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Nonlinear Effects of Inflation on Public Debt Sustainability in Somalia

Abdukadir Abdullahi Sheik Abdukadir[1*], Abdikani Yusuf Abdulle[2]

[1] Faculty of Management Sciences, SIMAD University, Mogadishu +252, Somalia
[2] Master of Economics Management, School of Social Science, University Sains Malaysia, Penang 11800, Malaysia

Corresponding Author Email: deex441@simad.edu.so

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ABSTRACT

The Central Bank of Somalia faces challenges in implementing effective monetary policies due to limited authority over the nation's monetary system and the incomplete development of the banking industry. This constraint may impede the bank's ability to regulate inflation effectively. Nevertheless, this paper investigates the asymmetric impacts of inflation on public debt sustainability in Somalia from 1977 to 2021. This research employs a Nonlinear Autoregression Distributed Lag (NARDL) model. The research explores how inflation impacts changes in public debt and uncovers potential nonlinearities or threshold effects within this dynamic association. Findings reveal asymmetric effects of inflation on public debt, indicating that inflation's increase positively influences public debt while its decrease adversely impacts it. Additionally, foreign direct investment exhibits a negative long-term correlation with inflation, and GDP shows a positive yet statistically insignificant connection with inflation in the long run. The study underscores the significance of prudent debt management practices and advocates caution when accumulating public debt, especially during periods of heightened inflation. Moreover, this study highlights the implications for governments in Somalia and similar economies facing analogous challenges. It emphasizes the importance of accounting for inflation's impact on public debt dynamics and advocates strategies to control inflation to mitigate the risks associated with rising public debt. The study supports the presence of asymmetrical effects between these variables, enriching theoretical frameworks. Despite, acknowledging limitations, such as temporal constraints and model assumptions, the study recommends future research employ more sophisticated methodologies, extend sequential scope, integrate qualitative approaches, explore policy interventions, and enhance data collection mechanisms for a more comprehensive analysis. Moreover, based on the study outcomes, policy recommendations proposed to enhance fiscal stability. These include implementing measures to curb inflation rates, prioritizing prudent debt management, strengthening fiscal responsibility, enhancing monetary policy's role in inflation management, diversifying investments, improving data monitoring, and focusing on long-term economic planning.

1. INTRODUCTION

In the realm of economic policy and fiscal management, the relationship between inflation and public debt sustainability remains a subject of paramount importance, particularly in the context of developing economies. Inflation, which refers to the continuous increase in the overall prices of goods and services, can significantly impact a nation's fiscal condition, particularly its public debt. The study of inflation and the determinants of its expansion has consistently captivated scholars and researchers, and this continues to be the case in contemporary times. The major objective of national public policy is to promote sustainable economic development by ensuring a low inflation rate [1]. Moreover, the intricacy of this issue is further compounded by considering the current conditions arising from the COVID-19 pandemic, together with the continuing hostilities in Europe. Within this particular framework, the central bank often encounters the predicament of reconciling the need to maintain price stability with its position as a key lender to the government [2].

It is crucial to acknowledge that in numerous developing and underdeveloped nations, the impacts of the COVID-19 outbreak, Russia-Ukraine conflict, budget deficit, famine, drought, and natural disasters necessitate governments incurring debt to tackle these issues and foster economic growth, notwithstanding the potential risks of inflationary pressures that may have adverse effects on economic growth [3].

Effectively managing the dynamics of inflation is essential for attaining the goals of monetary and fiscal policy. The correlation between public debt and inflation has emerged as a major subject of discussion in recent decades, owing to the substantial impact that public debt has on financing fiscal deficits [4]. Policymakers are now considering the possible

influence of varying levels of public debt on inflation. Based on the monetarists' belief that monetary forces have a disproportionate influence on inflation, the central bank uses inflation-targeting policies. However, subsequent studies have shown that this idea is obsolete or lacks a strong basis [5]. According to the 2021 report issued by the International Monetary Fund, worldwide debt escalated to $226 trillion, equivalent to 256% of the GDP, due to the challenges posed by the epidemic in 2021.

Paraguay's governmental debt has steadily increased since 2013, mostly due to the need to obtain financing for infrastructure projects. However, past evidence suggests that a rise in public debt might lead to potential consequences including currency devaluations, crowding-out effect, and increased inflation, contingent upon the prevailing monetary framework. Therefore, the possible occurrence of fiscal dominance (FD) is a significant hindrance to the efficient execution of monetary policy in Paraguay [6].

With a slow recovery from the pandemic, rising food and energy costs, and significant levels of public debt, the economic situation in Sub-Saharan Africa is currently presenting significant difficulties. A major ongoing issue in the area is the need to tackle inflation rates that have surged to their highest levels in 10 years. The elevated levels of inflation have had adverse impacts on both income and food stability. It is crucial to concurrently assist in the advancement of the economy [7]. In addition, in response to the 2007-2008 financial crisis, South Africa's fiscal authorities have implemented a proactive fiscal stimulus approach, resulting in a significant rise in public debt and a persistent government deficit. The country's debt-to-GDP ratio has had substantial growth during the past ten years, climbing from 27.8% in 2008 to 55.8% in 2018. This increase in the ratio signifies a significant expansion in the country's debt load compared to its economic production. It is expected that the indicated ratio will exceed 70% during the next three years owing to the current issues faced by the government regarding state-owned entities (SOEs). Simultaneously, the economy continues to struggle with the task of achieving substantial growth to assist the government in fulfilling its ever-larger spending obligations [8].

Somalia, a country grappling with persistent economic uncertainties compounded by historical instabilities, faces a precarious balance between managing its public debt and economic growth. High inflation rates not only erode the purchasing power of the currency but also exert adverse effects on fiscal policies, potentially compromising debt sustainability and endangering economic stability. In recent years, Somalia has seen a considerable rise in inflation, which has become a prominent worry. The nation's susceptibility to heightened inflation stems from a convergence of factors, including political instability, armed conflict, and inadequate economic investment. The depreciation of the Somali shilling exacerbates this problem, leading to an increase in pricing. The inflation in Somalia has detrimental effects on living standards, leading to a decreased availability of essential goods for a large portion of the population. In response, the Somali government has developed a variety of initiatives targeted at alleviating the adverse effects of inflation. The aforementioned efforts include initiatives focused on attaining currency stability and developing monetary policies to govern the money supply. The country continues to face economic and political difficulties, which reduces the effectiveness of these initiatives [9].

