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Exploring the dynamics of inflation, unemployment, and economic growth in Somalia: a VECM analysis

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ABSTRACT

Maintaining optimal levels of unemployment and external debt remains a significant challenge for ensuring consistent economic growth in many developing countries. Despite persistent economic difficulties marked by political instability, high unemployment, external debt, inflation, and limited capital formation, Somalia is increasingly recognizing the importance of fostering stability, instituting economic reforms, seeking debt relief through international collaborations, and promoting inclusive growth. Therefore, this paper empirically examines the relationship between gross domestic product (GDP), unemployment, external debt, inflation, and gross capital formation in Somalia using annual data from 1991 to 2021. To attain the aim of the study, we implemented the Augmented Dickey-Fuller (ADF), vector error correction model (VECM), variance decomposition, impulse response function, and Granger causality test. The outcomes of the study present a negative relationship between unemployment and economic growth, implying the applicability of Okun's law in Somalia. This suggests that the unemployment crisis in Somalia can be attributed to a lack of economic growth. Furthermore, the study identified that economic growth is negatively associated with inflation and external debt. Moreover, the study reveals unidirectional links between unemployment and GDP, gross capital formation and GDP, GDP and external debt, CPI and GDP, unemployment and gross capital formation, and external debt and unemployment. No causal effects were found in the other combinations of interactions. To sustain economic growth and job creation, the government must implement effective fiscal policies, create an inviting atmosphere, and have a flexible labour market policy to encourage the private sector and small businesses.

IMPACT STATEMENT

This study, titled "Exploring the Dynamics of Inflation, Unemployment, and Economic Growth in Somalia: A VECM Analysis," scrutinizes the intricate interconnections among essential macroeconomic variables in Somalia, utilizing data spanning from 1991 to 2021. Through the application of sophisticated econometric methodologies, the research substantiates Okun's law, revealing a negative correlation between unemployment and economic growth. Additionally, it elucidates the detrimental impacts of inflation and external debt on economic expansion. The insights garnered from this analysis are invaluable for policymakers, underscoring the imperative for effective fiscal policies and comprehensive economic reforms to stimulate private sector development and the growth of small enterprises. By addressing the critical issues of high unemployment, significant external debt, and persistent inflation, this study offers pivotal guidance for advancing sustainable economic development and ensuring stability in Somalia.

1. Introduction

Globally, policymakers and analysts emphasize unemployment as a significant issue in labor markets and a central factor hindering economic development. Moreover, unemployment acts as a barrier to the

international integration of several economies by reducing productivity and competitiveness, deterring domestic and foreign investment, lowering consumer demand, contributing to political and social instability, and causing trade imbalances (Saani et al., 2023). In developing economies, unemployment is particularly problematic, which highlights the inefficient utilization of resources. Achieving full employment should remain a significant focus of any government's macroeconomic policies due to its potential to boost and enhance economic performance. Consequently, the primary objective of governments is economic growth, which improves well-being, raises living standards, and reduces poverty (Hjazeen et al., 2021). Many East African economies, including Somalia, depend heavily on the agricultural sector, which employs over 60% of the workforce (ILO, 2020). Despite its significance, this sector is susceptible to environmental shocks, such as droughts and floods, and global price fluctuations (Abdi et al., 2023). These vulnerabilities can lead to instability in employment and income, posing substantial challenges for governments striving to achieve and maintain full employment. Furthermore, researchers have identified the importance of capital formation in fostering economic growth, which depends on a nation's macroeconomic stability, human resources, trade freedom, capital acquisitions, and infrastructure development (Abdi, Zaidi, et al., 2024).

The COVID-19 pandemic, floods, droughts, locust invasions, and political instability have caused various shocks to Somalia's economy. Despite these challenges, the economy showed improvement with GDP growth rates of 4.6% and 4.7% in 2015 and 2016, respectively, primarily due to the increasing number of livestock exports, a major factor in Somalia's economic growth. However, the nation's growth drastically decreased to 2.2% in 2017, mainly because of the drought. The economy rebounded in 2018 and 2019, driven by increased private sector investments and enhanced agricultural production due to better rainfall. In 2020, GDP growth dropped precipitously from 2.7% in 2019 to 0.3% because of the global COVID-19 epidemic, extreme weather events, and locust invasions. Somalia's economy expanded by 2.9% in 2021, mostly due to a rise in livestock exports and household remittances (MoPIED, 2023; World Bank, 2022). However, real GDP growth declined to 1.7% in 2022, down from the earlier projection of 2.7%, primarily due to climate-related shocks, such as a prolonged drought affecting exports and remittances. This led to widespread food insecurity, with predictions that over half of the population, around 8.3 million people, would be affected by the drought by February 2023 (Office for the Coordination of Humanitarian Affairs, 2023).

The aims of macroeconomic policy are to promote economic growth, control inflation, and manage unemployment. The abruptness of these three macroeconomic components directly impacts societies and may produce social and economic difficulties (Sinha, 2022). The GDP growth rate is insufficient to meet the growing demand for labor, especially among young people. A major issue facing Somalia is that a significant portion of its youth have extremely limited or no access to productive economic resources. With a per capita income of USD 226 and a poverty rate of 73%, Somalia is one of the world's poorest nations, with 43% living in extreme poverty. The civil conflict has profoundly impacted the nation, leaving it vulnerable, extremely poor, and threatened by various political and social issues. Despite the unrest and instability, businesses in Somalia are growing, contrasting with many other sub-Saharan African (SSA) nations. Agricultural production, involving a significant portion of the population, serves as the backbone of the economy, contributing substantially to the GDP and providing the main source of livelihood for many (Abdi, Sugow, et al., 2024). More than 70% of individuals in the country are under the age of 30, and youth unemployment and underemployment are particularly prevalent (ILO, 2020).

For sustained economic growth, the majority of developing nations rely heavily on foreign assistance and often carry significant levels of external debt. This reliance represents a predominant global challenge, profoundly impacting developing economies, particularly the highly indebted least-developed nations (Lau & Lee, 2016). The relationship between public debt and economic growth remains a contentious issue in both theoretical and empirical research. Within the framework of Keynesian macroeconomics, public debt can be utilized to finance government expenditure, which is recommended to stimulate the economy in the short term, especially during periods of economic downturns (Elmendorf & Gregory Mankiw, 1999). However, an alternative viewpoint highlights the detrimental effects of these initiatives on the economy. According to this perspective, public debt might deter investment by driving up interest rates (Kumar & Baldacci, 2010; Modigliani, 1961), upset the fiscal balance (Adam & Bevan,

2005), and trigger financial crises (Burnside et al., 2001). Furthermore, the long-term implications of escalating public debt necessitate the implementation of robust policy frameworks to ensure fiscal sustainability and mitigate potential economic disruptions. These frameworks must address the complex balance between leveraging public debt for immediate economic gains and safeguarding long-term economic stability.

