The Effect of Sectoral Output Volatility on Economic Growth in Ethiopia

Adisu Abebaw Degu

Department of Economics, College of Business and Economics, Salale University, Fiche, Oromia Region, Ethiopia

A R T I C L E I N F O

Article history:
Received : 30 July 2021
Revised : 13 October 2021
Accepted : 14 October 2021

JEL Classification:
F43, L60, O47

Key words:
Volatility, EGARCH, ARDL, Sectors output, Economic growth

DOI:
10.14414/jebav.v24i2.2765

A B S T R A C T

This study examined the effect of sectoral output volatility on economic growth and the determinants of economic growth in the Ethiopian economy. The study used annual time series data spanning from 1981 to 2018 and included capital stock, working-age population, trade balance, and sectoral output volatility as an explanatory variable. Using the Exponential General Autoregressive Conditional Heteroscedasticity (EGARCH) and Autoregressive Distributed Lag (ARDL) cointegration test, the study found a long-run relationship between economic growth and explanatory variables. From the ARDL model, capital stock and trade balance (which has been negative throughout the study period) was found to have a positive and negative significant effect on the economic growth of Ethiopia, respectively. In the long-run, volatility of industrial and service sector output growth had a negative and statistically significant effect on the economic growth of Ethiopia. In recent years the role of agriculture in the Ethiopian economy, particularly in terms of contribution to the national GDP, has been declining—indicating the growing importance of service and industrial sectors. Therefore, smoothening and maintaining the positive sectoral output growth is advisable for the betterment of the economy. Besides, balancing the foreign trade and curbing unrestricted importation is recommended as long as economic growth is concerned.

A B S T R A K

Penelitian ini menguji pengaruh volatilitas output sektoral terhadap pertumbuhan ekonomi dan determinan pertumbuhan ekonomi dalam perekonomian Ethiopia. Studi ini menggunakan data deret waktu tahunan dari 1981 hingga 2018 dan memasukkan stok modal, penduduk usia kerja, neraca perdagangan, dan volatilitas output sektoral sebagai variabel penjelas. Dengan menggunakan uji kointegrasi Exponential General Autoregressive Conditional Heteroscedasticity (EGARCH) dan Autoregressive Distributed Lag (ARDL), penelitian ini menemukan hubungan jangka panjang antara variabel penjelas pertumbuhan ekonomi dan pertumbuhan ekonomi. Dari model ARDL, stok modal dan neraca perdagangan (yang negatif selama periode penelitian) masing-masing memiliki pengaruh signifikan positif dan negatif terhadap pertumbuhan ekonomi Ethiopia. Dalam jangka panjang, volatilitas pertumbuhan output sektor industri dan jasa memiliki pengaruh negatif dan signifikan terhadap pertumbuhan ekonomi Ethiopia. Dalam beberapa tahun terakhir, peran pertanian dalam perekonomian Etiopia, khususnya dalam hal kontribusi terhadap PDB nasional, telah menurun. Hal ini menunjukkan semakin pentingnya sektor jasa dan industri. Oleh karena itu, mempermudah dan mempertahankan pertumbuhan output sektoral yang positif sangat disarankan untuk perbaikan perekonomian. Selain itu, menyeimbangkan perdagangan luar negeri dan membatasi impor sangat disarankan untuk menjaga pertumbuhan ekonomi.

1. INTRODUCTION

There are several studies conducted on the issue of economic growth. However, as important as economic growth is its volatility (Meller, 2013), particularly much attention has been directed to the issue of the relationship between volatility and economic growth (Lin & Kim, 2013). Output volatility affects aggregate economic growth, the stock market, and economic forecasting (Abubaker, 2015). In the realm of mainstream economics, the

** Corresponding author, email address: adisu278@gmail.com*

question of how volatility affects economic growth is relatively new (Dabušinskas et al., 2013). Output volatility gained center stage among economists and policy-makers (Lamaa et al., 2015).

According to Fang & Miller (2008), different models show a negative, positive, or independent relationship between the output growth rate and its volatility. Nevertheless, it is well known that output volatility affects economic growth through two available channels. On the one hand, high volatility indicates more income risk, which ultimately raises precautionary savings; this, in turn, boosts investment and hence economic growth (Kehinde & Agnes, 2017). On the other hand, high volatility causes investment risk, discouraging investment in the economy and slowing down economic growth. Output volatility generates risk about future investment, leading to a negative connection between output volatility and economic growth (Fang & Miller, 2008). Some studies based on endogenous growth theories framework have also postulated different forms of empirical relationships between volatility and long-run economic growth (Onyimadu, 2016).

The economic discourse on the consequences of output volatility for an economy is multifaceted and, so far, it has rendered mixed results (Jungeilges & Ryazanova, 2018). Many researchers are concerned about high output volatility, for it is closely associated with other negative aspects of the economic problem (Perry, 2019). For instance, output volatility can adversely affect economic growth, poverty, and welfare, among others (Bugamelli & Paternò, 2017). Ramey & Ramey (1915) concluded a negative correlation between macroeconomic volatility and long-run economic growth. Conventionally, business cycle and economic growth models have been treated as separate policies. Economic fluctuations are short-run and economic growths are long-run phenomena, and they are determined independently in different time horizons (Lin & Kim, 2013). For example, in the Solow growth model and the IS-LM framework, it was believed that the two phenomena had different causes and that, consequently, long-term economic growth was independent of cyclical factors (Dabušinskas et al., 2013). In the AK framework, however, the effect of volatility on economic growth is ambiguous as it depends on two offsetting effects.