Since 1991, there has been a consistent and continuous increase in the accumulation of debt, including both outstanding amounts and the corresponding penalties. The outstanding principal balance of $1.7 billion is part of the overall debt of $4.5 billion. Additionally, there is $1.0 billion in unpaid interest and $1.8 billion in penalties for late interest reporting. The majority of the debt is owed to the Paris Club, accounting for 53% of the total amount. Multilateral creditors hold 32% of the debt, while non-Paris Club bilateral creditors possess 14%. The aggregated domestic debt, which corresponds to 15% of the prevailing central government debt, represents 1.5% of the GDP [10]. In contrast, the inflation rate in Somalia exhibited a moderate trajectory prior to the advent of the pandemic [10]. However, the COVID-19 pandemic significantly influenced the inflation rate, resulting in a noticeable rise over the period from March to April 2020. The consumer price index (CPI) for food consistently decreased after December 2019.

From the beginning of the COVID-19 pandemic, there was a noticeable increase in the CPI, mostly driven by the rise in both food and non-food costs [11]. The national food inflation rate saw a significant surge, escalating from 3.1% in February 2020 to 5.2% in March. This discovery indicates that the enforcement of containment measures, such as lockdowns and border closures caused a sudden increase in panic purchasing behaviors, which in turn led to higher food prices. The inflation rate in Mogadishu rose from 1.3% in December 2019 to 2.7% in April 2020, as reported at the regional level [12]. The food price inflation rate in Mogadishu saw a substantial surge, escalating from 2.6% to 4.8% during the same period [2, 13].

Understanding the nexus between inflation and a nation's public debt is crucial, especially for countries facing economic challenges, such as Somalia, striving to attain fiscal stability and sustainable debt management amid a turbulent socio-political landscape. The primary purpose of this research is to explore and analyze the nuanced unequal effects of inflation on public debt sustainability in Somalia over a comprehensive time frame spanning from 1977 to 2021. Using a non-linear autoregression method, this study tries to find out how inflation affects changes in public debt in different ways. It also looks for any nonlinearities or threshold effects that might exist in this relationship. By employing advanced econometric techniques, the study aims to delineate how variations in inflation rates contribute to changes in public debt sustainability, thus contributing to the discourse on fiscal policy management in Somalia.

2. LITERATURE REVIEW

2.1 Theoretical review

Divergent perspectives exist in the literature about the connection between governmental debt and inflation. As Friedman suggested in 1968, the consensus concerning inflation is that it is primarily a monetary process. Friedman argues that the adoption of an expansionary monetary policy in the short term would lead to a rise in both real production and the general price level. Nevertheless, over an extended period, only the price level would undergo a rise [14].

According to Friedman's theory, monetary authorities wield influence over price levels. Therefore, effective management of a government's budget deficit necessitates involvement in

monetary expansion, entailing the printing of additional currency and directing surplus budgets toward debt repayment. The Fiscal Theory of the Price Level (FTPL) is a theoretical framework that explains the connection among fiscal policy, public debt, and the price level in an economy. It contends that other factors, such as fiscal deficits and debt, have an impact on inflation in addition to the money supply [15]. Conversely, two conflicting perspectives exist concerning the interaction between monetary and fiscal policy and their impact on maintaining price stability. According to the classical Ricardian theory, the evolution of liquidity demand over time is what determines price trends. This viewpoint suggests that fiscal policy assumes a passive role, implying that government bonds do not contribute to net wealth.

On the contrary, monetary policy operates through interest rate adjustments to impact price levels. As a result, the Ricardian perspective contends that, over an extended period, the money supply primarily determines price levels [16]. Furthermore, FTPL describes the relationship between fiscal policy, public debt, and inflation. This theory contends that fiscal deficits and the corresponding level of public debt. This theory contends that fiscal deficits and the amount of public debt necessary to finance them are additional factors that influence the inflation rate, in addition to the quantity of money in circulation. Consequently, variations in the inflation rate heavily rely on measures taken by a country's fiscal authorities.

The FTPL, when integrated into a non-Ricardian policy framework, holds substantial significance for emerging economies. This is particularly relevant as these economies often issue debt in their domestic currency and encounter challenges in generating adequate tax revenues. Hence, they depend on an "active" fiscal authority to mobilize the necessary funds. Additionally, emphasizing capital flows necessitates a "passive" approach to monetary policy [17].

The literature review has revealed a theoretical association between public debt and inflation. As a result, it becomes crucial to synchronize fiscal and monetary policies to curb inflation, highlighting the potential impact of public debt on inflation. Building upon this theoretical framework, the study will further explore empirical research that has delved into the relationship between public debt and inflation. It will utilize diverse datasets from various countries, encompassing studies that have yielded differing outcomes-be they positive, negative, or a mix of both-to comprehensively analyze this complex association. Public debt has been a topic of interest in empirical studies, with mixed results based on various models. Musgrave and Phelps are considered pioneers in the field, with a specific focus on examining the correlation between public debt and inflation [5]. Musgrave's research emphasized the potential inflationary pressures that may arise if private investors decide to sell off their government securities, thereby triggering a swift escalation in bank credit. Phelps contended that it is the central bank that should serve as the primary driver of inflation, allowing the treasury to implement corresponding adjustments in government deficits. Building upon Phelps' theoretical framework, Sargent and Wallace undertook an investigation into the interplay among debt management, monetary policy, and inflation [5]. Their analysis revealed that the fiscal authority holds sway over price levels, and the method by which government debt is financed-whether through taxation or currency issuance-plays a pivotal role in the realm of monetary policy. Multiple scholarly inquiries have also unearthed a favorable association between public debt and inflation. Nevertheless, the exact nature of the relationship linking public debt to inflation exhibits variance across nations, time frames, and methodological approaches. This scholarly endeavor seeks to explore the ramifications of public debt on inflation within the context of Somalia.

2.2 Empirical review

Researchers have conducted several studies investigating the correlation between public debt and inflation, using various methodologies and analyzing data from different nations. However, the conclusions have been inconsistent, with some studies suggesting a negative link between these variables and others indicating a favorable one. This section analyzes empirical evidence about the relationship between governmental debt and inflation.

The study undertaken by Fukunaga et al. [18] employs simulation and estimate techniques to objectively evaluate the impact of inflation shocks on the ratio of public debt to GDP in 19 advanced economies. The simulations show that a 1 percentage point increase in the inflation rate has the ability to decrease the debt-to-GDP ratio by an average of around 0.7 percentage points in these various economies. Furthermore, the predicted impulse reactions indicate significantly greater magnitudes and prolonged persistence. Importantly, the addition of financial restrictions in the analysis does not much enhance these effects. The results suggest that a slight increase in inflation, along with a certain degree of financial repression, would have no impact on reducing the weight of public debt.

