Economic growth and unemployment nexus: empirical test of Okun's law in Somalia

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Abstract

This paper aims to empirically examine the relationship between GDP and unemployment in Somalia from 2000 to 2021. The study also estimates Okun's coefficient. To evaluate the association between the unemployment rate and economic growth, we employ the Hodrick–Prescott (HP) filter detrending technique, the Augmented Dickey–Fuller (ADF) test, ordinary least squares (OLS), and fully modified OLS. The findings of this study demonstrate that the series is stationary at the level. However, the results confirm a statistically insignificant negative relationship between unemployment and economic growth. Consequently, our findings suggest that Okun's law does not apply in Somalia. For robustness, we employ fully modified ordinary least squares (FMOLS), canonical cointegrating regression (CCR), and dynamic ordinary least squares (DOLS). Nevertheless, the relationship between the GDP gap and unemployment is not strong enough to be considered statistically significant, and other factors may also influence unemployment. Therefore, policies aimed at reducing unemployment should take into account various factors, including education and training, labor market regulations, and social protection measures.

Keywords: Okun's coefficient, Okun's law, Gap version, Fully Modified OLS

1 Introduction

Unemployment is a major problem in developing countries and is often a symptom of inefficient resource allocation. In order for the economy to function properly, it is crucial to achieve full employment. Both theoretical and practical contributions from macroeconomics researchers have greatly enhanced our understanding and modeling of the intricate connections and linkages within an economy (Amidžić, Kurteš, and Kurušić 2022). The relationship between unemployment and output plays a critical role in labor market policy, fiscal policy, and monetary policy (Ball, Leigh, and Loungani 2017). By grasping Okun's law, decision-makers can better comprehend the interaction between the labor market and the goods market, gaining valuable insights into the overall health of the economy and guiding the use of effective policy instruments to achieve desired economic goals. This information also assists in the formulation of policies to address potential future market instability (Raifu 2023). Taking immediate action to address unemployment is essential for Somalia to make economic progress, improve living conditions, and reduce poverty.

The GDP growth rate is insufficient to meet the growing supply for labor, especially among young people. According to the ILO (2020), over 70% of the country's population is under 30 years, and youth unemployment is particularly widespread. Although Somalia's unemployment rate is lower than the Sub-Saharan African average, it remains higher than the global average and the rates seen in neighboring countries. This highlights the need for measures to create formal employment opportunities, especially for young people in Somalia. Several studies have been conducted in various countries to examine the relationship between economic growth and unemployment dynamics. Chenini et al. (2023) analyzed the existence of Okun's law in Algeria using both the gap and differences models, and concluded that Okun's law does not hold in Algeria. In the case of Pakistan, Akram et al. (2014). estimated Okun's law and found that it does not apply to the Pakistani economy. Nevertheless, there is still a lack of agreement in the empirical data used to evaluate Okun's law. This discrepancy can be attributed to several factors, such as the use of different versions of Okun's law specification (difference version versus gap version), the application of distinct data filter methods, and various modeling approaches to test Okun's law (Pizzo 2020). Given Somalia's high unemployment rate and slow GDP growth rate, it is crucial to examine the validity of Okun's law in this context. However, there is limited research on the country's economic growth and unemployment. While Warsame et al. (2022) investigated the macroeconomic causes of unemployment in Somalia, they did not utilize the gap version of Okun's coefficient. To the best of our knowledge, this study is the first of its kind to address this gap and explore how Somalia's economic growth impacts unemployment. The objective of this research is to examine the relationship between GDP and unemployment, as well as test the applicability of Okun's law in Somalia. Specifically, we aim to determine if Okun's law is relevant in this context and if there is a statistically significant negative relationship between economic growth and unemployment in Somalia.

The remainder of the study is organized as follows: The second part examines the study's empirical literature; the third section presents data sources, descriptions, theoretical framework, and model specification. Sections four and five summarize the study and make policy suggestions based on the empirical analysis and discussions.

