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Domestic Saving and Economic Growth Nexus in Ethiopia: Contemporary Evidence from Autoregressive Distributive Lag Approach

Wondaferahu Mulugeta Demissie (PhD)

Associate Professor of Economics, Department of Development Economics, Ethiopian Civil Service University, Addis Ababa, Ethiopia, wondm2001@yahoo.com

ABSTRACT

Accumulated savings serve as a foundation for capital stock, which subsequently foster an increase in investment and output, and ultimately promotes economic growth. Accordingly, this paper aims to analyze the effect of domestic saving on economic growth in Ethiopia, utilizing annual data from 1981 to 2023 and employing the Autoregressive Distributive Lag (ARDL) approach. Prior to conducting the regression analysis, the unit root and bounds cointegration tests indicate that the study variables exhibit mixed orders of integration, thereby validating the suitability of the ARDL approach and confirming the existence of long-term cointegration among them, respectively. Furthermore, the regression results reveal that human capital, exports of goods and services, and the average lending interest rate are significant contributors to economic growth in both the long and short run. Conversely, while the money supply robustly enhances growth only in the long term, domestic savings and economic reforms contribute positively, whereas the inflation rate significantly hinders economic growth in the short term. Therefore, it can be inferred that economic growth reacts differently to variations in domestic savings over the long and short term. Lastly, the coefficient of the Error Correction Term is negative and significant as expected, affirming the presence of a long-run relationship among the study variables. Furthermore, various post-estimation diagnostics and parameter stability tests have confirmed that the results are reliable for meaningful interpretation and validate the robustness of the empirical model. Consequently, this study underscores that the Ethiopian government should formulate and implement policies aimed at enhancing human capital, increasing both public and private savings, diversifying exports, and curbing inflation to expedite economic growth in Ethiopia.

Keywords: Domestic savings, Economic growth, ARDL model, Ethiopia

1. Introduction

Countries globally are tirelessly striving to attain rapid and sustained economic growth. This pursuit is driven by the understanding that economic growth serves as a key indicator of a nation's economic progress and health, and that a nation's ability to improve the living standards of its citizens is fundamentally reliant on its sustainable and long-term economic growth rate (Wondimu, 2023). Consequently, researchers have identified various structural, institutional, geographical, and macroeconomic factors that influence total factor productivity, aggregate demand, and economic growth over the past several decades, dating back to the 1950s. Among these factors is domestic savings. That is why numerous economists have

consistently argued that high levels of domestic savings can significantly enhance the economic growth of nations (Amusa and Busani, 2013).

Moreover, Krieckhaus (2002) emphasized that domestic savings within an economy play a crucial role in the economic growth and development process of countries, for they determine the national capacity for investment and production, which subsequently impacts the country's growth potential. Furthermore, Ma (2020) pointed out that the primary reasons behind the economic growth successes of the Asian Tigers from the 1950s through the 1990s and China since 1978 are their high saving rates coupled with social stability during their periods of rapid growth. According to Chakraborty (2023), the rapid economic growth observed in BRICS countries is largely attributed to their sustained increase in savings.

However, Rogg (2006) contends that developing countries encounter a significant issue regarding the resource gap, characterized by insufficient savings relative to investment. This gap has resulted in challenges for developing countries in securing the necessary financing for growth through domestic savings. Additionally, Geda and Kibret (2006) asserted that a contributing factor to the sluggish growth in Africa is the comparatively low rate of savings compared with other continents. Furthermore, Olapido (2010) opined that the inadequate level of domestic savings represents one of the primary obstacles that many developing countries must overcome to attain higher levels of investment, thereby fostering sustainable economic growth. On the empirical side, however, research examining the relationship between savings and economic growth, utilizing diverse analytical methods over different periods, has yielded inconclusive results.

Though Ethiopia's real GDP grew at an average of 8.1% between 2014 and 2023 (NBE, 2022/23), the country is not an exception to the serious problems developing countries are facing. Data from the IMF (2024) show that there is a serious resource gap in Ethiopia. That is, the trend of domestic savings to GDP in Ethiopia fluctuated between 1981 and 2023 and increased from 4.91% in 1991 to 13.48% in 1995, and exceeded 20% for the first time in the country's history, reaching 24.31% in 2004 after a decade of fluctuation. Furthermore, it reached 31.46% in 2011 and 32.33%—the highest over the study period—in 2018, but showed a declining trend thereafter, reaching 18.73% in 2023. On the other hand, the ratio of domestic investment, measured by gross domestic capital formation, was 11.52% in 1991, 12.35% in 1995, and 25.05% in 2004. Moreover, annual domestic investment was about 32.11% in 2011, 34.16% in 2018, and 21.04% in 2023, showing a resource gap in the country except in 1995. Overall, the resource gap in Ethiopia between 1981 and 2023 averaged 5.94%. The above figures also show that domestic investment was high in years when domestic savings to GDP were high. Thus, it can be inferred that a high level of domestic saving is critically important in Ethiopia to enhance domestic investment, as observed from the shortfall of domestic savings compared to domestic investment.

In addition to the resource gaps discussed above, there are three key reasons that justify the need for this study. Firstly, the lack of consensus among researchers on the effect of domestic savings on economic growth serves as a motivating factor for this investigation. Secondly, enhancing domestic savings on a sustainable basis has become a widespread national agenda in Ethiopia, aimed at ensuring sustainable investment and economic growth from internal sources

in the future. Thirdly, despite the critical role of domestic savings in fostering domestic investment and ultimately spurring economic growth in countries, there are few empirical studies in Ethiopia that focus either on the determinants of savings (such as Degefe, 2021; Deresa and Tesfaye, 2020) or the causal relationship between savings and economic growth (such as Mulualem, 2021; Abel, 2016). In other words, the studies referred to above have not explored the long-term and short-term effects of domestic savings on economic growth. Consequently, given that savings represent one of the policy instruments available for developing countries to enhance their growth prospects and development, it is essential to examine the impact of domestic savings on economic growth in Ethiopia, utilizing data from 1981 to 2023. This study also differs from the empirical literature reviewed by seeking to assess the effects of economic reforms implemented in Ethiopia since 1992 on long-term and short-term economic growth.

2. Related Literature

The Classical and Keynesian economists view strong association between saving and investment differently. According to the Classical economists view that saving and investment are always in equilibrium because the economy is always in full employment and any inequality between them will be brought to equality through flexible lending interest rate, which is determined by the demand for and supply of loanable funds That is, as savings increase, the supply of funds in an economy becomes in excess of demand, resulting in a reduction of interest rates for borrowed funds. Since the lending interest rate is the price businesses pay on their borrowing to finance investment, a reduction in the average lending interest rate is expected to encourage borrowing and hence investment at the same time. The opposite is likely to happen when the supply of loanable funds fall short of demand. Nevertheless, the Keynesian economists argue that savings is the result and not the cause of increased investment. Hence, equilibrium between savings and investment can take place even when the economy is below or above the level of full employment, which implies that equilibrium is not determined through interest rate adjustment, instead it is determined through changes in economic growth (Rohlf, 2002).