The study conducted by Busato et al. [19] presents an empirical examination of the relationship between public debt and economic development within a sample of 12 emerging economies spanning from 1980 to 2015. Distinguished as a pioneering endeavor focusing exclusively on emerging countries, this research stands out against previous investigations. In a departure from numerous prior studies, the findings unequivocally establish a positive correlation between public debt and economic development. The study underscores the notable impact of public debt, emphasizing its significance in the years to come. Moreover, the research sheds light on the positive effects of both domestic investment and remittances on economic growth throughout the observed time frame. However, the study highlights the adverse effects of inflation on economic growth, indicating its detrimental impact. Additionally, it identifies that trade openness, due to prevailing trade imbalances in several nations, exerts a negative influence on economic growth during the research period.

It is conducted by Saungweme et al. [20] delves into the complex correlation between debt and inflation in Rwanda, with a specific emphasis on analyzing the uneven influence of government debt on inflation. The analysis utilizes a time series dataset from 1980 to 2021 to thoroughly examine this relationship. The study employs various tests, including the limits F-test for cointegration, the BDS nonlinearity test, the Wald test for asymmetries, and the nonlinear autoregressive distributed lag (NARDL) model, to look into both short-term and long-term effects that are not distributed evenly. The NARDL limits F-test for cointegration reveals a robust and enduring nonlinear relationship between Rwanda's state debt and inflation. The BDS test findings indicate the presence of nonlinearity in all dimensions of the series. Conversely, the

findings from the Wald test indicate an uneven impact of public debt on inflation, regardless of the time period under review. Empirical evidence derived from the NARDL analysis reveals that, in the short term, an escalation in public debt corresponds to inflationary pressures. However, in the long term, a reduction in public debt tends to correlate with subsequent declines in inflation. Furthermore, the analysis underscores that inflation tends to react more promptly and exhibits a strong response to favorable changes in public debt compared to unfavorable changes. These findings provide insight into the intricate and unbalanced nature of the correlation between government debt and inflation in the specific context of Rwanda.

The study by Ezeanyeji et al. [21], which covered the years 1981 to 2017, delved into investigating the association between government debt and inflation in Nigeria. Various statistical tests, including the Augmented Dickey-Fuller (ADF) test, co-integration test, and Error Correction Model (ECM), were utilized to determine the connections between these variables. The analysis yielded significant and positive findings, indicating a strong relationship between public debt, exchange rate, money supply, and inflation in Nigeria. Moreover, the study indicates that the real GDP growth rate in Nigeria highlights a negative and statistically insignificant influence on inflation. In light of these outcomes, the report suggests crucial policy recommendations for the Nigerian government. It advocates for the implementation of stringent fiscal and monetary policies to maintain a reduced inflation rate. Additionally, it proposes the financing of budget deficits through non-inflationary means and advocates for the implementation of a price stabilization program involving the subsidization of essential food items.

In their study from 1980 to 2020, Saungweme and Odhiambo [22] empirically analyze the impact of governmental debt on inflation in Zimbabwe. The research seeks to evaluate the current patterns of public debt and domestic inflation in Zimbabwe, with the goal of providing valuable insights to inform policy decisions about debt and inflation. The paper aims to study the effectiveness of fiscal and monetary strategies in establishing macroeconomic stability in Zimbabwe, considering the worrisome patterns observed in recent public debt and inflation trends. This study uses ARDL bounds testing approach and an error correction mechanism (ECM) to examine the presence of cointegration. The ECM takes structural breaks into account. The findings revealed by this study underscore there is a clear and statistically significant relationship between public debt and inflation dynamics in Zimbabwe, especially over the long term. These results offer important insights into the relationship between public debt and inflation, providing essential information for policymakers and stakeholders involved in developing strategies for maintaining macroeconomic stability in the country.

The study conducted by Poku et al. [23] employs a vector autoregression (VAR) model to examine the practical consequences of state debt on inflation in Mozambique. The study examines data collected from the period between the first quarter of 2000 and the fourth quarter of 2016. The main goal is to examine the macroeconomic impacts of public debt in the specific setting of Mozambique's economy. The study's findings suggest that the negative effects of debt service variables on the economy are more significant than the effects of debt variables. The debt variables examined in this study did not show a statistically significant impact on real production. Nevertheless, the debt servicing component had a detrimental impact on actual production, leading to an increase in the overall price level and contributing to the devaluation of the local currency. These findings shed light on the subtle consequences of public debt, specifically emphasizing the significant influence of debt servicing factors on Mozambique's economy.

By examining annual data from 1983 to 2018Examines the impact of governmental debt on inflation in Ghana. The project seeks to utilize the ARDL bounds testing methodology for cointegration analysis and an ECM to investigate the correlation between public debt and inflation in Ghana. The results of the cointegrating regression analysis show that there is a strong and stable long-term link between inflation and the factors that explain it. This link stays the same even after a structural break is taken into account. Notably, the study's results demonstrate a significant and noteworthy influence of public debt on the inflation rate. These findings hold consistent validity, whether the regression analysis is conducted in the short-term or long-term. The paper contributes empirical evidence affirming the existence of inflationary implications linked to state debt in Ghana. Consequently, the study emphasizes the importance of prudence in government decisions regarding increases in public debt. It underlines the necessity for caution to mitigate potential fluctuations in inflation and the consequential risks posed to the economy.

A study by Onafowora and Owoye [24] examines how the long-term relationships between five Caribbean countries' public debt, foreign direct investment (FDI), and economic growth changed from 1975 to 2015. It does this by using auto-regressions, distributed lag, and order-invariant generalized forecast error variance decomposition. The study's primary aim is to uncover the interlinkages between these variables within the specified period and geographical context. The findings of this investigation confirm the presence of cointegration among the examined variables. Notably, domestic investment, foreign direct investment, human capital, and institutional quality exhibit significantly positive impacts on economic growth. Conversely, higher levels of public debt and inflation rates are found to impede growth. Also, the generalized forecast error variance decomposition shows that these economic indicators in the Caribbean countries that were studied are linked in several ways. Specifically. The analysis reveals a unidirectional Granger causality relationship between foreign direct investment (FDI) and economic growth in both nations. Furthermore, there is proof of a reciprocal relationship between growth and FDI, along with a unidirectional relationship from production growth to public debt in three nations. These findings emphasize the intricate and diverse connections between public debt, foreign direct investment (FDI), and economic growth in Caribbean nations.

The study by Maitra [25] studies the effects of public debt and foreign aid on different economic factors, such as income, price levels, and interest rates, in Sri Lanka after the implementation of reforms. The research endeavors to elucidate the effects of governmental debt, encompassing foreign debt, on income levels and inflation, as well as the potential influence of domestic debt on price levels. Additionally, it delves into analyzing the impacts of foreign aid on income and price levels while exploring the effects of both foreign debt and aid on short-term and long-term interest rates. The findings of the study suggest that governmental debt, particularly foreign debt, exhibits a detrimental effect on

income levels, concurrently contributing to increased price levels and indicating inflationary pressures. Furthermore, it appears that domestic debt may have an impact on price levels. Conversely, foreign aid is found to negatively impact both income levels and the price level. Foreign debt and aid have an impact on interest rates, both short-term and long-term. However, the study did not observe any significant influence of domestic debt on interest rates.

