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A Case of Public Debt Liquidation Using Inflation in Kenya

V. Amayoka Buhere¹ & Julius Korir¹

¹ Department of Economic Theory, Kenyatta University, Nairobi, Kenya

Correspondence: V. Amayoka Buhere, Department of Economic Theory, Kenyatta University, 43844-00100, Nairobi, Kenya. Tel: 254-713-620-519. E-mail: amayokabuhere@gmail.com

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Abstract

Kenya adopted Medium Term Debt Strategies in 2001 to reduce external borrowing, prioritise concessional debt, slow domestic debt accumulation, extend maturities, and set debt ceilings. Despite these efforts, concerns about debt sustainability persist. Inflation has been demonstrated to liquidate debt in advanced economies but remains unexplored in Kenya. This study used 1983-2022 data and time series analysis to assess inflation's potential to liquidate public debt, distinguishing domestic from external debt. The results indicated that a 2% shock inflation had a minimal impact on domestic debt, reducing the ratio by just 0.024% in ten years. Conversely, external debt to GDP increased by three and a half percent in five years but decreased by 282% in ten years, aligning with global findings that longer-term debt is more responsive to persistent inflation shocks. This study informs fiscal policy on inflation's role in managing public debt.

Keywords: debt overhang, financial repression, inflation, Keynesian, liquidation, public debt, shock, sustainability

1. Introduction

1.1 Problem Statement

Public debt is a critical issue globally, with both advanced and developing economies grappling with debt sustainability concerns. In many low-income and emerging economies, rising debt levels have been accompanied by fiscal imbalances, rising interest rates, fiscal crisis, budgeting complications, slow economic growth, and external vulnerabilities (Baum et al., 2013; Bhattacharya et al., 2022; Huang et al., 2018; Nautet & Menseel, 2011) leading to government's inability to deliver essential services to the nation's citizenry to meet essential obligations (Cecchetti et al., 2011).

As governments borrowed heavily to fund economic stimulus packages, healthcare costs, and social safety nets, the "global financial crisis" of 2008 and the COVID-19 epidemic dramatically raised public debt loads (Haile & Meron, 2022). According to the International Monetary Fund (IMF), the world's public debt increased from 84% in 2019 to approximately 99% of GDP in 2021, indicating previously unheard-of levels of borrowing (IMF, 2021). The United States (128%), Greece (193%), and Japan (262%), which have some of the highest debt to GDP ratios, are examples of advanced economies that have long maintained high debt levels (World Bank, 2022). However, debt sustainability remains particularly problematic for developing economies. In these economies, a high public debt burden or a debt overhang slows economic growth and hinders budgetary flexibility (Kaminsky & Pereira, 1996). For these countries, public debt is often unsustainable due to heavy reliance on external borrowing, weak revenue generation, and volatile economic conditions. Many of these countries experience debt overhang, where excessive debt accumulation reduces investor confidence and limits economic growth (Krugman, 1988). Public debt overhang has been linked to economic stagnation, inflationary pressures, and increased borrowing costs, exacerbating financial instability (Reinhart et al., 2012).

Kenya's rising public debt has reached unsustainable levels, posing a critical challenge to the nation's economic stability. The rapid increase in Kenya's public debt is attributable to several factors, including expansive infrastructure investments, high fiscal deficits, and external shocks. As seen in Figure 1, Kenya's state debt was nearly equally distributed between external and domestic debt by the 2020s. Domestic debt primarily consisted of short-term and long-term Treasury securities, which are issued to finance government expenditures and are mainly domestic held. Short-term domestic debt is generally associated with higher servicing costs, private sector crowding, and greater fiscal risks (Panizza, 2008) but less vulnerable to exchange rate fluctuations

(King'wara, 2014). The external debt burden held in foreign currencies has exposed Kenya to economic and market risks such as currency depreciation, inflation, and economic volatility (Arisa, 2020; King'wara, 2014).

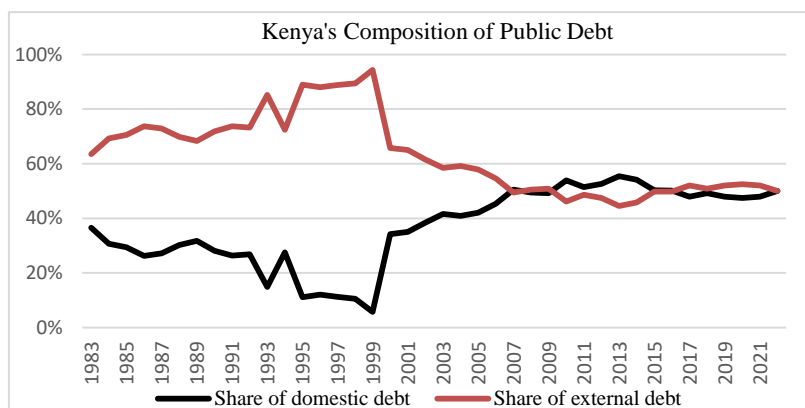


Figure 1. Composition of Kenya's public debt

Source: Data from Central Bank of Kenya.