Similarly, different growth models also postulate divergent hypotheses on saving-investment nexus. For instance, the Solow growth model emphasize on capital accumulation to ensure rapid economic growth. As a result, high saving is considered as a prerequisite to fostering growth via enhancing capital accumulation (Prescott, 1988). Furthermore, the neoclassical economists predicted a direct relationship between savings and economic growth. This relationship can be illustrated by the rise in savings; which can promote economic growth via domestic investment. Similarly, Khalil (2015) noted that as per the neoclassical paradigm a country that is not capable of generating high level of saving is subject to borrowing from the rest of the world (or bilateral and international agencies) to fill domestic resource gap to finance its investment needs. On the other hand, the endogenous growth model asserts that economic growth is contingent upon savings and human capital investment, as well as investment in research and development (Mattana, 2017).

Several empirical studies have sought to explore the connection between savings and economic growth in various developing nations. For example, Liu and Guo (2002) examined this

relationship in China by utilizing quarterly data from 1990Q1 to 2001Q4. The results of their regression analysis indicate that saving play a crucial role in fostering growth, with a unidirectional causality observed from economic growth to savings. Conversely, Lean and Song (2009) investigated the link between economic growth and savings in China, analyzing data from 1955 to 2004 and applying both Johansen co-integration and Granger causality tests. Their regression analysis demonstrated that domestic saving contributed to China's economic groth primarily in the long run. Besides, the study identified a bidirectional causality between saving and economic growth in the short run, in contrast to the unidirectional causality from economic growth to savings in the long-run.

In a similar vein, Chor and Chua (2009) examined the impact of savings on economic growth in Malaysia utilizing data from 1991 to 2006 along with nonparametric co-integration test as well as Dynamic OLS methods. Their results demonstrate that savings significantly contributed to economic growth in the long term by affecting capital formation. Similar result was also obtained by Jagadeesh (2015) in Botswana, who utilized data from 1980 to 2013 and employing Auto Regressive Distributed Lagged (ARDL) model. Nevertheless, Abel (2016) found that saving had a negative yet insignificant effect on economic growth in Ethiopia, a conclusion that contradicts established theoretical perspectives. Nevertheless, the Granger causality test indicated a unidirectional causality from GDP to national savings. In contrast, Elias and Worku(2015) identified a unidirectional causality running from saving to growth in Ethiopia.

Verman's (2007) study in India used more than five decade data spanning from 1951 to 2004 and employing ARDL approach. The regression results show that only domestic saving affects investment positively and robustly both in the long- and short-run but not growth. Applying the same methodology but extending the data set to 2015 for India, Yadav et al., (2018) also found similar results. Furthermore, this study indicates there is a unidirectional causality only running from saving to investment. Therefore, this study confirmed the important role of domestic saving in promoting investments in India. Nevertheless, the insignificant impact of savings and investment as well as the neutral causality between investment and growth as well as savings and growth indicates the traditional view that saving affects growth through its effect on investment may not have strong empirical support.

Similarly, using data from 1980 to 2016 and Johansen cointegration and Granger causality techniques, Karahan (2018) found that domestic savings did not serve as a catalyst for Turkey's economic growth over the study period. As a result, the author inferred that the primary reason for the negligible effect of savings on Turkey's growth could be attributed to foreign capital inflows, which results to the accumulation of foreign saving off-set the impact of domestic savings on economic growth. Nevertheless, Soylu (2019) study in Poland using data from 1992 to 20016 and employing ARDL approach found contradictory result to that of, Verman (2007) and Yadav et al., (2018) for India and Karahan (2018) for Turkey. Specifically, the findings of this study revealed that saving played a crucial role in Poland's economic growth during the study period, because increase in saving rate enhances capacity in times of financial distress.

The findings from cross-sectional studies regarding the saving-growth nexus are consistent with those from country-specific studies. For example, Bolarinwa and Obembe (2017) reported mixed outcome based on data from 1961 to 2014, applying the ARDL approach. Specifically,

a unidirectional causation was observed from economic growth to domestic saving in Ghana and Burkina Faso, whereas the opposite was true for Liberia, Niger and Sierra Leone, with no causality detected in Nigeria. Similarly, Chakraborty (2023) analyzed the issue using data from BRICS countries, employing CS-ARDL model along with Granger and Dumitrescu-Hurlin panel Granger causality tests to investigate whether the increase in savings among BRICS Nations accounts for their rapid economic growth. The results derived from the dynamic panel estimation method indicate that domestic saving served as a significant driver of growth throughout the study period and the causality tests reveal evidence for bidirectional causality between savings and economic growth across the BRICS countries collectively.

In addition to domestic savings, both theoretical and empirical literature have identified several macroeconomic factors that influence a country's growth prospect through their effect on total factor productivity. Among these macroeconomic factors, Mishra (2011) contended that despite the increasing global openness and integration, there remains conflicting theoretical and empirical evidence regarding the effect of exports of goods and service on economic growth of developing nations. Some empirical studies advocate for the export-led economic growth hypothesis while others do not, leading to uncertainty about whether to peruse export diversification strategies. Supporting this viewpoint, the research conducted by Duru and Siyan (2019) using data from SANE countries (South Africa, Algeria, Nigeria and Egypt) for the period 1980 to 2016 yielding mixed results concerning the impact of exports on economic growth. Specifically, the ARDL model regression results revealed that exports significantly enhanced growth only in South Africa and Egypt, while they were insignificant in the other two countries. On the other hand, while the causal relationship between exports and growth was neutral/independent for Algeria, a unidirectional causality confirming the export-led hypothesis was observed only for Nigeria and Egypt, whereas the revers causality- growth-led export was applicable solely only for South Africa. Similarly, the study by Kromtit et al. (2017) in Nigeria revealed that non-oil products exports were significant growth drivers, as determined by the ARDL model using annual data from 1985-2015. Nevertheless, utilizing annual data from 1980-2016 and Engel Granger cointegration technique, Vincent (2017) found that despite being the primary source of hard currency, the effect of non-oil products exports on Nigeria's economic growth was insignificant.

Money supply is a monetary policy instrument that affect total factor productivity within an economy. However, the theoretical and empirical literature on the effect of money supply, measured by broad money to GDP, on total factor productivity and growth of developing nations may differ between the short and long term. In this context, Abass (2022) contends that due to short-term rigidity of prices leads to a situation where an increase in money supply results in lower lending interest rate, thereby stimulating investment, aggregate demand, and economic growth. Conversely, in the long-run, an increase in money supply is likely to lead to inflation, which may have a significant negative impact on aggregate demand and economic growth. Supporting these claims, Abass found that an increase in money supply indeed promotes economic growth only in the short term within the Ghanaian economy. In contrast, the finding of Adaramola and Dada (2020) in Nigeria, along with Awuti's (2017) study in China as well as a recent cross-sectional panel study by Asongo et al. (2024) in Sub-Saharan Africa, revealed that money supply positively affects economic growth, measured by real GDP, significantly in both the long and short term.

