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Fostering economic growth in Somalia: the role of life expectancy and environmental degradation

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Abstract
Economic growth is a primary objective for countries worldwide since it has a pivotal impact on enhancing living standards, alleviating poverty, and promoting general societal well-being. Hence, this study examines the connection between life expectancy, environmental pollution, and economic growth in Somalia by using time-series data from 1990 to 2020. The study employs the autoregressive distributed lag (ARDL) bound test and fully modified ordinary least squares (FMOLS) method. The empirical results of the bound test indicate that life expectancy is statistically significant and positively affects economic growth in the long run. However, it does not significantly affect economic growth in the short run. Furthermore, environmental pollution does not significantly impact economic growth in the long run but enhances it in the short run. The study indicates that life expectancy improves economic growth. Based on the empirical evidence, the study provides several policy implications, including public health initiatives, health-related infrastructure, and sustainable environmental practices, which are recommended.

Keywords Economic growth · Life expectancy · Environmental degradation · Trade openness · Population growth

1 Introduction

Economic growth is a primary objective for countries worldwide, as it has a pivotal impact on enhancing living standards, alleviating poverty, and promoting general societal well-being. Understanding the factors that influence economic growth is crucial for policymakers, economists, and researchers to create impactful policies and strategies that foster sustainable and equitable development [1]. However, The process of economic development and civilization has led to a rise in the concentration of carbon dioxide (CO2) and other greenhouse gases (GHGs) in the environment on Earth [2].

Environmental contamination can impede economic growth in several ways. Pollution-induced health concerns, including respiratory diseases, cardiovascular disorders, and other illnesses, escalate healthcare expenses and diminish work efficiency [3]. Additionally, pollution affects ecosystems, disrupts supply chains, and discourages foreign investment. The costs of controlling and remediating pollution burden public budgets, diverting resources from profitable initiatives. Depleting these essential resources may lead to increased expenses for businesses and governments, ultimately impeding economic advancement [4].

Environmental degradation undermines Somalia's economy. The country experiences political instability, poverty, and poor infrastructure. Pollution worsens these challenges by lowering health, labor productivity, and depleting natural resources. It raises healthcare costs, reduces agricultural output, disrupts supply chains, and deters foreign investment. Pollution control

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and remediation expenses drain public funds, preventing investments in vital economic sectors [5]. Progress in medical technology is leading to a global rise in life expectancy. However, longer life expectancy, combined with population growth and increased old-age dependency, may lower income per capita [6]. In addition, life expectancy significantly affects economic growth. Longer life expectancy increases labor supply, productivity, and human capital accumulation due to a healthier and more productive workforce. It reduces disease and healthcare expenditures, allowing people to work and contribute to the economy [7]. Longer lifespans allow people to save and invest more and plan for retirement. As people live longer, they can share their expertise and experience to enhance technology and the economy[8]. There are positive as well as negative effects of life expectancy on economic growth. Economists agree that life expectancy affects economic growth in diverse ways.

Life expectancy serves as a crucial measure of the overall health and welfare of a population and is directly linked to economic development. A higher life expectancy typically results in a healthier and more productive workforce, allowing individuals to remain in the labor market for a longer period. This can lead to increased economic output and innovation in the long run [9]. In addition, capital, encompassing both physical and human capital, plays a crucial role in driving economic growth by enhancing productivity and labor efficiency. Increased capital accumulation facilitates the production of a greater quantity of goods and services, thereby stimulating economic growth [10]. Furthermore, trade openness, defined as the extent to which a nation participates in global commerce, has a substantial impact on economic growth. It does so by broadening markets, promoting competition, and enabling the exchange of knowledge and innovation. However, the benefits of trade openness depend on a nation's ability to compete globally and the structure of its economy. It is important to note that excessive reliance on imports or vulnerability to unpredictable global markets can also pose potential risks [11].