The IMF, World Bank, African Union, and EAC recommended debt ceilings of 60%, 64%, 65%, and 50%, respectively, and Kenya's ability to pay interest and principal was questioned internationally in 2022 when its public debt as a percentage of GDP reached 67.3%. Medium-Term Debt Strategies (MTDS) were adopted in an attempt to control Kenya's growing debt; these strategies aim to align borrowing practices with fiscal policy goals, encourage domestic borrowing, legislate nominal debt ceilings, lengthen maturities, and reduce reliance on foreign debt. However, despite the implementation of MTDSs to improve public debt sustainability, Kenya has had little success and still faces significant difficulties in managing its domestic debt (Ryan & Maana, 2014).

It is thus necessary to support continuous exploration of different strategies to ensure debt sustainability. Shock inflation has been proposed as a potential tool for debt liquidation and demonstrated using data from developed nations.

The purpose of this study is to examine and ascertain if inflation can efficiently pay off Kenya's state debt while differentiating between its impact on domestic and foreign debt. Using data from 1983 to 2022, this research looked at how inflation affected Kenya's governmental debt, both domestically and internationally. It also looked into the potential use of shock inflation to pay off debt. In general, this analysis used data from 1983-2022 to examine the likelihood of Kenyan public debt reduction utilising inflation. Specific objectives of the study were to:

- 1) Investigate the effect of inflation on domestic public debt in Kenya.
- 2) Investigate the effect of inflation on external public debt in Kenya.

This study contributes to the broader conversation on public debt management in Emerging Markets and Developing Economies (EMDEs). The findings of this study will inform economic policy to manage excessive debt and debt overhangs minimising its impact on households and firms.

1.2 Theoretical Literature Review

Keynes (1923), introduced shock inflation as a potential instrument to temporarily reduce a government's excessive domestic monetary fixed-value obligations by degrading the real worth of money via the Fisherian effect ($r \sim i + \pi$). According to the hypothesis, an inflation shock would temporarily cut real interest rate payments on domestic, non-indexed public debt by artificially keeping real interest rates lower than they would otherwise be through inflation manipulation. In the short term, interest rate expenditures for a given stock of debt, which is often non-indexed, would contribute to debt reduction. Keynes proposed utilising transitory inflation to handle abrupt or unusual outlays, particularly where prices are sticky and presumably unanticipated. This stemmed from Keynes' observation that between 1914 and 1920, various European nations benefitted off high inflation. This approach has historically benefitted governments during periods of economic crises, wars, or economic recessions to manage excessive debt levels without direct default.

The book also presented financial repression by way of currency depreciation and that could further address

sudden or exceptional outgoings; with emphasis on temporary measures to managing the political economy that would be more effective when prices are sticky and unanticipated. Mckinnon (1974) advanced this, describing financial repression as coordinated policy instruments to control the macroeconomic environment by controlling interest rates, inflation, banking reserve requirements, and resource allocation. However, there is caution that this could lead to disappearance of the domestic debt market, currency abandonment, sovereign bankruptcy, capital flights, misallocation of resources, hampered economic growth, liquidity trap and out of control deflation, and thinned banks margins, and political or civil unrest.

Keynes posited that this would be more effective when prices are sticky and unanticipated although not strictly so.

The government budget constraint that proposes that countries should run budget surpluses to minimise a growing public debt can be modified, to reveal a factor of inflation that is inversely correlated with the level of public debt

The theoretical underpinnings of this study are thus drawn from the Shock Inflation Theory (Keynes, 1923) that suggested that inflation has the potential of liquidating real debt, and the Financial Repression Theory (McKinnon, 1974) that highlights how governments may manipulate financial markets to contain public debt.

1.3 Empirical Literature Review and Evidence

Aizenman and Marion (2011) using US debt and inflation data from 1940 to 2009 modelled the costs and benefits of inflating away public debt. According to the predictions of the model, an inflation shock of 6% could decrease the debt to GDP ratio by 20% in four years and even more effectively with a larger share of external debt, foreign-held domestic-currency debt, non-indexed debt, and longer maturity debt.

Reinhart and Sbrancia (2011) studied twenty-eight developed countries from 1900 to 2009 and observed that 25% of liquidation years coincided with inflation shocks, especially in the 1970s, with more impact from higher inflation and negative real interest rates. The study emphasised that long-maturity, fixed rate public debt is more desirous for an inflation-induced debt liquidation while employing financial repression.

Reinhart and Sbrancia (2015) in a study with data from 1945-1980 of ten developed and emerging countries found that 92% of these years were liquidation years and concluded that countries with higher debt and/or higher inflation experienced higher savings.

Using the debt equation subjection to the fiscal budget constraint for six Euro nations and the US, Equiza-Goñi (2016) simulated a 1% permanent inflation shock on data from 1991-2013 led to debt liquidation by 4.2% in the Euro nations but only by 1.7% US, concluding that shock inflation has a larger impact on longer maturities than shorter maturities that characterised US debt.

Krause and Moyon (2016) undertook an analysis of US data from 2008 to 2023 applying a new Keynesian dynamic general equilibrium model predicted that a persistent increase in the inflation target of 4% set post-debt crisis would erode a third of the additional debt accumulated during the debt crisis after 10 years, emphasising that this would impact longer-maturities more.