On the one hand, higher volatility leads to higher precautionary savings, resulting in higher investment and faster economic growth. On the other hand, higher volatility reduces risk-adjusted incomes, which lowers investment and growth. The net effect depends on the elasticity of inter-temporal substitution, which is usually equal to the coefficient of relative risk aversion, particularly on whether it is bigger or smaller than unity (Dabušinskas et al., 2013).

Macroeconomic volatility varies significantly across nations (Tang & Leung, 2016). Much effort has been devoted to studying the reasons behind and its subsequent effect on long-term economic growth and whether there are possibilities for policies to improve the situation. On the other hand, Sectoral volatility is the primary source of aggregate GDP fluctuations for most economies and, therefore, understanding why some sectors have higher output volatility is essential (Olabisi, 2020). Unfortunately, vast of the previous studies, such as Abubaker (2015); Iseringhausen & Vierke (2019); Ćorić (2019); Meller (2013); Dabušinskas et al. (2013); Onyimadu (2016); Laurenceson & Rodgers (2020)) concentrated on aggregate output volatility issues. Therefore, this study examines how sectoral output volatilities affect the economic growth of Ethiopia.

The Ethiopian economy, disaggregated into the agricultural, industrial, and service sectors, has been growing annually at 10 percent in the past two decades. The Agricultural sector, which is the backbone of most Ethiopians, with an estimated more than 70 percent of the labor force engaged in this sector, is vulnerable to frequent drought and output shortfall (Dechassa & Tolosa, 2015). The service sector is becoming the prominent figure of the Ethiopian economy, particularly in its contribution to the national output. The industrial sector, on the other hand, fueled by policy ineffectiveness (Degu, 2019), has been experienced negligible contribution to the economy. This shift of sectoral contribution from agricultural to non-agricultural sectors to economic growth is due to the underlying structural transformation in the economy. Due to its volatility in growth rate, however, the Ethiopian economy is considered one of its stylized facts. However, whether this volatility would have a negative, positive or neutral effect on GDP is doubtful. To the extent that most of the recent volatility in the growth rate of GDP can be attributed to the increasing share of the volatility of some prominent sectors (such as the service sector), analysis of sectoral output volatility effects can help provide some enlightenment on the factors behind this phenomenon and its implications for policy formulation. Hence, the study's objectives are to assess the sectoral output volatility in Ethiopia over the study period and examine the effects of sectoral output volatility on economic growth. However, to the best of our knowledge, there is no previous study on similar issues in the case of Ethiopia**.** The rest of this paper is organized as follows; Section two; Theoretical framework and Hypothesis, Section three: Data and Method, Section four;data analysis and Discussion, and Section five; Conclusion, Implication, Suggestion, and Limitations.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

The causes of high volatility and economic crises in developing countries can be primarily associated with higher exposure to exogenous shocks and augmenting factors, faulty policies, and structural problems. The exposure to exogenous shocks includes both exposure to real external shocks (such as terms of trade) and external financial shocks (Perry, 2019). Output volatility, in turn, affects economic growth through two major networks. Firstly, high volatility implies more risk in income, raising savings, and encouraging investment and economic growth (Kehinde & Agnes, 2017). Secondly, high volatility means more investment risk, which depresses investment in the economy and slows down economic growth. This ultimately establishes a negative relationship between output growth and its volatility (Fang & Miller, 2018).

Numerous empirical studies are conducted on the link between output volatility and economic growth. Abubaker (2015) investigated the impact of trade openness on output volatility. Using a panel dataset for 33 countries from 1980 to 2009 and standard deviation of quarterly real GDP over five years as the dependent variable, the study revealed that trade openness increases output volatility. Moreover, the study revealed that trade openness has less effect on output volatility of more developed countries. Dabušinskas et al. (2013) investigated the impact of macroeconomic volatility on growth in a panel of 121 countries over the period 1980 to 2010. Their study showed that macroeconomic volatility is negatively related to economic growth using a different empirical methodology. Meller (2013) studied the relationship between international financial markets integration and output volatility. In the framework of a threshold model, it is empirically shown that financial openness decreases output volatility in countries with low financial risk.

In contrast, financial openness increases output volatility in countries with high financial risk. Onyimadu (2016) investigated the relationship between macroeconomic volatility and long-run economic growth in a panel of 40 African countries over the period 1980 – 2014. Their findings concluded a significant and positive correlation between volatility and economic growth regarding the sample data set used, which is against the negative relationship between volatility and economic growth postulated by Ramey & Ramey (1915). Laurenceson & Rodgers (2020) studied whether the growth volatility impacts China's trend rate of growth. Using a GARCH-M model, the analysis results confirm that volatility had either a positive or insignificant impact but was not harmful. Kehinde & Agnes (2017) investigated the impact of agriculture output volatility on economic growth in Nigeria. By using time series data ranging from 1970–2013, employed Generalized Autoregressive conditional Heteroscedasticity (GARCH) model to calculate the volatility of agriculture output and Eigenvalue test to capture the long term effects, the result revealed that agriculture output volatility has a negative and statistically insignificant impact on economic growth though. Iseringhausen & Vierke (2019) also studied the determinants of output volatility in a panel of 22 OECD countries. Using a Bayesian model selection to test for the presence of the non-stationary component, the results identified demographics and government size as essential determinants of macroeconomic volatility. Specifically, a larger share of prime-age workers is linked with lower output volatility, while higher public expenditure intensifies output volatility. Safdar et al. (2012) studied the agriculture sector volatility and its link with the economic growth in Pakistan. Using Auto-Regressive Conditional Heteroscadesticity (ARCH) models to detect volatility of agriculture sector and cointegration test, their study showed that agricultural productivity and employment are positively and significantly associated with economic growth. The study also suggested that agricultural volatility is negatively contributing to the economic growth of Pakistan. Ćorić (2019) investigated variations in output volatility in 38 OECD and non-OECD countries over the last two centuries. The study confirms significant structural changes in output volatility in all countries. A more than 70% of detected structural changes indicate a reduction in output volatility, suggesting that output volatility has been declining over the last two centuries. The results also show that the patterns of output volatility are different across countries.

