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Impacts of Private and Public Physical Capital Accumulation on Economic Growth of Ethiopia

Hayu Gemechu[1], Leta Sera[2] and Tekilu Tadesse[3]

[1]Department of Economics, Dambi Dolo University, Ethiopia

[2,3]Department of Economics, Jimma University, Ethiopia

Corresponding author email: tekitade.tt@gmail.com

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Abstract

The main objective of this research was to examine the impacts of private and public physical capital accumulations on economic growth in Ethiopia for the period ranging from 1974/75-2017/18 by using Auto Regressive Distributed Lag (ARDL) Approach to Co-integration and Vector Error Correction Model. The result showed that real private capital accumulation had statistically insignificant impact while public capital accumulation had negative and statistically significant impact on economic growth of Ethiopia in the long -run. The result also revealed that human capital and labor force had positive and statistically significant impact while trade openness, macroeconomic instability and foreign aid had negative and statistically significant impact in determining economic growth of Ethiopia in the long- run. In addition, in the short -run private and public capital stocks had negative and statistically significant impact on economic growth of Ethiopia at first lag while human capital, labor force, trade openness, macroeconomic instability and foreign aid had positive and significant impact on economic growth of Ethiopia with lag. Overall, the policy implication of this study is that, given the long -run insignificant impact of private capital and negative significant impact of public capital stocks on economic growth, it is recommendable to reduce public capital investment in different sector investments rather better to encourage private sector participation on economic activities in Ethiopia.

Keywords: Private capital stock, Public capital stock, Economic growth, Ethiopia, Auto Regressive Distributed Lag (ARDL) Approach

Introduction

The motive behind economic activity of every nation is to bring sustainable development. It is believed that economic growth explains much of the elements of development; countries utilize

much of their resources and time to ensure sustained economic growth. The overriding macroeconomic goal of every nation is to ensure a sustainable and steadily increasing economic growth (Amare, 2018). As a consequence, growth theory and the importance of capital accumulation have long occupied a central role in economics science, as stated by the works of Romer (2012) and Solow (1956). Without doubt, every country in the world today still lays tremendous emphasis on capital accumulation by making conducive environment to raise the level of investment in relation to output. This emphasis is to achieve the short-term fiscal policies and long-term national development plans of both the developed and the developing countries Christian and Adenutsi (2009).

Capital accumulation is often proposed as the ways for developing countries to speed up their long-term growth rates. Increasing capital accumulation requires to: increase savings ratios, maintain good banking system and system of loans, avoid corruption and political instability and good infrastructure to make investment more attractive. Capital accumulation through investment activities brings employment opportunities, revenue for government, efficient use of domestic resources and large scale production for LDCs (Solow, 1956).

Here in Ethiopia, capital is scarce and most of the production is labor intensive like, in other developing countries. The trend of physical capital (public and private capital) stocks across the different regimes varies significantly, because each government that came into power started a new and followed a different economic and political ideology in Ethiopia. For example, during the Imperial regime, the Ethiopian economy had a mixed type of economy, characterized in such a manner where the private and public sectors were given equal importance. During the socialist regime (1974/75-1990/91), the government nationalized all private sector capitals and advocated public capital to achieve sustainable and remarkable economic growth. The current government took power in 1991 and launched a free-market-oriented economy that increases the participation of the private sectors (Crewett et al., 2008). From this, we can observe that the trend of physical capital accumulation in Ethiopia is highly correlated with government strategy.

Various empirical studies have been conducted on the impacts of physical capital accumulation on economic growth across the world (Ajose1 and Oyedokun (2018); Themba et al. (2016); Xiaoqing (2005); Beddies (1999); Mankiw et al. (1992) and Benhabib and Spiegel (1991). In case of Ethiopia, the findings of overall study results of Gebre and Yushi (2015); Tilahun (2015); Kidanemariam (2013); Solomon (2013); Alemayehu and Befekadu (2005) showed that physical