Understanding the link between life expectancy and economic growth is crucial for effective government policy implementation to address challenges posed by rising life expectancy. In Somalia, a country grappling with continuous conflict, inadequate healthcare facilities, and widespread poverty, the average lifespan is significantly short [12]. This vital health indicator not only reflects the population's overall health but also plays a significant role in determining the country's economic capacity [12]. The relationship between life expectancy and economic growth is extensively documented in global literature, indicating that healthier populations significantly contribute to economic activity, have longer productive lives, and boost innovation, thereby accelerating economic growth [13]. Nevertheless, exploring this link in the Somali context has been lacking. The enduringly low life expectancy caused by preventable diseases, inadequate nutrition, limited healthcare accessibility, and continued violence could be substantially hindering economic growth by diminishing the workforce, constraining productivity, and hampering the development of human capacity. Additionally, severe environmental degradation resulting from deforestation, desertification, and climate change has further contributed to this situation. These factors have probably impeded economic progress [4].

The current study examines the connection between life expectancy environmental pollution, and economic growth in Somalia by using time-series data from 1990 to 2020. Our study contributes to the literature in several ways. First, as far as the authors are aware, no prior attempt has been made to examine the relationship between these variables in a unified framework in the context of Somalia. Second, the study employs sophisticated estimation techniques, such as the autoregressive distributed lag (ARDL) model. This technique is more convenient to analysis small sample sizes that generates more comprehensive policy recommendations by examining the relationship between life expectancy, environmental pollution, and economic growth in Somalia.

The organisation of this paper is clarified as follows. Section two comprises a comprehensive examination of the existing body of literature. Section three outlines the specific econometric techniques used and the data sources utilised. Section four of the report presents the findings and discussions, whereas the concluding section provides a summary and describes the relevant policy implications.

2 Literature review

A substantial body of theoretical and empirical research has investigated the influence of life expectancy on economic growth. Nevertheless, despite the utilization of several methodologies, there remains a lack of agreement or consensus on this topic. A theoretical study examines the positive effects of life expectancy on economic growth from two perspectives: investments in physical capital and human capital [14].

Theoretical analysis suggests that life expectancy indirectly benefits economic growth, which is dependent on intermediary variables like savings and human investment [15]. A rise in life expectancy raises the proportion of total

savings to output, leading to a further increase in investment in physical capital and the growth rate of per capita income.

Moreover, the human capital theory advocates allocating resources to developing individuals' skills and knowledge to create a skilled and educated workforce essential for economic growth[16]. This idea posits that a labour force's productivity is based on how formal it is.

Education, precisely the literacy level in the labour force, directly correlates with increased production [17]. Additionally, various growth theories have highlighted the significance of internal and external elements that might contribute to economic growth. Endogenous growth theory promotes investment in health and education to support human capital, leading to a skilled and educated workforce. This, in turn, stimulates endogenous technical progress, ultimately contributing to economic growth. Publicly producing human capital, primarily through income tax financing, necessitates an optimal income tax rate of six to ten per cent for education funding [18].

Endogenous growth theory offers another perspective to examine the influence of environmental contamination on economic growth. This theory highlights the significance of human capital, creativity, and knowledge in driving economic growth. From this standpoint, environmental contamination can exert both direct and indirect impacts on economic development [9].

Pollution can directly diminish the efficiency of labour and capital by adversely impacting the well-being of individuals and depleting natural resources, both of which are essential components in the production process. For instance, air and water pollution might result in increased healthcare expenses and decreased labor efficiency due to sickness, impeding economic advancement [3].

Environmental degradation can indirectly hinder innovation and the advancement of new technologies by diverting resources from research and development to mitigate environmental harm. Moreover, environmental deterioration can potentially diminish the overall quality of life, leading to political instability and a decline in economic productivity. Endogenous growth theory suggests that investments in green technologies and sustainable practices can stimulate economic growth by enhancing resource efficiency and creating new markets for environmentally friendly products [19].

2.1 The impact of life expectancy on economic growth

Ngangue & Manfred [2], The impact of life expectancy on economic growth was explored using a dynamic panel of 141 developing countries (DC) from 2000 to 2013. The study reported that life expectancy improves economic growth. Similarly, Turan [16], examined the effect of life expectancy on economic development in Sub-Saharan Africa and revealed that life expectancy increases economic growth. He & Li [14], studied the impact of life expectancy on economic growth for 65 countries within three levels of aging from 1980 to 2014. They found that life expectancy increases economic growth. Ecevit [7], analyzed the effect of life expectancy on economic growth in OECD countries. Using OLS, Pedroni DOLS, and FMOLS techniques, the study revealed that life expectancy has a positive and statistically significant impact on economic growth. Ngangue & Manfred [20], reported that life expectancy improves economic growth in 141 developing countries.