Mekonnen & Dogreul, (2017) empirically assessed the impact of openness on growth volatility in 29 Sub-Saharan African countries. Using data from 1981 to 2010 and the system GMM method, they showed that trade and financial openness significantly reduce growth volatility in Sub-Saharan Africa. Furthermore, trade in manufacturing goods significantly reduces volatility compared to non-manufacturing goods. Notwithstanding the importance of studying output volatility, there is a lack of such studies in the Ethiopian context. The study of Onyimadu (2016) and Laurenceson & Rodgers (2020) indicates that output volatility significantly affects economic growth.

In contrast, the study of Kehinde & Agnes (2017) and Safdar et al. (2012) show that agricultural volatility negatively affects growth. The study by Dabušinskas et al. (2013) confirmed that macroeconomic volatility has a negative effect on economic growth. Moreover, from the above literature, it is identified that output volatility is affected by one of among financial openness, structural change, public expenditure, trade openness, share of prime-age workers, or a combination of them.

3. RESEARCH METHOD

Data type and source

This study relied on secondary annual time series data from 1981 to 2018 taken from the national bank of Ethiopia (NBE) and the World Development Indicators of the World Bank. This study used six variables: economic growth, capital stock, working-age population, trade balance, agricultural, industrial, and service sectors output volatility. Economic growth is measured as the natural logarithm of Gross Domestic Product (*ln*GDP) in 2010 constant price. However, there is no readymade capital stock data for Ethiopia. For this case, we generated capital stock data following Degu & Bekele (2019) using the perpetual inventory technique. The data for the trade balance, which has been negative throughout the study period, is defined as the natural log of net trade in goods and services derived by compensating imports of goods and services against exports of goods and services. Data are in current U.S. dollars. The working-age population is defined as the total population between the ages 15 to 64, and the value is converted into the natural logarithm. Finally, the sectoral output volatility data are generated using Exponential General Autoregressive Conditional Heteroscedasticity technique.

Exponential General Autoregressive Conditional Heteroscedasticity (EGARCH)

The standard measure of volatility, the standard deviation of output growth, for it captures high-frequency shocks, is not suitable for an economy whose growth is characterized by frequent incidents of accelerated growth and growth breaks (Tang & Leung, 2016), which is the characteristic feature for many developing countries like Ethiopia. Therefore, sectoral output volatilities for this study are to be generated from the Exponential Generalized Autoregressive Conditional Heteroskedastic (EGARCH) process, which is the extension of the General Autoregressive Conditional Heteroscedasticity model. The GARCH (General Autoregressive Conditional Heteroscedasticity) model does not capture the asymmetric nature or skewness caused by the inverse correlation between volatility and returns referred to as the leverage effect (Ezzat, 2012). The GARCH model also uses declining weights for the squared residuals that the model estimates. The conditional variance equation of the standard GARCH model has a form of:

$$(\delta_t)^2 = \theta + \sum_{j=1}^{a} \beta\delta_{t-1}^2 + \sum_{i=1}^{p} a\varepsilon_{t-1}^2 \qquad (1)$$

where θ, α, β are non-negative parameters with $\alpha + \beta<1$ but should be close to unity for an accurate model specification. The extension of the GARCH model is Exponential GARCH (EGARCH) to capture the "leverage effect ."This effect explains that an unexpected value drop increases volatility more than an analogous unexpected value increase. In this paper, we consider the simple Exponential GARCH (1, 1) (EGARCH) model, which is adequate for time series volatility modeling (Risteski et al., 2013). The specification for the conditional variance in the EGARCH (1, 1) model is given by:

$$ln(\delta_t)^2 = \theta + \beta ln\delta_{t-1}^2 + a\left|\frac{\varepsilon_{t-1}}{\delta_{t-1}}\right| + \gamma\left|\frac{\varepsilon_{t-1}}{\delta_{t-1}}\right| \qquad (2)$$

One significant advantage of the EGARCH process is that it captures the leverage effect of past shock on the conditional variance and ensures positive values for the conditional variance without preconditions for the signs on the volatility parameters (Scott, 2018). Besides, there are no restrictions on the parameters θ, α, and γ. However, to maintain stationarity, β needs to be positive but less than one. The leverage effect, indicated by the value of γ, must be negative and significant for the leverage effect to be present (Ezzat, 2012).