The impact of interest rate on economic growth has been a central topic in both academic and policy discussion since the 1930's following the theories of Fisher (the classical) and Keynesian (Kim, 2024). Further, Shaukat et al. (2019) observed that managing the persistent rise in public debt is the main factor driving up nominal interest rates in developing countries, which further exacerbates domestic inflation, raises borrowing costs, discourages consumption and local investment, diminishes total factor productivity, and hampers long-term economic growth. Supporting this viewpoint,, the empirical research conducted by Abass's (2022) and Mutinda (2014) indicated that interest rates had a significant negative impact on long-term economic growth in Ghana and Kenya, respectively. Nevertheless, the studies conducted by Inedu (2020) and Adaramola and Dada (2020) indicated that lending interest rates were significant beneficial for growth Kenya and Nigeria, respectivelly. Compared to the aforementioned bi-polar findings, the research by Fatoumata (2017) and Lyndon and Peter (2016) reported an insignificant effect of interest rate on Nigeria's economic growth.

While moderate inflation rate may be stimulant to economic growth, high inflation reduce the purchasing power of money, create macroeconomic uncertainty, and hence reduce not only the demand for commodity and domestic investment but also total factor productivity, and the growth prospect of an economy. In this regards, while the empirical work of Razia et al. (2023) in Palestine and Shiyalini and Bhavan (2021) in Sri Lanka's demonstrate significant growth enhancing effect of inflation, the study conducted by Abass(2022) in Ghana, Adaramola and Dada (2020) in Nigeria and Riyath (2018) in Sri Lanka's found significant adverse impact of inflation on economic growth, contrasting the Keynesian model, which posit that since the long-term aggregate supply curve slopes upward, inflation and output move together.

3. Research design and Methods of data analysis

3.1. Research design

This study employs a quantitative research design, utilizing both descriptive and inferential statistics to illustrate patterns of change over time. Thus, before proceeding with the Autoregressive Distributed Lag (ARDL) Model regression analysis, the results of descriptive statistics and Pearson correlation coefficients were briefly analyzed. To this end, this study utilized annual time series secondary data spanning from 1981 to 2023, collected from various secondary sources.

3.2. Model specification

3.2.1. Theoretical Model specification

In contrast to the traditional Solow growth model, Romer's endogenous growth model recognized that, in addition to accumulation of labour and capital, total factor productivity plays a vital role in driving the economic growth of nations. Thus, following Wondaferahu (2013) study, the Cobb-Douglas production function in its growth accounting form, which connects economic growth (Y_t) with gross domestic capital formation or investment (K_t) and labour force (L_t) as well as total factor productivity (TFP) or (A_t) at any given period is defined as:

$$Y_t = A_t(K_t^{\gamma} L_t^{1-\gamma}) \text{---------- (1)}$$

Where, γ and $1-\gamma$ show the share of domestic capital and labour force in the production process. Taking the natural logarithm transformation of the variables in equation (1) above we have

$$lnY_t = lnA_t + \gamma lnK_t + 1 - \gamma lnL_t \text{---------- (2a)}$$

Nevertheless, endogenous growth model postulates that increase saving improves domestic investment, which in turn impact long-run economic growth. As a result, first the ratio of domestic saving to GDP is substituted for gross capital formation (orK_t) in growth accounting equation (2a) to avoid multicollinearity problem that may arise when including both domestic saving and investment in the growth model regression. Thus, equation (2a) is modified as

$$lnY_t = lnA_t + \gamma lnGDSG_t + 1 - \gamma lnL_t \text{---------- (2b)}$$

Where, $GDSG_t$ refers to domestic saving to GDP ratio. With regards to total factor productivity (TFP) or (A_t), literature also identified numerous macroeconomic factors that influence TFP and ultimately the growth prospect of a country. Among others, exports of goods and services ($lnEXPG_t$), money supply ($lnMSPG_t$), lending interest rate ($lnALDR_t$), inflation ($INFC_t$), and economic reforms as part of liberalization policy package ($ECOR_t$) are worth mentioning. Thus, a linear relationship for (TFP) or (A_t) is specified as:

$$A_t = \theta_1 lnEXPG_t + \theta_2 lnMSPG_t + \theta_3 lnALDR_t + \theta_4 INFC_t + \theta_5 ECOR_t + \varepsilon_t \text{------- (3)}$$

Where, θ_1 and ε_t indicate parameters of TFP determinants and random error term, respectively. The variables with suffix ln indicate that they are in natural logarithm form.

3.2.2. Empirical Model specifications

In order to assess the long-term and short-term effects of independent variables on the dependent variable (real GDP), this research employs Autoregressive Distributed Lag (ARDL) approach, which was developed by Pesaran and Shin (1999) and subsequently extended by Pesaran et al. (2001). The rationale for selecting ARDL approach over other methodologies, such as Johansen cointegration technique, lies in its advantages across five key areas: Firstly, since each underlying variable is treated as a separate equation, the issue of endogeneity is minimized in the ARDL technique, resulting in unbiased estimates (Akrout et al., 2021). Secondly, in contrast to Johansen cointegration techniques that necessitate all the variables to be stationary in their first difference or I(1), ARDL approach can be utilized regardless of whether the underlying variables are I (0), I (1) or a mix of both, as long as none of the variables are stationary at the second difference or I(2). Thirdly, the ARDL approach posits that there exists only one reduced form equation linking the dependent variable to the exogenous variables (Pesaran et al., 2001). Fourthly, the ARDL approach yields unbiased and efficient results even with a small size, whereas Johansen's cointegration method requires a large sample to produce valid outcomes (Narayan and Narayan, 2005). Lastly, it facilitates the estimation of both long-term and short-term effects of one variable on another (Bentzen and Engsted, 2001).