Islam et al [21], Explored The impact of human capital creation, measured by public education and health expenditures, on economic growth in Bangladesh. By employing the ARDL technique and the Toda–Yamamoto causality test, the study revealed that health expenditure boosts economic growth in the long run but not in the short term, while education spending positively affects short-term growth but negatively impacts long-term economic growth. Similarly, M. S. Islam, [9], examined the relationship between Human Capital and Per Capita Income in South Asia from 2000 to 2016. Using (ARDL) bound test, and Dumitrescu-Hurlin panel causality test. He found that Human Capital promotes Per Capita Income in South Asia. [22], investigated The influence of human capital formation on economic growth in Bangladesh, using time-series data spanning from 1990 to 2019. The study employed an ARDL approach and demonstrated that health expenditure has a positive impact on long-term economic growth, although this effect is not observed in the short term. Conversely, government spending on education has a favorable effect in the short term but a negative impact on long-term economic growth. Moreover, M. S. Islam [23], Analysed the effect of human capital formation as proxy of health and education expenditure on economic growth of five South Asian economies. using panel data for the period 2000–2017, by utilising ARDL model estimation, and Granger. They revealed that, health expenditure and government education expenditure increase in the long run, but not in the short run.

2.2 The impact of environmental pollution on economic growth

Climate change and environmental deterioration have garnered significant attention in academic research and policy debates. Although ample studies exist on the relationship between economic activity and the environment, there is a lack of empirical research investigating the reciprocal relationship—specifically, whether environmental deterioration impacts economic growth [24], [25]. There are various mechanisms by which environmental degradation might impact economic growth. According to. Ricci [26], explored the impact of environmental degradation on economic growth, noting that it is significant when viewed both as an input and a by-product of production. He argues that implementing measures to regulate environmental pollution may impede economic growth by imposing additional costs or restrictions on production.

A recent study by Acheampong & Opoku [24], explored the impact of Environmental degradation on economic growth in a global panel consisting of 140 countries spanning the years 1980 to 2021. The study employed the two-step dynamic system-generalized method of moment technique to address the issue of endogeneity. The findings of the study demonstrated that environmental deterioration declines in economic growth. Similarly, Albrizio et al [27], stated that strict environmental regulations might place an extra cost on companies, leading them to redirect resources from profitable industries to pollution mitigation sectors. This, in turn, hinders economic growth. However, considering the significance of health in enhancing economic activity. Moreover, Soytas & Sari [28], suggest that the correlation between environmental degradation and economic growth can be observed, as implementing policies aimed at mitigating environmental degradation can foster technological advances and enhance factor productivity. the study conducted by Rehman et al [29], examined the effect of environmental pollution on economic growth in Pakistan by using the ARDL approach and analysed data spanning from 1971 to 2017. The study revealed a positive relationship between carbon dioxide emissions in the transportation sector and economic growth in Pakistan. The study by Zhai and Song (2013) revealed a positive correlation between carbon dioxide emissions and economic growth, both in the short- and long-term. Onofrei et al, [30] Assessed the connection between economic growth and CO2 emissions in the 27 EU member states from 2000 to 2017 using Dynamic Ordinary Least Squares. They revealed that economic growth increases CO_2 emissions 27 EU member states.

More importantly,Vatamanu & Zugravu [31], examined the impact of financial development on renewal energy consumption Utilizing a dataset consisting of 27 European Union member states spanning from 2000 to 2020. They reported that financial development promotes the renewal of energy consumption, which ultimately affects CO2 emissions.

Considering the above literature, both life expectancy and environmental pollution significantly promote economic growth, as most reviewed studies show. However, several other studies have recorded contradictory results—life expectancy and environmental pollution significantly hamper economic growth. This shows why further studies on this topic in different countries are needed. Therefore, this research explores how economic growth in Somalia is affected by life expectancy and environmental pollution, but there are no studies on this theme.