Once the sectoral output volatility is extracted, the next step is examining the possible empirical link between sectoral output volatility and economic growth in Ethiopia. The source of the econometric model of this study is extended from the neoclassical growth model. A neoclassical growth model depicts capital accumulation, labor, and technological progress as determining economic growth. Many factors are determining the economic growths of Ethiopia. These factors can be categorized as physical capital, demographic, and external trade factors. Understanding characteristics and determinants of economic growth require an empirical framework that can be applied to a relatively long time frame. This study considers some of these factors that have quantifiable, reliable, and appropriate data set (human capital and technological progress indicator data are known to be among the primary economic growth determinants. However, due to the lack of uninterrupted and continuous time-series data (for the period 1981 to 2018), we did not include these two variables in this study). In the following specifications, we included physical capital (capital formation), demographic factor (working-age population as a proxy for labor force), external trade activities (trade balance, which considers export and import trade), and sectoral output volatility that determine Economic growth in Ethiopia. Trade balance (which considers both the value of exports and imports) is more indicative of the country's foreign trade performance than that of trade openness. Most developing countries' economies (such as Ethiopia), whose foreign trade is characterized by an unfavorable trade balance, need to be examined using trade balance instead of trade openness. Trade openness indicates only the extent of foreign trade, whereas the trade balance shows (indirectly) how import and export trade affects the economy. The functional relationship between dependent and independent variables gives the following form:

$$Y=f(K,WAP,TB,V) \quad (3)$$

$$Y_t = K_t^{\beta_1} WAP_t^{\beta_2} TB_t^{\beta_3} Vi_t^{\beta_4} e^{ut} \quad (4)$$

From the above equations, Y_t, K_t, WAP_t, and TB_t represents GDP (the value of all goods and services produced by an economy based on 2011 base-year prices), capital stock, the working-age population (the number of the population between aged 15 and 64), trade balance (the value of export less import), respectively. Vi_t stands for sectoral output volatilities (agricultural, industrial, and service sectors output volatility) at time t. The relationship between economic growth and its determinants is non-linear. The first step in the time series analysis is testing the nonlinearity of series. The non-linear process is any stochastic process that is not linear. It displays features that cannot be modeled by the linear process. Hence, it is worth testing for nonlinearity before doing other time series exercises. This study tested all series for nonlinearity using BDS (derived from the originators; Brock, Dechert, Scheinkman, & LeBaron) technique. The BDS test is a portmanteau test for time-based dependence in a series. It can be used to test against various possible deviations from independence, including linear dependence, non-linear dependence, or chaos. Accordingly, all series under consideration are not linear—suggesting that the series need to be transformed into logarithmic form. So that the above equation (4) is transformed into logarithmic form as follows.

$$lnY_t = \beta_0 + \beta_1 lnK_t + \beta_2 lnWAP_t + \beta_3 lnTB_t + \beta_4 lnVi_t + u_t \quad (5)$$

Autoregressive Distributed Lag (ARDL) approach to Co-integration

Cointegration, defined as the long-term relationship between explained and an explanatory variable, is to be examined based on the Bound test to Co-integration. The bound test approach to cointegration is found from the ARDL framework. The ARDL technique is a linear model. Hence, all variables under consideration need to be transformed into a logarithmic form. The above equation (5) is estimated via the ARDL technique of estimation. ARDL models are suitable for small sample sizes, compared to the Johansen cointegration technique. Another advantage of the ARDL model is that it generates consistent estimates of long-run coefficients that are asymptotically normal, regardless of whether the variables are purely stationary at level, at the first difference, or a combination of them (Pesaran et al., 2001). Besides, one well-known advantage of working with ARDL specification, where all right-hand side variables enter the equation with a lag, is that it mitigates any contemporaneous causation from the dependent to the independent variables, which might bias the estimates (Bane, 2018). The ARDL model can be separated further as the long-run and short-run equations. Consider the following equations for which the ARDL model was constructed for economic growth as the dependent variable.

$$\Delta(lnGDP)t = \beta 0 + \sum_{j=1}^{p} \alpha j \Delta(lnGDPt - j) + \sum_{l=1}^{p} \alpha l \Delta\,(Xt - l) + \beta 1(lnGDPt - 1) + \beta 2(lnXt - i) + \ \varepsilon t \qquad (6)$$

where 'Δ' is the first difference operator, *ln* denotes logarithmic operator, *i* is the maximum lag number, *ln*GDP$_t$ is natural log Gross domestic product measured by 2010 constant price, of, X_t is a vector of independent variables, ε_t are error terms. α_i and β_i are the short-run and long-run coefficients of independent variables, respectively.

Pesaran et al. (2001) suggested ARDL bounds test for cointegration with two sets of asymptotic critical values to test the null hypothesis of no cointegration. The first set of critical values assumes that all variables in a study are stationary at level, I(0)—produces lower bound, whereas the second set of critical values is constructed based on the assumption that all variables are stationary after the first difference, I(1)—produces upper bound. If the test statistics are greater than the upper bounds of critical values, the null hypothesis of no cointegration is rejected. Similarly, the null hypothesis of no cointegration is accepted if the test statistics are below the lower bounds of critical values. However, if the test statistics are laid in between, the cointegration test becomes inconclusive. Since the ARDL procedure is sensitive for a given lag length, the number of appropriate lags is selected by Akaike Information Criteria (AIC). It is also worthwhile to examine the level of integration of variables using the Augmented Dickey-Fuller (ADF) unit root test before cointegration testing. Once cointegration is confirmed, a dynamic error correction model can be extracted from the ARDL model. If the error correction term (ECT) is negative and significant, it will confirm the long-run relationship between economic growth and explanatory variables in Ethiopia. The following equation (7) represents the short-run dynamics for *ln*GDP model.

$$\Delta\big(ln(GDP)\big)t = \ \beta 0 \ + \ \textstyle\sum_{j=1}^{p} \beta j \Delta\big(ln(GDPt - j)\big) + \sum_{l=1}^{p} \beta l \Delta(ln(Xt - l)) \ + \Upsilon ECTt - 1 \ + \ \mu t \qquad (7)$$

where β's are the coefficients associated with short-run dynamics of the model coverage to equilibrium, ECT_{t-1} is the error correction term, and μt is a stochastic error term.