2 Literature review

Studies conducted in Arab nations have shown a significant negative relationship between economic growth and unemployment rates (Khaliq et al., 2014). Hjazeen et al. (2021) examined economic growth and unemployment in Jordan from 1991 to 2019 using an autoregressive distributional lag (ARDL) model and a bootstrap cointegration method. They discovered a negative relationship between economic growth and unemployment in Jordan. Kreishan (2011) analyzed the connection between unemployment and economic growth in Jordan using Okun's Law; however, the data did not support this relationship. Moosa (2008) investigated economic growth and unemployment in Arab nations using gap and growth models. The research findings indicate a lack of a relationship between output and unemployment in the four nations studied. In Saudi Arabia, Amor and Hassine (2017) investigated the applicability of Okun's Law from 1980 to 2015 and found a cointegrated connection between the variables. Louail and Riache's (2019) examined the gap between Saudi Arabia's

unemployment rate and economic growth, confirming the relevance of Okun's rule for the Saudi economy. Kamal (2022) used the autoregressive distributed lag (ARDL) model to study the applicability of Okun's Law to the Egyptian economy from 1991 to 2021. However, the study's findings contradict economic theory and previous research papers conducted in other countries. Neifar (2022) analyzed the relationship between economic growth and unemployment in six Arab nations, including Tunisia, Egypt, Morocco, Lebanon, Jordan, and Oman. The empirical findings from the models support the inverse relationship suggested by Okun's Law, except in Oman. El Andari and Bouaziz (2015) questioned the validity of Okun's Law in Tunisia using quarterly time series data from 1990Q1–2014Q1. However, their findings confirm the validity of Okun's rule in the Tunisian economy, confirming the inverse link between output and unemployment in the short and long terms.

Studies conducted in African nations, such as Nigeria, have shown that Nigerian economics does not follow Okun's Law (Bankole and Fatai 2013; and Nigeria 2019). Yet, other studies by Akeju and Olanipekun (2014), Ejukwu & Okwudiri (2019), and Ojima (2019) confirm Okun's Law in Nigeria. Dahmani and Rekrak (2015a) estimated Okun's Law in Algeria from 1970 to 2014 and found a different version of Okun's Law that showed a persistent negative effect in one situation. Chuttoo (2020) investigated the connection between economic growth and unemployment rates in Mauritius. The findings showed a negative cointegration between economic growth and unemployment in both the long run and the short run, although it was not statistically significant. However, the outcome of the Okun's Law-gap version demonstrated the applicability of Okun's Law to Mauritius' small economy. Sinha and Tseladikae (2018) studied the applicability of Okun's Law in Botswana and found that it does not show a negative association between the macroeconomic factors mentioned.

Tingi and Lingii (2011) used a Hodrick–Prescott (HP) filter and the autoregressive distributed lag (ARDL) approach to analyze Okun's law in Malaysia. According to their findings, Okun's model appears stable in Malaysia. Nadeshan and Gnanachandran (2021) examined the applicability of Okun's Law in Sri Lanka but failed to find sufficient evidence to support the claim that the unemployment rate and economic growth rate are inversely related. Mojica and Tatlonghari (2017) examined the empirical relationship between real output and unemployment in the Philippines and consistently found a negative relationship based on Okun's coefficients. Singh and Nurudeen (2022) investigated the application of Okun's law to China and found that it holds true. Ahmed et al. (2011) studied the applicability of Okun's law to the Pakistani economy but found no evidence to support it. Tumanoska (2020) examined the relationship between economic growth, youth unemployment rates, and overall unemployment rates in a panel setting and found a statistically significant negative link between the unemployment rates and economic growth in both panels in the context of Okun's Law. Hashmi et al. (2021) investigated the impact of changes in unemployment rates on output in the BRICS nations and found support for the applicability of Okun's law.

Given the contrasting research findings, the connection between economic growth and unemployment remains uncertain. This study contributes to the existing literature by examining the accuracy of Okun's law's gap version in Somalia, where there is limited previous research on the macroeconomic factors influencing unemployment.

3 Theoretical framework and methodology

3.1 Theoretical framework

Macroeconomic theory has a very small number of models that relate unemployment to GDP growth. The dispute over the empirical link between unemployment and GDP fluctuations was originally brought to light by Okun (1962). Okun's rule is straightforward to understand: as aggregate demand changes, businesses adapt their production plans, which leads to changes in labor demand and, ultimately, affects unemployment rates. In his initial study, Okun identified two empirical relationships between real output and unemployment. This is Okun's Law in its various and incomplete forms (Knotek 2007).