Therefore, to derive the conventional ARDL model first economic growth (Y_t) is represented by real GDP and labour force (L_t), with human capital being proxied by gross secondary school enrollment in equation (2b). Romer (1986) cited by Wondaferahu (2013) contended that gross secondary school enrollment serves as an indicator of human capital that influences TFP through the accumulation of knowledge, enhancement of learning capabilities, and a general

rise in resource productivity. Finally, substituting equation (3) into equation (2b) for A_t and rearranging the order of the variables, we arrive at the following conventional log-liner ARDL $(p, k_1, k, \dots, k_7)$ economic growth model, which incorporates both the level and first difference form of the variables as:

$$\begin{aligned}\Delta lnRGDP_t = a_0 + \sum_{i=1}^{p} \beta_1 \Delta lnRGDP_{t-i} + \sum_{i=0}^{k1} \beta_2 \Delta lnHUCA_{t-i} + \sum_{i=0}^{k2} \beta_3 \Delta lnGDSG_{t-i} \\ + \sum_{i=0}^{k3} \beta_4 \Delta lnEXPG_{t-i} + \sum_{t=0}^{k4} \beta_5 \Delta lnMSPG_{t-i} + \sum_{i=0}^{k5} \beta_6 \Delta lnALDR_{t-i} \\ + \sum_{i=0}^{k6} \beta_7 \Delta INFC_{t-i} + \sum_{i=0}^{k7} \beta_8 \Delta ECOR_{t-i} + \varphi_1 lnRGDP_{t-1} + \varphi_2 lnHUCA_{t-1} \\ + \varphi_3 lnGDSG_{t-1} + \varphi_4 lnEXPG_{t-1} + \varphi_5 lnMSPG_{t-1} + \varphi_6 lnALDR_{t-1} \\ + \varphi_7 INFC_{t-1} + \varphi_8 ECOR_{t-1} + \mu_t \dots\dots\dots\dots\dots (4)\end{aligned}$$

Where, $lnRGDP_t$ represents the dependent variables, which signifies real GDP, and serves as an indicator of economic growth, while $lnRGDP_{t-i}$ indicates its lag. The variables of human capital and gross domestic saving are denoted by $lnHUCA_t$ and $lnGDSG_t$, respectively. The remaining five control variables are as defined in equation (3) earlier. The symbol $\triangle$ represents the first difference operator; t indicates the time subscript; a_0 denotes the constant; and φ_i and β_i are the coefficients associated with the long-run and short-run dynamics of the ARDL models. Additionally, μ_t represents the error term, which accounts for all other variables not included in equation (4) and is presumed to exhibit normal properties of zero mean, non-serial correlation and constant variance assumptions. Furthermore, p and k $(k_1, k_2, \dots, k_7)$ on top of the summations in model (4) signifies the optimal lags of the dependent and independent variables (in their respective order) for the short run model. Thus, the unrestricted long-run growth ARDL model is derived from the general ARDL growth model (4) as follows:

$$\begin{aligned}lnRGDP_{t-1} = a_0 + \varphi_1 lnRGDP_{t-1} + \varphi_2 lnHUCA_{t-1} + \varphi_3 lnGDSG_{t-1} + \varphi_4 lnEXPG_{t-1} \\ + \varphi_5 lnMSPG_{t-1} + \varphi_6 lnALDR_{t-1} + \varphi_7 INFC_{t-1} + \varphi_8 ECOR_{t-1} \dots . (5)\end{aligned}$$

As in the case of the long-run model, the restricted ARDL-Error Correction Model (ECM) economic growth model, is derived from Equations (4). Using the same variables like the long-run ARDL model, the restricted ECM-ARDL model is written as follows:

$$\begin{aligned}\Delta lnRGDP_{t-i} = \sum_{i=1}^{p} \beta_1 \Delta lnRGDP_{t-i} + \sum_{i=0}^{k1} \beta_2 \Delta lnHUCA_{t-i} + \sum_{i=0}^{k2} \beta_3 \Delta lnGDSG_{t-i} + \\ \sum_{i=0}^{k3} \beta_4 \Delta lnEXPG_{t-i} + \sum_{t=0}^{k4} \beta_5 \Delta lnMSPG_{t-i} + \sum_{i=0}^{k5} \beta_6 \Delta lnALDR_{t-i} + \sum_{i=0}^{k6} \beta_7 \Delta INFC_{t-i} + \\ \sum_{i=0}^{k7} \beta_8 \Delta ECOR_{t-i} + \delta ECT_{t-i} + \mu_t \dots\dots\dots\dots\dots\dots\dots\dots\dots (6)\end{aligned}$$

Where; ECT_{t-1} is one period lag of Error Correction term (ECT) and its parameter 'δ' is the adjustment coefficient, which tells us the percentage by how much the short run disequilibrium is corrected in the current year and how long it will take to correct the disequilibrium created due to short-run shock and adjust to the steady state. According to Monineath (2018), the coefficient of ECM or the speed of adjustment should be negative and statistically significant at 5% level significance.

Table 1. Variables Description, Data source, and expected signs

Variables	Description	Data Source	Exp. sign
Dependent variables			
Economic growth ($lnRGDP_t$)	It is measured by real GDP (in $US dollar) and transformed to natural logarithm	WB(2025)	NA
Independent variables			
Human capital ($lnHUCA_t$)	It is measured by gross secondary school enrollment and transformed into natural logarithm.	WB(2024) MoE (2024) database	+
Domestic saving ($lnGDSG_t$)	It is the ratio gross domestic saving to GDP and transformed to natural logarithm	IMF(2024)	+
Exports($lnEXPG_t$)	It is measured by the ratio of exports of goods and services to GDP and transformed into natural logarithm	WB (2025)	+
Money Supply ($lnMSPG_t$)	It is measured by broad money supply (M2) as a percentage of GDP and transformed into natural logarithm	WB(2025)	+/-
Lending interest rate ($lnALDR_t$)	It is measured by annual average of the minimum and maximum market lending rate of commercial banks (in percentage) and transformed into natural logarithm	IMF & IFS (2010) and NBE	+/-
Inflation rate ($INFC_t$)	It is measured by annual % change of in consumer price index.	WB(2025)	-
Economic reform ($ECOR_t$)	It is measured by dummy variable as 1 for the years since 1992 and 0 for the period before 1992.	NA	+

Note: The acronym IFS refers to International Financial Statistics. The data for average lending interest rate is obtained from IMF and IFS (from 1981 to 2008) and NBE, various issues (from 2009-2023)

3.3. Estimation procedure

Unit root test is the preliminary step for econometric analysis of time series data to refute the null hypothesis (H_0) of unit root (the variable is non-stationary) against the alternative hypothesis (H_1) no unit root (the variable is stationary). In this study, Augmented Dickey-Fuller (ADF) and Philip-Perron (PP) tests were employed to examine whether a time series variable is stationary or not. Then, decision is made by comparing the calculated t-statistics of ADF and PP tests with McKinnon's critical values. The null hypothesis that a variable is non stationary or has a unit root is accepted (rejected) if its calculated t-statistics is greater (less) than the Mackinnon's critical values. According to Gujarati (2021) a time series is said to be stationary if its mean and variance are constant over time. The ADF and PP unit root tests are estimated at the level and first difference of the variables first only including the drift term; then including both drift and trend; and finally without drift and trend terms.