4. DATA ANALYSIS AND DISCUSSION

Unit root test and breakpoint unit root tests

The first step in times series analysis is identifying the order of integration of variables under consideration. Thus we applied the augmented dickey fuller (ADF) unit root test and breakpoint unit root test to evaluate the order of integration of variables. Accordingly, the augmented dickey fuller (ADF) test, as indicated in Table 1, revealed that sectoral output volatilities are integrated of order zero I(0), and the rest of the other variables are integrated order one, I (0). Hence all variables under consideration are a mixture of I(0) and I(I).

Table 1. Augmented Dickey Fuller unit root tests

Variables	Level		First difference		Integration
	Stat.	Prob.	Stat.	Prob.	
*ln*GDP	-0.8951	0.9459	-6.2205	0.0001*	I(1)
*In*K	-1.0284	0.9271	-5.2443	0.0007*	I(1)
*ln*WAP	-1.8138	0.6736	-3.7901	0.0308**	I(1)
*ln*TB	-1.5665	0.7864	-10.8969	0.0000*	I(1)
VA	-3.8050	0.0275**	-7.5173	0.0000*	I(0)
VIN	-4.3419	0.0090*	-3.4414	0.0642***	I(0)
VSR	-3.9965	0.0175**	-6.9370	0.0000*	I(0)

*, ** and *** represents significance level at 1%, 5% and 10%, respectively.

However, as Perron (1989) points out, structural change and unit-roots are closely related, and the conventional unit root tests are biased toward a false unit root null when the data are trend stationery with a structural break. So, it is useful to check, the breakpoint unit root test assessed the stationary process in the time-series data. This test can be considered an extension of the ADF test, which takes account of structural breaks in the time-series data (Furuoka, 2018). Accordingly, Table 2 shows the breakpoint unit root test results, which suggest the occurrence of structural breaks in all variables in different periods.

Table 2. Breakpoint unit root test results

Variables	Level			First difference			Integration
	Stat.	Prob.	Breakpoint	Stat.	Prob.	Breakpoint	
*ln*GDP	-2.5561	0.9806	1990	-6.4879	< 0.0100*	1994	I(1)
*ln*K	-9.6596	< 0.0100*	2012	-6.8712	< 0.0100*	1988	I(0)
*ln*WAP	-0.9351	> 0.9900	2005	-4.6665	0.02720	2005	I(1)
*ln*TB	-4.2264	0.2439	2005	-11.7385	< 0.0100*	2000	I(1)
VA	-5.2253	0.0164	2004	-7.8066	< 0.0100*	2007	I(0)
VIN	-12.4169	< 0.0100*	1992	-9.9513	< 0.0100*	2000	I(0)
VSR	-9.6470	< 0.0100*	1992	10.5907	< 0.0100*	1992	I(0)

*, ** and *** represents significance level at 1%, 5% and 10%, respectively.

The test statistics indicated that the *p*-value for all differenced series is less than 0.05, leading us to reject the null hypothesis of a unit root. Based on these two results, standard time-series cointegration analysis methods, such as the Engle-Granger and Johansen cointegration tests, are not the proper methods to examine the cointegration of variables under consideration.

Cointegration Tests

Cointegration refers to a long-run stable relationship between series under consideration. There are different test methods for cointegration among the variables, such as the Johansen test approach and the two steps Engle and Granger cointegration test. However, estimation of variables with a combination of different level stationary under the Johansen procedure may lead to biased results. Another problem with the Johansen test approach techniques is that it is not efficient for relatively small samples. In this study, we used ARDL bound test approach to cointegration to examine the possible link between GDP, capital stock, working-age population, trade balance, and sectoral output volatility. For this purpose, we constructed three different models (A, B, and C) by including the same dependent variable (*ln*GDP) and independent variables, except sectoral output volatilities. Agricultural sector output volatility, industrial sector output volatility, and service sector output volatility are separately included as explanatory variables in the first, second, and third models.

As the ARDL models are lag sensitive, the appropriate lag length is chosen based on the Akaike information criterion (AIC). Accordingly, the ARDL (3, 1, 0, 1, 2), ARDL (3, 1, 1, 3, 2) and ARDL (3, 1, 3, 3, 3) is selected for respective three models. The results of the Bound test of the three models are reported in Table 3. Accordingly, the F-statistics of the first, the second, and the third models are 9.11799, 20.50453, and 13.38960, respectively, which is much higher than the above-bound limit value, even at a 1 % percent significance level. Therefore, we can conclude a long-run relationship between variables when economic growth is treated as an explained variable.