Akitoby et al. (2017) simulated inflation shocks for G7 countries with data from 2012-2017 using the standard debt equation, demonstrating that compared to 0% inflation rate that reduced the net debt-GDP ratio by 5% in the following five years, raising inflation to 6% would decrease the net debt-GDP ratio by 11% under the full Fisher effect, but only for medium to long-term domestic-currency-denominated non-indexed debt and an environment of financial repression.

Using US data from 2009 to 2017, Hilscher et al. (2022) developed a forward-looking model on the debt dynamic with intertemporal budget constraint to measure the likelihood that future inflation will considerably liquidate the real value of debt. Because of the concentration of short-term and privately owned debt, the study calculated that a 1% sustained increase in inflation would result in a negligible 1.75% fall in the debt to GDP ratio. The research also concluded that longer debt maturities, higher private holdings, unexpected and persistent inflation, and a greater debt load would all result in more debt devaluation; this would be especially true if financial repression was also implemented by requiring maturities to be extended ex-post (Hilscher et al., 2022; Kose et al., 2021).

Fukunaga et al. (2022) examined the effects of shock inflation in 19 advanced economies with average debt levels of 86.3%. They found that an inflation shock of 1% reduced the debt to GDP ratio by around 0.7% over a five-year period. A sustained shock that raises inflation to 6% reduced the short-term debt to GDP ratio by 10% and the longer-term debt to GDP ratio by 10.1%. This illustrates how insignificant maturity is in the event of an

inflation shock. Additionally, the study found that starting with debt overhangs and more sustained inflation shocks had a greater impact.

There is consensus that while both anticipated and unanticipated inflation shocks would significantly impact public debt in a liquidating effect, the impact would be smaller with anticipated inflation. The general agreement is also that the potential of public debt liquidation is more evident with longer maturity debt, non-indexed debt and if it commences after a debt overhang or a debt crisis. However, inflationary shocks must be carefully managed to avoid unintended consequences such as reduced investor confidence, capital flight, and higher borrowing costs. If inflationary pressures become persistent rather than temporary, they may lead to macroeconomic instability, counteracting any potential benefits from debt liquidation. Policymakers must consider these trade-offs when assessing shock inflation as a potential tool for managing Kenya's domestic debt.

2. Methods and Techniques

2.1 Research Design and Data

This study utilised a time-series analysis approach to evaluate the relationship between Kenya's public debt level and inflation, specifically focusing on the effects of inflationary shocks on external and domestic debt levels. By simulating inflation shocks, the research examined how controlled inflation can influence debt sustainability in Kenya over both short-term and long-term horizons. Data sources include the Central Bank of Kenya (CBK) and Kenya National Bureau of Statistics (KNBS) which provide comprehensive data on macroeconomic indicators from 1983 to 2022. This extensive timeframe allows for an in-depth analysis of historical trends in debt accumulation, inflation, and related economic variables, setting a robust baseline for the empirical analysis.

The key variables examined in this study include Kenya's debt to GDP ratio, inflation rate, interest rate, GDP growth rate, and the primary balance to GDP ratio. The primary balance, defined as the difference between government revenues, and non-interest expenditures, is an essential metric for debt sustainability.

Testing time series properties of data including stationarity and cointegration were established, as diagnostic tests for normality, homoscedasticity, and autocorrelation, and model specification and stability.

The research employed two scenarios for domestic and external debt to GDP ratio forecasts for analysis and comparison: a baseline scenario (control) and a treatment scenario that simulates the effects of a 2% inflation shock.

2.2 Definition & Measurement of Variables

The variables used are presented in Table 1 below.

Table 1. Definition & measurement of variables

Variable	Definition	Measurement
b_t^d	The domestic debt to GDP ratio at a specified time t	The annual domestic debt stock in Kenya shillings divided by the annual nominal GDP in Kenya shillings in period t
b_t^e	The external debt to GDP ratio at a specified time t .	The annual external debt stock in Kenya shillings divided by the annual nominal GDP in Kenya shillings in period t
s_t	The primary balance surplus expressed as a percentage of the GDP at a specified time t .	The primary balance surplus is the difference between government's revenue and government expenditure (excluding interest payments on debt). The difference between the annual tax revenue and annual government expenditure in Kenya shillings divided by the annual nominal GDP in Kenya shillings in period t
i_t^d	This is the country's implicit interest rate on domestic debt at a specified time t .	The annual nominal interest payments on domestic debt in Kenya shillings at time t divided by the stock of domestic debt in Kenya shillings at time $t-1$ expressed as a percentage as proposed by (Ryan & Maana, 2014)
i_t^e	The country's implicit interest rate on external debt at a specified time t .	The annual nominal interest payments on external debt in Kenya shillings at time t divided by the stock of external debt in Kenya shillings at time $t-1$. expressed as a percentage as proposed by (Ryan & Maana, 2014b)
π_t	The steady increase in the price level in the economy as measured by the annual percentage change in the Consumer Price (CPI) index at fiscal end year (Kose et al., 2021) (Korishchenko & Pilnik, 2017)	The annual average inflation rate as estimated by the KNBS
g_t	This is the growth rate of the economy measured herein	This is the GDP growth as estimated by the KNBS as GDP growth rate at a specified time t

2.3 Proposed Model

This study adopted the shock inflation theory suggested by Keynes (1923). This phenomenon is presented in the standard debt model derived from the government budget constraint, which proposes that countries run budget surpluses to minimise a growing public debt.