Since the bound cointegration is sensitive to the optimal lags of the dependent and independent variables, the second step in ARDL approach is lag length determination. This step requires, estimating equations (4) first imposing lags 2 as recommended by Hundie, et al. (2022) and increase the lags until we get the appropriate lags that ensure absence of autocorrelation in

residuals (Nkoro and Uko (2016). Performing of the bound cointegration test immediate after estimation of equation (4), is the third step when applying ARDL approach. This step enables researchers to check if variables included in the ARDL model (4) empirically give meaningful long-run equilibrium relationships and hence generate parsimonious the long-run coefficients or not. The bound cointegration test requires investigating the null hypothesis (H_0) of no cointegration among variables (or $\varphi_i = 0$) against the alternative hypothesis (H_1) that states there exists cointegration among variables (or$\varphi_i \neq 0$).

In the analysis process, Pesaran et al. (2001) recommended comparing the estimated Fisher (F-statistics) with the critical values of upper bounds, I (1) and the lower bounds, I(0). Then, the null-hypothesis is rejected if the estimated F-statistics of the growth model exceed the critical values of the two bounds at 5% significance level, indicating the existence of long-run relationship among the study variables. In this case, both the long-and short-run ARDL models should be estimated in the fourth and fifth steps, as suggested by Adeyemi and Ogunsola (2019). Conversely, the null-hypothesis is accepted when the F-statistics are lower than the two bounds critical values at 5% significance level, which indicates absence of long-run relationship among the variables examined. In such as case, only the short-run ARDL-Error Correction Model (ECM) is estimated. If the estimated F-statistics is lower than the critical value for the lower bounds, I(0) at 5% significance level, then the issue of cointergation is inconclusive and hence, ARDL approach is inappropriate.

3.4. Diagnostic and Model Stability tests

In empirical studies using time series date, it is mandatory to perform post-estimation diagnostic tests as well as model stability tests in order to check whether the residuals fulfil all the white noise assumptions and hence the results are valid for meaningful interpretation and confirm the robustness of empirical model (Shatz, 2023). Therefore, the null-hypotheses examined are no autocorrelation, no heteroscedasticity problem, the residuals are normally distributed, and no omitted variables or model misspecification problem against the alternative hypotheses that the problems exist next to the short-run ARDL-ECM estimations of the growth model According to Wooldridge (2016), insignificant p-vales confirm absence of the problems and hence the validity of an estimated model.

Finally, stability test is conducted to evaluate whether the coefficients are stable overtime or not using the cumulative sum (CUSUM) and cumulative sum of square (CUSUMSQ) tests introduced by Brown et al. (1975) cited in Awan et al. (2014). According to Alam et al., (2022) we should observe the position of the blue line in the two figures to check whether there is stability or not. That is, if the blue line oscillates between the two red lines, then the null hypothesis that all the parameters of are stable cannot be rejected, implying the stability condition is satisfied and when the blue line does cross the red lines, the null hypothesis is rejected suggestion there is parameter instability.

4. Results and Discussions

4.1. Descriptive statistics of the study variables

The summary statistics of all variables included in the estimation of growth model are shown in Table 2 below. The mean of real GDP between 1981 and 2023 is $35,941.47, with the

maximum and minimum being $112,653.3 and $10,259.87, recorded in 2023 and 1985, respectively. On the other hand the gross secondary school ennoblement averaged to about 23.6%, which increased from 10.4% in 1981 to the maximum of 45.98% is 2022. The annual average of gross domestic saving to GDP stands at about 16.67% for the period covered in this study, which is very low by any standard despite a maximum of almost double for the year 2018. Similarly, the ratio of export of goods and services to GDP is only 9.745%, due to extreme dependence on export of primary agricultural products. The ratio of broad money supply to GDP is about 30.78%, which is very high by any standard. Inflation rate, measured by annual change in consumer price index ranges from the highest 44.36% in 2008, the worst in the history of the country to the lowest negative 9.81% in 1986. The standard deviations of all the study variables, except the dummy for economic reform, indicate that there was high variation from their means for most years.

Table 2. Descriptive statistics of study variables

Statistics	RGDP	HUCA	GDSG	EXPG	MSPG	ALDR	INFC	ECOR
Mean	35941.47	23.599	16.666	9.745	30.782	10.525	10.848	0.744
Std. Dev.	31042.51	11.629	9.291	3.575	5.686	2.985	11.915	0.441
Maximum	112653.30	45.980	32.330	16.687	44.624	15.080	44.360	1.000
Minimum	10295.87	10.400	4.951	3.238	19.015	4.000	-9.810	0.000

Source: Own computation using row data (2025)

4.2. Correlation analysis

Table 3 below indicates that economic growth (real GDP) in Ethiopia has strong positive association with all the study variables, except the ratio of exports and money supply to GDP. It is an obvious impact that increase in real GDP is expected to enhance human capital through its effect on investment in education and the saving habits of the population. Similarly, human capital is correlated positively and robustly with all variables, except money supply. More importantly, the significant positive association of domestic saving with human capital reveal that not only people with higher human capital are well paid people from their employment, which intern promote their savings but also people with higher savings are likely to invest in their human capital. Similarly, its positive and significant correlation with exports of goods and service is also in line literature.

Table 3. Pairwise Correlation among RGDP, Domestic saving and control variables

Variable	lnRGDP	lnHUCA	lnGDSG	lnEXPG	lnMSPG	ALDR	INFC	ECOR
lnRGDP	1.0000							
lnHUCA	0.9346*	1.0000						
lnGDSG	0.8592*	0.5528*	1.0000					
lnEXPG	0.2367	0.3733*	0.5604*	1.0000				
lnMSPG	0.1341	0.1236	0.3472*	0.2683	1.0000			
lnALDR	0.6623*	0.5565*	0.6045*	0.4022*	0.3619*	1.0000		
INFC	0.4767*	0.5387*	0.2825	-0.0375	-0.0573	0.2338	1.0000	
ECOR	0.5829*	0.5540*	0.6307*	0.6077*	0.5373*	0.6403*	0.1673	1.0000

Source: Own Compilation from data used in this thesis using Eviews 12 (2025)
*Note: values in Table 2 are rounded to 4 decimal places. * refers significance at 5%*

Nevertheless, money supply has significant positive correlation with domestic saving, average lending interest rate, and economic reform dummies. In addition to its moderate positive association with money supply, the correlation between money supply and inflation as well as annual average lending interest and inflation were insignificant. These associations inform at least two important issues about the monetary policy stance in Ethiopia over the study period. First, the National Bank of Ethiopia relied on reserve money, prior to July 2024 under monetary targeting policy, which is based on the quantity theory of money, which postulates that it is possible to control inflation through managing money supply growth, assuming that demand for money has a stable relationship with aggregate output and prices. Second, despite raising public debt positive change in lending rate was not the cause for the rise in inflation. In general, all the correlation coefficients are below 0.7, suggesting that there is no multicollinearity problem among the independent variables.