Okun's law relates changes in output to changes in unemployment. When an economy is in a recession, it not only lowers output but also leads to the firing of workers who were previously employed. An economy that emerges from a recession not only starts to generate more goods but also hires people who were previously unemployed. The relationship between variations in unemployment and output is not well defined by Okun's law like it is by all other economic laws. It evolves with time for a given nation as well as between nations (Ahmad et al., 2011).

Okun's law is constructed in such a way that testing its premise involves two challenging empirical issues. First, according to the law, real gross domestic product (GDP) and unemployment must not deviate from their long-term or equilibrium tendencies. These trends are sometimes referred to as potential GDP and the natural rate of unemployment, respectively. Either time series methods (Moosa 1997) or construction utilizing a modified production function approach (Adams and Coe 1990; Gordon and Clark 1984) must be used to estimate these equilibrium trends. In both approaches, potential output is calculated using fully employed inputs. Any calculation of prospective or long-term numbers will very certainly still contain a substantial amount of measurement error. This is true regardless of the strategy used. Furthermore, the most recent year of observation for these created data sets is 1988, a year in which Gordon. (1997) calculated that the natural unemployment rate was above 6.0%, a figure that is far higher than the levels we saw in the mid-to-late 1990s during a period of steady to dropping inflation. Second, Okun makes it quite obvious that he is not referring to a ceteris paribus link between changes in the unemployment rate and changes in real GDP when he formulates his law. Later, Okun (1970, p. 140) wrote under the assumption that other inputs and parameters would change in tandem with employment. The 3% result from a 1% decrease in the unemployment rate suggests that significant output increases during a time of rising utilization rates are caused by some combination of induced increases in the labor force's size, longer average weekly hours, and higher productivity. Therefore, elements like capital inputs, labor hours, and participation rates, all evaluated as departures from long-run trends, would be included in an adequate formulation of the impact of changing unemployment rates on production. Attempts to incorporate these factors in tests of Okun's rule have shown conflicting findings, since it is very difficult to assess their levels, let alone their potential values (Attfield and Silverstone 1997; Prachowny 1993).

This study's approach consists of many phases. First, we gathered information from reputable sources like the World Bank on Somalia's GDP and unemployment rate from 2000 to 2021. Afterward, we used the Hodrick–Prescott (HP) filter detrending method to eliminate cyclical components from the data. We then employed the Augmented

Dickey–Fuller (ADF) test to determine if the series was stationary. To determine the link between GDP and unemployment, we used ordinary least squares (OLS). Furthermore, we used dynamic ordinary least squares (DOLS), canonical cointegrating regression (CCR), and fully modified ordinary least squares (FMOLS) to perform robustness testing. The analysis's design was built using Okun's law's gap version.

3.2 Data description

The information utilized in this analysis includes yearly data gathered and spans the years 2000–2021. The World Bank is the source of the data on the GDP and unemployment. To guarantee that the research concentrates on the long-term link between GDP and unemployment, the data was modified using the Hodrick–Prescott (HP) filter to exclude cyclical components. We followed Raifu's work and utilized real GDP as an approximation of GDP.

Economic growth is an increase in an economy's ability to generate goods and services when contrasted between two points in time. It can be measured in real terms, which are adjusted for inflation, or in nominal terms. Gross national product (GNP) or gross domestic product (GDP) is the traditional unit of measurement for gauging overall economic growth (Romer and Romer 2008).

According to the (World Bank n.d. 2023)The percentage of the labor force that is unemployed yet looking for work is referred to as unemployment. According to the International Labour Organization's 2003 definition of unemployment, it includes persons who have lost their jobs and those who have chosen to leave their positions but are still economically active and looking for work.

3.3 Model specification

In this section, we present the empirical methodology used to estimate long-term trends for unemployment and output. We begin with presenting the standard model of the Okun coefficient.

