Determinants of Economic Growth in Ethiopia: An Application of Autoregressive Distributed Lag Model (ARDL)

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Abstract
Ethiopia has grown on average 10\% annually for more than a decade and the country is the fifth fastest growing economy among the 188 IMF member countries. As such, growth in one sector of the economy does not automatically transform into equal benefits for the population. This study specified an empirical investigation of the relationship between the economic growth of Ethiopia and its determinant as studies in this area are inadequate. Alongside this backdrop, the data span for the study was the annual data from 1974 to 2013, and employed the Autoregressive Distributed Lag (ARDL) Approach to Co-integration. Error Correction Model (ECM) was used in order to examine the long-run and short run relationship between the dependent variable (real GDP) and its determinant independent variables. The findings of the bounds test confirmed that there was the steady long run association between the real GDP, Physical capital, human capital, export, foreign aid, external debt and inflation. Moreover, the empirical results reveal that physical capital, human capital, export, foreign aid and inflation were found to have a positive impact on economic growth both in the long run and short run, whereas external debt affects economic growth negatively, but statistically significant both in the long run and short run. Conversely, the study reveals that total export of goods and service, foreign aid and inflation were statistically insignificant at 5\% level on the GDP growth of Ethiopia in the long run.

Keywords: Economic growth, Autoregressive Distributed Lag, Ethiopia

1. Introduction
Economic growth is one of the most vital goals of all countries in the world. It is an increasing in the amount of goods and services produced per head of the population over a period of time in the form of gross domestic product (GDP) (Khalid Y. and Kenji, 2016). According to Osipia, (2009), the economic growth is a quantifiable transformation that increases the total output of the nation in a given period of time. It is also the process that growths the welfare of the nation (Hatem et al., 2016). The World Bank stated that the GDP is one of the fundamental macroeconomic indicators to measure the economic growth as an increase of national wealth that conventionally measurable in percentage rise of the GDP. By convention economists usually use the GDP to measure the nations’ economic development (Hatem et al., 2016). For instance, if the country GDP is decreasing, the economy is suffering and hence the nation is slowdown an economic ground. Conversely, if the GDP is growing, the economy is healthy and the nation is moving onward. Economic growth is a process of chang the nations’ that brings economic, getting satisfaction and achieving better quality of life and social transformation (Esubalew A. Sahilea, 2015; Hatem et al., 2016) through an integration of physical capital, human capital, and technological innovations.

According to Muhdin M. Batu (2016), the economic growth moved with an improvement in the material well-being of the poor, a shift to a decline of agriculture’s share of national output to an increasing the output share of industry and service sectors, as well an increase in the education and skills of the labor force within the country. The economic prosperity will lead to the growth dividend shared in a fairer way that results improvement of the living standards, the quality of life, suitable
conditions of health care, enhancement of the educational system, clean environment, community support and reduce the gap between the rich and the poor people within the country (Haller, 2012; Ibukun C. Oluseye and Aremo A. Gabriel, 2017). Over the last 70 years, the issue of economic growth has attracted growing reflection in both empirical and theoretical studies. The long run economic growth is usually taken as the vital concern of economics discipline. The world economy grew 3.5 percent in 2017 to reach $77 trillion in current prices, and this economic growth is expected to accelerate to 3.6 percent in 2018. In developing countries, the projected rise of economic growth was 4.5 and 4.8 percent in 2017 and 2018, respectively (IMF, 2017). The economic growth of developed countries has been predicted to 1.9 and 2.0 percent, respectively, in 2017 and 2018(IMF, 2017).

Ethiopia is one of the least developed countries in Sub-Saharan Africa, with the population of about 102 million people in 2016 (UNDP, 2016). After suffering economic stagnation for most of the 1970s and 1980s, Ethiopia’s economy has begun to grow in early 2000s. During the last decade it has become one of the fastest and sustainable growing economies in the world with on average the GDP growth rate of about 10% per annum (Admasu S., 2017). Since 1991, the political and economic policy of Ethiopia has been changed fundamentally and introduced liberal economic policies to encourage private enterprise and to attract foreign direct investment. Accordingly, Ethiopia has been recording sustainable and strong economic growth for more than a decade. The growth was driven by a strong domestic demand investment of infrastructural development and economic liberalization. Furthermore, the tight macroeconomic policies contributed for structural changes from agricultural sector to manufacturing and service sectors, the share of the GDP shifted from low productive agricultural sector to high value-added manufacturing and service sectors (Khalid Y. and Kenji, 2016; IMF, 2011; MoFED, 2014). The government expenditure of the infrastructural and human capital development has been increasing intensely as well as emphasizing to introduce the economic policies to encourage private sectors expansion. These have been attracted many foreign investors’ attention, since the investment policy of Ethiopia has been changed the foreign firms considered the best destination for investment. Thus, Ethiopia registered remarkable double-digit economic growth for more than a decade and become one of the fastest growing economies in Sub-Saharan Africa countries (IMF, 2014; MoFED, 2014).

This study examined the most determinant factors that contributed to the current economic growth of Ethiopia. The GDP, hereafter, was used to indicate the economic growth. Several determinant factors affect the growth of the GDP of Ethiopia. In this paper, these factors (variables) were narrowed and classified as physical capital formation (gross investment), human capital (health and education), total export (goods and services), foreign aid, external debt and general inflation due to their highest importance over the period of 1974 to 2013 using the annual time series data.