The research by Manalo et al. [26] researches the intrinsic factors influencing public debt in the Philippines, particularly focusing on FDI, gross capital formation, inflation rate, and trade balance. The study aims to discern the impacts of these variables on public debt dynamics within the country. The findings of the research indicate that a one-unit increase in FDI leads to a substantial reduction of 272.559 units in debt, suggesting that higher FDI contributes significantly to decreasing public debt. Conversely, the study highlights the adverse effects of trade balance and the inflation rate on public debt, indicating a negative impact of both variables. Furthermore, the researchers suggest incorporating additional variables such as interest rates, exchange rates, and the debt-to-GDP ratio to mitigate and manage debt effectively. Despite the potential impact, the study concludes that the inflation rate and trade balance were deemed insignificant, as both variables did not meet the predetermined level of significance set at a 5% threshold. The research underscores the potential efficacy of FDI as a viable strategy for reducing public debt, lessening dependence on borrowing, and addressing financial obligations within the Philippines.

Utilizing a structural vector autoregression approach, Mohanty and Panda [27] analyze the macroeconomic impacts of public debt in India between the years 1980 and 2017. The main aim of this study is to examine the impact of public debt on different economic indicators in the Indian context, such as interest rates, investment levels, inflation rates, and total economic growth. The verdicts derived from the analysis of impulse response functions reveal several significant outcomes. It is indicated that public debt exerts a detrimental influence on economic growth, suggesting that higher levels of public debt tend to impede overall economic growth in India. Conversely, public debt shows a favorable effect on both short-term and long-term interest rates. Moreover, the impact of public debt on investment and inflation yields mixed outcomes, encompassing both negative and positive effects. This variability suggests that the influence of public debt on investment and inflation is multifaceted, displaying both adverse and beneficial impacts. The study advocates for effective management and allocation of public debt, particularly domestic debt, emphasizing the necessity of directing resources toward productive endeavors. By regulating the management of public debt, the research suggests that positive outcomes for the Indian economy can be achieved, highlighting the significance of prudent and targeted utilization of public debt for the nation's economic growth. The study by Cherif and Hasanov [28] investigates the impact of macroeconomic shocks on US public debt dynamics, specifically focusing on the effects of austerity, inflation, and growth shocks. The research employs a VAR model to analyze these dynamics. The findings of the study reveal intriguing insights into the relationship between different shocks and their influence on the US public debt ratio. Notably, when a primary balance shock characterized by austerity measures occurs, there is an initial reduction in the debt ratio. However, this debt reduction comes at the expense of diminished economic growth. Consequently, the debt ratio eventually reverts to its pre-shock trajectory, suggesting that the implementation of austerity measures may undermine their intended objectives. On the other hand, an inflation shock initially leads to a reduction in the debt ratio. Additionally, a positive-growth shock unequivocally decreases the level of debt. The study also shows that when the debt equation is added to VAR models, different debt impulse reactions and projections are seen compared to models that either do not include debt or include it linearly.

3. METHODOLOGY

This study utilized a non-linear autoregression distributed lag (NARDL) empirical model, which was developed based on insights derived from the literature review. This study employed an empirical model [29]. The practical model is defined by the following equation:

$$Inflationt\ f\ (PUBDEBTt\ , LFDIt, LGDPt, MSt) \qquad (1)$$

where, **GDP deflator, PUB-DEBT, GDPt, FDI, and MS**, are inflation, External government debt, Gross Domestic Product, foreign direct investment, and Money Supply.

Eq. (1) is transformed into natural logarithms as follows:

$$Inflation_t = \alpha^{-} + \beta_1 \mathbf{LPUBDEBT}_t^{+} + \beta_2 LPUB\mathbf{DEBT}_t + \beta_3 \mathbf{LFDI} + \beta_4 \mathbf{LGDP}_t + \beta_5 \mathbf{MS}_t + \pi t \qquad (2)$$

In this model, '*t*' denotes the residuals, while the other variables are explicitly defined. Economic theory suggests that a surge in inflation may result in an upswing in Government debt. The fiscal policies adopted by the government can impact inflation by influencing the budget deficit. A persistent government budget deficit might lead to increased borrowing and higher levels of money circulation in the economy. This augmentation in the money supply has the potential to exacerbate inflationary tendencies. Researchers anticipate an inverse relationship between foreign direct investment in the economy and the inflation rate. Similarly, analysts predict an inverse relationship between the inflation rate and economic growth, which stands as a critical determinant. The analysis also foresees that heightened inflation, notably in countries like Somalia, may precipitate a decline in GDP, displaying a negative link between GDP and inflation. However, theoretically, a strong correlation exists between the money supply and inflation. If the growth rate of the money supply exceeds that of actual output, prices may escalate, potentially leading to inflation. Augmenting the money supply through central bank actions can subsequently trigger an inflationary uptick.

3.1 Data analysis

The research utilized annual time series data spanning from 1977 to 2021. Five variables were employed for empirical investigation in Somalia, the variables used in this research were selected based on previous empirical studies, ensuring academic researchers, economists and econometricians. The dataset includes important variables, including aggregate public debt (PD) and inflation (INF). Additionally, control variables such as money supply (MS), economic growth

(GDPC), and foreign direct investment (FDI) were included in this study. The researchers obtained the data from the World Bank Development Indicators database and SESRIC data. The natural logarithm function was applied to all variables, except for inflation and money supply, which is standard practice. The natural logarithm function was applied to all variables, except for inflation and money supply, as per standard practice. Table 1 provides a detailed description of the data measurement approach and displays the anticipated coefficient values for each variable based on theoretical projections.

3.2 Estimation technique

The study used the NARDL model to examine the findings. The lag orders of q and p, as well as the long-run coefficients in Eq. (3), were calculated. In addition, the study examined the immediate effects of both cutting inflation on public debt and increasing inflation. The utilization of the NARDL model represents a significant advancement in the current research, as it captures the non-linear relationships between variables [30]. The NARDL model, introduced in empirical research, includes a nonlinear relationship by proposing an equation that accounts for both positive and negative shocks in the explanatory variables.