3.3.1 The different version

Okun (1962) claims that the empirical link between real GDP and unemployment may be calculated using the first-differences method. The mathematical expression for Okun's Law is as follows:

$$(Y_t - Y_{t-1}) = \beta_0 + \beta_1(U_t - U_{t-1}) + \varepsilon_t \tag{1}$$

where $\Delta U_t = U_t - U_{t-1}$ and $\Delta Y_t = Y_t - Y_{t-1}$. ΔU_t represents the changes in the unemployment rate between the current and previous periods; ΔY_t is the growth rate of output (GDP) in percent between the current and the previous periods; ε_t is the Error term in period t; β_1 is the Coefficient of Okun. According to Knotek (2007), Okun's Law holds when the coefficient β_1 is negative, a growing economy should lead to reducing unemployment in the long term.

3.3.2 The gap version

Okun's law, proposed by Okun (1962), demonstrated an inverse connection between unemployment and output. The empirical regularity that exists between cyclical output

and cyclical unemployment is referred to as this law. This relationship's level form may be expressed mathematically as

$$(U_t - U_t^*) = \beta(Y_t - Y_t^*) + \varepsilon_t \tag{2}$$

where U_t is the log unemployment rate; Y_t is the log of real GDP; U_t^* is a natural rate of unemployment; Y_t^* is potential output; ε_t is the error term in period t; and β is the coefficient of Okun.

The gap model has been chosen for further examination of Okun's law by following the works of (Bilal Louail et al. 2019; Dahmani and Rekrak 2015b). The right-hand side represents the output gap $(Y_t - Y_t^*)$ and the left-hand side represents the unemployment gap $(U_t - U_t^*)$.

Calculating the potential output and the natural rate of unemployment are necessary steps in the gap technique. As a result, we must separate the trend components of output and unemployment. To extract the trend components of the variable, a variety of techniques have been utilized in the literature. In terms of Okun's law test, the Hodrick–Prescott (1997) filter technique (HP) is the most often utilized (Table 1).

3.4 HP filter approach

A significant issue with the model (2) is that there is no observable data on the natural rate of unemployment (U_t^*) and potential output (Y_t^*); hence, they must be inferred, which necessitates the generation of the Y and U trend series. We use the Hedrick–Prescott (HP) filter detrending technique to overcome it relatively and to verify the durability of Okun's coefficients.

To derive the trend in an actual data set, the HP filter is a very common technique. It's famous for its simplicity and for being a univariate method that allows it to work in a relatively short time series. Mathematically, the HP filter is a linear filter that computes the smoothed series Y_t^* of Y by minimizing the variance of Y around Y_t^*, subject to a penalty that constrains the second difference of Y_t^*. This means that to minimize the quantity, the HP filter selects Y_t^*:

$$\sum_1^T (Y_t - Y_t^*)^2 + \lambda \sum_2^T ((Y_{t+1} - Y_t^*) - (Y_t - Y_{t-1}^*))^2 \tag{3}$$

The trade-off between the two objectives is administered by the smoothing parameter λ. The higher the esteem of λ, the smoother the assessed drift. For quarterly information, it has been regularly accepted esteem of $\lambda = 1600$, as prescribed by Hodrick and Prescott (1997).

By following the work of (Alichi 2015; Raifu 2023), We compute the unemployment gap and output gap using the method below after extracting the trend component of

Table 1 Variables and data source

Variable	Measurement	Source
Gross domestic product	Constant 2015 Prices	World bank
Unemployment	% of the total labor force	World bank

output as potential GDP and the trend component of unemployment as the natural rate of unemployment:

$$\text{Ungap}_t = \left(\frac{U_t - U_t^*}{U_t^*} \right) * 100 \tag{4}$$

$$\text{GDPgap}_t = \left(\frac{Y_t - Y_t^*}{Y_t^*} \right) * 100 \tag{5}$$

The parameters are changed to log form. Equation (2) will thus be reduced as follows:

$$\ln\text{Ungap}_t = \beta_0 + \beta_1 \ln\text{GDPgap}_t + \varepsilon_t \tag{6}$$