Over the last two decades, empirical research has increasingly focused on the effect of external debt on economic growth in response to the rising levels of external debt in SSA nations. There is ample evidence of the adverse effects of unmanageable foreign debt in Africa. Both academic and non-academic entities have made several recommendations to mitigate the negative economic impacts of high debt on output (Mensah et al., 2017). However, recent literature presents contradictory findings regarding the interaction between economic growth and external debt. Diverse short- and long-term effects of external debt on economic growth have been reported by Agyeman et al. (2022) and Guei (2019), with no solid long-term relationship observed. In contrast, Mohanty (2017) found that Ethiopia benefited from its external debt in terms of economic growth. For East African nations, Tarawalie and Jalloh (2021) found no empirical linkage between external debt and long-term economic growth. On the other hand, Chindengwike (2021) found that Tanzania's economic growth has benefited from external debt. These conflicting results highlight the lack of consensus among studies on this topic.

Thus, this study advances our understanding of the subject by examining the relationship between external debt and economic growth in the SSA region, where conflicting findings continue to appear. Few attempts have focused on Somalia, including Warsame et al. (2022), who investigated the macro-economic factors influencing unemployment. Due to Somalia's elevated levels of external debt, high unemployment rate, and inadequate GDP growth rate, there remains a notable gap in research examining the interconnection among these variables. Given this background, this study aims to fill this gap by investigating the connection between GDP, unemployment, external debt, inflation, and gross capital formation in Somalia from 1990 to 2021. In this respect, this study employs the vector error correction model (VECM), which offers a flexible framework for analyzing the dynamic interdependencies among multiple time series variables simultaneously. To guarantee robust and reliable outcomes, this study utilizes an array of econometric techniques. These include unit root tests, the Johansen cointegration method, bounds testing, Granger causality analysis, impulse response functions, and variance decomposition analysis. Additionally, the study provides insights that can guide targeted policies to address the challenges posed by high external debt, elevated unemployment, and overall economic stability in Somalia.

The remainder of the study is organized as follows: The second section reviews the empirical literature; the third section presents the theoretical framework, data sources, model specification, and econometric approach. Section 4 provides empirical analysis and discussions, and the final section summarizes the study and offers policy recommendations.

2. Literature review

Over the past several decades, literature has consistently explored the association between unemployment and economic growth, considering factors such as Okun's Law, labor market dynamics, and policy implications. Research has illuminated the complex relationship between unemployment and economic growth in Arab countries. For instance, Abdul-Khaliq et al. (2014) revealed a negative relationship, indicating that unemployment is inversely related to economic growth across nine Arab nations. Specifically focusing on Jordan, Hjazeen et al. (2021) found consistent results, highlighting a negative association between economic growth and unemployment. Conversely, Kreishan (2011) arrived at a different conclusion, determining no significant relationship between unemployment and inflation. Various studies investigating the relationship between unemployment and economic growth provide varying degrees of support for Okun's Law across different regions (Efrianti et al., 2018; Nadeshan & Gnanachandran, 2021; Tingi & Lingii, 2011). While evidence from Sri Lanka and Indonesia supports Okun's Law, Malaysia exhibited a strong and consistent bidirectional association. Additionally, India showed a negative correlation between unemployment and economic growth.

The complex relationship between unemployment and economic growth in various African countries has been the subject of several studies. The influence of unemployment on Nigeria's economic growth is significant, as demonstrated by Ojima (2019) and Akeju and Olanipekun (2014). Both studies indicated the harmful impact of unemployment on economic growth. However, Bankole and Fatai (2013) present a contrasting perspective, revealing a positive relationship between unemployment and economic growth. These diverse findings highlight the complexity and variability in the dynamics between unemployment and economic growth in Nigeria. Folawewo and Adeboje (2017) examined the relationship between GDP growth and unemployment rates within the Economic Community of West African States (ECOWAS) from 1991 to 2014. They found a modest and statistically insignificant influence of GDP growth on unemployment, which suggests weak employment elasticity within the ECOWAS region. In contrast, Dahmani and Rekrak (2015) focused on Algeria from 1970 to 2014 using the autoregressive distributed lag (ARDL) model. Their findings revealed a stable, long-term negative effect of unemployment on economic growth, indicating a sustained relationship over the long-run, whereas no such association was detected in the short-run. This reveals the importance of considering different time frames when analyzing the complex dynamics between unemployment and economic growth in distinct regional contexts.

The literature asserts that the level of investment plays a crucial role in driving economic growth and development. Saani et al. (2023) conducted a comprehensive study examining the relationship between remittances and unemployment in Ghana from 1990 to 2021. Their analysis revealed a positive long-term connection between the unemployment rate and several economic variables, including inflation and GCF. Using a vector autoregressive (VAR) method, Pasara and Garidzirai (2020) analyzed time series data from 1980 to 2018 and revealed a favorable long-term relationship between GDP and gross capital formation (GCF). Furthermore, they found that unemployment had no direct impact on GDP in the short-run. Additionally, a high positive correlation was found between unemployment and GCF, but an inverse link was proposed between GDP and unemployment. Utilizing an asymmetric ARDL cointegration approach, Abdi, Zaidi, et al. (2024) found that domestic investment plays a vital role in boosting national output in Somalia. Their findings indicate that both increases and decreases in FDI contribute to Somalia's economic expansion in the short- and the long-run.

On the other hand, the literature suggests that inflation has a complex relationship with economic growth. Sekwati and Dagume (2023) evaluated how inflation and unemployment affected South Africa's economic expansion between 1994 and 2018. Their results indicated that these factors had a long-term association, and the VECM confirmed that unemployment and inflation had a detrimental impact on economic expansion. This contrasts with the findings of Sinha (2022), which showed that real GDP was not affected by unemployment over the long run. The negative association between inflation and economic growth is further supported by Burdekin (1994), who notes that the effects of inflation on growth are more pronounced in industrial countries. However, Sitanggang (2022) suggests that low and stable inflation can actually promote economic growth. Shifting focus, Durguti et al. (2021) explored the connection between macroeconomic variables influencing inflation in Western Balkan nations, finding that economic expansion contributes to inflation increases. Abdulai (2023) suggests that inflation has a positive impact on GDP growth. Moreover, Magazzino (2011) indicated a unidirectional causality from inflation to expenditure in Cyprus, France, and Spain and a bidirectional causality in Italy, Malta, and Portugal.