A country economic growth and the major functions depend on its physical capital formation and human capital accumulation (Adeko1a, 2014). Several studies confirmed that the physical capital formation (gross investment) is the main source of accumulated gross fixed capital formation and it is vigorous driver for economic development (Beddies, 1999). Economic theory allocated that the macroeconomic benefits to the physical capital formation through which it impacts on the nation economy (Ghur1997; Biswas and Saha, 2014). Some of the advantages of the physical capital formation were concise as follows: increasing the production capacity, increasing domestic expenditure, enhancing labor productivity through the increasing of employment, provides production of innovation and high quality products, and connecting the technological gap with the most advanced countries which will increase the share of the country in the international market (Hatem et al., 2016; Balet et al., 2016).

Similarly, in the modern economics literatures, the human capital accumulation has been considered as one of the key determinants of all kinds of growth such as political, social, cultural, production, innovation and economic (Dinkneh B and Jiang Y., 2015). The educational system and health care are the two most important integrated human capital parts which moved together to make an individual more effective and efficiency on the production and innovation sector (Gebrehiwot K., 2016; Dinkneh G. and Jiang Y., 2015). It was belief that investment on the human capital to promote
the economic growth eventually has been started since 1776 during the time of Adam Smith (Adawo 2011; Adekola 2014). Thus, accumulation of the human capital includes investments on abilities of employees, technical skills, creative skills, knowledge, and enhancing innovation and improves the health of the society. Hence, financing additional resources to the human capital will bring positive and significant outcome on the production, which further progress on the economic growth by transforming resources to mankind’s use and value (Adelakun, 2011). In Ethiopia a few empirical studies have been conducted on the impact of human capital on the economic growth of the country (Gebrehiwot K., 2016). Some studies found the positive, significant and stable long term relationship of the human capital and economic growth (Gebrehiwot K., 2016; Dinkneh G. and Jiang Y., 2015; Girma, Z., Abdulwahab, S. & Gupta, K. 2013). Conversely, other studies reported the human capital doesn’t have a major impact on the economic growth of Ethiopia (Seid, 2000; Woubet, 2006).

Concerning the total export, it has a substantial advantage to encourage the level of quantity and quality of production and the growth of employment in a country. Export leads to the economic improvement through foreign trade multiplier effort (Hatemet et al., 2016). In addition, the foreign currency made available by the export growth allows the import of capital goods which used to increase the production capacity and quality of the economy (Usman et al., 2012). Besides, an increase in the total volume of the rivalry in the export market creation causes in an economies of scale and acceleration of technological advancement in production (Ribeiro Ramos, 2001). Furthermore, the competitiveness of the country in the international trade leads to the production of innovative product and enabling the domestic firms to withstand the competition in the global market (Velnampyand Achchuthan, 2013). The share of different countries in the international market shows the important relationship between the macroeconomics variables leading to rise in the exports and growth in the economic activity. Accordingly, several studies highlighted the robust relationship between the macroeconomics variables and the growth of GDP, (Sied H. 2008; Usman et al., 2012; Soressa J. 2013; Woinshet B. 2014; Hatemet et al., 2016).

Moreover, there is an extensive rise of foreign aid capital inflow to African countries, but the significant impact for the economic growth has not been acceptable by several Sub-Saharan African countries, its fundamental role to the nation still continues an area of dispute (Haile G., 2015). According to reports, Ethiopia has been one of the beneficiaries from the foreign aid capital inflow among the sub-Saharan African countries (Tesfahun B., 2014) though less economic growth and poverty remain inherent for many years (Yohannes B., 2011). Few studies have been evaluated the efficiency of foreign aid capital income on the country economic growth. Besides, conflicting the results on its effectiveness on the economic growth have been reported previously (Abeba S., 2002; Tesfahun B. 2014; Tasew T. 2011; Yohannes B., 2011). For instance, (Haile G., 2015) indicated that the foreign aid capital income has a negative impact on the economic growth of Ethiopia. In contrast, (Tasew T. 2011; Yohannes B. 2011) stated the positive effect of the foreign aid capital inflow on the economic growth of Ethiopia.

Likewise, external debt is another factor which plays the major role in shaping the economic motion of developing country like Ethiopia (Teklu K. et al., 2014). A country resort the external debt due to various reasons such as financing development projects, meeting short-term and long-term obligation, access to foreign currencies, buying of equipments and new technologies (Wessene K., 2014). The increasing of economic deficits driven by a higher level of external debt servicing is a main threat to the economic growth of a nation. The massive accumulation of the external debt leads the country high debt burden and become worse especially non-oil exporting Sub-Saharan African countries like Ethiopia (Hailemariam, 2011). Some studies showed the positive relationship of the past external debt and economic growth of Ethiopia (Befekadu, 1992). On the contrary, other scholars indicated the negative relation of the past external debt and economic growth of the country (Hailemariam, 2011; Wessene K., 2014; Teklu K. et al, 2014).

In the present work, the major determinant factors on the economic growth of Ethiopia were investigated, using the aforementioned macroeconomic variables, both in the long and short-run association. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) statistical tools were used to estimate the existence of unit roots of the time series data. The bound of co-integration between the
variables were determined using ARDL testing (Autoregressive Distributed Lag). In addition, an error correction model (ECM) was applied in order to estimate the short-run dynamics of this study.