The standard debt equation was derived as follows:

The GDP in period t (Y_t) is given as

$$Y_t = (1 + g_t)Y_{t-1} \quad (1)$$

Where g_t is GDP growth rate and Y_{t-1} is GDP for period $t - 1$

The government budget constraint is;

$$G_t + r_t B_{t-1} = (B_t - B_{t-1}) + T_t \quad (2)$$

Where B_t – nominal public debt in current year t , B_{t-1} – nominal public debt in the prior year, r_t – implicit real interest rate on the public debt in period t , G_t – nominal government expenditure in period t , and T_t is the tax revenue in period t .

Thus, in nominal terms, disintegrating to;

$$r_t B_{t-1} - (B_t - B_{t-1}) = T_t - G_t \quad (3)$$

and further to;

$$B_t = -S_t + (1 + r_t)B_{t-1} \quad (4)$$

where S_t is the primary balance surplus given as $T_t - G_t$.

Dividing equation (4) by equation (1) gives;

$$\frac{B_t}{Y_t} = \frac{-S_t}{Y_t} + \frac{(1+r)B_{t-1}}{Y_t} \quad (5)$$

Fisher's equation is presented as;

$$1 + i = (1 + r)(1 + \pi) \quad (6)$$

and plugging in equation (6) into equation (5),

$$\frac{B_t}{Y_t} = \frac{-S_t}{Y_t} + \frac{(1+i_t)B_{t-1}}{(1+g_t)Y_{t-1}} \quad (7)$$

$$b_t = -s_t + b_{t-1} \frac{1+i_t}{(1+g_t)(1+\pi_t)} \quad (8)$$

Where b_t – debt to GDP ratio, s_t - primary balance surplus to GDP ratio, i_t – implicit nominal interest rate on public debt, g_t – economic growth rate, and π_t –inflation rate.

The models for objective 1 and objective 2 are specified in equations (9) and (11) respectively.

$$b_t^d = -s_t + b_{t-1}^d \frac{(1+i_t^d)}{(1+g_t)(1+\pi_t)} \quad (9)$$

$$b_t^d = \beta_0 + \beta_1 s_t + \beta_2 b_{t-1}^d + \beta_3 i_t^d + \beta_4 g_t + \beta_5 \pi_t + e_t \quad (10)$$

and

$$b_t^e = -s_t + b_{t-1}^e \frac{(1+i_t^e)}{(1+g_t)(1+\pi_t)} \quad (11)$$

$$b_t^e = \beta_0 + \beta_1 s_t + \beta_2 b_{t-1}^e + \beta_3 i_t^e + \beta_4 g_t + \beta_5 \pi_t + e_t \quad (12)$$

Where d implies domestic, e implies external, and t implies time.

2.4 Time Series Properties

To ensure that the data used was stationary to avoid spurious regression, the ADF and KPSS tests were undertaken. All variables were stationary according to the KPSS tests. While according to the ADF tests, some variables, including the domestic debt to GDP ratio, the external debt to GDP ratio, and the implied interest on external debt, were non-stationary, they were confirmed to be stationary at first difference.

For equation (10), due to misspecification of the functional model of the domestic debt to GDP ratio, the square of the implicit interest rate on domestic debt was introduced as an explanatory variable. The explanatory

variables were thus the primary balance surplus to GDP Ratio, the implied interest rate on domestic debt, inflation, the GDP growth rate and the square of the implied interest rate on domestic debt. Equation (10)'s ARDL process produced the lag matrix (4 4 1 3 3 4). The ARDL bounds test for H0: no levels relationship conclusively revealed that with $F = 23.805$ and $t = 0.412$, there existed a cointegrating relationship among the variables at 5% level of significance and thus the long run ARDL model was considered more appropriate to estimate the dependent variable.

For equation (12), to avoid misspecification error even after including the square of the implicit interest rate, the square of inflation rate was introduced to the model. Thus, the dependent variable was the external debt to GDP ratio, and the explanatory variables were primary balance surplus to GDP ratio, implied interest rate on external debt, inflation, GDP growth rate, and the square of the annual average inflation. The second model's ARDL process produced the lag matrix (1 0 3 4 3 2). The ARDL bounds test for H0: no levels relationship conclusively revealed that with $F = 15.937$ and $t = -6.88$, there existed a cointegrating relationship among the variables at 5% level of significance and thus the long run ARDL was considered more appropriate as well. The results of the ARDL bounds test conducted for both models are shown in Table 2.

Table 2. Results of the ARDL bounds test

Pesaran/Shin/Smith (2001) ARDL bounds test results at 5% level			
H0: no levels relationship			
Model 1	F=23.805	t=0.412	Conclusion
I(0) - Lower-bound critical values	2.96	-3.13	Levels relationship
I(1)- Upper-bound critical values	4.18	-4.46	Levels relationship
Model 2	F=15.937	t=-6.883	Conclusion
I(0) - Lower-bound critical values	2.96	-3.13	Levels relationship
I(1)- Upper-bound critical values	4.18	-4.46	Levels relationship

Note.
 Accept H0 if $F < \text{critical I(0) value}$, reject if $F > \text{critical I(1) value}$.
 Accept H0 if $t > \text{critical I(0) value}$, reject if $t < \text{critical I(1) value}$.