In addition, Ibrahim and Farah (2020) employed the Error Correction Model (ECM) to investigate the connection between Somalia's external debt stock and economic development from 1990 to 2016. The co-integration analysis indicated a long-run relationship between Somalia's external debt stock and economic development during this period. The results from the ECM emphasized a harmful impact, suggesting that an increase in external debt is associated with a decline in economic growth. Daba Ayana et al. (2023) studied the short- and long-run effects of external debt on the economic growth of 39 SSA countries. The study's conclusions showed that external debt consistently has a negative impact on economic growth over the short- and long-run. Parallel to this, Abate (2023) examined Ethiopia's public debt and its effect on economic development. The author discovered that the link between debt and economic growth is asymmetric. Notably, a large positive shock to debt increased economic development, but a small negative shock had the opposite effect. On

the other hand, Yusuf and Mohd (2021) found that government debt has short-term benefits but hampers long-term economic growth. Extending this understanding, Okwoche and Makanza (2023) proposed that public debt may become detrimental if it surpasses a certain threshold, indicating a nonlinear relationship with growth.

In summary, the literature collectively presents the complex relationships between inflation, government debt, and economic growth. This emphasizes the importance of considering various econometric approaches to understand the dynamics of these links. Despite numerous empirical studies on GDP, unemployment, foreign debt, inflation, and GCF in recent years, the literature has largely neglected the interdependence of these variables. This study investigates the causal linkage between GDP, unemployment, external debt, inflation, and gross capital formation. Unlike existing studies, our research will focus on the specific economic context of Somalia, utilizing a comprehensive set of econometric methodologies to uncover the complex association between these key variables.

3. Methodology and data

3.1. Theoretical framework

There are only a few models in macroeconomic theory that link unemployment to GDP growth. In his pioneering paper, Okun (1962) was the first to focus on the empirical relationship between unemployment and output fluctuations. Okun's law is straightforward: when aggregate demand changes, firms adjust their output plans, which causes changes in labor demand and influences unemployment rates. Okun's law ties fluctuations in output to fluctuations in unemployment. During a recession, the economy not only sees a decrease in output but also an increase in layoffs. Conversely, when the economy rebounds from a recession, production increases, and previously jobless workers are re-employed. Like all economic laws, Okun's law does not provide a precise association between changes in unemployment and production. The relationship varies not only between countries but also over time within a specific country (Ahmad & Khalil, 2011).

3.2. Sampling and data sources

Data from 1991 to 2021 has been used to develop a time series model for the study. Information was acquired from the United Nations Statistics Division (UNSD), the Organization of Islamic Cooperation (OIC-SESRIC), and the World Bank. The variables adopted in this analysis include unemployment, external debt, inflation, gross capital formation, and GDP, as demonstrated in Table 1. A nation's economic health is gauged by its GDP, which is the total value of goods and services generated within its boundaries. GDP includes all the money people, companies, governments, and foreign entities spend on goods and services (Hadush et al., 2023). Gross capital formation tracks the value of fixed asset purchases made by different industries after deductions for disposals. It is a part of GDP expenditure and shows how much of the economy's new value is invested instead of consumed (Abdi, Zaidi, et al., 2024; Wondimu, 2023). Additionally, a sustained increase in the average price of goods and services over time within an economy is referred to as inflation (Hadush et al., 2023). To measure inflation in Somalia, the study uses the consumer price index (CPI) (Abdi, Warsame, et al., 2024). Additionally, external debt is the value of debt owed to nonresidents repayable in currency, goods, or services, encompassing public, publicly guaranteed, and private nonguaranteed long-term debt, short-term debt, and use of IMF credit expressed in current USD. Moreover, unemployment refers to the share of the labor force without work but available for and seeking employment.

Table 1. Variables and the data source.

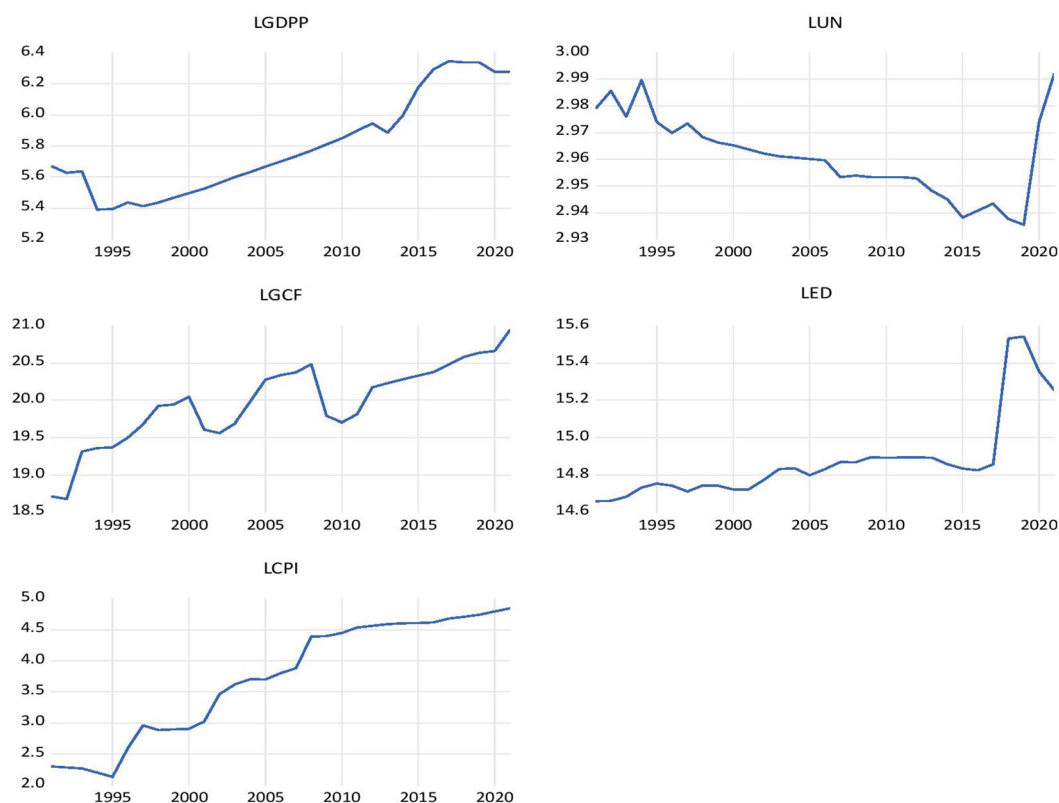| Variable	Proxy	Measurement	Source
Gross domestic product	GDP	GDP per capita (constant 2015 prices)	UNSD
Unemployment	UN	% of the total labour force	World Bank
External debt	ED	Total (current prices in thousands)	SESRIC
Inflation	CPI	Consumer price index	FSNU
Gross capital formation	GCF	Current price in USD	UNSD

Figure 1. Trend analysis of variables.