4.3. Results of Unit-root tests and discussion

Before conducting ARDL long and short-run estimation, the time series characteristics of the variables was estimated using Augmented Dickey-Fuller (ADF) test and Phillips Perron (PP) test. The ADF test results in Table 4 indicate that all the variables, except inflation rate and average lending interest rate, are integrated of order one or are I(1). That is, inflation rate and average lending interest rate are stationary in their level but the other variables become stationary in their first difference. The PP test results are also similar to ADF, except average lending rate, which becomes I(1). Thus, since the order of integration of the study variables is mixed; i.e., they are a mix of I (0) and I (1) but none of them are I(2) variable, the application of ARDL approach in this study is appropriate. The similarity of ADF and PP unit-root test results further confirm absence of structural break in the variable over the study period. Moreover, the ADF and PP test results indicate that there is no difference in stationarity when estimated including only a constant term and both the constant and time trend. The implication is that including time trend does not improve the stochastic nature of the variables. Hence, the long-run ARDL model is estimated by including only unrestricted constant.

Table 4. Unit-root test results

Variables	ADF Adj. t-statistics			PP Adj. t-statistics			Stationarity
	With Constant only	With Constant & trend	Without Constant & trend	With Constant only	With Constant & trend	Without Constant & trend	
lnRGDP	1.1580	-1.8918	3.9032	1.6286	-1.7886	4.3513	I(1)
D(lnRGDP)	-7.4381***	-8.0582***	-1.9183*	-7.4554***	-8.3784***	-5.7931***	
lnHUCA	-0.6719	-2.0536	1.6761	-0.5992	-1.1604	1.9424	I(1)
D(lnHUCA)	-5.9040***	-5.8327***	-5.6038***	-5.8956***	-5.8135***	-5.5635***	
lnGDSG	-1.7419	3.3674	0.2393	-1.5508	-2.3516	0.7218	I(1)
D(lnGDSG)	-8.5601***	-6.0322***	-8.5080***	-10.0491***	-10.4665***	-8.8963***	
lnEXPG	-1.4511	-1.1543	-0.2874	-1.5746	-1.3229	-0.2964	I(1)
D(lnEXPG)	-5.2607***	-5.2995***	-5.3878***	-5.1674***	-5.1789***	-5.2457**	
lnMSPG	-2.6399*	-3.0636	0.2699	-2.6798*	-2.0636	0.2477	I(1)
D(lnMSPG)	-5.5354***	-5.8625***	-5.6002***	-5.5354***	-5.8561***	-5.6002***	
LnALDR	-3.2314**	-3.8388**	0.7629	-2.2450	-2.8781	0.7267	I(0)
D(lnALDR)	-6.3934***	-6.4488***	-6.2640***	-6.4076***	-6.4546***	-6.2933***	
INFC	-4.0112***	-4.8695***	-0.2991	-4.0175***	-4.8654***	-2.2968**	I(0)

D(INFC)	-8.7385***	-8.6788***	-8.7486***	-11.3670***	-12.0715***	-11.2800***	
ECOR	-1.7182	-1.5979	0.0000	-1.7162	-1.5979	0.0000	I(1)
D(ECOR)	-6.4031***	-6.4637***	-6.3246***	-6.4031***	-6.4760***	-6.3246***	

Source: Own computation by E-views 12 (2025)

Note: ***, ** and * show the significance at p<0.01, p<0.05, and p<0.1, respectively

D in front of the variables indicate the variables are in their first difference

Next to checking the stationarity of the variables, the conventional ARDL model (equation 4) was regressed imposing 2 lags on each variable and performed immediately the bound cointegration test. Accordingly, the optimal lags for the ARDL-ECM were found to be (2, 1, 1, 1, 1, 1, 2, 2). Furthermore, as can be seen from Table 5, the estimated F-statistics is 5.166626, which exceeds the upper and lower bounds critical values of 2.96 and 4.26 at 1% significance level for I(0) and I(1). Therefore, the null hypothesis of no cointegrating relationship is rejected, suggesting real GDP has long run relationship with domestic saving, human capital, exports, money supply, lending interest rate, inflation, and economic reform variables.

Table 5. Results of ARDL Bound cointegration Test

F-Bounds test		**Null Hypothesis: No level relationship**		
Test statistics	Value	Significance level	I(0)	I(1)
F-statistics	5.166626			
K	7	10%	2.03	3.13
		5%	2.32	3.5
		2.5%	2.6	3.84
		1%	2.96	4.26

Source: Own computation by Eviews 12 (2025)

4.4.Long and short run Estimation Results and Discussions

The study results in Table 6 show that human capital, export of goods and services, and average lending rate enhance economic growth significant at least at 5% in the long run, while money supply ay 10%. Whereas, gross domestic savings, inflation rate, and economic reform failed to affect growth in the long-run. Human capital, measured by gross secondary school enrollment enhance economic growth significantly in the long-run in line with the theoretical and empirical expectation. The coefficient of human capital show that a 1% increase in human capital will increase real GDP of Ethiopia by about 1.77%. This result supports the findings of Ridho and Razzaq (2018) for Islamic and non-Islamic countries. The result implies that secondary education is an input of growth because it affects productivity in terms of knowledge and learning ability.

The other variable which is entered on the long run growth equation was gross domestic saving, the main policy variable of the study. Though positive, gross domestic saving has failed to influence economic growth significantly in the long run. This finding is consistent with the findings of Karahan (2018), Yadav et al., (2018), and Verman (2007), who found that domestic savings is not an engine of economic growth, a finding that also violates the theoretical prediction of Solow and Keynesian prediction that increase in savings is instrumental to economic growth.

Another growth enhancing variable is the ratio of export of goods and service to GDP. The result shows that increase in exports by 1% boosts economic growth of Ethiopia by about 0.58%, other variables remain constant. This result supports the findings of Lwin (2017) for Myanmar; and Mishra (2011) for India, all of which confirm the export-led growth hypothesis. Moreover, money supply is also among important variables, which enhance economic growth of Ethiopia significantly. The long-run result show that an increase in money supply by 1% pushes long-run economic growth by about 0.78%, ceteris paribus. This result contradicts the findings of Abass (2022) who found that increase in money supply promote economic growth only in the short-term but supports that of Adaramola and Dada (2020) and Awuti's (2017) findings. The implication is that increment in the money supply did not worsen long-run inflationary trend to the extent of reducing aggregate remand and economic growth in Ethiopia.