2. Data, Model and Methodology

2.1. Data sources

This study was based on the annual time series data covering the period from 1974 to 2013, which comprises 40 data points. The data were obtained from Ministry of Finance and Economic Development of Ethiopia (MoFED, 2014); National Bank of Ethiopia (NBE, 2014), and the World Bank, World Development Indicators (WDI, 2014).

2.1. Model of Study

Simple economic growth model was used to identify the major macroeconomic causes affecting the economic growth in Ethiopia. The macroeconomic theory has identified various factors that influence the economic growth, however many scholars asserted that the vitals elements that affect the economic growth among them: infrastructure quality, natural resources, financial resources, fixed investment, human capital, population, innovation and technology, government policies, foreign aid, external debt, trade openness, institutional framework, foreign direct investment, GDP volatility, government consumption and inflation (Tella SA, Alimi O., 2016; Raheem ID, Isah KO, Adedeji AA., 2016; Anand R, Mishra S, Peiris S. 2015; Biswas and Saha 2014). Understanding the features and the elements of economic growth requires an empirical framework that can be applied to a relatively long term structure. As discussed in many theoretical literature reviews, the initial point of this study is based on the econometric model that extended from neoclassical growth model theory as follows:

\[ Y = F(P_K, L_F) \]

Where, \( Y \) is the economic growth measured by the real gross domestic product (GDP), which is a function of, \( P_K \) and \( L_F \) indicates the Physical capital and human capital respectively (see Solow Robert M., 1956). Following the extended neoclassical growth model, as proposed by several studies, determinant factors that affect the economic growth of Ethiopia were considered, including physical capital, human capital, exports of goods and service, foreign aid, external debt and inflation. Therefore, the mathematical relationship of the study variables are presented as follows:

\[ \text{GDP} = F(\text{PC}, \text{HC}, \text{EXT}, \text{AID}, \text{EXD}, \text{INF}) \]

Where, GDP, PC, HC, EXT, AID, EXF, INF are the real GDP, physical capital, human capital, export, foreign aid, external debt and inflation respectively. According to Asteriou D. and Hall SG. (2007), the logarithm transformation of the time series variables are very popular in econometrics, since many economic time series data show a strong trend and taking the natural logarithm of a series would make successfully linearizes the exponential trend (if any). Because this study motivated on the time series data, therefore, the log of the variables was chosen in order to avoid cumbersomeness and hetroskedasticity of the modeling (Gujarati, 2004). Thus, the multiple regression equation is reformulated as follows:

\[ \ln \text{GDP}_t = \beta_0 + \beta_1 \ln \text{PC}_t + \beta_2 \ln \text{HC}_t + \beta_3 \ln \text{EXT}_t + \beta_4 \ln \text{AID}_t + \beta_5 \ln \text{EXD}_t + \beta_6 \ln \text{INF}_t + \epsilon_t \]  

Where, \( \text{GDP}_t \), represented GDP growth as a dependent variable at a time \( t \); while the independent variables \( \text{PC}_t, \text{HC}_{EXT}, \text{AID}_t, \text{EXD}_t, \text{INF}_t \) represent the physical capital, human capital, exports, foreign aid, external debt and general inflation, respectively, at the time \( t \). Let \( \beta \)'s is the unknown parameters (coefficient of elasticity) and \( \epsilon_t \) stands for the error term assumed to be normally and independently distributed with mean zero and constant variance.
2.3. Methodology

2.3.1. The Autoregressive distributed lag Model (ARDL) Bound Testing Approach

An Autoregressive Distributed Lag Model (ARDL) was used in this study to evaluate the long-run association between the determinant variables. The ARDL was initially developed and proposed by Pesaran and his research group (Pesaran and Shin, 1995; and 1998; Pesaran et al. 1996; Pesaran, 1997; Pesaran et al., 2001). Recently, this model has been preferred by several empirical studies, since it is more reliable method than the other conventional co-integration approaches (Husam-Aldin et al., 2012). Besides, the model is more flexible when the variables are in different order of integration irrespective of the underlying regressors are purely I (0), purely I (1) or the combination of both mutually co-integrated (Pessaran et al., 2001). As a result, it avoids the pre-testing problems associated with standard co-integration, which requires that the variables be already classified into I(1) or I(0) or mixture of both (Pessaran et al., 2001). In addition, unlike to the most conventional co-integration procedures, which are valid for large sample data size, whereas the ARDL approach is more statistically significant approach to determine the co-integration relation, robust and performs when dealing with a small or finite sample data sizes (Pessaran et al., 2001; Narayan, 2004).