The set of graphs in Figure 1 below presents trends in various economic indicators for Somalia over time. The GDP per capita graph shows a general upward trend from the early 1990s to around 2020, indicating consistent economic growth. There are slight fluctuations, but the overall trajectory is positive, suggesting that despite some economic cycles of expansion and contraction, the overall productivity and economic health of Somalia have improved steadily. The unemployment graph displays a downward trend until the mid-2010s, followed by a sharp increase towards the end of the period. This suggests that unemployment was decreasing due to better economic conditions or effective employment policies. However, the sudden rise in recent years could indicate economic shocks, policy changes, or external factors such as a global financial crisis or pandemic, which may have led to a spike in unemployment rates.

The Gross capital formation graph shows an increasing trend, though with more pronounced fluctuations compared to the GDP per capita. GCF represents investments in physical assets like buildings, machinery, and infrastructure, essential for long-term economic growth. The fluctuations might reflect periods of economic uncertainty or changing investment policies, but the overall upward trend suggests ongoing investment and economic development in Somalia. The external debt graph indicates a steady increase over the period, with a significant spike towards the end. This rise in external debt could be due to increased borrowing to finance development projects, budget deficits, or to manage economic crises. The spike towards the end might reflect emergency borrowing in response to unexpected economic challenges. The CPI graph shows a steady increase, indicating persistent inflation. A rising CPI suggests that prices for goods and services have been increasing, which can be a sign of economic growth but also indicates the need for careful inflation management to prevent eroding purchasing power. In summary, the graphs collectively suggest that Somalia has been experiencing overall economic growth, increased investment, and rising prices over the long term but is also facing challenges like increasing external debt and recent spikes in unemployment. These trends provide a reasonable overview of the country's economic dynamics, highlighting both progress and areas needing attention.

3.3. The econometric model

Reviewing the associations among inflation, unemployment, external debt, gross capital formation, and economic growth is the primary goal of the current study. In order to mitigate the issue of heteroskedasticity and facilitate clearer interpretation in terms of percentages, this study employed a transformation approach by converting all examined variables into natural logarithms. Inspired by the work of Aminu and Anono (2012), we developed a model to elucidate these relationships.

$$lnGDP_t = \alpha_0 + \beta_1 lnCPI_t + \beta_2 lnUN_t + \beta_3 lnGCF_t + \beta_4 lnED_t + \varepsilon_t \tag{1}$$

where GDP, CPI, UN, GCF, and ED stand for GDP per capita, the consumer price index, unemployment, gross capital formation, and external debt, respectively. α_0 indicates the intercept, and the coefficients $\beta_1 - \beta_4$ are the parameters that need to be estimated. In addition, ε_t denotes the model's error term, and 'ln' denotes the natural logarithmic function.

3.4. Unit root test

As the model used in this study encompasses a time trend (t), non-stationarity implies that a straightforward regression analysis will produce misleading and untrustworthy results. Therefore, it is imperative to confirm that the time series variables are integrated of order one before executing the VECM test. To achieve this, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are employed. In these tests, the alternative hypothesis (H_1) contends that the series is stationary, whereas the null hypothesis (H_0) asserts that the series has a unit root.

3.5. Johansen cointegration test

Johansen (1995) developed the co-integration test, which is used in this study to examine the long-term relationship between the variables. Since it determines the total number of co-integrating vectors in non-stationary time series data, this test is considered more important than Sims' VAR model (1980). The maximum eigenvalue and trace tests are the two different likelihood tests used in Johansen's test. Equations (2) and (3) represent these two tests:

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \tau_i) \tag{2}$$

$$J_{max} = -Tln(1 - \tau_{r+1}) \tag{3}$$

where τ_i is the ith largest canonical correlation, T is the sample size, r is the number of co-integrating vectors, and n is the number of variables in the system. The alternative hypothesis (H_1) of n co-integrating vectors is tested against the null hypothesis of r co-integrating vectors using the trace statistic. The null hypothesis (H_0) indicates that the number of co-integrating relations i is equal to or less than the number of co-integrating vectors (s). However, the alternative hypothesis of $r+1$ co-integrating vectors is tested against the null hypothesis of r co-integrating vectors using the maximum eigenvalue test (A. Kalaitzi, 2015).

3.6. Vector error correction model

If the time series variables are found to be cointegrated, the application of the VECM test is valid (Chamalwa & Bakari, 2016; Shadab, 2021). The VECM test reveals the direction of the causal relationship between the time series variables and the significance of their long-term relationship. Because the VEC model incorporates a wide range of short-term dynamic fluctuations, it can be considered a VAR model with cointegration constraints. VEC expressions can limit the long-term behavior of endogenous variables and ensure convergence to their cointegration relation (Khurshid, 2023). The Vector Error Correction Model (VECM) used in this study is described as follows:

$$\Delta lnGDP_t = \alpha_1 + \sum_{i=1}^{n} \beta_1 \Delta lnGDP_{t-i} + \sum_{i=1}^{n} \varphi_1 \Delta lnCPI_{t-i} + \sum_{i=1}^{n} \omega_1 \Delta lnUN_{t-i} + \sum_{i=1}^{n} \vartheta_1 \Delta lnGCF_{t-i} + \sum_{i=1}^{n} \rho_1 \Delta lnED_{t-i}$$
$$+ \gamma_1 ECT_{t-1} + \varepsilon_t$$