Table 6. Long-run ARDL Model Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
lnHUCA	1.7696	0.3234	5.4717	0.0000***
lnGDSG	0.0941	0.2426	0.3879	0.7017
lnEXPG	0.5826	0.1790	3.2548	0.0035**
lnMSPG	0.7839	0.4380	1.7894	0.0867*
lnALDR	0.8183	0.3726	2.1960	0.0384**
INFC	-0.0044	0.0083	-0.5221	0.6066
ECOR	0.1270	0.3474	0.3657	0.7179
C	2.0852	2.2353	0.9329	0.3606

Source: Own computation by Eviews 12 (2025). Values in this table are rounded into 4 decimal place
Note: ***, ** and * show the significance at $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively

The long-run results in Table 6 also revealed that annual average lending interest rate was also growth enhancing. That is, other things constant, a 1% increase in lending interest rate increase the long-run economic growth of Ethiopia by about 0.82%. The implication is that, despite increased public debt, positive change in annual average lending interest rate was not the reason for increase in inflation, increase the cost of borrowing, discourage local investment, weaken total factor productivity, and economic growth a findings consistent with Inedu (2020) and Adaramola and Dada (2020). Though inflation and economic reform failed to affect economic growth, their sign are consistent with empirical literature. These results are not surprising in a sense rising inflation is a recent phenomenon to affect economic growth adversely. Yet, economic reforms implemented since 1992 were not instrumental in enhancing real GDP of Ethiopia significantly, mainly due to policy failure to enhance private sector investment.

In the short-run, the coefficient of lagged RGDP is positively and significantly at 1% significant level. That is, a 1% increase in last year real GDP enhance the current year economic growth by about 0.44%, other things constant. The implication is that, current economic growth is a function of previous year growth. Similar to the long-run, human capital also affect economic growth positively and significantly at 5% significance level in the short-run. Other things remain unchanged, a 1% increase in human capital improves growth of real GDP by 0.17%. This means that improvement in gross enrollment to secondary school and economic growth change in the same direction. Nevertheless, unlike the long run model, domestic saving exerted positive and statistically significant impact on short-run economic growth. Other things remain

constant, a 1% increase in domestic saving enhance economic growth of Ethiopia by about 0.1%, mainly raising the amount of loanable fund in commercial banks in the short run. This implies that, compared to long run, the impact of national saving on economic growth is stronger in the short run, a findings consistent with Ribaj and Mexhuani (2021), Soylu (2019), and Nguyen and Nguyen (2017) findings.

Similar to the long run, export is found to be among the variable that boost RGDP robustly in the short run. Other things remain fixed, a 1% increase in export leads to about 0.13% increase in real GDP. This finding also support that despite dominated by primary agricultural products, the composition of exports of goods and services are also growth enhancing, supporting export-led growth hypothesis in the short-term. Unlike the long-run, however, money supply failed to enhance economic growth significantly in the short run. The result is against the findings of Abass (2022), Adaramola and Dada (2020) and Awuti's (2017) who found that increase in money supply promote economic growth in the short-term. The implication despite short-run price rigidity, increase in money supply could not reduce lending interest rate to boost aggregate demand and economic growth as argued by Abass (2022) because interest rate is determined by the National bank of Ethiopia, than market forces.

Table 7. Results of Short-run dynamics (2, 1, 1, 1, 1, 1, 2, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRGDP(-1))	0.4417	0.1012	4.3669	0.0002***
D(LNHUCA)	0.1686	0.0791	2.1312	0.0439**
D(LNGDSG)	0.0973	0.0431	2.2564	0.0339**
D(LNEXPG)	0.1252	0.0568	2.2055	0.0377**
D(LNMSPG)	-0.0113	0.1049	-0.1076	0.9152
D(LNALDR)	0.2650	0.0971	2.7280	0.0120**
D(INFC)	-0.0036	0.0009	-4.0062	0.0006***
D(INFC(-1))	-0.0066	0.0010	-6.7254	0.0000***
D(ECOR)	0.1808	0.0641	2.8193	0.0097***
D(ECOR(-1))	0.3772	0.0811	4.6517	0.0001***
ECT(-1)	-0.2149	0.0647	-3.3236	0.0030***
R-squared	0.9596	Mean dependent var		0.1499
Adjusted R-squ.	0.9321	S.D. dependent var		0.1014
S.E. of regression	0.0456	Akaike info criterion		-3.0385
Sum squ. resid	0.0478	Schwarz criterion		-2.2862

Log likelihood	80.2892	Hannan-Quinn criter.	-2.7645
F-statistic	703.0103	Durbin-Watson stat	2.1717
Prob(F-statistic)	0.0000		

Source: Own computation by E-views 12 (2025)

Note: ***, ** and * show the significance at $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively

D in front of the variables indicate the variables are in their first difference

In the short run, increase in average lending interest rate has also positive and significant impact on economic growth. Other things remain constant, a 1% increase in domestic saving enhance economic growth of Ethiopia by about 0.27% in the short run. The implication is that the non-market based interest rate determination by the National Bank of Ethiopia over the study period didn't deter capital inflow and increase in the amount of loanable fund with domestic financial institutions, which in turn increase investment, total factor productivity, and consequently economic growth.

The coefficient of this and last year change in inflation rate exert significant negative and statistically significant impact on short-run economic growth in Ethiopia. That is, higher rate of inflation reduces output growth for it causes increased macroeconomic uncertainty, which in turn create macroeconomic uncertainty, reduce consumption and investment, and affects economic growth adversely. This finding is in line with findings of Abass (2022), Adaramola and Dada (2020), and Riyath (2018). As expected, economic reforms perused since 1992 also affect short-run economic growth positively in Ethiopia. That is, other things remain constant, additional economic reform in this and the previous year enhances the growth of real gross domestic product significantly in the short-run by about 0.18% and 0.38%, respectively. This result implies that economic reforms are designed and implemented in Ethiopia, either advised by or as a conditionality to obtain loan from multinational cooperation, attempt mainly to address pressing short-term challenges and shocks rather than laying the foundation for sustained long-run economic growth.

The coefficient of lagged Error Correction Term (ECT) is negative and statistically significant as expected, confirming the Bound cointegration test that indicate presence of long-run relationship among the study variables. The size of the error correction term is about -0.215, suggesting that about 21.5% of the deviation from the long run equilibrium is corrected in the current year and complete adjustment takes about 4 years and 8 months (1/0.215=4.651). Furthermore, the value adjusted R-square, in the lower panel of Table 4 is 0.9321, suggesting the seven explanatory variables included in the ARDL models explain about 93% of total variations in economic growth, measured by real GDP. The p-value of F-statistics also shows the joint significance of the explanatory variables in affecting economic growth in the short-run. Moreover, the value of Durbin Watson, which is about 2.17, indicates that the ARDL-ECM is free from autocorrelation problem.

4.5. Diagnostic and stability tests

The p-values of post estimation diagnostic tests, shown in Table 8, are all insignificant revealing that all the null hypotheses are accepted (see Table 8). This is, so because the estimated model has residuals that are free from autocorrelation problem, have homoscedastic/constant variance, and are normally distributed. The Ramsey RESET Test statistic also indicates that the model does not have omitted variable and hence, it is correctly specified.