This article proposes to analyze the unequal effects of inflation on public debt by transforming Eq. (1) into a nonlinear form. This transformation involves segregating public debt into increasing and decreasing values. Notably, the NARDL model has been extensively utilized in recent scholarly works [20, 31]. The formulas representing the ascending and descending values are as follows:

$$PUBDEBT_t^+ = \sum_{k=1}^{t} In\, PUBDEBT_k^+ = \sum_{k=1}^{T} Max(\Delta\, InPUBDEBT_k, 0) \quad (3)$$

$$PUBDEBT_t^- = \sum_{k=1}^{t} In\, PUBDEBT_k^- = \sum_{k=1}^{T} Min(\Delta\, InPUPDEBT_k, 0) \quad (4)$$

This study employs the non-linear ARDL approach to estimate Eq. (3), which employs an organizational strategy to determine the long-term co-integration between inflation and public debt. Before evaluating the model's performance using NARDL, the study does a long-run co-integration test utilizing the limits testing approach.

$$\Delta\, inflation_t = \alpha + \sum_{k=1}^{n} \alpha_{1k}\, \Delta\, inflation_{t-k} + \sum_{k=0}^{n} \alpha_{2k}\, \Delta\, InPub\text{-}debt^+_{t-k} + \sum_{k=0}^{n} \alpha_{3k}\, \Delta\, Inpub\text{-}debt^-_k + \sum_{k=0}^{n} \alpha_{4k}\, \Delta\, InFDI_{t-k} + \sum_{k=0}^{n} \alpha_{5k} \Delta InGDP_{t-k} + \sum_{k=0}^{n} \alpha_{6k} \Delta MS_{t-k} + \boldsymbol{\theta}_1\, \Delta inflation_{t-1} + \boldsymbol{\theta}_2\, InPub\text{-}debt^+_{t-1} + InPub\text{-}debt^-_{t-1} + \boldsymbol{\theta}_4 InFDI_{t-1} + \boldsymbol{\theta}_5\, InGDP_{t-1} + \boldsymbol{\theta}_6 MS_{t-1} + \varepsilon$$

where, q and p are lag orders in Eq. (3) and long-run coefficients are computed as $\beta_2 = y^- / \beta_1$ and β_3 / γ^+. In addition, $\sum_{i=0}^{q} \pi^+$ captures the short-run impact of inflation increase on public debt while $\sum_{i=0}^{q} \pi^-$ captures the short-run impact of inflation reduction on public debt.

The study used the general-to-specific method and the stepwise Ordinary Least Squares (OLS) procedure to estimate Eq. (3). The objective was to find out if there is a possible long-term link between inflation and government debt. The study used the general-to-specific method and the stepwise OLS procedure to estimate Eq. (3). The goal was to find out if there is a possible long-term link between inflation and government debt. Additionally, the research employed the bounds testing method to investigate long-term cointegration, conducted for predictive modeling [32]. In determining the nature of the relationship, if y1=y2=y3=0, the result is considered symmetrical as per the null hypothesis. Conversely, according to the alternative hypothesis, if y is not equal to y2, y is not equal to y3, and none of them equal zero, then the effect is considered asymmetrical. The presence of asymmetry provides distinct insights into this relationship. To examine the presence of asymmetric cointegration between inflation and governmental debt in Somalia, the study employed data from the Wald F-test. Before establishing a long-term correlation among the variables, the research aimed to confirm the suitability of the variables for nonlinear modeling. For this purpose, the BDS test, introduced by Broock et al. [33], was employed. This test assesses the validity of the model's null hypothesis of linearity. The study employed the ADF test as an analytical method to identify non-linear unit roots in the variables.

4. RESULTS AND DISCUSSION

4.1 Descriptive statistics

The subsequent descriptive analysis presents the minimum, maximum, and mean values. The mean value represents the highest average level, while the standard deviation reveals the extent of variability. The variable that is influenced by other factors is inflation, which is displayed in Table 1. The average value is 68.98449 units, the standard deviation is 31.03008 units, and the highest value is 215.4668 units. Concerning the independent variables, such as LPUB-DEBT, LFDI, GDP, and MS, the average LPUBDEBT stands at 20.92776 units, displaying a standard deviation of 1.800510 units, with a maximum value reaching 21.84492 units. The average mean is 15.01346 units, with a standard deviation of 2.868513 units and a maximum value of 19.94674 units. The average LGDP is 21.60883 units, with a standard deviation of 0.372824 units and a maximum value of 22.81883 units. Furthermore, the mean money supply is 22.81883 units, suggesting a standard deviation of 1.990 units, with a maximum value of 5.34 units. Next, the research will proceed by performing a unit root test using ADF method. This test aims to determine the presence of nonlinearity.

4.2 Unit root tests

The results from the ADF test in Table 2 show that inflation is stationary at levels, but LPUBDEBT, LFDI, LGDP, and MS exhibit nonstationary conduct. It suggests that we include the inflation of order one. The ADF unit root test results indicate that all variables, except inflation, are nonstationary in levels, implying that they possess a unit root. Due to the presence of nonlinearity, the results of the ADF test confirm that all variables have an integration order of one (1). The subsequent task is determining the ARDL cointegration among the non-linear elements.

4.3 The Spearman pairwise correlations

This study expanded its analysis by calculating Spearman pairwise correlations to reinforce the initial findings. Table 3 displays the outcomes, presenting coefficients and p-values for each pairwise variable. An observed correlation coefficient of -0.059 signifies a negative relationship between inflation and

public debt. Conversely, the relationship between inflation and foreign direct investment displays a positive correlation, indicated by its coefficient of 0.139. Furthermore, the correlation coefficients between GDP growth, money supply, and inflation highlight positive associations, with values of 0.30 and 0.113, respectively.

4.4 Nonlinearity test

This study aims to investigate the presence of nonlinear characteristics in the time series of total public debt and inflation.

Classifying nonlinearity is crucial as it suggests that findings derived from a linear model might be biased due to disregarding nonlinear dependencies within the total public debt and inflation sequence. Conducting this test prior to commencing the nonlinear estimation process is a recommended practice.

The BDS test, proposed by Broock et al. [33], is commonly utilized to detect nonlinearity in time series data and has been employed in this investigation. Table 4 presents the findings of the BDS test for the variables. The null hypothesis postulates a linear association between the total public debt series and inflation in Somalia. Specifically, it suggests that these series are not identically and independently distributed (IID) across various dimensions (m=2, 3, 4, 5, 6). At the 5% level of significance, the null hypothesis was rejected, encompassing the control variables.

This rejection implies that employing a nonlinear model is more suitable for examining the relationship between total state debt and inflation in Somalia. Therefore, the study utilizes the NARDL technique to investigate the association between these factors.