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capital is largely positive and significantly associated with economic growth. On the other hand, the result of Rao and Leta (2017) revealed that in Ethiopia the relationship between investment and economic growth was negative and significant. Whereas, Muhammad Javid (2019); Ashauer (2000); Dessus and Herrera (2000); Calamitsis et al. (1999) and Ghura (1997) tried to examine the separate impact of public and private capital stock and found a positive relationship between both types of capitals and economic growth. In the contrary, Akitoby and Cinyabuguma (2004) found a positive impact of private capital and negative impact of public capital accumulation on economic growth. However, all of these studies used the gross capital formation/ investment as a proxy for capital accumulation which is not appropriate measure of capital accumulation. The plenty of previous studies used gross capital formation/ investment as a proxy for capital accumulation to analyze the impact of physical capital accumulation on economic growth. However, as outlined by Beddies (1999), as far as economic growth is a long -run phenomenon, investment should be accumulated to show its impact on economic growth in the long -run and termed as capital stock not simply investment/gross capital formation.

In Ethiopia, Tilahun (2015) and Solomon (2013) tried to use appropriate measure of capital accumulation (perpetual inventory method) to generate capital stock but they failed to address the separate impacts of private and public capital accumulation on economic growth. They used old literatures and missed to incorporate important variables in growth equation as a result their estimation may be underestimated or overestimated based on the direction of impacts of missed variables and the study tries to fill the time gap by using the most recent data ranging from 1974/75-2017/18.

In general, there is no clear consensus on the empirical evidences from both developed and developing countries with regard to whether public or private capital stock has more impact on economic growth. This indicates consensus that the contribution is significant and private stock is more important than public. However, as far as the researchers' knowledge is concerned, no empirical study has been made that analyzed the separate impacts of private and public capital stock on economic growth in Ethiopia. Therefore, this study analyses the separate impact of private and public physical capital accumulation on economic growth by calculating capital stock (both private and public) using the perpetual inventory method and incorporating more variables

in the model that the above studies have not considered so far. To mention specifically, macroeconomic instability and foreign aid are included in the model.

Methodology

Model specification

The production function with human capital that has been used in this paper is specified within Cobb-Douglas production function, the conventional growth accounting model framework with both short-run and long- run relationships following the work of Edwin Dewan (2001) and Knight et al. (1993) and is written as follows:

$$Y(t) = F(t)\big(K(t), H(t), L(t), A(t)\big) = K(t) * H(t) * L(t) * A(t) \quad \text{.....(2.1)}$$

Based on the interest of this study capital stock is divided in to three: private physical capital, government (public) physical capital and human capital. Then the production function will be written as;

$$Y(t) = F(t)\big(K_P(t), K_g(t), H(t), A(t), L(t)\big) = K_p(t) * K_g(t) * H(t) * L(t) * A(t)) \quad \text{.....(2.2)}$$

Where $K_p(t)$, $K_g(t)$, H(t) and L(t) are the private physical capital, public physical capital, human capital and Active Labor force respectively. A(t) is an overall efficiency. A(t) includes the level of technology, some policy measures and the quality of government management of the economy in both internal and external economy, for instance, foreign aid, macroeconomic stability, trade openness included in the model. However, there is not capital stock series data readily available for Ethiopia. Due to this, the author tried to calculate a capital stock series by using the perpetual inventory method as used by Baler et al. (2006a) and Beddies (1999):

$$K_t* = K_{t-1} + I_t* - \delta K_{t-1} \quad \text{.....(2.3}a\text{)}$$

$$I_t* = K_t* - K_{t-1} + \delta K_{t-1} \quad \text{.....(2.3}b\text{)}$$

By simplifying the above equation (3.10a and 3.10b) we can get,

$$I_t* = K_t* - (K_{t-1} - \delta K_{t-1})$$

There fore $I_t* = K_t* - (1-\delta)K_{t-1}$

And $K_t* = I_t* + (1-\delta)K_{t-1}$

Where K_t* = the total capital stock at time period t; K_{t-1} = the level of capital stock one period lag; I_t* = is the total investment level at period t and δ is depreciation rate.