$$(4)$$

$$\Delta lnCPI_t = \alpha_2 + \sum_{i=1}^{n} \beta_2 \Delta lnGDP_{t-i} + \sum_{i=1}^{n} \varphi_2 \Delta lnCPI_{t-i} + \sum_{i=1}^{n} \omega_2 \Delta lnUN_{t-i} + \sum_{i=1}^{n} \vartheta_2 \Delta lnGCF_{t-i} + \sum_{i=1}^{n} \rho_2 \Delta lnED_{t-i}$$
$$+ \gamma_2 ECT_{t-1} + \varepsilon_t$$

$$(5)$$

$$\Delta lnUN_t = \alpha_3 + \sum_{i=1}^{n} \beta_3 \Delta lnGDP_{t-i} + \sum_{i=1}^{n} \varphi_3 \Delta lnCPI_{t-i} + \sum_{i=1}^{n} \omega_3 \Delta lnUN_{t-i} + \sum_{i=1}^{n} {}_3 \Delta lnGCF_{t-i} + \sum_{i=1}^{n} \rho_3 \Delta lnED_{t-i}$$
$$+ \gamma_3 ECT_{t-1} + \varepsilon_t$$

$$(6)$$

$$\Delta lnGCF_t = \alpha_4 + \sum_{i=1}^{n} \beta_4 \Delta lnGDP_{t-i} + \sum_{i=1}^{n} \varphi_4 \Delta lnCPI_{t-i} + \sum_{i=1}^{n} \omega_4 \Delta lnUN_{t-i} + \sum_{i=1}^{n} \vartheta_4 \Delta lnGCF_{t-i} + \sum_{i=1}^{n} \rho_4 \Delta lnED_{t-i}$$
$$+ \gamma_4 ECT_{t-1} + \varepsilon_t$$

$$(7)$$

$$\Delta lnED_t = \alpha_5 + \sum_{i=1}^{n} \beta_5 \Delta lnGDP_{t-i} + \sum_{i=1}^{n} \varphi_5 \Delta lnCPI_{t-i} + \sum_{i=1}^{n} \omega_5 \Delta lnUN_{t-i} + \sum_{i=1}^{n} \vartheta_5 \Delta lnGCF_{t-i} + \sum_{i=1}^{n} \rho_5 \Delta lnED_{t-i}$$
$$+ \gamma_5 ECT_{t-1} + \varepsilon_t$$

$$(8)$$

The parameters are represented by the coefficients β, φ, ω, ϑ, and ρ in the given VECM equation, where Δ denotes the first difference and n denotes the lag order. γ is the rate of adjustment towards the long-run equilibrium after an exogenous shock to the model; ECT stands for the error correction term. To guarantee convergence towards equilibrium, the coefficient of ECT is expected to have a negative and significant sign. In this study, we only consider Equation (4), where GDP per capita is the dependent variable.

4. Result and discussion

4.1. Descriptive statistics

The preliminary summary statistics and correlation matrix for the major factors defining the raw data are presented in Tables 2 and 3 using Eviews 12. According to Table 2, the mean for Gross Capital Formation (GCF) is the highest at 19.96, while the mean for unemployment is the lowest at 2.96. Notably, GCF reaches its highest maximum value of 20.94, whereas the unemployment rate has its lowest minimum of 2.93. One significant finding is that the consumer price index (CPI) has the largest standard deviation (0.94), indicating a wider range of values around its mean. This suggests a greater deviation between CPI values and their average. The Jarque-Bera test results indicate that, except for external debt, the data are identically and normally distributed. Table 3 presents the correlation matrix of the variables. With the exception of unemployment, all variables show a positive association with GDP per capita. The negative correlation between unemployment and GDP reinforces the validity of Okun's Law. Similarly, all variables, excluding unemployment, exhibit a positive correlation with CPI. The negative correlation between CPI and unemployment illustrates the Phillips curve. In contrast to CPI and GDP per capita, foreign debt shows a positive relationship with all other variables except unemployment.

Table 2. Descriptive statistics.

	lnGDP	lnUN	lnGCF	lnED	lnCPI
Mean	5.793274	2.960963	19.96216	14.87774	3.713830
Median	5.699674	2.960623	19.97813	14.83168	3.800812
Maximum	6.345022	2.992226	20.94127	15.54208	4.844187
Minimum	5.390349	2.935451	18.67758	14.65935	2.129686
Std. Dev.	0.319117	0.015132	0.543917	0.228399	0.946230
Skewness	0.544608	0.221626	−0.548739	1.929398	−0.374534
Kurtosis	2.001003	2.388987	2.944253	5.794798	1.627108
Jarque-Bera	2.821499	0.736002	1.559775	29.32238	3.159333
Probability	0.243960	0.692116	0.458458	0.000000	0.206044
Observations	31	31	31	31	31

Table 3. Correlation.

	lnGDP	lnUN	lnGCF	lnED	lnCPI
lnGDP	1				
lnUN	−0.552	1			
lnGCF	0.687	−0.525	1		
lnED	0.743	−0.349	0.670	1	
lnCPI	0.843	−0.685	0.813	0.660	1

4.2. Lag length criteria

This study employed the majority technique to determine the appropriate lag length. The five criteria considered are the sequential modified LR test statistic (LR), the final prediction error (FPE), the Akaike information criterion (AIC), the Schwarz information criterion (SIC), and the Hannan-Quinn information criterion (HQ), as shown in Table 4. All five criteria indicate that the most appropriate lag length is two.

4.3. Unit root test

This study employs a model with a time trend (t), for which non-stationarity could lead to unreliable results from a simple regression analysis. It is essential to confirm that the time series variables demonstrate first-order integration before running the Vector Error Correction Model (VECM) test. To meet this need, the study uses the ADF and PP unit root tests. In both the ADF and PP tests, the alternative hypothesis indicates the absence of a unit root problem, whereas the null hypothesis suggests the existence of one. Therefore, if the variable's t-statistic is greater than the critical t-value, we accept that the data are stationary and reject the null hypothesis of non-stationarity. Conversely, if the t-statistic is less than the critical t-value, we cannot rule out the non-stationarity null hypothesis. Essentially, these tests help determine whether the data exhibit a consistent mean and variance over time.

Moreover, all variables are nonstationary, as shown by the results of the ADF and PP unit root tests, summarized in Table 5. Using nonstationary variables can lead to spurious conclusions with significant implications. The results in Table 5 demonstrate that all variables exhibit unit roots at their levels; therefore, they were transformed to their first differences before model construction. Consequently, the variables are stationary at I(1), confirming the appropriateness of using the Johansen cointegration and Vector Error Correction Model (VECM) in this study.