4 Results and discussion

4.1 Descriptive statistics

The descriptive analysis of the variables used in this study is presented in this section and can be found in Table 2. LGDP is the logarithmic transformation of Gross Domestic Product, a common measure that reduces data skewness and better captures proportional changes in economic growth, making it easier to compare economies. Similarly, LUN is the logarithmic form of the unemployment rate, which helps create a more linear relationship with other macroeconomic variables, such as GDP. These transformations smooth out non-linearities in the raw data, making it easier to analyze trends in both economic performance and unemployment. The table displays the distribution of each variable, as well as its mean, standard deviation, minimum, and maximum values. Comparing the mean and standard deviation of LUN (2.95 and 0.013) to LGDP (22.128 and 0.369), noticeable differences can be observed. In addition, Table 2 includes correlations among the variables of interest. It is important to note that LGDP and LUN are negatively correlated, indicating an inverse relationship in terms of Okun's coefficient.

4.2 Unit root test

The assumption of stationarity is violated when time series data exhibit periodic trends. To avoid drawing incorrect conclusions, we use the Augmented Dickey–Fuller (ADF) test to determine the presence of a unit root in the relevant variables. For the purpose of testing a unit root, let's consider the series called Y_t:

Table 2 Descriptive statistics and correlation

	LGDP	LUN
Mean	22.12833	2.954871
Maximum	22.64232	2.992276
Minimum	21.47737	2.935345
Std. Dev	0.369593	0.013070
Observations	22	22
Correlation	LGDP	LUN
LGDP	1	−0.2756
LUN	−0.2756	1

Table 3 Stationarity test

Variables	t-statistics	Prob	Decision
LnGdpgap	−3.896552	0.0083	I(0)
LnUngap	−3.833353	0.0111	I(0)

Table 4 OLS result

Dependent variable: LnGdpgap

Variable	Coefficient	Std. Error	t-Statistic	Prob
LnUngap	−0.644842	0.394913	−1.632870	0.1181
C	−0.000254	0.064226	−0.003958	0.9969

$$\Delta Y_t = \alpha + \pi Y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta Y_{t-i} + \mu_t \qquad (7)$$

where.

$\pi = \alpha\text{-}1$

$\alpha =$ coefficient of Y_{t-1}

$\Delta Y_t =$ First difference of Y_t

The null hypothesis of ADF is $\pi = 0$, while the alternative hypothesis of $\pi < 0$. If we accept the null hypothesis, the series is non-stationary whereas rejection means the series is stationary.

Table 3 presents the unit root results, which indicate that both the log of the GDP gap and the log of the unemployment gap are integrated at level I (0). The key to effective time series analysis lies in selecting the appropriate technique. Using an incorrect approach or model specification can lead to biased and inaccurate estimates. When all the important variables are stationary, the process becomes simpler, and unbiased estimates can be generated using ordinary least squares (OLS) models (Shrestha and Bhatta 2018).

4.3 Ordinary least square (OLS)

Unit root testing is an initial step in the time series analysis procedure. If the unit root test indicates that all the variables under analysis are stationary, the OLS technique can be employed to establish the relationship between the variables. Using Eq. (6) above, we have identified and estimated the regression model. According to the results, there is an inverse correlation between the unemployment gap and the GDP gap, but it is not statistically significant. This study differs from previous research conducted by Mohseni and Jouzaryan (2016) and Mojica and Tatlonghari (2017), but it aligns with the findings of Davis (2019), Sadiku et al. (2015), and Sakib (2023). In addition, the results suggest that Okun's law does not apply in Somalia. This highlights the importance of considering broader contextual factors. While Okun's law proposes a negative relationship between unemployment and economic growth, the lack of a significant correlation in this study implies that other factors may have a more significant impact on unemployment rates (Table 4).