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To construct a series on private and public capital stocks from there, the series are obtained as the same way to that of the total capital stock by calculating the capital output ratio for both private and public capital stocks and (Tilahun, 2015; Solomon, 2013), depreciation rate of 5% and their respective private and public investments. These can be calculated as:

$K_{Pt} = K_{Pt-1} + I_{Pt} - \delta K_{Pt-1}$ Or $K_{Pt} = I_{Pt} + (1-\delta)K_{Pt-1}$ ---------- 2.3c

$K_{gt} = K_{gt-1} + I_{gt} - \delta K_{gt-1}$ Or $K_{gt} = I_{gt} + (1-\delta)K_{gt-1}$ ---------- 2.3d

From above equation, perpetual use, the net capital stock (particularly private and public) at the beginning of period t, K_t, can be written as a function of the net capital stock at the beginning of the previous period t-1,K_{t-1},gross investment in the previous period t-1, I_{t-1}. Thus, in order to be able to apply the Perpetual Inventory Method to calculate the current capital stock, we need (i) a time series of investment data, (ii) information on the initial capital stock at the time when the investment time series starts and (iii) information on the rate of depreciation of the existing capital stock.

Therefore, the process of obtaining private and public capital stock accumulation series data from equation 2.4c and equation 2.4d are called Perpetual Inventory Method.

Accordingly, the equivalent equation for Equation (2.2) above which is used for estimation purpose was written as follows:

$$\ln RGDP = \beta_0 + \beta_1 \ln K_{Pt} + \beta_2 \ln K_{gt} + \beta_3 \ln Hc_t + \beta_4 \ln Lf_t + \beta_5 \ln To_t + \beta_6 \ln Mii_t + \beta_7 \ln Fa_t + U_t \text{.....(2.4)}$$

Where β_0 is constant term; β_1, β_2, β_3, β_4, β_5, β_6 and β_7 are coefficients of the explanatory variables (long -run coefficients).

$LnRGDP_t$ is the natural logarithm of real gross domestic product at time t;$LnKp_t$ is the natural logarithm of private physical capital stock at time t; $LnKg_t$ is the natural logarithm of public physical capital stock at time t; $LnHC_t$ is the natural logarithm of human capital accumulation at time t; $LnLF_t$ is the natural logarithm of active labor force at time t; $LnTO_t$ is the natural logarithm of trade openness at time t; $LnMII_t$ is the natural logarithm of the indicators of macroeconomic stability at time t; $LnFA_t$ is the natural logarithm of foreign aids at time t and U_t is represent an error term at time t.

Measuring macroeconomic instability index (MII)

Macroeconomic Instability Index is a relatively more comprehensive criterion of the macroeconomic instability. Hence, an increase in macroeconomic instability index is meant an increase in one or more indexes of macroeconomic instability, such as increase in inflation rate; change in exchange rate, budget deficit ratio to gross domestic product (GDP) and public debt ratio to gross domestic product (GDP) (Ismihan, 2003).

Thus, the MII is constructed in two steps by utilizing UNDP HDI methodology. In the first step, the mentioned four macroeconomic instability indexes are built based on the following relation:

$$I_t = \frac{(X_t - X_{min})}{(X_{max} - X_{min})}$$

Where I_t refers to the index value of variable X, i.e. macroeconomic instability indicator X, in year t; X_t refers to the actual value of indicator X in year t and Xmin (Xmax) refers to the minimum (maximum) value of indicator X over the whole period under consideration. It should be noted that, the formula implies all sub-indices have a common range that lies between zero and 0 and 1.

In the second step, the Macroeconomic Instability Index (MII) is obtained based on the four simple averages of the above variables.

Table 1 Definitions, Measurements and Sources of Variables

Variables	Definition	Measurement	Source
RGDP	Real Gross Domestic Product	In millions of birr	NBE, WB and MoFED
KP	Private physical capital (computed using perpetual inventory method)	In millions of birr	MoFED and NBE
KG	Public/Government physical capital (computed using perpetual inventory method)	In millions of birr	MoFED and NBE
HC	Human capital (Proxed by expenditure on health and education)	In millions of birr	MoFED
LF	Labor force	Total number of employed and unemployed	WB (WDI)
TO	Trade Openness (the ratio of import plus export to real GDP	In percentage	WB (WDI) and NBE
MII	Macroeconomic instability (includes inflation, budget deficit, public debt and fluctuations and changes in real exchange rate measured using HDI)	Average	IMF, NBE, MoFED and WDI
FA	Foreign Aid (only bilateral aid)	In millions of birr	NBE and WDI

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Note: All variables are expressed in real term which is calculated based on 2010 base year and macroeconomic instability index was calculated based above formula.