Table 1. Descriptive statistics

	Inflation	LPUB_DEBT	LFDI	LGDP	Money_Supply
Mean	68.98449	20.92776	15.0134	21.6088	1.6000
Median	70.83000	21.66854	14.6039	21.5432	7.07000
Maximum	215.4668	21.84492	19.9467	22.8188	5.34000
Minimum	13.04844	15.35445	9.21034	21.2360	5.1800
Std. Dev.	31.03008	1.800510	2.8685	0.37282	1.9900
Skewness	1.927459	-2.531295	0.0606	2.22778	0.9039
Kurtosis	12.48051	7.983575	2.1678	7.34071	2.1049
Jarque-Bera	196.3885	94.62343	1.3259	72.5512	7.6304
Probability	0.000000	0.000000	0.5153	0.00000	0.0220
Sum	3104.302	941.7493	675.605	972.397	7.2200
Sum Sq. Dev.	42366.09	142.6408	362.048	6.1158	1.74000
Observations	45	45	45	45	45

Source: computed by the authors (2024)

Table 2. Unit root tests

Variables	Level		First Difference	
	Intercept	Trend & Intercept	Intercept	Trend & Intercept
Inflation	-5.078763**	-5.592205**	-9.900395**	-9.807968**
LEX-debt	-0.458797	-0.846124	-6.499505**	-6.995588**
LFDI	-1.817906	-2.429010	-6.309709**	-6.287739**
LGDP	0.572437	-0.222652	-6.269525**	-6.539675**
Money supply	-1.351521	-1.040414	-5.842072**	-5.917651**

Source: computed by the authors (2024)

Table 3. The Spearman pairwise correlations

Correlation (Probability)	INFLATION	LPUB_DEBT	LFDI	LGDP	MS
INFLATION	1.00000	-0.0590	0.1398	0.3041	0.1130
LEXT_DEBT	-0.05903	1.0000	-0.5003	-0.8382	0.3752
LFDI	0.1398	-0.50037	1.0000	0.6152	-0.37963
LGDP	0.3041	-0.8382	0.6152	1.0000	-0.34571
MS	0.1130	0.3752	-0.37963	-0.34571	1.0000

Note: probability for all dimensions is zero
Source: computed by authors (2024)

Table 4. Broock, Dechert and Scheinkman (BDS) statistic tests [33]

Variables	BDS Statistic				
	Dimension 2	Dimension 3	Dimension4	Dimension 5	Dimension 6
Inflation	0.7109 **	0.9870 **	0.9992**	0.9999**	0.1999**
LEXT_DEBT	0.23009**	0.2261**	0.8906**	0.0909**	0.0734**
LFDI	0.0934**	0.8138**	0.1178**	0.0781**	0.2287**
LGDP	0.3093**	0.1954**	0.9170**	0.1145**	0.1229**
Money supply	0.8597**	0.9967**	0.9999**	0.2999**	0.14999**

Note: Probability for all dimensions is zero
Source: computed by the authors (2024)

4.5 NARDL bounds cointegration tests

The NARDL cointegration test is used in this paper to analyze an unconstrained model. The F-test is used to evaluate the collective hypothesis that the lagged long-run parameters are all equal to zero. The results are displayed in Table 5 below. The results offer statistical proof that the variables are cointegrated in the long term. Specifically, the computed F-statistic of 5.555058 surpasses the critical value of 3.38 at a significance level of 5%. This indicates a substantial long-term relationship between Somalia's inflation and the public debt.

Table 5. NARDL bounds cointegration results

Critical Value (%)	Lower Bound I (0)	Upper Bound I(1)
10%	2.08	3
5%	2.39	3.38
2.5%	2.7	3.73
1%	3.06	4.15
NARDL F-statistics	**Wald F-stat**	**5.555058*****

Notes: *** 10% significance level, **5% significance level, *1% significance level. Null hypothesis: no asymmetric cointegration. Alternative hypothesis: asymmetric cointegration
Source: prepared by the authors (2024)

4.6 NARDL long-run parameter estimation

The rejection rule stipulates that the null hypothesis should be rejected if the F-statistic exceeds the higher threshold. The NARDL regression illustrates the long-run parameters, substantiating the evidence for nonlinear cointegration. These outcomes are showcased in Table 6. The selection of the nonlinear ARDL specification with lag structures 2, 0, 4, 0 is grounded in empirical studies. The analysis reveals that the positive effects of the examined public debt (LPU_DEBT NEG) are comparatively smaller, while the negative impacts (LPUB_DEBT POS) are notably larger than the negative ones. The predicted equilibrium values for positive and negative public debt (LPUB_DEBT) shocks are 1.967444 and 0.034959, respectively. Thus, the results indicate that inflation shows greater responsiveness to adverse shocks compared to favorable shocks.

The findings demonstrate that a 1% increase in inflation leads to a 1.96% upsurge in public debt, yet this relationship is statistically insignificant. These findings indicate that inflation had a positive effect on the process of accumulating governmental debt in Somalia, aligning with similar studies [5, 20, 31]. Furthermore, the results also indicate that the coefficients of foreign direct investment align with the study's expectations.

Table 6. NARDL long-run parameter estimation

Exogenous Variables	Parameters	P-Values
LPUBDEBT_POS	1.967444	0.0025***
LPUBDEBT_NEG	0.034959	0.9955
LFDI	-2.273317	0.0354***
LGDP	16.77219	0.6960
Money supply	-4.1213	0.9702
R-squared	0.989510	
Adjusted-R-squared	0.867132	
Selected model:	ARDL (2, 0, 4, 0)	

Source: computed by authors (2024)

In the long term, the money supply (MS) coefficient displays a negative and statistically insignificant influence, indicating a negative effect of money supply on inflation in Somalia, aligning with comparable studies [34, 35]. The coefficient on GDP, on the other hand, shows that the results regarding gross domestic product demonstrate a positive and statistically insignificant impact on inflation.

4.7 NARDL short-run estimation and diagnosis

Table 7 presents the diagnostic outcomes for both short-run and residual analyses. The Ect (-1) term, also known as the error correction term, plays a crucial role in determining the rate at which equilibrium is achieved. According to the data provided in Table 8, the coefficient of the error term is not only statistically significant but also positive. As the value surpasses 1, it indicates a considerable deviation from equilibrium. Moreover, Table 7 also demonstrates that the results meet the criteria for diagnostic statistics. The diagnostic test outcomes suggest that the absence of serial correlation, heteroskedasticity, and normality assumptions have been met.