Applying the ARDL technique can obtain unbiased and efficient estimators of the model (Pesaran, 1995). However, the procedure will crash in the presence of I(2) series. Finally, by using the ARDL approach, the long-run and short-run component of the variables in the regression model can be estimated simultaneously (Pessaran et al., 2001). In estimating the long-run relationship, a two-step procedure was utilized. Without having any prior information about the direction of relationship, if the first step predicts that there is a long-run relationship among the variables, the error correction version was formulated and specified as follows:

\[
\Delta \text{lnGDP}_t = \alpha_0 + \sum_{i=1}^{p} \beta_0 \Delta \text{lnGDP}_{t-i} + \sum_{i=1}^{p} \beta_1 \Delta \text{lnPC}_{t-i} - i + \sum_{i=1}^{q} \beta_2 \Delta \text{lnHC}_{t-i} - i + \sum_{i=1}^{r} \beta_3 \Delta \text{lnEXD}_{t-i} - i + \sum_{i=1}^{s} \beta_4 \Delta \text{INF}_{t-i} - i + \sum_{i=1}^{p} \theta_1 \text{lnGDP}_{t-i} + \sum_{i=1}^{p} \theta_2 \text{lnPC}_{t-i} + \sum_{i=1}^{p} \theta_3 \text{lnHC}_{t-i} + \sum_{i=1}^{p} \theta_4 \text{lnEXD}_{t-i} + \sum_{i=1}^{p} \theta_5 \text{INF}_{t-i} + \varepsilon_{t}. \]

\[ \text{..................................................... (2)} \]

Where \( \text{GDP} \) is the real GDP at a time \( t \), \( \text{PC} \) is Physical capital, \( \text{HC} \) is expenditure of health and education, \( \text{EXD} \) is total export of goods and services, \( \text{AID} \) is foreign aid, \( \text{INF} \) is the general inflation, \( \varepsilon \) is serially uncorrelated disturbance with zero mean and constant variance, which is assumed to be white noise. \( p \) is the optimal lag length and \( \text{ln} \) is natural logarithm, \( \theta = 0, 1, 2, 3, 4, 5, 6 \) is the corresponding long-run multipliers, whereas, \( \theta_0 \) is parameters, where \( i = 0, 1, 2, 3, 4, 5, 6 \) are the short-run dynamic coefficients of our ARDL model and \( \Delta \) is the first difference operator.

In the above model (equation 2), the null hypothesis of no co-integration defined by \( H_0: \theta_0 = \theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5 = \theta_6 = 0 \) is accepted. This replies no long run relationship among the variables and hence it is tested against the alternative hypothesis \( H_1: \theta_0 \neq \theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq \theta_5 \neq \theta_6 \neq 0 \). According to (Pessaran et al., 2001; Narayan, 2005), there are two sets of critical value bounds for all classifications of regressors’ upper and lower critical bound value. The critical values \( I(1) \) and \( I(0) \) series are referred, respectively, as upper and lower bound critical values. If the calculated \( F \)-statistic is greater than the upper bound critical value, then the null hypothesis of no long-run relationship among the variables can be rejected regardless of the orders of integration for the time series. Conversely, if the test statistic falls below the lower bound critical value, the null hypothesis cannot be rejected i.e. the null hypothesis no co-integration among the variables. Finally, if the calculated \( F \)-statistic falls between the lower and upper bound critical values, then the result is inconclusive. After establishing the existence of the co-integration between the variables, the long-run model for the economic growth could be estimated in equation 3 as follows:
lnGDP_t = α_0 + θ_1 lnGDP_{t-1} + θ_2 lnPC_{t-1} + θ_3 lnHC_{t-1} + θ_4 lnEXT_{t-1} + θ_5 lnAID_{t-1} + θ_6 lnEXD_{t-1} + ε_t  

The lag orders of the variables were chosen by using the appropriate Akaike Information Criteria (AIC) and Schwarz Bayesian Criteria (SBC) to determine the optimal structure for the ARDL specification (Table 3). Determination of the optimal lag length is crucial in the ARDL model, since it helps us to avoid over parameterizations and to save the degree of freedom, for annual data (Pesaran and Shin, 1999) recommend that a maximum of 2 lags. From this, the lag length that minimizes Akaike Information criterion (AIC) was selected. Finally, after the estimation of the ARDL determination of the optimal lag specification and calculation of the associated long-run multipliers, the error correction model was formulated in order to estimate the short-run dynamics model in equation 4:

\[
\Delta \text{lnGDP}_t = \alpha_0 + \sum_{i=1}^{p} \beta_0 \Delta \text{lnGDP}_{t-i} + \sum_{i=1}^{p} \beta_1 \Delta \text{lnPC}_{t-i} + \sum_{i=1}^{p} \beta_2 \Delta \text{lnHC}_{t-i} + \sum_{i=1}^{p} \beta_3 \Delta \text{lnEXT}_{t-i} + \sum_{i=1}^{p} \beta_4 \Delta \text{lnAID}_{t-i} + \sum_{i=1}^{p} \beta_5 \Delta \text{lnEXD}_{t-i} + \sum_{i=1}^{p} \beta_6 \Delta \text{lnINF}_{t-i} + \gamma_{ECM_t} 
\]

Where: \( \beta, i=0, 1, 2, 3,4,5,6 \) are the short-run parameters. \( \gamma \) is the speed of adjustment parameter which was expected to be less than zero. ECM is the lagged error correction term obtained from the estimated co-integration model of equation (4). It denotes the adjustment coefficient, should be negative and statistically significant in order to approve the co-integration relationship. To make confirm the stability of the long-run and short-run coefficients, cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMQ) tests, both have been developed and introduced by (Pesaran, 1997) to the residual equation were applied in order to examine if the two statistics were within the 5 percent significant level. Likewise, (Pesaran, 1997) argued that it is essential to determine the reliability of the long-run multipliers by testing the above error-correction model for the steadiness of its parameters.