3 Materials and method

3.1 Data sources and descriptions

The current study examines the impact of life expectancy and environmental degradation on economic growth in Somalia using data from 1990 to 2020 for all variables. Table 1 presents a detailed overview of the data, comprising its definition, source, and unit of measurement. The accessibility of the data determines the sample period. The World Bank and SESRIC are the data sources. The study variables include environmental pollution, life expectancy, trade openness, population growth, capital, and economic growth. Heteroskedasticity was addressed by applying natural logarithm adjustments to all variables. Trade openness, population growth, and capital drive economic growth [11, 32] . Hence, trade openness, population growth, and capital are control variables that affect economic growth. Natural logarithms were constructed using all variables. The data and its sources are shown in Table 1.

3.2 Econometric methodology

The study employs the ARDL technique to achieve its objective. In numerous aspects, the ARDL methodology exhibits superior performance compared to alternative cointegration strategies. The ARDL model can be effectively employed

Table 1 Data sources and description

Variable	Code	Description	Source
Carbon dioxide emission	$LnCO_2$	Carbon dioxide emission kilotons	World Bank
Gross Domestic Product Per capita	LnRGDPC	Real gross domestic product per capita	SESRIC
Population growth	LnPG	Population growth	SESRIC World Bank
Life expectancy	LnLE	Life expectancy total	World Bank
Capital	LnCapita	Gross capital formation	SESRIC
Trade openness	LnTO	Import plus export divided by GDP	SESRIC

with limited sample sizes and does not require extensive time-series data. Additionally, if the variables are not integrated at the second difference I. (2), the ARDL can be used for a regression analysis. More importantly, when compared to previous methodologies. It does a simultaneous regression analysis of the variables' short- and long-term cointegration [33].

The Following efforts of Rehman et al., [29] Warsame & Sarkodie [2], Hussein et al. [11], Warsame et al [35], and Hussein et al [34]. The ARDL co-integrating equation is

written as shown in:

$$lnRGDPC_t = \beta_0 + \beta_1 lnLE_t + \beta_2 lnCO_{2_t} + \beta_3 lnPG_t + \beta_4 lnTO_t + \beta_5 lnCapital_t + \varepsilon_t \quad (1)$$

$lnCO_{2t}$ is the log of carbon dioxide emission in year t, $lnLE_t$ is log of Life expectancy in year t, $lnPG_t$ is the log of Population growth in year t, $lnTO_t$ is log of Trade oppenness in year t, $lnRGDPC_t$ is Gross domestic product per capita, $lnCapital_t$ is log of Capital in year t, and ε_t is the disturbance term in time t. Model 2 employs the similar ARDL method of cointegration, which is denoted by:

$$\begin{aligned} \Delta lnRGDPC_t = {} & + \alpha_0 + \sum_{i=0}^{p} \Delta\alpha_1 lnCO_{2t-k} + \sum_{i=0}^{p} \Delta\alpha_2 lnLE_{t-k} + \sum_{i=0}^{p} \Delta\alpha_3 lnTO_{t-k} \\ & + \sum_{i=0}^{p} \Delta\alpha_4 lnPG_{t-k} + \sum_{i=0}^{p} \Delta\alpha_5 lnCapital_{t-k} \beta_1 LnRGDPC_{t-1} \\ & + \beta_2 lnLE_{t-1} + \beta_3 lnPG_{t-1} + \beta_4 lnTO_{t-1} + \beta_5 lnCO_{2t-1} + \beta_6 lnCapital_{t-1} \emptyset ECT_{t-1} + \varepsilon_t \end{aligned} \quad (2)$$

whereas $\alpha_{1\text{-}4}$ is the coefficient of short-tun, and α_0 is the intercept, β1-4 denotes the coefficient of long-run variables, Δ is the operator of the first difference, p represents the number of lags, and the ECT is the error correction term, and ε_t is the error term. The significance of determining the long-term cointegration of the dependent and independent variables cannot be overestimated. Thus, equation (2) is regressed, utilising the ordinary least squares (OLS) technique. In Somalia, the Wald F-statistic is employed to assess the alternative hypothesis, which posits the presence of cointegration between the variables, compared to the null hypothesis, which suggests the absence of cointegration among the variables. The theory is formulated as follows:

$H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$ |The null hypothesis (H_0): the indicators are not cointegrated.

$H_a : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$|The alternative hypothesis (H_a): the indicators are cointegrated.