Table 8. Summary of Diagnostic tests result

Tests	Null hypothesis	F-stat [DF]	Prob.	Decision
Breusch-Godfrey Serial correlation	No serial correlation	0.8831 [F(2,21)]	0.4283	Accept H_0
Breusch-Pagan-Godfrey Heteroskedasticity	No Heteroskedasticity	0.4382 [F(17,23)	0.9573	Accept H_0
ARCH Heteroskedasticity	No Heteroskedasticity	0.3959 [F(2,36)]	0.6760	Accept H_0
Jarque Bera Test of Normality	Residuals are normally distributed	1.3829	0.5008	Accept H_0
Ramsey RESET Test	No specification error	0.0037 [F(1, 22)]	0.9518	Accept H_0

Source: Own computation from Eviews 12 (2025)

The parameter stability tests conducted using CUSUM) and CUSUMSQ tests and shown in Appendix 1, indicate that the blue trend line lies between the red lines. Hence, the parameters are stable at five percent critical bound and hence, the results can be used in Ethiopia for economic analysis, policy formulation, and recommendation.

5. Conclusions and Policy Implications

This study attempted to examine the impact of domestic saving on economic growth in Ethiopia using time series data from 1981 to 2023. In order to achieve the objective of the study two important techniques were used; those are ARDL approach. For analysis of long run and short run relationship among variables, ARDL bound cointegration test and error correction term (ECT) econometric approaches were used. The mixed order of integration of the variables support the appropriateness of the ARDL approach and bound test result demonstrate the existence of long run relationship among the study variables.

The findings of the study reveal human capital, exports, money supply, and annual average lending were instrumental in enhancing long-run economic growth of Ethiopia robustly. In the short-run, however, domestic saving has a pivotal role in lifting up economic growth in Ethiopia. Moreover, human capital, exports of goods and services, average lending interest rate, and economic reforms also promote real GDP growth significantly in the short-run. Whereas, inflation rate was significant growth retarding only the short run because rising inflation was a recent phenomenon, after 2007 global financial crisis. Therefore, it can be conclude that human capital development, exports, and average lending rate were the three drivers of economic growth in Ethiopia both in the long- and short-run. The lagged error correction term is negative and statistically significant as expected, confirming presence of long-run relationship among the study variables supporting the Bound cointegration test. The rejection of all the null hypotheses for post estimation diagnostic tests indicate that the estimated parameters are BLUE (Best, linear, and unbiased estimates). Similarly, the parameters are stable overtime, confirming the results can be used for economic analysis, policy formulation, and recommendation.

Therefore, the government should design and implement policies amenable to raise both private and public savings in a sustainable manner and divert the savings in to productive investment;

enhance human capital by investing in secondary school educational facilities and resources so as to achieve sizeable returns from quality human capital; diversifying exports, and inflation targeting policy to curb the rising money supply, inflation, and stabilizing lending inflation rate in the near future to expedite economic growth in Ethiopia. The author also acknowledge the limitations of this manuscript. Thus, future researches on the saving-economic growth nexus are advised to focus on investigating the transmission mechanism how domestic saving affects growth through its impact on domestic investment, identifying the thresholds beyond which level inflation rate affect economic growth, and investigate causal relationships, which this manuscript did not consider.

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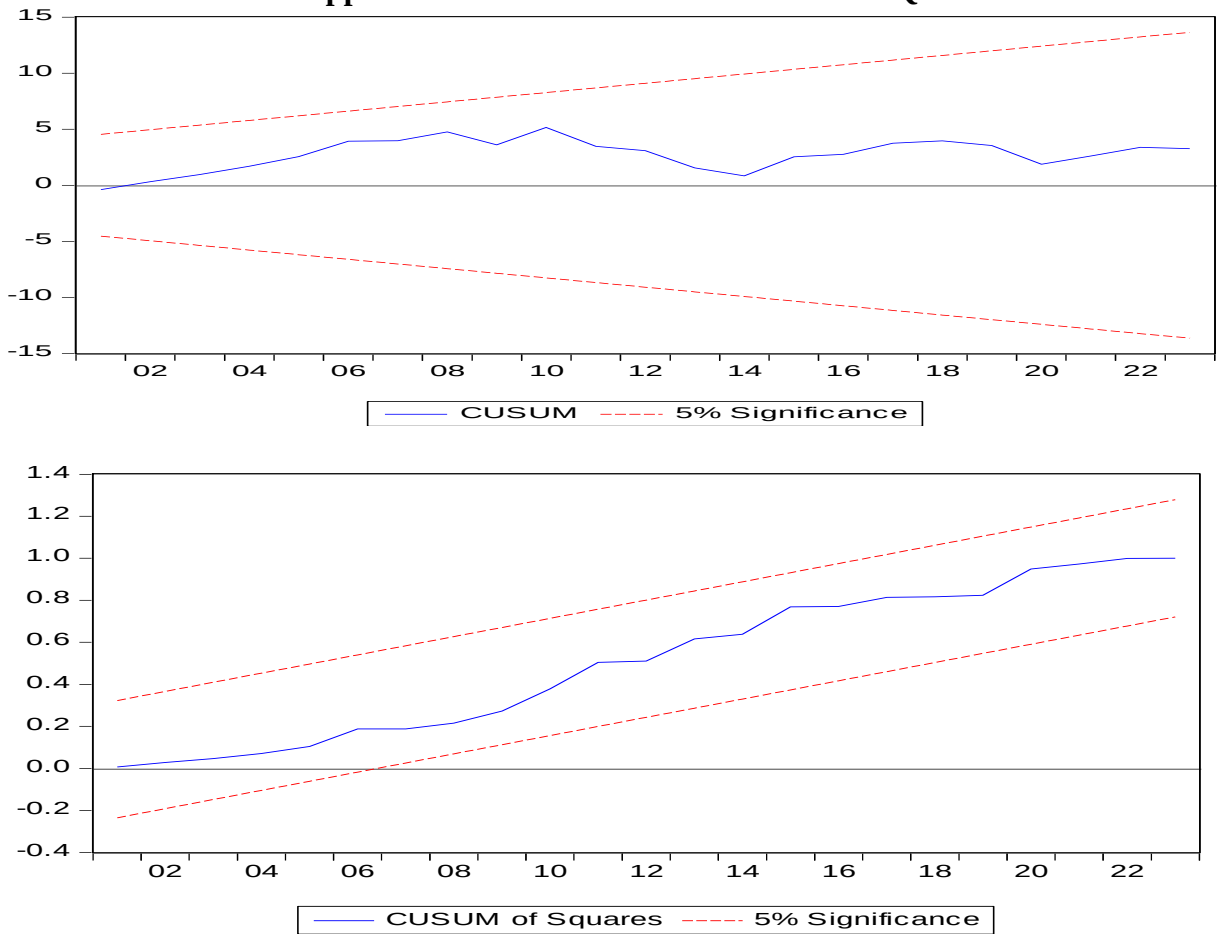
Appendix 1. Plot of CUSUM and CUSUMSQ



Source: Author's computation using Eviews 12 result (2025)