Model Estimation Techniques

The Autoregressive Distributed Lag Model (ARDL)

A large number of past studies have used the Johansen Co-integration and Engle-Granger causality technique to determine the long-term relationships between variables of interest. In reality, this remains the technique of choice for many researchers who argued that this is the most accurate method to apply for I (1) variables in the past studies.

However, a recent series of studies by Narayan (2004) and Pesaran et al. (2001, 1999) have introduced an alternative co-integration technique known as the 'Autoregressive Distributed Lag (ARDL)' or bound test. There are numbers of advantages of using ARDL model also called 'Bound Testing Approach' instead of the conventional Engle Granger two-step procedure (1987), Maximum likelihood methods of co-integration (Johansen and Juselius, 1990; Johansen, 1988).

First, the ARDL model is the more statistically significant approach to determine the co-integration relation in small samples (Narayan, 2004; Pesaran et al., 2001), while the Johansen co-integration techniques require large data samples for validity. A second advantage of the ARDL approach is that unlike other co-integration techniques, it does not require all of the regressors to be integrated of the same order; the ARDL approach can be applied whether the regressors are purely order zero [I(0)], purely order one [I(1)], or mixture of both. This implies that the ARDL approach avoids the pre-testing problems associated with other co-integration, which requires that the variables to be already classified into I(1) or I(0) or mixture of both (Pesaran et al., 2001).

Third, with the ARDL approach it is possible that different variables have different optimal numbers of lags while in Johansen-type models this is not permitted. Forth, the other advantages of bound testing approach in the long- run and short- run parameters of the model in questions are determined simultaneously as follows:

The ARDL representation of equation (2.4) is written as follows;

$$\Delta lnRGDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i}\Delta lnRGDP_{t-i} + \sum_{i=0}^{n} \alpha_{2i}\Delta lnKp_{t-i} + \sum_{i=0}^{n} \alpha_{3i}\Delta lnKg_{t-i} + \sum_{i=0}^{n} \alpha_{4i}\Delta lnHc_{t-i} + \sum_{i=0}^{n} \alpha_{5i}\Delta lnLf_{t-i} + \sum_{i=0}^{n} \alpha_{6i}\Delta lnTo_{t-i} + \sum_{i=0}^{n} \alpha_{7i}\Delta lnMii_{t-i} + \sum_{i=0}^{n} \alpha_{8i}\Delta lnFa_{t-i} + \beta_1 lnRGDP_{t-1} + \beta_2 lnKp_{t-1} + \beta_3 lnKg_{t-1} + \beta_4 lnHc_{t-1} + \beta_5 lnLf_{t-1} + \beta_6 lnTo_{t-1} + \beta_7 lnMii_{t-1} + \beta_8 lnFa_{t-1} + \varepsilon_t \dots\dots\dots (2.5)$$

Where, α_0= Drift component; Δ = Operator of the first difference; and ε_t =Error term

In the above equation, the left- hand side is the real gross domestic product. The first until eight expressions with summation $(\alpha_1 - \alpha_8)$ on the right- hand side represents short- run dynamics. The remaining expressions $(\beta_1 - \beta_8)$ on the right- hand side represents the long- run relationship.

Thus, to investigate the presence of long- run relationship between dependent variable and explanatory variable, ARDL or bound test procedure is employed. The bound testing procedure is conducted based on the F-test. F-test is actually a test of the hypothesis of no cointegration among variables against the existence of cointegration among the variables, stated as;

The null hypothesis of no presence of co integration

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = 0$

While, the alternative hypothesis of the presence of co integration is presented as:

H_A: $\beta_1 \neq \beta_2 = \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq \beta_7 \neq \beta_8 \neq 0$

The ARDL bound test procedure is based on the Wald-test (F-statistic). The asymptotic distribution of this Wald-test is non-standard under the null hypothesis of no cointegration among the variables of interest. The lower critical bound assumes that all the variables are I(0) meaning that there is no cointegration among the variables. The upper bound assumes that all the variables are I(1) meaning that there is cointegration among the variables. When the computed F-statistic exceeds the upper bound critical value, then the H_0 is rejected (this implies that variables are cointegrated). When the F-statistic falls short of lower bound critical value, then the H_0 cannot be rejected (there is no cointegration among the variables). When the computed F-statistics falls between the two lower and upper bound, the results are inconclusive.