The ARDL-ECM estimation was considered theoretically the appropriate model to estimate the relationship between the domestic debt to GDP ratio and the external debt to GDP ratio and their explanatory variables. However, for equation (10), due to an explosive positive error correlation term correction (Nkoro & Uko, 2016) of 0.0371667 that was statistically insignificant at 5% level, the ARDL short-run model estimated.

2.5 Diagnostics

Diagnostic tests were undertaken to evaluate various assumptions of the model and determine whether the model and variables were valid. Successful tests were conducted including the Durbin-Watson test for autocorrelation, the correlation matrix, the Shapiro-Wilks & Jarque-bera normality tests, and the White's test for heteroscedasticity tests, and the Ramsey and the CUSUM of squares tests for specification and stability respectively.

2.6 Forecasting Debt to GDP Ratio

A baseline forecast up to ten (10) years into the future, or 2032, was created using the Local Projection method. To determine b_5^d and b_{10}^d , which are forecasts under objective 1, this study examined historical data on the designated macroeconomic variables in the designated models to provide projections for the domestic debt to GDP ratio for the next 5 and ten years. Likewise, objective 2 estimates the external debt to GDP ratio b_5^e and b_{10}^e were determined.

2.7 Simulating Shock Inflation

A persistent shock inflation Δ_t was imposed on the existing debt in the equation over a period of ten years following the methodology of Akitoby et al. (2017). A shock $\Delta_t = 2\%$, where $t = \text{year 2022}$ was set as a one-off arbitrary shock inflation to predict its impact on debt to GDP ratio in 5 and 10 years. The simulated models are presented below:

$$b_t^{d*} = -s_t + b_{t-1}^d \frac{1+i_t^d}{(1+g_t)(1+\pi_t^*)} \quad (13)$$

$$b_t^{e*} = -s_t + b_{t-1}^e \frac{1+i_t^e}{(1+g_t)(1+\pi_t^*)} \quad (14)$$

where,

$$\pi_t^* \text{ contains } \pi_{2022} + \Delta_t \quad (15)$$

Baseline and treated forecasts under objective 1 and objective 2 were compared over five and ten years. The presence or absence of a debt-liquidating effect of a shock inflation was determined.

3. Results

3.1 Effect of Inflation on Domestic Debt to GDP Ratio

From correlation tests displayed in Table 3, a slight negative relationship was observed between inflation and domestic debt level. There was also an implied though slight positive relationship between inflation and the level of interest payments. Higher interest rate payments on domestic debt also decrease the level of primary surplus balance more than rising interest payments on external debt.

Table 3. Correlation Matrix (1)

Variable	Domestic debt to GDP ratio	Primary balance surplus to GDP ratio	Implied interest rate on domestic debt	Inflation rate	GDP growth rate
Domestic debt to GDP ratio	1				
Primary balance surplus to GDP ratio	0.2421	1			
Implied interest rate on domestic debt	-0.4565	-0.5756	1		
Inflation rate	-0.1123	-0.4516	0.2357	1	
GDP growth rate	0.1665	0.2276	-0.3408	-0.4366	1

To quantitatively assess the interplay of inflation and domestic debt, this study estimated the short-run Autoregressive Distributed Lag (ARDL) (4 4 1 3 3 4), with the domestic debt to GDP ratio as the dependent variable alongside the following explanatory variables: primary balance surplus to GDP Ratio, implied interest rate on domestic debt, inflation, GDP growth rate, and the square of the implied interest rate on domestic debt.

Table 4 below illustrates how inflation effects reflected in domestic debt level by the current values and its three lags, with all its coefficients being negative as expected. At current level, the coefficient for inflation (-0.016) is both statistically insignificant (p-value 0.226 < 5%) and economically small.

Nevertheless, the first- and third lags' coefficients were statistically significant at 5% level. A 1% increase in the first and third lag of inflation would result in a 0.13% and 0.45% respective significant decrement of the domestic debt to GDP ratio, implying that a slight liquidating effect of inflation could only have occurred during the first and the third lags. Further, the Wald tests result confirmed that the coefficients of inflation and its lags were jointly significant at 5%, suggesting that higher inflation in prior years would potentially decrease Kenya's domestic debt level during current periods.

Worth noting is a strong significant inverse link between the primary balance surplus to GDP ratio and the domestic debt to GDP ratio. Interestingly, GDP growth rate did not seem to bear a significant relationship with the domestic debt level.