4.4. Cointegration test

The long-term link between time series variables can be statistically ascertained using the Johansen co-integration Max-Eigenvalue and trace tests. These tests consider the null hypothesis that there are no co-integrating vectors and calculate the rank of the co-integration matrix. The Johansen Max-Eigenvalue and trace test results, shown in Table 6, provide evidence of three co-integrating equations among the variables in Somalia. This conclusion is supported by the fact that both the trace and Max-Eigen statistics exceed their respective critical values, indicating statistical significance. As a result, we can reject the null hypothesis that no co-integrating vector is present.

Table 4. Lag order selection criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	86.72142	NA	2.45e-09	−5.635960	−5.400219	−5.562129
1	196.3158	173.8394	7.40e-12	−11.47006	−10.05561	−11.02707
2	248.8662	65.23500*	1.31e-12*	−13.37008*	−10.77694*	−12.55794*

Table 5. Results of the unit root.

	ADF	PP
Variables	Level intercept	Level intercept
lnGDP	−0.1231	0.1157
lnCPI	−0.9225	−0.9957
lnUN	−1.5155	−1.3602
lnED	−1.3206	−1.1830
lnGCF	−1.7215	−1.6316
	First difference	First difference
	Intercept	Intercept
lnGDP	−4.0378**	−4.0379***
lnCPI	−4.5105**	−4.8999**
lnUN	−4.3153**	−4.3353***
lnED	−4.6411***	−7.3043***
lnGCF	−4.7581***	−4.7980***

Notes: (*) Significant at 10%; (**) Significant at 5%; (***) Significant at 1%. The provided t-statistic is derived solely from the constant term.

Table 6. Johansen's co-integration.

Hypothesized	Trace test			Max-eigen test		
No. of CE(s)	Statistic	Critical value	Prob.**	Statistic	Critical value	Prob.**
None *	137.9559	69.81889	0.0000	60.91170	33.87687	0.0000
At most 1 *	77.04424	47.85613	0.0000	36.18903	27.58434	0.0031
At most 2 *	40.85521	29.79707	0.0018	25.42095	21.13162	0.0117
At most 3	15.43426	15.49471	0.0511	13.35262	14.26460	0.0693
At most 4	2.081645	3.841465	0.1491	2.081645	3.841465	0.1491

Notes: Trace test and Max-eigenvalue indicate three co-integrating equation(s) at the 0.05 level, respectively. * denotes rejection of the hypothesis at the 0.05 level. ** MacKinnon-Haug-Michelis (1999) p values.

4.5. Results of normalized long-run equation

The results of the normalized long-run equation are shown in Table 7. These results demonstrate that, over time, each of our predictor variables significantly affects GDP. Specifically, the findings indicate that a 1% increase in the Consumer Price Index (CPI) results in a 0.37% decrease in GDP. This suggests that rising CPI over time can lead to a decline in the nation's GDP due to a reduction in society's purchasing power, ultimately leading to lower production. Additionally, we observed that unemployment has a substantial and adverse effect on GDP. The estimated long-run coefficient of −86.19 indicates that a 1% increase in unemployment causes an 86.19% drop in GDP. Moreover, there is a significant positive influence of GCF on Somalia's economic growth. A 1% increase in GCF corresponds to a 0.32% increase in GDP. Furthermore, external debt significantly harms GDP. This indicates that higher levels of external debt burden the economy, thereby reducing its GDP or overall production.

4.6. Short-run dynamics (VECM)

The results of the short-run dynamics are presented in Table 8. The error correction term is statistically significant at the 5% level. The short-run dynamics converge to equilibrium at a rate of 18.64%, as indicated by the estimated error correction term of −0.1864. Additionally, the results demonstrated a negative and significant relationship between short-run GDP and $\Delta lnGDP_{t-2}$, $\Delta lnUN_{t-1}$, and $\Delta lnEDt-1$. This implies that an immediate increase in the lagged values of these variables will result in reductions in GDP by 1.08%, 0.06%, and 0.04%, respectively. Specifically, an instantaneous increase in the lagged value of unemployment will result in a 0.06% reduction in GDP. This finding aligns with Dahmani and Rekrak (2015), which emphasizes the importance of short-term adjustments in economic models to

Table 7. Normalised long-run results.

Variables	Coefficients	Standard errors	t-statistics	p value
lnCPI	−0.372273	0.14610	−2.545	0.0167
lnUN	−86.19428	13.2681	−6.495	0.0001
lnGCF	0.327261	0.13744	2.380	0.0268
lnED	−2.078738	0.46041	−4.513	0.0001

Table 8. Short-run results.

Variable	Coefficient	Standard error	t-statistics	p value
ECM	−0.186472	0.03725	−5.00649	0.0001
$\Delta lnGDP_{t-1}$	−0.281492	0.22306	−1.26193	0.2251
$\Delta lnGDP_{t-2}$	−1.084848	0.24633	−4.40399	0.0004
$\Delta lnUN_{t-1}$	−0.069561	0.07481	−1.26193	0.0003
$\Delta lnUN_{t-2}$	−1.084848	0.05990	1.15622	0.1843
$\Delta lnGCF_{t-1}$	12.96700	2.86582	4.52470	0.3192
$\Delta lnGCF_{t-2}$	−3.667406	2.64303	−1.38758	0.3953
$\Delta lnED_{t-1}$	−0.043749	0.04256	−1.02802	0.0345
$\Delta lnED_{t-2}$	−0.045223	0.05177	−0.87347	0.0702
$\Delta lnCPI_{t-1}$	0.194608	0.08421	2.31109	0.3662
$\Delta lnCPI_{t-2}$	−0.140374	0.07234	−1.94039	0.2646
Constant	0.061042	0.01522	4.00973	0.0010
Diagnostic tests				
Serial correlation	1.374(0.1228)	Multicollinearity variables	Centered VIF	
Normality	1.298(0.737)	LUN	1.955281	
Heteroskedasticity	1,234(0.9806)	LGCF	3.262162	
		LED	2.015347	
		LCPI	4.513695	
		C	NA	

Note. values in the () are the p values.

maintain equilibrium. The negative relationship between the lagged value of external debt and economic growth in the short term indicates that fluctuations in external debt levels have an unfavorable effect on overall economic performance. This inverse relationship suggests that higher external debt in the preceding period leads to lower economic growth in the current period. This finding corroborates the findings of recent studies by Ibrahim and Farah (2020), Abate (2023), and Okwoche and Makanza (2023), which also reported a negative link between external debt and economic growth. Furthermore, the R^2 value of 0.76 indicates that 76% of the fluctuations in Somalia's economic growth can be explained by CPI, unemployment, gross capital formation, and external debt.