3. Results and Discussion

3.1. Stationarity, Lag Length and Bound Test

Before carry out the ARDL bound test of co-integration, the stationarity status of all the variables were tested, in order to sure the order the variables. But, the ARDL model does not impose pre-testing of variables for unit root problems because the model can accommodate both \( I(0) \) and \( I(1) \) variables, or mutually co-integrated variables (Pesaran et al., 2001). However, to avoid spurious results in the regressions analysis, the stationarity test could confirm better estimation in the ARDL model within the variables (Oteng-Abayie F. and Frimpong M., 2006).

According to Ouattara, B. (2004), if the presence of I(2) variables the computed F statistics provided by (Pesaran et al., 2001) could not valid since the bounds test was based on the assumption of the variables \( I(0) \) and \( I(1) \) or mixture of both. Therefore, the implementation of unit root tests in the ARDL procedure was necessary to ensure none of the variables were integrated of order 2 or beyond (Oteng-Abayie F. and Frimpong M., 2006). In the current work, the unit root tests were performed to identify the presence of mixtures in the order of integration of the variables (Pesaran et al., 2001). The presence of the unit root implies the time series under investigation is non-stationary; while the absence of a unit root shows that the stochastic process is stationary (Ibukun Cleopatra Oluseye et al., 2017). Table 1 and 2 presents the order of integration of the time series variables determined by the Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests, respectively.
Table 1: ADF stationary test for the variables

**Source:** Authors’ own calculation.
**Note:** The null hypothesis of the series is non-stationary or contains a unit root. The rejection of the null hypothesis for both ADF and PP tests is based on the MacKinnon (1996) critical values, the rejection of the null hypothesis the non-stationary at 5% significance level.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Test Statistics (With Intercept)</th>
<th>Test Statistics (Trend and Intercept)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At Level</td>
<td>At First Difference</td>
</tr>
<tr>
<td>LHC</td>
<td>3.934</td>
<td>-4.012</td>
</tr>
<tr>
<td>LAID</td>
<td>-1.075</td>
<td>-5.999</td>
</tr>
</tbody>
</table>

*MacKinnon (1996) with constant, no trend

<table>
<thead>
<tr>
<th>Test critical values:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1% level</td>
</tr>
<tr>
<td>5% level</td>
</tr>
<tr>
<td>10% level</td>
</tr>
<tr>
<td>-3.616</td>
</tr>
<tr>
<td>-2.941</td>
</tr>
<tr>
<td>-2.609</td>
</tr>
</tbody>
</table>

*MacKinnon (1996) with constant and trend

<table>
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<tr>
<th>Test critical values:</th>
</tr>
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<tbody>
<tr>
<td>1% level</td>
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<tr>
<td>5% level</td>
</tr>
<tr>
<td>10% level</td>
</tr>
<tr>
<td>-4.219</td>
</tr>
<tr>
<td>-3.533</td>
</tr>
<tr>
<td>-3.198</td>
</tr>
</tbody>
</table>

From the Table 1, the GDP (LGDP), Physical capital (LPC), human capital (LHC), export (LEXT) and external debt (LEXD) were integrated with an order of one \( I(1) \) whereas, the foreign aid (LAID) and general inflation (INF) were integrated of order zero \( I(0) \). In other words the foreign aid and inflation are stationary at level with intercept. While the GDP, Physical capital, Human capital, export and external debt are stationary in the first difference (trend and intercept). However, with intercept, except the GDP and Human capital, all the variables were stationary in first difference. The GDP and human capital were stationary in level. From these, it was assumed that all the variables were characterized as \( I(0) \) and \( I(1) \) process at 5% significant level.

Table 2: PP stationarity test of the variables
<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LHC</td>
<td>3.611</td>
<td>-4.008</td>
<td>-2.939</td>
<td>I [0]</td>
<td>-0.318</td>
<td>-5.061</td>
<td>-3.533</td>
<td>I [1]</td>
</tr>
</tbody>
</table>

*MacKinnon (1996) with constant, no trend
Test critical values:

- 1% level: -3.610
- 5% level: -2.939
- 10% level: -2.608

with constant and trend
Test critical values:

- 1% level: -4.219
- 5% level: -3.533
- 10% level: -3.198

Source: Authors’ own calculation.
Note: The null hypothesis of the series is non-stationary or contains a unit root. The rejection of the null hypothesis for both ADF and PP tests is based on the MacKinnon (1996) critical values, the rejection of the null hypothesis the non-stationary at 5% significance level.

Likewise, the Phillips-Perron test statistic (PP Test) in the table 2, revealed that there is a mixture of integration order zero and orders one. Order one, i.e. the GDP, Physical capital, human capital and inflation were stationary in level while export, foreign aid and external debt were stationary in first difference (with intercept only). However, except the inflation all the variables were stationary after the first difference with intercept and trend. Form table 1 and 2 it can be confirmed that none of the variables were entered in the regression of order two, which are not desirable in applying the ARDL model.