Table 7. NARDL short-run estimation and diagnosis

Exogenous Variables	Parameters	P-Values
C	-481.8125	0.0169
LEXT_DEBT_POS	-2.737779	0.6964
LEXT_DEBT_NEG (-1)	1.756533	0.2641
LFDI(-1)_	-4.178678	0.0000**
LGDP(-1)	26.30014	0.0064**
MONEY SUPPLY (-1)	-1.38E-11	0.2125
ECT (-1)	0.907170	0.0000
R-squared	0.930591	
Adjusted R-squared	0.916709	
Heteroskedasticity Test: Breusch-Pagan-Godfrey		0.181446 (0.9999)
Jarque-Bera Test		0.810396 (0.5344322)
Breusch-Godfrey Serial Correlation LM Test		2.05169 (0.1912)

Source: computed by the authors (2023)
Notes: *** 10% significance level, **5% significance level, *1% significance level

4.8 Long-run and short-run asymmetric tests

The objective of the research was to investigate if the long-run and short-run coefficients exhibit symmetrical or asymmetrical patterns. Table 7 illustrates the outcomes of an asymmetrical test. The data depicted in Table 7 strongly indicates the statistical significance of both positive and negative effects of inflation on public debt at a 5% significance level. This evidence goes against the null hypothesis, which says that there is no asymmetry in the means. Instead, it supports the alternative hypothesis, which says that there is an asymmetric link between Somalia's inflation and public debt. These findings suggest an unevenness and disparity in the coefficients.

The investigation delved deeper into assessing whether the long-term and short-term coefficients demonstrate symmetrical or asymmetrical characteristics. The findings of the asymmetry test presented in Table 7 demonstrate that both the positive and negative effects of inflation on public debt are statistically significant at the 5% level. Therefore, the study challenges the idea that there is no asymmetry and recognizes the presence of an asymmetric relationship between inflation and public debt in Somalia, demonstrating fluctuations in the coefficients.

Table 8. Long-run and Short-run Asymmetric Test

Dependent Variable	F-Statistics	P-Value	Presence of Asymmetric
Long-run asymmetry of LPUB-DEBT	3.149234	0.0086	Yes
Short-run asymmetric of LPUB-DEBT	5.13454	0.0026	Yes

Source: computed by authors (2024)

Table 8 highlights the outcomes obtained from an unequal or asymmetric test. The data presented in this table distinctly reveals that both the positive and negative effects of inflation on public debt hold statistical significance at a 5% level. These findings challenge the null hypothesis that suggests the absence of asymmetry. Consequently, this suggests an unevenness and disparity in the coefficients, indicating their inequality. Furthermore, the study conducted an assessment to ascertain the robustness of the predictive model. Figure 1 clearly demonstrates that both the CUSUM and the CUSUM of squares indicate the model's stability.

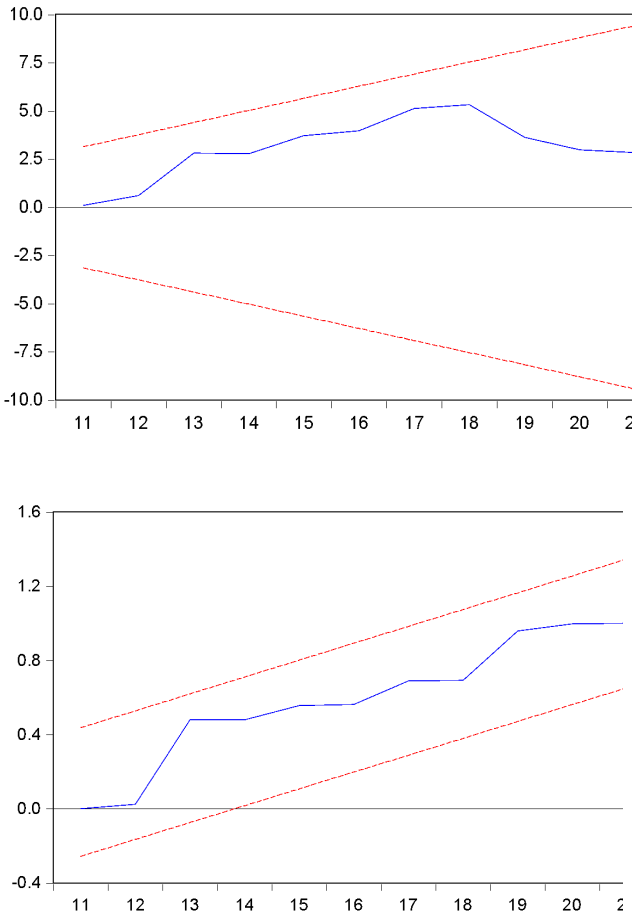

Figure 1. CUSUM and the CUSUM square test

Additionally, Figure 2 illustrates the outcome of the dynamic multiplier on public debt, showing both positive and negative changes. The signifies of the solid black line exhibits the symmetrical adaptation of GDP growth following a favorable shock in public debt within a specified timeframe, illustrating advantageous advancements. The dashed black line illustrates how inflation responds to an adverse impact caused by the introduction of public debt within a specific period. The red dashed line is used to differentiate between positive and negative shocks. Figure 2 demonstrates that positive shocks display greater volatility in the short-run in comparison to negative shocks. Nevertheless, these temporary disturbances eventually reach a state of stability over an extended period.

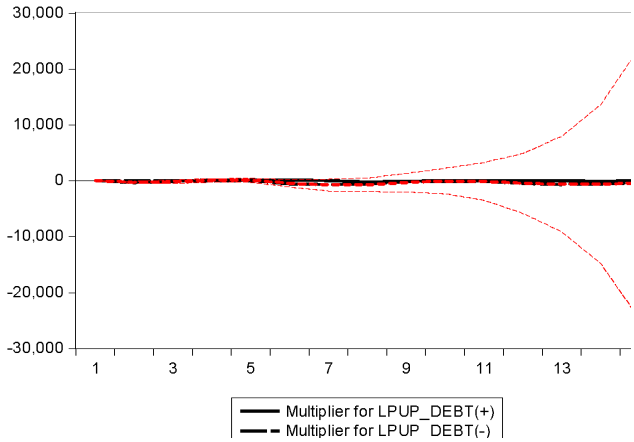

Figure 2. The impact of the dynamic multiplier of changes in public debt

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The Central Bank of Somalia faces challenges in implementing effective monetary policies due to limited authority over the nation's monetary system and the incomplete development of the banking industry. This constraint may impede the bank's ability to regulate inflation effectively. However, this article delves into examining the asymmetric effects of inflation on the public debt of Somalia spanning from 1977 to 2021. The findings obtained from ADF unit root tests suggest that all variables, with the exception of inflation, exhibited nonstationary at the level. However, they became stationary upon first differencing, suggesting a mixed order of integration, with first-order integrated I (0) and second-order integrated I (1) for all variables.

The study employed the Nonlinear Autoregression Distributed Lag (NARDL) model to examine the uneven effects of inflation on public debt in both the long-term and short-term timeframes. The Wald tests indicated that inflation had a balanced impact on state debt. The results confirmed that a rise in inflation had a positive impact on Somalia's public debt, while a decrease in inflation had an adverse effect on public debt. Furthermore, it was shown that foreign direct investment had a detrimental effect on inflation in the long-run, whereas the relationship between gross domestic product (GDP) and inflation was positive but statistically insignificant over the long run. Besides, the impact of the monetary supply on inflation, both in the short and long run, was found to be negative and insignificant.