We conducted several diagnostic tests, as presented in Table 8, to meticulously scrutinize the coherence of the model assumptions. The empirical results demonstrate that the model passed the diagnostic tests. The series displays a normal distribution and shows no evidence of serial correlation or heteroscedasticity. In addition, multicollinearity was also rigorously examined to ensure the robustness of our model. To assess multicollinearity, we employed variance inflation factors (VIF). VIF values above 10 are often considered concerning, suggesting significant multicollinearity that may require addressing in the analysis. The results of the test indicate that multicollinearity was not a significant issue in our model, confirming the stability of parameter estimates and the validity of our findings regarding the relationships between the variables under study.

4.7. Granger causality test

Table 9 summarizes the results of the Granger causality test, which was used to determine whether macroeconomic variables explain each other. The table shows the findings based on the null hypothesis of no Granger causality. The study reveals unidirectional links between unemployment and GDP, gross capital formation and GDP, GDP and external debt, CPI and GDP, unemployment and gross capital formation, and external debt and unemployment. No causal effects were found in the other combinations of interactions. These results provide insights into the directional influences among the key macroeconomic variables studied.

Table 9. Granger causality tests.

Null hypothesis	F-Statistic	Prob
lnUN does not Granger Cause lnGDP	5.34361	0.012
lnGDP does not Granger Cause LUN	0.85732	0.4369
lnGCF does not Granger Cause lnGDP	5.42678	0.0114
lnGDP does not Granger Cause lnGCF	3.37297	0.0512
lnED does not Granger Cause lnGDP	0.09733	0.9076
lnGDP does not Granger Cause lnED	7.29039	0.0034
lnCPI does not Granger Cause lnGDP	4.56445	0.0209
lnGDP does not Granger Cause lnCPI	0.90674	0.4172
lnGCF does not Granger Cause lnUN	0.45829	0.6378
lnUN does not Granger Cause lnGCF	4.12662	0.0288
lnED does not Granger Cause lnUN	27.5960	6.00E-07
lnUN does not Granger Cause lnED	3.40162	0.05
lnCPI does not Granger Cause lnUN	0.58267	0.5661
lnUN does not Granger Cause lnCPI	1.16339	0.3294
lnED does not Granger Cause lnGCF	2.19461	0.1333
lnGCF does not Granger Cause lnED	1.44580	0.2553
lnCPI does not Granger Cause lnGCF	3.13169	0.0619
lnGCF does not Granger Cause lnCPI	3.11704	0.0626
lnCPI does not Granger Cause lnED	1.65750	0.2117
lnED does not Granger Cause lnCPI	0.05156	0.9498

4.8. Impulse response function and variance decomposition

Furthermore, the impulse response function (IRF) data depicted in Figure 2 illustrate a decrease in GDP from period 2.5 to 5 following a one-standard-deviation shock in unemployment. The initial response is positive from period 1 to period 2 but levels off to negative in period 2.5. These findings align with Okun's law, underscoring the inverse relationship between unemployment and gross domestic product. Similarly, CPI exhibits a negative response in the first three periods, transitioning to zero into period 4 and then asserting a positive response into period 4.5. When subjected to a shock, external debt contributes to a zero in GDP during the initial 1.5 periods, after which it turns negative from periods 2 to 5. Notably, Table 10 provides that by Period 5, about 1.6% of lnGDP shocks belong to unemployment, gross capital formation explains 3.4%, external debt explains 14.5%, and 1.2% is explained by consumer price index, with the remaining 79.2% related to GDP shocks. Thus, the impacts of gross capital formation and external debt are more visible in longer time periods because the changes from period 1 to period 5 are quite large.

4.9. Analyses of the sensitivity

We performed a robustness check with the ARDL to verify the long-term outcomes of the VECM. The results show that the F-statistic of 10.25 is statistically significant at the 5% level, as shown in Table 11. The ARDL's strong verification bolsters the validity of the long-term outcomes derived from the VECM analysis.

5. Conclusion and policy recommendations

This paper provides an empirical examination of the relationship between GDP, unemployment, external debt, CPI, and gross capital formation in Somalia from 1991 to 2021. The study also validated Okun's law. To evaluate the association between GDP, unemployment, external debt, CPI, and gross capital formation, we used ADF, PP, VECM, variance decomposition, impulse response function, and Granger causality test. The outcomes of this study demonstrated that the series are stationary in first differences. The research discovered a negative relationship between unemployment and economic growth, implying the applicability of Okun's law in Somalia. This suggests that the unemployment crisis in Somalia can be attributed to a lack of economic growth. Furthermore, the study identified a negative link between CPI and GDP. The unfavourable relationship between GDP and CPI raises the possibility of inflationary pressure on economic expansion, which indicates the significance of price stability in promoting long-term economic growth. However, intriguingly, the findings indicated a significant negative connection between external debt and GDP. Given these findings, the effect of debt accumulation on economic
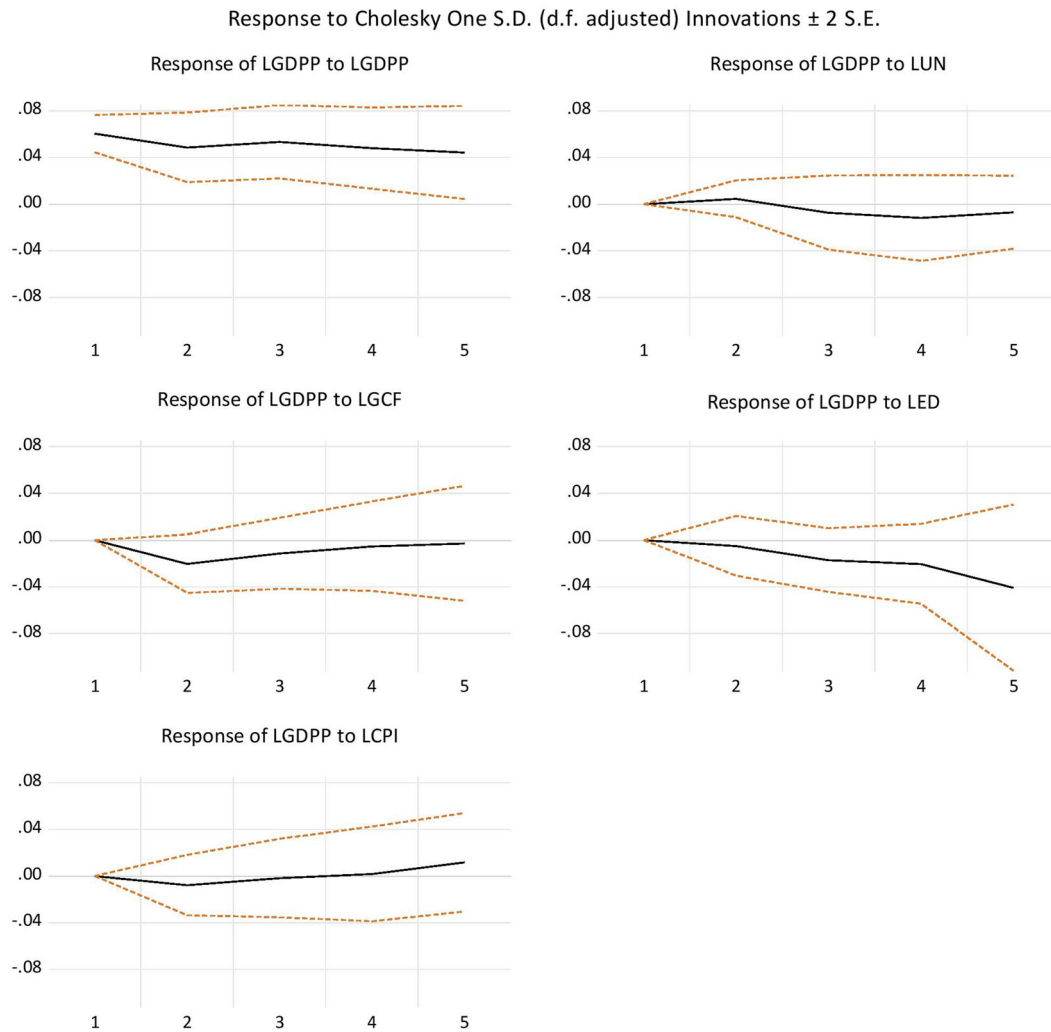
Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E.