Table 5 Diagnostic test

Diagnostic	Test	Probability value
Normality	Jarque–Bera test	0.3064
Heteroskedasticity	Breusch–Pagan Godfrey	0.5496
Serial correlation	LM test	0.0685

Table 6 Robust analysis

	FMOLS	DOLS	CCR
Variable LnGdpgap	Coefficient −0.689659 (0.1403)	Coefficient −0.121251 (0.8963)	Coefficient −0.701152 (0.1795)

Values in parenthesis represent *p* value

4.4 Diagnostic test

The findings from the three diagnostic tests—the Jarque–Bera test for normality, the Breusch–Pagan Godfrey test for heteroskedasticity, and the LM test for serial correlation—are presented in Table 5. Each test provides a probability value, which indicates the likelihood of obtaining the observed results if the null hypothesis is true. In the case of the Jarque–Bera test, the null hypothesis is that the data are normally distributed. For the Breusch–Pagan Godfrey test, the null hypothesis is that the errors have constant variance. Finally, the null hypothesis for the LM test is that there is no serial correlation in the errors.

According to the results in Table 5, the null hypothesis that the data is normally distributed cannot be rejected. This is because the probability value of the Jarque–Bera test, 0.3064, is larger than 0.05. Therefore, it is reasonable to infer that the data has a normal distribution. Similarly, the null hypothesis that the variance of the errors is constant cannot be disproven. This is evident from the probability value of the Breusch–Pagan Godfrey test, which is 0.5496, greater than the significance level of 0.05. Hence, we can assume that the errors' variance is constant. In addition, the null hypothesis that there is no serial correlation in the errors cannot be rejected. The LM test probability value, 0.0685, is larger than the significance level of 0.05.

4.5 Robustness

The study tested the robustness of the computed OLS estimator parameters using a variety of methodologies. In Table 6, the fully modified ordinary least squares (FMOLS), canonical cointegrating regression (CCR), and dynamic ordinary least squares (DOLS) long-run estimates are shown. FMOLS, CCR, and DOLS are utilized for robustness testing because of their ability to manage cointegration and endogeneity issues, yielding reliable estimates of the long-term relationship between GDP and unemployment. These methods strengthen the robustness of the results by mitigating potential biases and ensuring the validity of the findings. According to the accuracy analysis's findings, the coefficients' sign and level of significance are consistent with what the OLS model estimates. This therefore confirms the validity of the study's OLS

findings. All coefficients are insignificant, since the *p* value for all values in parentheses is more than 5%.

5 Conclusion and recommendation

This paper aims to empirically examine the relationship between GDP and unemployment in Somalia from 2000 to 2021. In addition, the study estimates Okun's coefficient. To evaluate the association between the unemployment rate and economic growth, the study uses the Hodrick–Prescott (HP) filter detrending technique, Augmented Dickey–Fuller (ADF), ordinary least square (OLS), and fully modified OLS. The findings of this study demonstrate that the series is stationary in level. However, the results support a negative and insignificant relationship between unemployment and economic growth, which aligns with the conclusions of authors such as Nadeshan and Gnanachandran (2021), Ahmed et al. (2011), and Ejukwu & Okwudiri (2019). Therefore, these findings suggest that Okun's law does not hold in the context of Somalia, highlighting the unique economic landscape of the country. This work diverges from previous research, in contrast to (Mohseni and Jouzaryan 2016; Mojica and Tatlonghari 2017). This challenges the conventional belief that reducing the GDP gap will automatically lead to decreased unemployment. Instead, it indicates that Somalia's unemployment crisis is influenced by various factors beyond economic growth, including structural challenges, limited investment, political instability, and insufficient social safety nets. This study is significant as it examines the connection between GDP and unemployment in Somalia and disproves conventional economic theories by demonstrating the lack of relevance of Okun's law. It emphasizes the limitations of focusing solely on GDP growth to address unemployment and the need for context-specific analysis. The results highlight the importance of considering structural, political, and social factors, and recommend that policymakers adopt comprehensive strategies. This research contributes to our understanding of unemployment dynamics in Somalia and helps shape country-specific policies by identifying the main causes of unemployment and providing recommendations for effective interventions. Based on these findings, policymakers could consider a range of policy recommendations, including diversifying economic strategies, investing in human capital development, supporting small and medium enterprises, implementing labor market reforms, promoting inclusive growth, investing in infrastructure, fostering public–private partnerships, and strengthening social protection measures. These policies aim to address the underlying structural challenges of unemployment and promote sustainable economic growth in Somalia.

Data availability
The data sets used and/or analysed in the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
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.

Consent for publication
Not applicable

Competing interests
The authors declare no competing interests.

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