4 Empirical results and discussion

4.1 Descriptive statistics

Summary statistics of the study are reported in Table 2. The sampled variables' mean, median, maximum, and minimum values are reported. Mean values of the economic growth, trade openness, Life expectancy, population growth, Capital, and environmental pollution are 5.6, 1.85, 3.8, 2.1, 18.0, and − 2.6, respectively. Capital has the highest standard deviation value of 18. Moreover, economic growth, trade openness, and environmental pollution have positive skewness; however, life expectancy, population, and capital have a negative skewness. Besides, the correlations of the variables

are also presented in Table 2. Environmental pollution and capital are negatively related to economic growth, whereas Life expectancy, trade openness, and population growth are positively correlated with economic growth.

4.2 Unit root

The main objective of time series analysis is to verify the stationarity of the variables. The presence of a unit root issue in the variables may lead to the production of inaccurate results. The Augmented Dickey-Fuller (ADF) and Philips Perron (PP) tests are employed to determine whether this problem may affect the variables. The null hypothesis of ADF and PP provides evidence of a unit root issue, whereas the alternative hypothesis confirms the absence of a unit root issue. Suppose the t-statistic of the variable exceeds the critical t-value assigned to it. In that case, we reject the null hypothesis that the data are non-stationary and do not reject the alternative hypothesis that the data are stationary. Based on the results shown in Table 3, it can be observed that all variables examined exhibit stationarity at the first difference level I (1). However, both the partial probability PP and ADF unit root tests indicate that all variables indicate stationarity at the first difference, hence failing to reject the alternative hypothesis of stationarity. The lack of unit root problems in our data, as evidenced by the ADF and PP tests, suggests that the ARDL bound test suits the data's attributes.

The result of the ARDL bound test is presented in Table 4. The bound F-statistics are 40.72, which is greater than the upper bound critical value of 3.06 at the 1% significance level. Hence, we conclude that life expectancy, environmental pollution, trade openness, population growth, and gross capital formation are cointegrated into economic growth in Somalia in the long run.

Further, the long- and short-run cointegration coefficients are reported in Table 5. It was observed that all the explanatory variables are statistically significant and positively affect economic growth except population growth, which is a negative coefficient. Moreover, environmental pollution has an insignificant impact on economic growth. A 1% increase in trade openness is translated to a 0.24% increase in economic growth in the long run. Similarly, life expectancy substantially improves economic growth. A 1% increase in life expectancy is associated with a 0.80% increase in economic growth in the long run. Notably, energy consumption has the highest coefficient elasticity compared to other independent variables. Moreover, Capital rises for economic growth in Somalia. A 1% increase in capital leads to a 1.72% increase in economic growth in the long run. On the contrary, population growth impedes economic growth in Somalia in the long run. A 1% increase in population growth results in a 0.56% decrease in economic growth in the long run.

The short-run result of the study is also reported in Table 5. Most independent variables are statistically significant in the short run except life expectancy. However, the previous value of TO has a mitigating effect on economic growth in the short run. A 1% increase in the previous value of TO reduces economic growth by about 0.02% in the short run. Similarly,

Table 2 Summary statistics

	LnRGDPC	LnTO	LnLE	LnPGG	LnCAPITAL	LnCO2
Mean	5.698	1.855	3.888	2.103	18.054	− 2.641
Median	5.668	1.537	3.924	2.247	19.113	− 2.795
Maximum	6.039	4.669	4.019	2.397	19.451	− 1.933
Minimum	5.390	1.153	3.279	0.315	2.642	− 3.059
Std. Dev	0.206	0.975	0.168	0.447	4.184	0.369
Skewness	0.129	2.336	− 3.025	− 3.184	− 3.466	0.748
Kurtosis	1.816	7.069	11.138	12.098	13.039	2.182
Jarque–Bera	1.833	48.000	128.555	154.175	186.083	3.636
Probability	0.399	0.000	0.000	0.000	0.000	0.162
Correlations						
LnRGDPC	1					
LnTO	0.494	1				
LnLE	0.387	0.311	1			
LnPG	0.012	0.231	0.057	1		
LnCAPITAL	− 0.418	− 0.765	− 0.200	− 0.112	1	
LnCO2	− 0.709	− 0.459	− 0.669	− 0.507	0.293	1