The results of Akaike Information Criterion (AIC) and Schwartz-Bayesian Criterion (SBC) criteria were different (Table 3), thus the lag order of 2 was selected based on the AIC criteria. The optimal lag length of each variable of the ARDL model was found by estimated following: (p+1)^k

regression methods, where k is the number of independent variables in the equation and p is the maximum number of lags involved for a variable in the single equation of the ARDL model.

Table 3: Lag length Criteria

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>49.41411</td>
<td>343.3185*</td>
<td>3.49e-09*</td>
<td>0.346626*</td>
<td>2.759910*</td>
<td>1.205254*</td>
</tr>
<tr>
<td>2</td>
<td>95.88371</td>
<td>56.25267</td>
<td>5.23e-09</td>
<td>0.479805</td>
<td>5.004714</td>
<td>2.089733</td>
</tr>
</tbody>
</table>

Source: Authors’ own calculation.

3.2 Bound Tests for Co-integration
After insuring that none of the variables were integrated in order I(2), the ARDL analysis was then proceeded. In this step, the presences of the long-run relationships were examined (Equation 3). F-test has been used to check the existence of a long-run association between the variables with following the null hypothesis i.e. $H_0: \theta_0 = \theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5 = \theta_6 = 0$ against the alternative hypothesis $H_1: \theta_0 \neq \theta_1$. 

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of co-integration (Pesaran et al., 2001). The F-test had a nonstandard distribution which depends upon: (i) whether the variables included in the ARDL model I(0) or I(1) or the mixture of both, (ii) the number of regressors and (iii) whether the ARDL model contains an intercept and/or a trend (Pesaran et al., 2001). Table 4 shows the results of calculated F-statistics when each variable was considered as a dependent variable (normalized) in the ARDL-OLS regressions.

Table 4: The ARDL Co-integration Tests with the LGDP, LPC, LHC, LEXT, LAID, LEXD and INF for Ethiopia (1974-2013)

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>AIC Lags</th>
<th>F-statistic</th>
<th>10% Critical</th>
<th>5% Critical</th>
<th>2.5% Critical</th>
<th>1% Critical</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1% Bounds</td>
<td>1% Bounds</td>
<td>1% Bounds</td>
<td>1% Bounds</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F_{LGDP} (LGDP</td>
<td>LPC LHC LEX LAID LEXD INF)</td>
<td>2</td>
<td>7.0674</td>
<td>2.12</td>
<td>3.23</td>
<td>2.45</td>
<td>3.61</td>
</tr>
<tr>
<td>F_{LPC} (LPC</td>
<td>LGDP LHC LEX LAID LEXD INF)</td>
<td>2</td>
<td>4.4363</td>
<td>2.12</td>
<td>3.23</td>
<td>2.45</td>
<td>3.61</td>
</tr>
<tr>
<td>F_{LHC} (LHC</td>
<td>LGDP LPC LEX LAID LEXD INF)</td>
<td>2</td>
<td>5.6498</td>
<td>2.12</td>
<td>3.23</td>
<td>2.45</td>
<td>3.61</td>
</tr>
<tr>
<td>F_{LEX} (LEX</td>
<td>LGDP LPC LHC LEX LAID LEXD INF)</td>
<td>2</td>
<td>1.3714</td>
<td>2.12</td>
<td>3.23</td>
<td>2.45</td>
<td>3.61</td>
</tr>
<tr>
<td>F_{LAID} (LAID</td>
<td>LGDP LPC LHC LEX LEXD INF)</td>
<td>2</td>
<td>2.9850</td>
<td>2.12</td>
<td>3.23</td>
<td>2.45</td>
<td>3.61</td>
</tr>
<tr>
<td>F_{LEXD} (LEXD</td>
<td>LGDP LPC LHC LEX LAID INF)</td>
<td>2</td>
<td>3.9890</td>
<td>2.12</td>
<td>3.23</td>
<td>2.45</td>
<td>3.61</td>
</tr>
<tr>
<td>F_{INF} (INF</td>
<td>LGDP LPC LHC LEX LAID LEXD)</td>
<td>2</td>
<td>6.4939</td>
<td>2.12</td>
<td>3.23</td>
<td>2.45</td>
<td>3.61</td>
</tr>
</tbody>
</table>

Source: Authors’ own calculation.

Note: The relevant critical value bounds are obtained from Pesaran et al. (2001). Table CI (iii) Case III: Unrestricted intercept and no trend p. 300. The number of regressors is six. Lower bound I(0) = 3.15 and Upper bound I(1) = 4.43 at 1% significance level.

The calculated F-statisticsof the following dependent and independent variables such as: $F_{LGDP} (LGDP|LPC LHC LEX LAID LEXD INF) = 7.0674; F_{LPC} (LPC| LGDP LHC LEX LAID LEXD INF) = 4.4363; F_{LHC} (LHC| LGDP LGCF LEX LAID LEXD INF) = 5.6498; and $ F_{INF} (INF| LGDP LPC LHC LEX LAID LEXD) = 6.4939 with their respective results were higher than the upper bound critical value of 4.43 at the 99% significant level. Thus, the null hypothesis of no co-integration was rejected, implying that there was long-run co-integration among the variables. Regarding the other variables, the calculated F-statistics confirmed that there was no co-integration when $F_{LEX}, F_{LAID}$ and $F_{LEXD}$ were used in the dependent variable of the ARDL regressions. However, based on the growth theory the GDP was the dependent variable.