Figure 2. Impulse response function.

Table 10. Variance decomposition.

Period	S.E	lnGDP	lnUN	lnGCF	lnED	lnCPI
1	0.060402	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.080779	92.09332	0.320967	6.255093	0.380800	0.949821
3	0.099301	89.91101	0.753864	5.444415	3.228608	0.662101
4	0.112933	87.58604	1.687756	4.423880	5.767575	0.534747
5	0.128736	79.22946	1.590839	3.453004	14.49332	1.233383

Table 11. Bounds testing technique.

F-bounds test		Null hypothesis: no level relationship		
Test statistic	Value	Signify	I(0)	I(1)
			Asymptotic: n = 1000	
F-statistic	10.25851	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

performance is a matter of concern. To prevent adverse effects on economic growth and stability, this emphasises the necessity of prudent debt management policies.

In addition, the forecast error variances of the variables were decomposed to assess the impact of various shocks on the system. The results for different predicted horizons showed that a small portion of GDP shocks was attributed to unemployment, a significant portion to external debt, a moderate portion

to gross capital formation, and a minor portion to CPI, with the majority linked to unemployment shocks. This indicates that the effects of gross capital formation and external debt become more significant over longer time periods, as evidenced by substantial changes from the initial to later periods. The series exhibits a normal distribution with no evidence of serial correlation, heteroscedasticity, or multicollinearity, ensuring the robustness of the model. Moreover, the Granger causality findings unveiled a unidirectional link between unemployment and GDP, gross capital formation and GDP, GDP and external debt, CPI and GDP, unemployment and gross capital formation, and external debt and unemployment. However, no causal effects exist in the other combinations of interactions. Overall, these results highlight the intricate interactions between various elements influencing the Somali economy and highlight the necessity of thorough and focused policy interventions to deal with important issues like capital formation, inflation, unemployment, and debt sustainability. This intricate analysis provides valuable academic insights into the dynamics of unemployment, economic growth, CPI, and external debt in Somalia, contributing to a broader understanding of economic relationships.

The empirical results of this study provide policymakers in Somalia with a more detailed understanding of the role unemployment and economic development play in developing investment policies. To sustain economic growth and job creation, the government should implement effective fiscal policies to improve the structure and functioning of the governance system. Therefore, to create more jobs and absorb a large number of unemployed people, the government needs to create an inviting atmosphere and a flexible labour market policy or legislation that encourages many private sector and small businesses, which will, in turn, strengthen existing entrepreneurship activities with new entrepreneurs. According to our variance decomposition results, about 14.5% of the log of GDP shocks is related to the log of external debt. Based on this discovery, a specific example may be that a nation with substantial foreign debt may see a large decrease in gross domestic production during a financial crisis. This demonstrates the significance of controlling and lowering foreign debt to limit the impact of economic shocks on GDP. Policymakers should prioritise policies to reduce debt and strengthen the country's resilience to external economic fluctuations.

This study contributes to a deeper understanding of economic phenomena, guides policy choices, and suggests future lines of inquiry by providing insightful scholarly analysis of the economic relationships and dynamics in Somalia. While the current study provided valuable insights into the relationship between macroeconomic variables and GDP, it is essential to recognise that the economy is a complex system influenced by numerous factors. By narrowing the focus to macroeconomic variables, we may overlook important microeconomic dynamics and non-economic factors that could significantly impact GDP growth. Further studies are encouraged to enlarge the scope of the analysis to include cross-country comparisons and investigate the findings' generalizability. Moreover, future research should analyze debt thresholds to further our understanding of the nonlinear relationship between debt and GDP growth.

Ethical approval

This study follows all ethical practises during writing. We declare that this manuscript is original, has not been published before, and is not currently being considered for publication elsewhere.

Authors' contributions

The writers significantly contributed to the composition of the work. Abdisalan Aden Mohamed oversaw the study's conception, design, and development and authored the article's first draft. He also conducted data collection and analysis and reviewed and edited the manuscript. Abdikafi Hassan Abdi aided in data collection, wrote parts of the introduction and literature review, and assisted in editing and reviewing the article.

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Data availability statement

The datasets used and/or analysed in the current study are available from the corresponding author on reasonable request. The datasets used in this study are accessible via the following links: https://unstats.un.org/unsd/snaama/Index; https://www.sesric.org/query.php; and https://public.knoema.com/lftihvf/world-development-indicators-wdi

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