Table 3 Unit root tests

Variable	ADF		PP	
	Level intercept	Intercept and trend	Level intercept	Intercept and trend
LnCO2	− 1.299	− 1.937	− 1.266	− 1.369
LnLE	− 2.752*	− 3.520*	− 2.567	− 3.185
LnRGDPC	− 0.363	− 2.093	− 0.363	− 2.005
LnPG	− 2.781*	− 2.936	− 2.329	− 2.671
LnCapital	− 0.297	− 1.002	− 0.297	− 1.002
LnTO	− 0.570	− 1.321	− 0.651	− 1.426
	First difference intercept	Intercept and trend	First difference intercept	Intercept and trend
LnCO2	− 3.643***	− 4.371***	− 4.104***	− 4.655***
LnLE	− 5.2643***	− 6.426***	− 10.814***	− 10.42***
LnGDPC	− 3.809***	− 5.983***	− 5.150***	− 5.192***
LnPG	− 5.917***	− 4.824***	− 6.227***	− 4.846***
LnCapital	− 5.378***	− 5.712***	− 5.378***	− 5.777***
LnTO	− 5.186***	− 5.332***	− 5.188***	− 5.441***

***, **, and *show significance level at 1%, 5%, and 10%, respectively

Table 4 ARDL Bounds Test

F-statistic	40.720	K (5)
Critical value bounds		
Significance	I0 Bound	I1 Bound
10%	2.08	3
5%	2.39	3.08
2.50%	2.7	3.73
1%	3.06	415

K Number of independent variables

the prior year's value of life expectancy reduces economic growth by about 0.02% in the short run. More importantly, the error correction term (ECT) is significant and has a negative coefficient, as expected. Any shock deviation that occurs in economic growth in the short run is adjusted 85% in the long run by the sampled independent variables annually.

Our result aligns with the study conducted by Ngangue & Manfred [20], which reported that life expectancy improves the economic growth in 141 developing countries. Similarly Turan [16], revealed that life expectancy rises economic growth in sub-saharan african. He & Li [14], Studied the impact of life expectancy on economic growth for 65 countries within three levels of ageing from 1980 to 2014. They found that life expectancy increases the economic growth. Additionally, Ecevit [7], found that life expectancy enhances economic growth in 65 countries within three levels of ageing and OECD countries, respectively. M. S. Islam [23], revealed that, health expenditure and government education expenditure increase in the long run, but not in the short run. Furthermore, the positive relationship between environmental pollution and economic growth confirms with other studies such as Rehman et al [29], and Soytas & Sari [28] in Pakistan and European union contries respectively.

To obtain robust results, we perform several diagnostic tests, such as serial correlation, heteroskedasticity, normality, model misspecification, and model stability tests. Hence, the study's result model has passed all the diagnostic problems, as reported in Table 6. It is also stable, as shown in Fig. 1—CUSUM and CUSUM square tests.

4.3 Robustness analysis

We perform the fully modified ordinary least squares (FMOLS) as a robust analysis to find robust results. The results reported in Table 7 revealed that all explanatory variables are positive and statistically insignificant for economic growth except capital, whereas population growth significantly hampers economic growth in Somalia.

Table 5 Long- and short-run results

Variable	Coefficient	Std. Error	t-Statistic	P-value
Long run result				
LnTO	0.247	0.059	4.182	0.006
LnLE	0.809	0.289	2.797	0.031
LnPG	− 0.566	0.186	− 3.041	0.023
LnCAPITAL	1.728	0.286	6.038	0.001
LnCO2	0.148	0.091	1.635	0.153
C	− 29.200	4.839	− 6.034	0.000
Short-run result				
Δ (LnRGDPC(-1))	0.149	0.038	3.848	0.008
Δ (LnTO)	− 0.021	0.002	− 7.923	0.000
Δ (LnTO(-1))	− 0.016	0.009	− 1.71	0.138
Δ (LnTO(-2))	− 0.134	0.008	− 16.33	0.000
Δ (LnLE)	− 0.029	0.029	− 0.985	0.362
Δ (LnLE(-1))	− 0.525	0.043	− 12.135	0.000
Δ (LnPG)	− 0.805	0.035	− 22.601	0.000
Δ (LnPG(-1))	− 0.182	0.014	− 12.501	0.000
Δ (LnCAPITAL)	0.041	0.002	15.688	0.000
Δ (LnCAPITAL(-1))	− 1.465	0.061	− 24.032	0.000
Δ (LnCAPITAL(-2))	− 0.428	0.066	− 6.467	0.001
Δ (LnCO2)	0.277	0.045	6.08	0.001
Δ (LnCO2(-1))	− 0.606	0.049	− 12.286	0.000
Δ (LnCO2(-2))	0.375	0.034	10.776	0.000
CointEq(-1)	− 0.859	0.036	− 23.876	0.000