Table 4. ARDL model estimation results of domestic debt to GDP ratio

Variable	Coefficient	Std. Error	t-statistic	p-value	Conclusion
L1. Domestic Debt to GDP Ratio	0.392712	0.186247	2.11	0.061	Not significant
L2. Domestic Debt to GDP Ratio	-0.3982	0.125059	-3.18	0.01	Not significant
L3. Domestic Debt to GDP Ratio	0.526346	0.190026	2.77	0.02	Not significant
L4. Domestic Debt to GDP Ratio	0.516306	0.170592	3.03	0.013	Significant
Primary Balance Surplus to GDP Ratio	-0.46094	0.166553	-2.77	0.02	Significant
L1. Primary Balance Surplus to GDP Ratio	-0.83351	0.182079	-4.58	0.001	Significant
L2. Primary Balance Surplus to GDP Ratio	0.219971	0.074234	2.96	0.014	Significant
L3. Primary Balance Surplus to GDP Ratio	0.191242	0.102658	1.86	0.092	Not significant
L4. Primary Balance Surplus to GDP Ratio	0.555919	0.089445	6.22	0	Significant

Variable	Coefficient	Std. Error	t-statistic	p-value	Conclusion
Implied Interest Rate on Domestic Debt	-0.16026	0.089588	-1.79	0.104	Not significant
L1. Implied Interest Rate on Domestic Debt	-0.12359	0.110193	-1.12	0.288	Not Significant
Inflation rate	-0.01657	0.050574	-0.33	0.75	Not significant
L1. Inflation rate	-0.13532	0.060025	-2.25	0.048	Significant
L2. Inflation rate	-0.13936	0.091984	-1.52	0.161	Not significant
L3. Inflation rate	-0.45806	0.088414	-5.18	0	Significant
GDP Growth Rate	0.109683	0.15195	0.72	0.487	Not significant
L1. GDP Growth Rate	0.197614	0.142505	1.39	0.196	Not significant
L2. GDP Growth Rate	-0.21267	0.187971	-1.13	0.284	Not significant
L3. GDP Growth Rate	-0.28523	0.182585	-1.56	0.149	Not significant
Square of Implied Interest Rate on Domestic debt	0.164308	0.054502	3.01	0.013	Not significant
L1. Square of Implied Interest Rate on Domestic debt	-0.04301	0.065164	-0.66	0.524	Not significant
L2. Square of Implied Interest Rate on Domestic debt	0.211788	0.027772	7.63	0	Significant
L3. Square of Implied Interest Rate on Domestic debt	0.136725	0.031447	4.35	0.001	Significant
L4. Square of Implied Interest Rate on Domestic debt	-0.03361	0.011922	-2.82	0.018	Significant
_constant	0.072493	0.035381	2.05	0.068	Not significant
R-squared =	0.9931				
Adj R-squared =	0.9765				

Key: Ln: nth lag of the variable

3.2 Effect of Inflation on External Debt to GDP Ratio

As illustrated in Table 5, there was a seemingly strong positive association between inflation and external debt and an even stronger relationship with the square of the inflation rate. Inflation and implied interest rates on external debt had a very weak relationship, giving an indication that local inflation has no effect on interest rate on external debt. There was also a moderately strong negative relationship between inflation and GDP growth.

Table 5. Correlation Matrix (2)

Variable	External Debt to GDP ratio	Primary balance surplus to GDP ratio	Implied interest rate on external debt	Inflation rate	GDP growth rate	Square of the inflation rate
External Debt to GDP ratio	1					
Primary balance surplus to GDP ratio	-0.5718	1				
Implied interest rate on external debt	0.3992	-0.2167	1			
Inflation rate	0.5379	-0.4516	0.09	1		
GDP growth rate	-0.4086	0.2276	-0.1994	-0.4366	1	
Square of the inflation rate	0.6516	-0.4971	0.0375	0.9444	-0.4179	1

The ARDL-ECM was estimated as illustrated in Table 6 below, with the error correction term of -0.5172 indicating a moderate speed of adjustment to equilibrium level which was statistically significant. Thus, both long and short run effects of the explanatory variables on the external debt to GDP ratio were investigated.

In the long run, the external debt to GDP ratio exhibited a negative and statistically significant autoregressive effect, where 1% rise in inflation is connected to a 2.35% decrease in external debt to GDP ratio.

In contrast, however, in the short run, 1% increase in the first, second and third lags of inflation variable would result in a 0.98%, 0.33% and 0.34% respective increase in the external debt to GDP ratio, with their joint significance at 5% level established by the Wald test. A tentative inference may be drawn that an applied inflation shock should be allowed to persist for a longer period to benefit from its debt-liquidating effects.

Inflation also appeared to bear a non-linear relationship with external debt to GDP ratio. In the long run, inflation ceases to have a liquidating effect on external debt is when the inflation rate rises to 22.56%.

Implicit interest rate on external debt and external debt had an expected positive and statistically significant long-run relationship where a percentage decrease in implied interest rates may potentially decrease the level of external debt to GDP by 3.49%. In contrast, however, in the short run, a percentage decrease in the first difference, first and second lags of the implied interest on external debt would potentially increase external debt to GDP ratio by 0.75%, 0.63% and 0.71% respectively. It is thus likely that a combination of lower interest rates

and higher inflation may only have an impact on external debt to GDP ratio in the long run but not in the short run.

The primary balance surplus to GDP ratio had a negative and significant coefficient indicating that higher primary surpluses could be associated with lower external debt burden in the long run with a percentage change in the primary balance surplus to GDP ratio resulting to a 0.62% decrease in external debt to GDP ratio.