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ARDL approach will be employed to estimate the short and long-run dynamic relationships. The error correction version of ARDL model pertaining to the variables in the former equation can be expressed follows:

$$\Delta lnRGDP_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i}\Delta lnRGDP_{t-i} + \sum_{i=0}^{n} \alpha_{2i}\Delta lnKp_{t-i} + \sum_{i=0}^{n} \alpha_{3i}\Delta lnKg_{t-i} + \sum_{i=0}^{n} \alpha_{4i}\Delta lnHc_{t-i} + \sum_{i=0}^{n} \alpha_{5i}\Delta lnLf_{t-i} + \sum_{i=0}^{n} \alpha_{6i}\Delta lnTo_{t-i} + \sum_{i=0}^{n} \alpha_{7i}\Delta lnMii_{t-i} + \sum_{i=0}^{n} \alpha_{8i}\Delta lnFa_{t-i} + \gamma ECT_{t-1} + U_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.6)$$

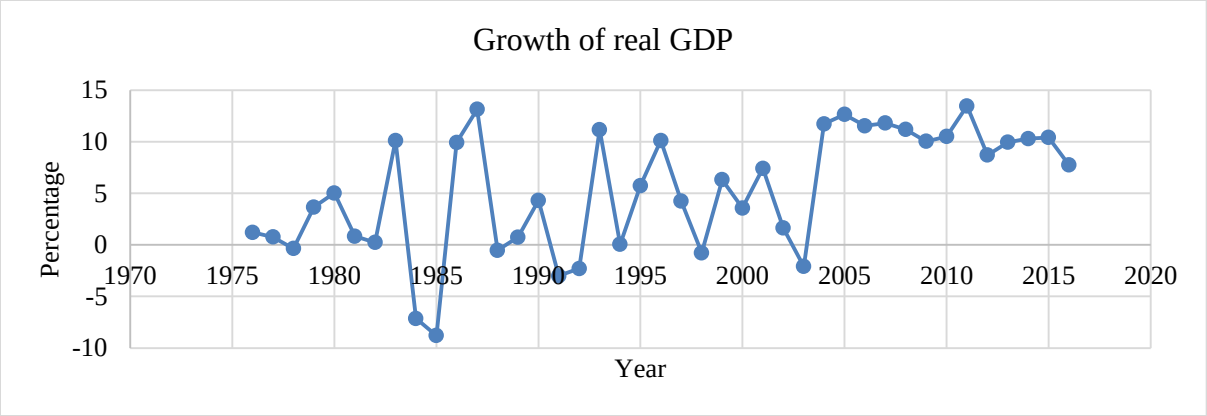
Where, γ is the speed of adjustment parameter; and should be negative and significant. ECM_{t-1} is the error correction model term which has to be negative and statistically significant and represents the speed of adjustment to long -run equilibrium following a short- run shock.

Result and discussion

Descriptive statistics

The trend and performance of real GDP in Ethiopia

Ethiopia has experienced tangible progress in key economic and social indicators and also known as one of Africa's fastest-growing economies, with near double-digit GDP growth over the past decade and huge infrastructural development since the early 2000s. Average annual real GDP growth increased from 2.5% during the 1980s to over 10.7% in the period from 2003/04 to 2017/18. The country registered an average annual growth rate of 8.8% between 2000/01 and 2017/18, and as the population growth rate of 2.6% implying real GDP per capita increased by about 6.9%. Largest growth rate recorded during pre-economic reform was 13.1% in 1987 while least growth was -8.7% in 1985 due to frequent drought and civil war along with distorted economic policy followed by the socialist government whereas there has been positive growth and fluctuation trend observed after the economic reform took place except for the year of 1998 and 2003 in which Ethiopia economy has challenged by external shocks such as famine and Eritrean war devastated the economic growth.



Source: Author computation from national bank of Ethiopia abstracts and MOFEC data

Figure 1. The growth rate of real GDP

Trends and Performances of Private and Public Capital Accumulations

As shown in Table 2, during the entire period under review (1975/76-2017/18) the growth rate of private and public capital stock were 16.85% and 20.88% respectively. During the early period of the military government, from 1975 to 1979, private capital stock grew by about 4.34% whereas public capital stock grew approximately by 2.99 percent. During the entire period of the Derg regime (1974/75-1990/91), the growth rate of private capital stock reached an average of 7.88% and that of public capital stock was 9.5% percent.