***, **, and *indicate the significance level at 1%, 5%, and 10. Δ differencing, ECT error correction term

5 Discussion of the result

The empirical study offers fascinating insights into the correlation between life expectancy, environmental pollution, and economic growth, revealing the complex mechanisms operating across different periods. The findings of the bound test indicate a statistically significant and positive long-term influence of life expectancy on economic growth. This finding aligns with the theory that improvements in public health, as evidenced by an increase in life expectancy, benefit productivity and long-term economic growth. Improved population health can lead to higher average productivity, longer labor force participation, and greater contribution to human capital development. These factors are crucial for long-term economic prosperity.

In contrast, the relationship between environmental degradation and economic growth is shorter-term but less enduring. The findings suggest that although long-term economic growth is not considerably affected by environmental degradation, there is a significant positive impact in the short term. The immediate effect can be attributed to the escalation of commercial and economic operations, which add to pollution and stimulate economic productivity in the short run. Although these activities may enhance short-term economic growth, they may not be favourable to sustainable development because of the potential long-term consequences of environmental degradation, including

Table 6 Diagnostic tests

Reset test	0.187 [0.859]
Adjusted R-square	0.997
Heteroskedasticity test	14.288 [0.815]
Serial correlation test	3.41819 [0.065]
Normality	0.6293 (0.730)

T-statistics values are in (.) parenthesis. P-values are in [.]