In the long run, 1% rise in GDP growth rate may decrease external debt to GDP ratio by 3.26%. In stark contrast, however, in the short run, a 1% increase in the first difference of GDP growth rate and its two lags would result in the external debt to GDP ratio increasing by 1.72%, 1.35% and 0.97% respectively. This may suggest that while acquisition of a larger share of external debt may grow the economy in the short run, it may be detrimental to the economy in the long run.

Table 6. ARDL-ECM estimation results of external debt to GDP ratio

D.External Debt to GDP Ratio	Coefficient	Std. Error	t-statistic	p-value	Statistical Conclusion
Adjustment					
L1.External Debt to GDP Ratio	-0.5172	0.0751	-6.88	0	Negative sign of error correlation term indicates speed of adjustment which is also statistically significant
Long-run					
Primary Balance Surplus to GDP Ratio	-0.6206	0.2519	-2.46	0.025	Significant
Implied Interest Rate on External Debt	3.4936	0.4508	7.75	0	Significant
Annual Average Inflation Rate	-2.3539	0.5431	-4.33	0	Significant
Annual GDP Growth Rate	-3.262	0.6352	-5.14	0	Significant
Square of Annual Average Inflation Rate	5.4446	1.3642	3.99	0.001	Significant
Short-run					
D1.Implied Interest Rate on External Debt	-0.7564	0.285	-2.65	0.017	Significant
LD.Implied Interest Rate on External Debt	-0.6323	0.254	-2.49	0.023	Significant
L2D.Implied Interest Rate on External Debt	-0.7167	0.2479	-2.89	0.01	Significant
D1.Annual Average Inflation Rate	0.2845	0.2739	1.04	0.313	Not significant
LD.Annual Average Inflation Rate	0.982	0.1627	6.04	0	Significant
L2D.Annual Average Inflation Rate	0.3336	0.0856	3.9	0.001	Significant
L3D.Annual Average Inflation Rate	0.3399	0.0593	5.73	0	Significant
D1.Annual GDP Growth Rate	1.7215	0.4382	3.93	0.001	Significant
LD.Annual GDP Growth Rate	1.3461	0.3557	3.78	0.001	Significant
L2D.Annual GDP Growth Rate	0.9796	0.2583	3.79	0.001	Significant
D1.Square of Annual Average Inflation Rate	0.9327	0.6744	1.38	0.185	Not significant
LD.Square of Annual Average Inflation Rate	-1.4498	0.3525	-4.11	0.001	Significant
_constant	0.21718	0.03806	5.71	0	Significant
R-squared	=	0.9811			
Adj R-squared	=	0.9610			

Key: Ln: nth lag of the variable

3.3 Forecasting and Simulation

The local projection method was used to forecast domestic debt to GDP ratio over a ten-year horizon. Figures 2 and 3 present the baseline and simulated forecasts of the domestic debt to GDP ratio and the external debt to GDP ratio. The simulated forecasts contained a 2% shock inflation (+0.02 in the year 2022).

3.3.1 Domestic Debt to GDP Ratio – Baseline and Treated Forecasts

The forecast lines depict a gradually increasing domestic debt to GDP ratio over time. Although the effect of the inflation shock was not observable throughout the entire time horizon under consideration, it became more pronounced towards the latter part of the forecast period. This is as illustrated in Figure 2.

The findings from the inflation shock simulation indicate that the effect of a 2% inflation over ten years would result in domestic debt to GDP ratio of 33.871% against the baseline's 33.879%, representing a slight decrease by 0.024% of the domestic debt level.

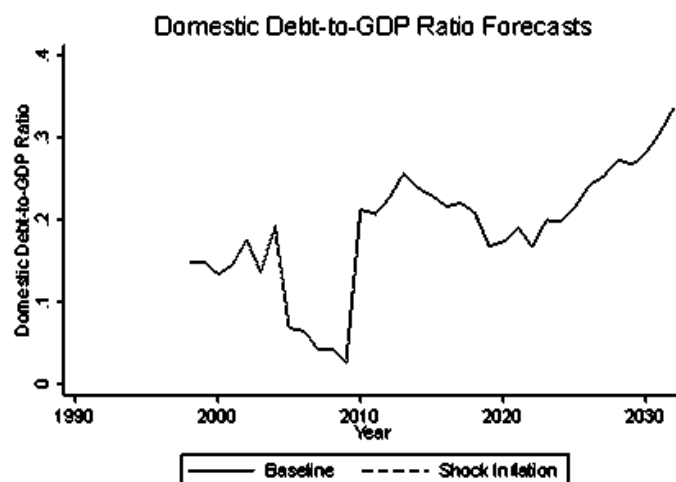


Figure 2. Forecast of domestic debt to GDP Ratio

3.3.2 External Debt to GDP Ratio – Baseline and Treated Forecasts

The forecast lines exhibit smooth turns, exhibiting little volatility as illustrated in Figure 3. More prominent changes occur towards the tenth period, where the external debt to GDP ratio treated forecast of -0.654% which was lower than the untreated forecast of 0.36% by 282% . It appears that in the longer term, a 2% shock to inflation would disappear Kenya's external debt to GDP ratio to sub-zero levels. In the fifth period however, the inflation shock inflation increased external debt level by 3.5% , up from 2.426% of GDP to 2.513% of GDP.