In this regime from the year 1974/75-1985/86, the growth rate of both capital stocks showed a little change with some fluctuations because of absence of incentives given for private investors. However, due to policy reforms both private and public capital stocks grew with higher rate especially in 1987. They grew by 13.53% and 15.56% respectively. These policy reforms helped boost the share of private capital stock (19.99% of real GDP) in the later periods of the military government, in 1987, which may be considered the peak of capital stock during the military period.

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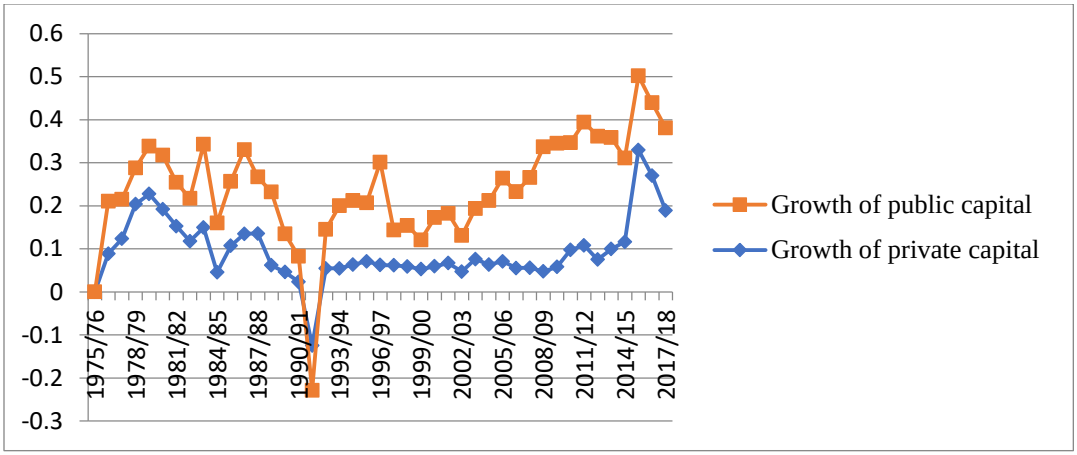
Table 2. Trends in private and public capital stocks growth rates

Year	1974/75-1990/91	1991/92-2000/01	1991/92-2017/18	2001/02-2017/18	2017/18	1974/75-12017/18
Private capital stock growth rate	7.13	8.78	18.46	10.71	18.88	16.85
Public capital stock growth rate	9.5	12.41	23.64	20.17	19.18	20.88

However, the transitional government of Ethiopia (TGE) attempted to reduce its role in the economy and promoted the active participation of domestic private sector through various economic reforms. The market liberalization geared towards creating a favorable environment for both domestic and foreign private investment.

Figure 2 and Table 2 show in the EPRDF regime (1991/92-2017/18) the growth rate of private sector capital stock was an average of 18.46% and that of public capital was an average of 23.64 %. In the year 1991/92, both private and public capital stocks registered a lowest negative growth rate (-12.44% and -10.43%) respectively because of unfavorable economic basis inherited from the previous regime. In the first ten years of the EPRDF (1991/92-2000/01) both private and public capital stocks registered remarkable growth rate which were about 8.78% and 12.41% respectively and this further continued to rise and for the second seventeen years of this regime (2001/02-2017/18) their growth rate reached an average of 10.71% and 20.17 % respectively. In the year 2012 public capital stocks grew with higher rates (i.e. 28.6%) and in the year 2018, private capital stocks grew with higher rates (i.e. 19.5%) since many incentives were under taken to increase the performance of investment activities.