Fig. 1 Model stability tests

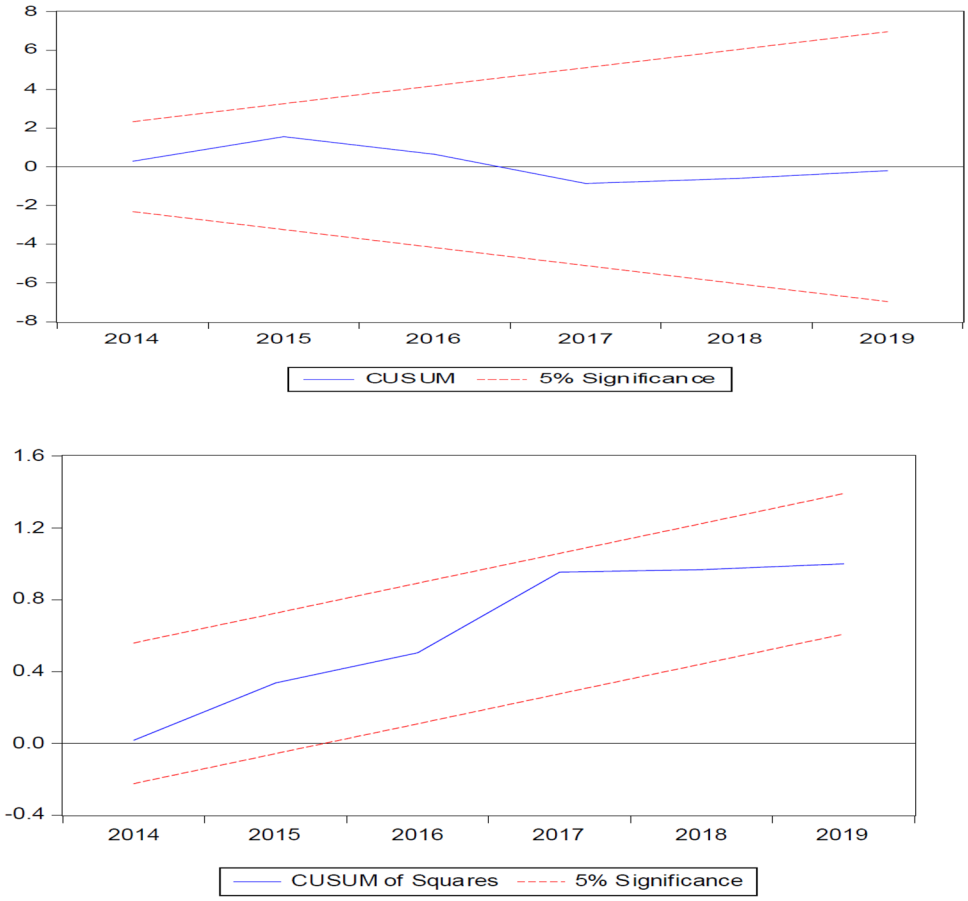

Table 7 Fully Modified Least Squares (FMOLS)

Variable	Coefficient	Std. Error	t-Statistic	P. value.
LPG	− 0.204	0.289	− 0.705	0.507
LLE	0.167	0.463	0.361	0.729
LCAPITAL	2.425	0.682	3.553	0.012
LCO2	0.367	0.285	1.287	0.245
LTO	0.335	0.190	1.757	0.129
C	− 40.367	12.495	− 3.23	0.018

R-squared: 0.992, Mean dependent var: 5.691, Adjusted R-squared: 0.961, S.D. dependent var: 0.207

health problems, biodiversity loss, and climate change. These negative impacts could outweigh any initial economic benefits. The result emphasises the possible conflicts between economic expansion and environmental sustainability, indicating that policies prioritising immediate growth may have adverse long-term consequences.

Furthermore, The negative correlation between population increase and economic growth in Somalia can be explained by examining many widespread socioeconomic aspects in the country. Given the scarcity of resources, rapid population increase can put significant pressure on vital services like education, healthcare, and infrastructure, which are currently inadequate in Somalia. This burden results in a decrease in the amount of resources that are accessible, consequently diminishing the overall quality of human skills and reducing possibilities for economic progress. Moreover, the population's rapid growth might worsen unemployment, especially among young people, resulting in increased levels of poverty and economic inequality. Inadequate employment creation in proportion to the expanding population might impede productivity and innovation, exacerbating the hindrance to economic progress. This result is supported bu other studies such as Khan et al. [36] and Erdoğan et al. [37] who reveal that population growth undermines economic growth.

6 Conclusion

Sustainable economic growth is the primary goal of economic policy in most countries worldwide. Energy is essential in facilitating sustainable economic growth in emerging and developed countries. Hence, the connection between life expectancy, environmental pollution, and Somalia's economic growth can be determined using time-series data from 1990 to 2020. The study employs the autoregressive distributed lag (ARDL) bound test. The empirical results of the bound test indicate that life expectancy improves economic growth. Similarly, environmental pollution increases economic growth in Somalia but is statistically insignificant.

The results of this study have significant policy implications for Somalia's strategy towards economic development. The connection between life expectancy and economic growth is positive and statistically significant, indicating that expenditures in healthcare, nutrition, and living conditions could result in substantial economic benefits. Recognizing that enhanced life expectancy can be a critical catalyst for economic advancement, policymakers should prioritise public health initiatives and health-related infrastructure. Furthermore, although the statistical analysis did not show a significant association between environmental pollution and economic growth, it is essential to pay attention to the potential long-term effects of pollution on health and sustainability. It is imperative to consider implementing policies that promote sustainable environmental practices to prevent economic expansion from causing environmental damage.

Nevertheless, it is essential to recognise that the study has specific constraints. The analysis relies on time-series data from 1990 to 2020, potentially overlooking more impending difficulties. Subsequent investigations would be enhanced by incorporating more up-to-date data and considering additional aspects, such as technological advancement and education, to attain a more all-encompassing understanding of the determinants impacting economic growth in Somalia. Moreover, the study's emphasis on Somalia may restrict the applicability of its findings to other situations, indicating that doing comparable studies in many locations or countries could provide significant comparative perspectives.

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Data availability Raw data: https://data.worldbank.org/country/somalia, https://www.sesric.org/query.php.

Declarations

Competing interests The authors declare no competing interests.

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