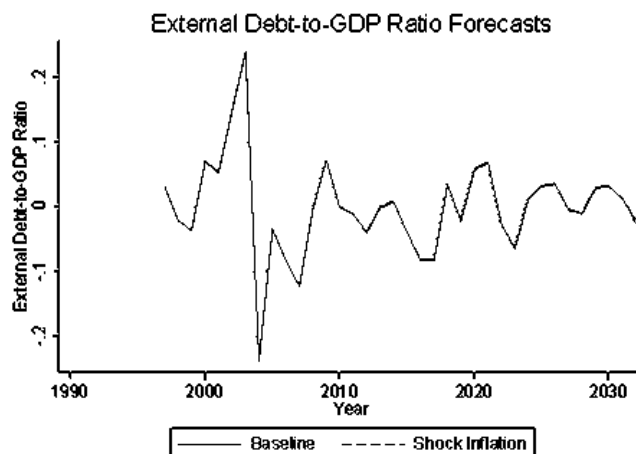


Figure 3. Forecast of external debt to GDP Ratio

4. Discussion

The results indicate that inflation may be a potential tool for public debt management and underscores the distinction between external and domestic debt responses to inflation, with long-term external debt showing greater sensitivity to inflationary pressures. This sensitivity aligns with Keynesian shock inflation theory, which suggests that controlled inflation can reduce the real burden of debt by lowering the real interest rate. However, this dynamic suggests that while inflation may be a valuable tool for managing long-term external debt, it offers limited benefits for domestic debt management.

Kenya's domestic debt is characterised by shorter maturities, frequent issues and refinancing at market rates, domestic creditors, and non-indexation. Comparatively, Kenya's external debt is characterised by longer maturities and foreign creditors.

Over a forecasted period of ten years, the domestic debt to GDP ratio would decrease by 0.024% and by a very negligible level in five years when an inflation shock of 2% is introduced. This limited effect is because interest rates adjust periodically to reflect inflationary changes (Reinhart & Sbrancia, 2015) and may thus not be a viable

option in the case of Kenya.

In sharp contrast, over a forecasted period of ten years, the external debt to GDP ratio would increase by 3.5% in five years but decrease external debt to GDP ratio by 282% in ten years. This could suggest that inflation should be allowed to persist for a longer period as suggested by (Equiza-Goñi, 2016; Fukunaga et al., 2022; Hilscher et al., 2022; Krause & Moyen, 2016).

This is also consistent with the findings of various studies that observed that for shorter term debt maturities, shock inflation had a minimal to non-existent effect on debt (Aizenman & Marion, 2011; Equiza-Goñi, 2016; Fukunaga et al., 2022; Hilscher et al., 2022; Reinhart & Sbrancia, 2011, 2015). Further, it is congruent to the conclusions of Equiza-Goñi (2016), Fukunaga et al. (2022), Krause and Moyen (2016), and Hilscher et al. (2022) of a larger impact of persistent shock inflation on longer maturities. Although, we emphasise that inflation would cease its liquidating effect on external debt in Kenya when inflation rises to 22.56%.

However, this greater effect on external debt is inconsistent with the theory presented by Keynes (1923) and the assertions of Krause and Moyen (2016) that the liquidating effect of inflation may *only* be observed with domestic debt.

5. Conclusion

The distinct responses of external and domestic debt to inflation underscore the importance of targeted policy interventions. While controlled inflation can serve as an effective tool for managing external debt in the long run, it may be less useful for reducing short-term domestic debt. Consequently, Kenya could benefit from inflation-based debt management policies, provided they are applied cautiously to avoid exacerbating inflationary pressures within the domestic economy.

However, there are constraints to its application in Kenya. First, Kenya's high exposure to foreign currency-denominated debt means that currency depreciation and higher servicing costs due to rising inflation could offset the benefits of inflationary debt liquidation. Second, higher inflation could also deter foreign investment and destabilise Kenya's financial markets, thereby hampering economic growth and increasing the long-term debt burden (Huang et al., 2018). Third, the short-term nature of Kenya's domestic debt leads to quick adjustments of that nominal interest rates thus increasing debt servicing costs, thus undermining inflation's debt liquidation benefits. Fourth, there are socio-economic considerations such as reduced purchasing power and potential increases in inequality and social instability (Obiero, 2022).

This study's recommendation for actions include:

- (i) Flexible inflation targets.
- (ii) Debt composition adjustments
- (iii) Lengthen maturities of domestic debt
- (iv) Proper fiscal budgeting and discipline

Authors' Contributions

V. Amayoka Buhere was responsible for conceptualization, review of literature, data collection, study design, methods, data analysis, original draft preparation, and research results. Julius Korir was responsible for data analysis techniques used, and technical guidance in the preparation of this paper. V. Amayoka Buhere and Julius Korir were jointly responsible for the discussion of research results and approval of the final draft.

Competing Interests

The authors declare that there are no competing personal or financial interests that may have influenced the findings reported in this paper.

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