Table 3. ARDL bound test

Model		A		B		C	
F-statistic		9.1180		20.5045		13.3896	
Selected lag length		ARDL (3, 1, 0, 1, 2)		ARDL (3, 1, 1, 3, 2)		ARDL (3, 1, 3, 3, 3)	
Bounds		I(0) Bound	I(1) Bound	I(0) Bound	I(1) Bound	I(0) Bound	I(1) Bound
Significance	10.0%	2.20	3.09	2.20	3.09	2.20	3.09
level	5.0%	2.56	3.49	2.56	3.49	2.56	3.49
	2.5%	2.88	3.87	2.88	3.87	2.88	3.87
	1.0%	3.29	4.37	3.29	4.37	3.29	4.37
Null Hypothesis: No long-run relationships exist				Note: K is 4 for all models			

Long-run and Short-run Estimation results

The long-run estimation results for all three models are reported in Table 4 below. In the first model (column A), economic growth (GDP) regressed against the capital stock, working-age population, trade balance, and agricultural output volatility. Accordingly, economic growth in Ethiopia is affected by capital stock positively and significantly. Similarly, trade balance has a negative and statistically significant effect on the economic growth of Ethiopia in the long run. At the same time, the working-age population has a negative but insignificant effect. However, agricultural output volatility has an insignificant effect on Ethiopia's economic growth. In contrast, other previous studies, such as Kehinde & Agnes (2017) and Safdar et al. (2012), showed that agricultural volatility has a negative effect on growth.

Table 4. The long-run estimation results

Explanatory Variables	Long-run Models (*ln*GDP is the dependent variable)					
	A		B		C	
	Coefficient	P- value	Coefficient	P- value	Coefficient	P- value
*ln*K	0.5700	0.0001*	0.3100	0.0021*	0.3700	0.0121**
*ln*WAP	-0.3300	0.3202	0.1800	0.4168	0.0150	0.9602
*ln*TB	-0.1900	0.0024*	-0.2300	0.0000*	-0.2600	0.0001*
VA	2.8000	0.6328	--	--	--	--
VIN	--	--	-22.9000	0.0003*	--	--
VSR	--	--	--	--	-18.3600	0.0338**
C	8.7400	0.0039*	6.4780	0.0010*	6.9500	0.0061*

*, ** and *** represents significance level at 1%, 5% and 10%, respectively.

In the second model (column B), economic growth regressed alongside capital stock, working-age population, trade balance, and industrial output volatility. Once again, the capital stock has a positive and significant level on economic growth. On the other hand, trade balance has a negative and statistically significant effect on economic growth. Industrial output volatility negatively affects economic growth at a 1 percent significance level. This implies that economic growth is affected by the fluctuation of industrial sector performance, and this specific result is in parallel with the findings of Dabušinskas et al. (2013) and against the study of Onyimadu (2016) and Laurenceson & Rodgers (2020). In the third model (C), economic growth is regressed on capital stock, working-age population, trade balance, and service output volatility. Service sector output volatility is found to have a negative and significant effect on the economic growth of Ethiopia. In recent years the service sector has been expanding and dominating economic activities. The sector encompasses 40 percent of GDP and 20 percent of total employment as of 2019. Capital stock has a positive and significant effect on the economic growth of Ethiopia, as depicted in the three estimated long-run models. Capital stock, which is scarce for most developing countries, is more productive, and it backs much of an economy. This shows how the capital stock is contributing factor for the long run and sustained economic growth of the country. When capital stock grows by one percent, economic growth increases by about 0.57, 0.31, and 0.37 percent in the first, second, and third models. Trade balance (export value less import value) which is negative throughout the study year, on the other hand, has a negative and statistically significant effect on the Ethiopian economic growth in all three estimated models. A one percent increase in the trade balance leads the GDP to decrease by about 0.19, 0.23, and 0.26 percent in the first, second, and third models.

The significant and negative impact of the trade balance on economic growth can be liked by the nature of foreign trade. Almost all developing countries, including Ethiopia, have an unfavorable trade balance due to their structure of exports and imports. These countries export fewer commodities (usually unprocessed and raw materials, such as coffee, hides, skins, oilseeds, and pulses) and import a more substantial amount of manufactured and final products. The international market determines the price of primary products, which is price and income inelastic. This leads to an unfavorable trade balance that ultimately consumes the country's scarce foreign currency reserve. After a long-run relationship between the explanatory variables is established, the next step is to test the error correction model for all three models. The results are reported in Table 5. In the short run, the capital stock has a positive and significant effect on the economic growth of Ethiopia, as it is portrayed in all three models.

The results of the error correction terms (ECT) of the first, the second, and the third models are -0.50, -0.64, and -0.53, respectively, with a one percent significance level and expected negative sign, which confirms the existence of a long-run relationship between the economic growth and explanatory variables. Technically speaking, the estimated coefficients ECT (-0.50, -0.64, and -0.53) indicated that approximately 50%, 64%, and 53 % of the disequilibria from previous year shock converge back to the long-run equilibrium each period, in the first, second, and third models, respectively.