3.3. Long run estimation
The main aim to conduct ARDL model was to find out the existence of long-run relationship between gross domestic product (GDP) and its determinants, taking into account the control variables. Before performing the ARDL co-integration, the existence of long-run relationship among the variables through the F-test was checked. The results were reported in Table 4. Accordingly, the null hypothesis of no long-run relationship between these variables was rejected, which implies that there exists a long-run relationship between the variables. As there were long-run relationships among the variables consequently, the long-run coefficients of the GDP and the explanatory variables were estimated (Table 5).

![Source: Authors' computed Figure 1. Long-Run relationship](image)

### Table 5: Estimated long run coefficients using the ARDL approach

<table>
<thead>
<tr>
<th>ARDL (1, 0, 0, 2, 1, 2, 2) selected by Akaike Information Criterion (AIC). Dependent variable is LGDP</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>T-Statistics</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPC</td>
<td>0.299790***</td>
<td>0.078020</td>
<td>3.842480</td>
<td>0.0008</td>
</tr>
<tr>
<td>LHC</td>
<td>0.257903***</td>
<td>0.069576</td>
<td>3.706799</td>
<td>0.0012</td>
</tr>
<tr>
<td>LEXT</td>
<td>0.002297</td>
<td>0.50846</td>
<td>0.45174</td>
<td>0.9644</td>
</tr>
<tr>
<td>LAID</td>
<td>0.017819</td>
<td>0.039167</td>
<td>0.454950</td>
<td>0.6534</td>
</tr>
<tr>
<td>LEXD</td>
<td>-0.084025***</td>
<td>0.023005</td>
<td>-3.652477</td>
<td>0.0013</td>
</tr>
<tr>
<td>INF</td>
<td>0.001759</td>
<td>0.002483</td>
<td>0.708602</td>
<td>0.4857</td>
</tr>
<tr>
<td>Constant</td>
<td>7.663722***</td>
<td>0.746622</td>
<td>10.26453</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

**Source:** Authors’ own calculation.

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

Table 5 illustrate the physical capital formation (gross investment) had a very high significant level and positive impact on the GDP of Ethiopia. It implies that the higher the gross capital formation leads to raise the economic growth in Ethiopia in the long run. This finding is not surprising particularly in the context of Ethiopia; since Ethiopia is a developing country which needs more capital for exploiting in consumption and production purposes. The coefficients could be interpreted as the elasticity with respect to real GDP; a 1% increase in the physical capital (gross investment) leads to
approximately 0.30% increase in the GDP of Ethiopia, all the other variables were equal. This result was in line with the growth theory of economic; which states that capital formation is the major factors of economic growth theory: Keynesian theory of growth and Solow theory of growth (Solow Robert M., 1956; Keynes, J.M .1936). Additionally, this positive association between the PC and the economic growth in Ethiopia was consistence with the previous studies by (Weeks et al., 2004; Tadesse, 2011) in Ethiopia; (Biswas and Saha, 2014, Balet al. 2016) in India; (Iqbal and Zahid, 1998) in Pakistan; (Ndambiri H.K., et al. 2012) in Africa and (Hatemet al., 2016) the kingdom of Saudi Arabia.

Similarly, the coefficient of the human capital has a highly significant and positive impact on the economic growth in the long run (Table 5). A 1% increase in the human capital leads to approximately 0.26% increases in the economic growth of Ethiopia. Similar to our study, (Gebrehiwot K., 2016; Dinkneh G. and Jiang Y., 2015; Girma, Z., Abdulwahab and Gupta, 2013) were reported the same findings. The coefficients of exports and inflation were insignificant and had positive impact on economic growth in the long run i.e. a 1% increase exports and inflation might lead to a 0.0023% and 0.0018% increases in the economic growth respectively. Likewise, the coefficient of foreign aid (LAID) was 0.017819 suggesting that, 1% increase in foreign aid will cause a 0.02% increase in the economic growth in the long-run. This is consistent with the study of (Tasew T. 2011 and Yohannes B., 2011) who demonstrated the impact of the foreign aid in the economic growth of Ethiopia. Whereas, the long-run impact of the external debt on the GDP was negative but statically significant (Table 5). Previous reports indicated that Ethiopia is one of the highly indebted poor countries in the world (Hailemariam, 2011). Our results are also consistence with the outcome of (IMF, 2002) working paper for developing countries, (Hailemariam, 2011; Wessene K., 2014; Teklu K. et al, 2014) in Ethiopia. The regression test result showed a 1% increase in the external debt would cause a 0.084% decreases in the GDP during the study periods of the Ethiopian economy. Finally, the long run estimated model of the variables is presented on equation 6, the figures in the parenthesis is indicates the calculated t-values.

\[ \text{LGDP} = 7.663722 + 0.299790\text{LPC} + 0.257903\text{LHC} + 0.002297\text{LEXT} + 0.017819\text{LAID} \]
\[ -0.084025\text{LEXD} + 0.001759\text{INF} \]

\[ (10.26453, 3.842480, 3.706799, 0.45174, 0.454950, -3.652477, 0.708602) \]  
\[ (0.0000, 0.0220, 0.8921, 0.0225, 0.0037, 0.0093) \]

3.4 Short-Run Dynamics Model

The short-run error correction model (ECM) is presented in Table 6. It was estimated after approving the long run coefficients of the growth equation (Table 5). The error correction model indicated the speed of adjustment to restore the equilibrium in the dynamic ECM model. It was a one lagged period residual obtained from the estimated dynamic of the long run model (Equation 3). The coefficient of the error correction term indicated how rapidly the variables converge to equilibrium. Likewise, it should be a negative sign and statistically significant at the standard significant level of p-value should be less than 5%.

