant at 5% level, which indicates that the inflation series was mean reverting. Overall, the coefficient of real GDP growth (current level) is statistically significant at 5%, and with the expected negative sign.

Table 6: Error Correction Representation for the Selected ARDL Model
Selected model (3, 3, 0, 1, 2, 1, 3) based on AIC

Variable	Coefficient	Standard Error	t-statistics	p-value
Δ*(Inifl-2)*	-0.523**	0.222	-2.36	0.032
Δ*(lnrgdp)*	-0.494**	0.199	-2.48	0.025
Δ*(lnrgdp_1)*	1.019**	0.403	2.53	0.023
Δ*(lnrgdp_2)*	0.904**	0.326	2.78	0.014
Δ*lngm3*	0.0404***	0.013	3.12	0.007
Δ*r*	-0.065	0.040	-1.62	0.125
Δ*lnnexr*	-5.014***	1.340	-3.74	0.002
Δ*(lnnexr_1)*	-1.191**	0.514	-2.32	0.035
Δ*bd*	-0.0058	0.041	-0.14	0.093
Δ*(lnto_1)*	-1.492**	0.512	-2.91	0.011
Δ*(lnto_2)*	-1.083**	0.400	-2.71	0.016
ECM_{t-1}	-0.585***	0.188	-3.12	0.007
R2 = 0.7446	F-statistic	1.256	Prob (F-statistic)	0.0159

Note: *** p<0.01, ** p<0.05, * p<0.1
Source: The author estimates.

The growth of money supply is statistically significant at 1% level, and positively determines inflation in the short-run. Interest rate has a negative sign—in line with the theoretical prediction—but not statistically significant. Nominal exchange rate and fiscal deficit have the opposite (negative) sign, with the former being statistically significant. The coefficients of trade openness (first and second lags) were negative and statistically significant at a 5% level, which is in line with Romer's (1993) hypothesis; and confirms that trade openness reduces inflation in the short-run.

Post Estimation Diagnostics and Stability Tests

Post-estimation diagnostic tests are very crucial for the validity and reliability of the short- and long-run estimates of the model. The most common are Breusch-Godfrey LM test for autocorrelation, Cameron and Trivedi's decomposition of IM-test or Breusch-Pagan test (heteroscedasticity), Shapiro-Wilk W test results (normality), and test for model stability. Such tests guarantee results that are free from spurious regression, and warrant robustness of the model. The Breusch-Godfrey Lagrange Multiplier autocorrelation test revealed the absence of serial correlation between the ARDL estimates since the observed p-value (0.2810) exceeds 0.05. Whereas, the Cameron and Trivedi's decomposition of IM-test indicates that the estimated model is homoscedastic with a probability value of 0.420, which is greater than the 5% significance level as Table 7 shows.

Table 7: Diagnostic Tests

OLS Assumption	Tests	ch2	df	Prob.	Decision
Autocorrelation	Breusch-Godfrey LM test	0.115	1	0.2810	No Serial correlation
Heteroscedasticity	Cameron & Trivedi's decomposition of IM-test	35	34	0.4204	Homoscedastic

Source: Author's estimates

The Shapiro-Wilk W test was employed to assess whether residuals conform to a normal distribution, and the test results are presented in Table 8. Given that the p-value is 0.6926, which is greater than 0.05, the null hypothesis was not rejected, thereby suggesting that the residuals follow a normal distribution.

Table 8: Shapiro-Wilk W Test Results

Variable	Obs	W	V	Z	Prob>z
Resid	35	0.97799	0786	-0503	0.69265

Source: Author's estimates

The stability and accuracy of the ARDL model test were conducted. The cumulative sum of the recursive residuals (CUSUM) and the CUSUM of squares results showed that the models are stable since the CUSUM and the CUSUM of squares are within the 5% significance lines (Figure 2), thereby supporting the robust stability of the model.

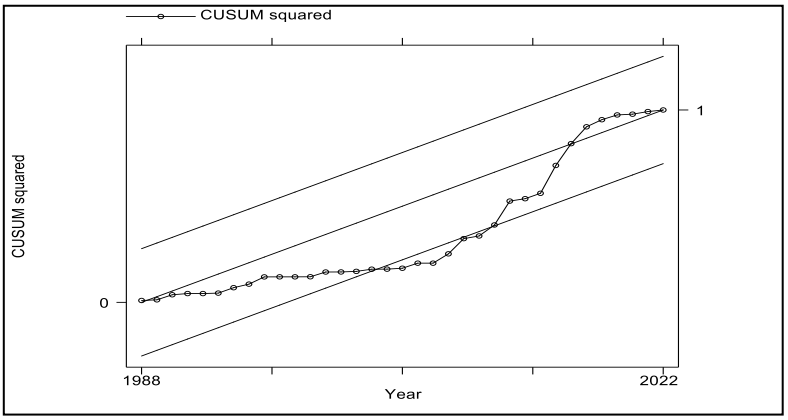

Figure 2: CUSUM Squared Graphical Presentation

The results indicate consistency in the coefficients throughout the period under study. This suggests that the variables in the regression model have not been impacted by any structural changes.

Conclusion and Implications

This study investigated factors that influence inflation in Tanzania in the post-reform period 1980–2021 by applying descriptive and econometric data analyses. From the ARDL model, it was found that the variables were co-integrated in the long run. Furthermore, the study found long-run real GDP growth, money supply, and interest rate are significant determinants of inflation in Tanzania. The budget deficit—though not statistically significant—exerts a positive effect on CPI in the long-run. The nominal exchange rate, while found to be statistically significant, was negatively signed, contrary to theoretical expectations. The Romer's hypothesis was found not

to hold in Tanzania, given a depreciation of exchange rate—an inverse relationship between trade liberalization and CPI growth in the short-run. Accordingly, the demand side, supply side and external factors contribute to the inflationary process in Tanzania. The error correction term—with a negative coefficient of -0.585, and statistically significant at 1% level—suggests a stable long-run equilibrium with the speed of 59% per annum to restore the long-run equilibrium following a shock in the short run. Real GDP growth, money supply and trade openness were found to fuel inflation in both the long- and short-run.

Following from these empirical findings, maintaining low and stable inflation in Tanzania would require prioritising social and infrastructural investments in the real output sectors of agriculture and industry to promote their productivity and growth, as well as that of the economy as a whole. The monetary policy implementation, on the other hand, should maintain interest rate levels that ensure sufficient money supply in the productive sectors in line with market demand and low and stable inflation. Since trade openness was found to reduce inflation in the short-run, Tanzania should consider timely importation of food grains such as rice and sugar when there is a shortage so as to ease supply-side pressure, while considering import substitution policy options in the long-run.

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