Table 5. Short Run estimation results

Explanatory variables	Short-run Models (Δ*ln*GDP is the dependent variable)					
	A		B		C	
	Coefficient	P- value	Coefficient	P- value	Coefficient	P- value
Δ(*ln*GDP(-1))	0.2258	(0.2941)	0.0898	(0.3653)	-0.072 0	(0.5707)
Δ(*ln*GDP(-2))	0.3355	(0.1238)	-0.3601	(0.0026)*	-0.3440	(0.0140)**
Δ(K)	0.9374	(0.0031)*	0.7530	(0.0010)*	0.8630	(0.0010)*
Δ(*ln*WAP)	-0.1668	(0.3421)	3.6530	(0.1992)	-0.1280	(0.9754)
Δ(*ln*WAP(-1))					-14.5110	(0.1294)
Δ(*ln*WAP(-2))					7.7316	(0.0883)***
Δ(*ln*TB)	-0.0228	(0.2861)	0.0110	(0.5324)	-0.0240	(0.2917)
Δ(*ln*TB(-1))			0.0400	(0.0705)***	0.0470	(0.0861)***
Δ(*ln*TB(-2))			0.0790	(0.0011)*	0.0400	(0.1446)
Δ(VA)	1.6574	(0.5530)				
Δ(VA(-1))	6.1384	(0.0161)**				
Δ(VIN)			-4.6940	(0.0310)**		
Δ(VIN(-1))			7.0080	(0.0021)*		
Δ(VSR)					-7.7290	(0.0219)**
Δ(VSR(-1))					6.0480	(0.0292)**
Δ(VSR(-2))					-3.4060	(0.1474)
ECT(-1)	-0.5023	(0.0000)*	-0.6383	(0.0000)*	-0.5350	(0.0000)*

*, ** and *** represents significance level at 1%, 5% and 10%, respectively.

Diagnostic tests

To scrutinize the reliability of the estimated ARDL long-run and short-run models, we performed different diagnostic tests such as; Jaque-Bera Normality test, Breusch-Godfrey LM serial correlation test, Breusch-Pagan-Godfrey Heteroskedasticity test, and Ramsey RESET test. The tests and their respective statistics results are summarized in Table 6. Accordingly, the residuals are normally distributed, there is no serial correlation, and the models have no specification problem. Therefore, the estimated coefficients are consistent and efficient—implying the basic classical assumptions are satisfied and the policy implications of the model are reliable.

Table 6. Diagnostic tests

Tests	A		B		C	
	F- Statistics	P-value	F-Statistics	P-value	F-Statistics	P-value
Jarque-Bera Normality test	2.0418	0.3602	1.1950	0.5502	0.6133	0.7359
Breusch-Godfrey LM serial correlation test	1.1197 (3,20)	0.3647	0.2706 (3,17)	0.8457	0.2252 (3,14)	0.8773
Breusch-Pagan-Godfrey Heteroskedasticity test	1.9097 (11,23)	0.0921***	1.5661 (14,20)	0.1751	1.2002 (17,17)	0.3555
Ramsey RESET test	0.3536 (1, 22)	0.5581	0.8965 (1,19)	0.3556	1.6440 (1, 16)	0.2180

Note: the degree of freedom (d.f) is in parenthesis
*, ** and *** represents significance level at 1%, 5% and 10% critical values, respectively.

5. CONCLUSION, IMPLICATION, SUGGESTION, AND LIMITATIONS

In this study, we established determinants of economic growth and the effect of sectoral output volatility on the economic growth of Ethiopia using the National Bank of Ethiopia (NBE) and the World Bank (WB) annual time series data ranging from 1981 to 2018. We included capital stock, working-age population, trade balance and, sectoral output volatility as an explanatory variable. Sectoral output volatility was computed using Exponential General Autoregressive Conditional Heteroscedasticity (EGARCH) technique. We estimated three different ARDL models to determine the cointegration and the long-run and short-run dynamic between variables. All three estimated models revealed the presence of a long-run relationship between economic growth and explanatory variables. From the long run ARDL model, we found that capital stock, trade balance, industrial and service sector output volatility had a significant effect on the economic growth of Ethiopia. Particularly, economic growth was positively and statistically significantly affected by capital stock—both in the long and short run. In the long run, trade balance (which has been negative throughout the study period) was found to have a negative and statistically significant effect on economic growth. In the long-run, volatility of industrial and service sector output growth was found to have a negative and statistically significant effect on the economic growth of Ethiopia. However, the study proved that the working age of the population had no statistically significant effect on the economic growth of Ethiopia. Thus, economic growth in Ethiopia is highly determined by the availability of capital investment, trade balance, and sectoral output fluctuations. The results of the error correction terms (ECT) of the first, the second, and the third models confirms the existence of a long-run relationship between the economic growth and explanatory variables. Technically speaking, the estimated coefficients ECT indicated that approximately 50 percent, 64 percent, and 53 percent of the disequilibria from the previous year's shock converge back to the long-run equilibrium each period, in the first, second, and third models, respectively.

As the economy exhibits structural transformation from the agricultural to modern sectors, the relative significance of sectors also changes. In recent years the role of agriculture in the Ethiopian economy, particularly in terms of contribution to the national GDP, has been declining—indicating the growing importance of service and industrial sectors. Therefore, smoothening and maintaining the positive sectoral output growth is advisable for the betterment of the economy. In addition, balancing the foreign trade, especially augmenting and diversifying the export structure and curbing of unrestricted importation of goods, is recommended as long as economic growth is concerned.

REFERENCES

Abubaker, R. (2015). The asymmetric impact of trade openness on output volatility. *Empirical Economics*, 49(3), 881-887.

Bane, J. (2018). Dynamics and determinants of inflation in Ethiopia. In *Economic Growth and Development in Ethiopia* (pp. 67-84). Springer, Singapore.