Table 6: Error correction representation for the selected ARDL model.

<table>
<thead>
<tr>
<th>Unrestricted constant and no trend</th>
<th>ARDL (1, 0, 0, 2, 1, 2, 2) selected by Akaike Information Criterion (AIC). Dependent variable is DLGDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regressor</td>
<td>Coefficient</td>
</tr>
<tr>
<td>D(LPC)</td>
<td>0.148731***</td>
</tr>
<tr>
<td>D(LHC)</td>
<td>0.1596 17**</td>
</tr>
<tr>
<td>D(LEXT)</td>
<td>0.004668</td>
</tr>
<tr>
<td>D(LEXT(-1))</td>
<td>-0.074886**</td>
</tr>
<tr>
<td>D(LAID)</td>
<td>0.049510***</td>
</tr>
<tr>
<td>D(LEXD)</td>
<td>-0.041521***</td>
</tr>
</tbody>
</table>
Similar to the long run result, the role of the physical capital (gross investment), human capital (expenditures to health and education), foreign aid and inflation were remain positive and statistically significant in the error correction model (Table 6). This showed a 1% increase in the physical capital formation would be result approximately a 0.15% increase in the GDP in the short run (Table 6). Likewise, a 1% increase in the human capital and foreign aid would give in 0.16% and 0.05% increase in the economic growth in Ethiopia, respectively while other variables kept constant. The total exports were insignificant similar to the long run term, but positive elasticity was obtained, which confirmed the positive correlation between the export and GDP growth. However, one lagged period of total export was significant with negative coefficient (Table 6). The external debts showed a negative impact on the economic growth; i.e. an increase in external debt slowed the economic growth. Our result shows that over the sample period investigated, a 1% increase in external debt would result in 0.04% decrease in Ethiopian’s economic growth. However, one period lagged of external debt is become statistically significant with positive coefficient (Table 6).

The coefficient of error correction term has been measure of the speed of adjustment (Bal et al., 2016). The equilibrium correction model coefficient (ECM-1), estimated as -0.6190 (0.0000), was highly significant and has the correct negative sign (Table 6). This implies that a high speed of adjustment to equilibrium after a shock, suggesting the series was non-explosive and the long-run equilibrium was attainable. Since, the ECM-1 measures the speed at which the endogenous variable adjusts to changes in the explanatory variables before converging to its equilibrium level. The coefficient of error correction model (ECM) term indicated the growth of the economy. Approximately 61.90% of disequilibria from the previous year’s shock converge back to the long-run equilibrium in the current year (Table 6). According to (Kidanemariam, 2016), the highly significant error correction term further confirmed the existence of a stable long-run relationship. Additionally, the coefficient of determination (R-squared) was highly explained that about 84.89% of variation in the GDP was attributed to variations in the explanatory variables in the model. Further, the DW statistic does not suggest autocorrelation and hence the F-statistic was quite robust.

### Stability Tests

The current study demonstrated that the long run and short-run model passed through all the diagnostic tests. There were no evidence of autocorrelation at 5 percent confidence level and the model approved the test for normality, the error term was also proved to be normally distributed. Besides, there was no existence of white heteroscedasticity in the model. For testing the stability of the long-run coefficients alone with the short-run dynamics, the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) were applied. A graphical illustration of CUSUM and CUSUMSQ is exposed in Figures 2 below. The plots of both the CUSUM and the CUSUMSQ were inside the boundaries, and hence these statistics verified the stability of the long-run coefficients of the regressors that have an effect on economic growth in Ethiopia. The model looks to be stable and properly indicated given that none of the two tests statistics go outside the bounds of the 5 percent level of significance.
The straight lines represent critical bounds at 5% significance level. Figure 2: Plot of Cusum and Cusumq test for coefficients stability for ECM model

4. Conclusion

Prior to our mode of investigation regarding the specification was being initiated from the unit root mechanism, that is, the stationarity status of all the variables were tested by the Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests. These tests confirmed that there exist the mixture order of integration $I(0)$ and $I(1)$ among the variables. Afterwards, the ARDL method was used to measure both the long-run and the short-run association between the dependent (the GDP) and its determinant (independent) variables. Before transferring to the ARDL technique, the presence of the long-run relationship among the variables was tested using the F-test statistics.

The determinant variables that affect the GDP of Ethiopia includes physical capital (gross investment), human capital (health and education), total export (goods and services), external debt, foreign aid and inflation were considered as the variables for the model during the period of 1974-2013. The bound test suggested that the series of interests were bound together in the long-run. The associated error correction model was also significant, confirming the existence of long-run relationships. A faster equilibrium that restored before the mid of the year was obtained. The empirical results suggested that the physical capital (gross investment), human capital (health and education), total export (goods and services), foreign aid and inflation were important in explaining the economic growth both in the long-run and short run in Ethiopia.
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