In addition, the short-term outcomes indicated that the inflationary shock had a significant impact on increasing public debt. The findings indicate that inflation can have an impact on public debt in both the short and long term. The empirical findings indicate the presence of a nonlinear cointegration relationship in the model.

The findings of the error correction term (ECT) analysis

indicate that a state of equilibrium will be achieved from the short run to the long run, with a merging rate of 0.9% annually. Somalia governments should implement fiscal and monetary policies based on inflation targeting and maintaining public debt below the threshold to ensure stable economic development and prevent future public debt crises.

5.2 Implications

Governments in Somalia and other economies experiencing similar situations should consider the implications of inflation for public debt management. Policymakers should adopt measures that account for the potential impact of inflation on the country's debt dynamics. Strategies focused on controlling inflation could help mitigate the risk associated with rising public debt. The study highlights the importance of prudent debt management practices. It suggests that authorities should be cautious about the accumulation of public debt, particularly during periods of high inflation. Vigilant debt management can help control the potential adverse effects of inflation on public debt. Inflation and public debt can cause economic instability by reducing purchasing power, disrupting economic planning, and causing uncertainty. This can impact low-income households and those on fixed incomes, eroding confidence in the economy. Inflation also has distributional implications, with fixed-income individuals struggling to maintain their standard of living. The burden on future generations may be imposed by the presence of public debt, leading to higher taxes or reduced public spending. Inflation can also increase financial market volatility, with higher interest rates compensating for inflation risk. Unsustainable public debt levels can lead to increased borrowing costs and market volatility.

The findings of the research make a significant contribution to understanding the non-linear correlation that exists between inflation and public debt. This challenges the traditional linear assumptions and emphasizes the need for more comprehensive models that consider non-linear dynamics. The study supports the presence of asymmetrical effects between inflation and public debt. This finding adds depth to theoretical frameworks and models, suggesting that the relationship between these variables might not be uniformly symmetric. The study suggests caution in Somalia's approach to increasing total public debt due to its associated risks. However, the absence of detailed data on the specific components of public debt hinders the examination. Subsequent investigations may employ data that has been broken down into smaller components, specifically focusing on oil prices., and exchange rates to examine the non-linear correlation between external and domestic public debt and inflation in the Gambia, with the possibility of expanding the research to other nations.

5.3 Policy recommendations

The following policy recommendation can be considered based on the study findings:

The government should implement policies focused on curbing inflation rates. This could involve adopting tighter monetary policies or fiscal measures aimed at controlling excessive money supply growth. Such measures will help mitigate the adverse impact of inflation on public debt. The government should prioritize prudent debt management practices. Exercise caution when accumulating additional public debt, especially during periods of high inflation. Strengthen debt management policies to ensure sustainable debt levels and reduce vulnerability to inflationary pressures. The government should enhance fiscal responsibility by ensuring that government spending aligns with revenue streams. This includes focusing on effective revenue collection strategies, reducing unnecessary expenditures, and utilizing borrowed funds for productive investments. The government should strengthen the role of monetary policy in managing inflation. Ensure that the central bank maintains price stability by using interest rate adjustments or other monetary tools to regulate the money supply and control inflationary pressures. The government should encourage diversification of investments and sources of revenue. Promote foreign direct investment in productive sectors of the economy to reduce reliance on debt financing and mitigate inflationary effects. The government should improve data monitoring and analysis of inflation and public debt dynamics. Regularly assess the impact of inflation on public debt and refine policies accordingly to adapt to changing economic conditions. The government should focus on long-term economic planning that considers the impact of inflation on public debt sustainability. Develop strategies that promote economic stability while managing public debt to manageable levels. Monetary policy focuses on controlling inflation through interest rate changes. Fiscal policy, which involves governments reducing spending and increasing taxes, can help combat inflation. Somalia governments can issue bonds to borrow money and stimulate the economy. Maintaining low interest rates stimulates the economy, generates tax revenue, and reduces national debt. Somalia governments can raise taxes to cover expenditures and debt, including federal, state, and local tax.

5.4 Study limitations and recommendations

This research encounters several limitations that should be acknowledged. Primarily, the study relies on available data spanning from 1977 to 2021, a period characterized by Somalia's economic volatility, political turmoil, and limited data accessibility. This temporal constraint might not fully encapsulate the nuanced dynamics of inflation and public debt, potentially overlooking critical shifts or variations due to data scarcity.

The study utilized the NARDL model, which, despite its strengths in capturing non-linear relationships, might not encompass the entirety of the complexities inherent in the interaction between inflation and public debt. The model's assumptions and specifications might have omitted certain essential variables or factors that could influence the relationship, potentially limiting the depth of the analysis. The contextual constraints within Somalia, such as civil unrest, economic informality, currency instability, and geopolitical challenges, were not thoroughly factored into the research due to data limitations. These multifaceted contextual elements could significantly impact inflation and public debt but were not fully explored due to constraints in data availability and analysis. The study of inflation and public debt faces limitations due to data accuracy and reliability issues. The complex relationship between these two is influenced by factors like monetary policy, fiscal policy, and external shocks, making it difficult to establish a clear cause-and-effect relationship. Moving forward, future research endeavors could address these limitations by employing more sophisticated methodologies and extending the scope of analysis.

Longitudinal studies that encompass a more extended time frame beyond the study's duration could provide a more comprehensive understanding of the evolving relationship between inflation and public debt in Somalia. Additionally, future research could explore more complex models or hybrid methodologies that integrate qualitative approaches alongside quantitative analyses. Qualitative research methods, such as case studies or interviews, could offer deeper insights into the socio-political and economic factors influencing inflation and public debt. Moreover, the exploration of policy implications based on the study's findings and conducting scenario-based analyses could offer actionable insights for policymakers. Further research that delves into policy interventions and their potential impacts on mitigating inflationary pressures and managing public debt would be valuable. Finally, enhancing data collection mechanisms, particularly in challenging environments like Somalia, and expanding datasets to encompass a broader array of economic, political, and social indicators would be crucial for conducting more comprehensive analyses in future research endeavors. Effective coordination between monetary and fiscal authorities is crucial for maintaining price stability and sustainable public finances. Monetary policy, controlled by the central bank, manages inflation by adjusting interest rates and controlling the money supply, while fiscal policy, controlled by the government, influences public debt levels through responsible spending, taxation, and debt management. Governments should adopt prudent fiscal management, such as realistic budget targets, tax reforms, and long-term fiscal frameworks. Regular debt sustainability analysis is essential to assess long-term affordability and risks associated with public debt. Transparent communication between central banks and governments is crucial for managing public expectations and minimizing uncertainty. Structural reforms can enhance economic efficiency and promote sustainable growth.

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