Bugamelli, M. & Paternò, F. (2017). Output growth volatility and remittances. *Economica*, 78(311), 480-500.

Ćorić, B. (2019). Variations in output volatility: Evidence from international historical data. *Economics Letters*, 178, 102-105.

Dabušinskas, A., Kulikov, D., & Randveer, M. (2013). The impact of volatility on economic growth. *Bank of Estonia Working Paper No. wp2012-7*.

Dechassa, C. & Tolosa, T. (2015). The contribution of agriculture to development: A critical review in Ethiopian context. *The international journal of social sciences*, 32(1), 54-66.

Degu, A. A. (2019). The nexus between population and economic growth in Ethiopia: An empirical inquiry. *International Journal of Business and Economic Sciences Applied Research (IJBESAR)*, 12(3), 43-50.

Degu, A. A. & Bekele, D. T. (2019). Macroeconomic determinants of total factor productivity and its trend in Ethiopia. *International Journal of Research in Business and Social Science*, 8(6), 219-228.

Ezzat, H. (2012). The application of GARCH and EGARCH in modeling the volatility of daily stock returns during massive shocks: The empirical case of Egypt. *International Research Journal of Finance and Economics*, 78(96), 143–154.

Fang, W. S. & Miller, S. M. (2018). The great moderation and the relationship between output growth and its volatility. *Southern Economic Journal*, 819-838.

Furuoka, F. (2018). Is population beneficial to economic growth? An empirical study of China. *Quality & Quantity*, 52(1), 209-225.

Iseringhausen, M. & Vierke, H. (2019). What drives output volatility? The role of demographics and government size revisited. *Oxford Bulletin of Economics and Statistics*, 81(4), 849-867.

Jungeilges, J. & Ryazanova, T. (2018). Output volatility and savings in a stochastic Goodwin economy. *Eurasian Economic Review*, 8(3), 355-380

Kehinde, O. H. & Agnes, O. (2017). Impact of agricultural output volatility on economic growth in Nigeria: EGARCH analysis. *Journal of Agriculture and Veterinary Science* (IOSR-JAVS), 10(1), 04-10.

Lama, A., Jha, G. K., Paul, R. K., & Gurung, B. (2015). Modelling and forecasting of price volatility: an application of GARCH and EGARCH models. *Agricultural Economics Research Review*, 28(1), 73-82.

Laurenceson, J. & Rodgers, D. (2020). The Impact of Volatility on Growth in China. *Frontiers of Economics in China, 5(4), 527-536*.

Lin, S. C. & Kim, D. H. (2014). The link between economic growth and growth volatility. *Empirical Economics*, 46(1), 43-63.

Mekonnen, J. L. & Dogreul, A. S. (2017). Growth volatility and openness in Sub-Saharan Africa. *Marmara Journal of Economics,* (2), 209-228.

Meller, B. (2013). The two-sided effect of financial globalization on output volatility. *Review of World Economics*, 149(3), 477-504.

Olabisi, M. (2020). Input–output linkages and sectoral volatility. *Economica*, 87(347), 713-746.

Onyimadu, C. (2016). *Macroeconomic volatility and economic growth: Evidence from selected African countries*. University Library of Munich, Germany.

Perron, P. (1989). The great crash, the oil price shock, and the unit root hypothesis. *Econometrica: Journal of the Econometric Society*, 1361-1401.

Perry, G. (2019). Causes and consequences of high volatility in developing countries. Chapter 1. *Beyond Lending: How Multilateral Banks can Help Developing Countries to Manage volatility*. Retrieved from www.cgdev.org.

Pesaran, M.H., Shih, Y., & Smith, R. (2001). Bounds testing approaches to the analysis of the level relationships. *Journal of Applied Econometrics*, 16, 289-326

Ramey, G. & V. Ramey. (1915). Cross-country evidence on the link between volatility and growth. *American Economic Review*, 85, 1138–1151.

Risteski, D., Sadoghi, A., & Davcev, D. (2013, November). Improving predicting power of EGARCH models for financial time series volatility by using google trend. In *Proceedings of 2013 International Conference on Frontiers of Energy, Environmental Materials and Civil Engineering. Shangai, China*.

Safdar, H., Maqsood, S., & Ullah, S. (2012). Impact of agriculture volatility on economic growth: A case study of Pakistan. *The Lahore Journal of Economics*, 1(2), 24-34.

Scott, A. O. (2018). Oil price volatility and business cycles in Nigeria. *Studies in Business and Economics*, 12(3), 31-40.

Tang, S. H. K. & Leung, C. K. Y. (2016). The deep historical roots of macroeconomic volatility. *Economic Record*, 92(299), 568-589.

APPENDICES

List of Variables and Data Sources: The dataset is taken from the national bank of Ethiopia (NBE) and the World Development Indicators of World Bank.

Variables	Data Sources
Economic growth (GDP)	World Bank, World Development Indicators (2020)
Capital stock	Author's extraction using National Bank of Ethiopia data (2020) & Perpetual inventory technique
Working age population	World Bank, World Development Indicators (2020)
Trade balance	World Bank, World Development Indicators (2020)
Agricultural sector output volatility	Author's extraction using the World Bank data (2020) & EGARCH approach
Industrial sector output volatility	Author's extraction using the World Bank data (2020) & EGARCH approach
Service sector output volatility	Author's extraction using the World Bank data (2020) & EGARCH approach