Source: Author computation from national bank of Ethiopia abstracts and MOFEC data

Figure 2. The growth rate of public and private sector capital stock

Econometric Analysis

Result of Unit Root Test

Table 3. ADF Unit Root test result

	Level		First Difference	
Variables	Constant	Constant and Trend	Constant	Constant and Trend
LNRGDP	1.5083	-2.6433	-6.2430**	-6.6921**
LNKPt	1.1887	-0.4326	-6.6450**	-1.4225
LNKGt	0.3088	-1.4542	-8.1594**	-7.3815**
LNHCt	0.3067	-2.4252	--5.3185**	-5.3299**
LNLFt	1.8779	-0.6516	-4.0833**	-4.3961**
LNTOt	-2.6863	-2.1770	-6.6157**	-7.0387**
LNMIIt	-3.4556**	-3.3765	-4.3667**	-4.3088**
LNFAt	0.8451	-3.7562**	-2.6791	-2.7226

Source: Own computation using EVIEWS 9.

*Note: ***, **& * indicates level of significance at 1%, 5% and 10%.*

The above Table 4 shows that, at level except for (LNMIIt and LNFAt which are stationary al level) the other dependent and independent variables are non-stationary at 5% level of significance and we could not reject the null-hypothesis of a unit root at 5% significance level. However, at first difference they are stationary at conventional significance level. This means, not all variables are stationary at the same level or the variables are integrated of different order I(0) or I(1) at 5% level of significance. This situation forced the researchers to apply ARDL modeling and bounds testing for this study to test the existence of cointegration among variables of interest in the long- run and short- run.

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Diagnostic Tests and Model Stability Tests

Diagnostic Test

The ECM model checked all short- run diagnostic tests such as absence of serial correlation, no conditional autoregressive serial correlation, no heteroscedasticity and correctly specified functional form and distributed error term. The regression for the underlying ARDL equation fits very well at R^2= 0.99.25 and also one of the diagnostic tests checking which is presented in the following table.

Table 4 Short-run ECM version of ARDL (2, 1, 1, 2, 2, 2, 2, 2) Diagnostic Tests

Tests	LM-version		*F*-version	
	statistic	P-value	Statistic	P-value
A:Serial Correlation: Breusch-Godfrey serial correlation LM test	χ2 (2)= 8.554	0.0999	*F*(2, 29)= 2.70249	0.1810
Heteroskedasticity: Breusch-Godfrey test	χ2 (10)= 3.181	0.6290	*F*(9,31)= 1.17346	0.2640
Normality: Jarque-Bera test	χ2(2)= 1.92921	0.2322	Not applicable	
Functional Form: Ramsey RESET test	χ2(1)=.125801	0.1156	*F*(1, 22)= 0.21582	0.9310

Source: Author's computation of E view 9.5 result

Model stability tests

In this paper, the stability of the model for long- run and short- run relationship is detected by using the cumulative sum of recursive residuals (CUSUM) and cumulative sum squares of recursive residuals (CUSUMSQ) that is presented by Brown et al. (1975). The test finds serious parameter instability if the cumulative sum plots goes outside the area of 5 percent level of significance and never returns back between the two critical lines. In this study, the result of this test shows that both CUSUM and CUSUMSQ plots are within the critical bounds at 5 percent level of significance. Therefore, we can say that results of the estimated model are reliable and efficient.

Lag Length Selection

As shown in the Table 5 below, the maximum lag length included and the selected lag length is lag two. This is because, out of the five criteria AIC was selected automatically by the criterion and the remaining four (LR, FPE, SC and HQ) supported an optimal lag selected automatically at 5% level of significance. The following table provides the maximum lag length included and the

correct lag length automatically selected for the model out of six given information criterion. In the table there is a star on the results where the criteria had optimal lag. So that the optimal lag selected automatically by AIC is confirmed by other criteria like (LR, FPE, SC and HQ) is lag two.

Table 5**.** Lag Order Selection Criterion

VAR-Lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC
0	52.81422	NA	1.63e-11	-2.134010	-1.803026
1	490.4928	687.7807	3.23e-19	-19.92823	-16.94937
2	612.0474	144.7078*	2.92e-20*	-22.66892*	-17.04218*

** indicates lag order selected by the criterion*

Where,*LR: sequential modified LR test statistic (each test at 5% level);FPE=Final prediction error;AIC= Akaike information criterion;SC= Schwarz information criterion;HQ=Hannan-Quinn information criterion*

Long- Run ARDL Bounds Tests for Cointegration

As the results of all variables are integrated at first order integration to undertake appropriate bound test, first the best ARDL model was determined by using the Akaike Information Criterion (AIC). As the resulted indicated below in Table 6, null hypothesis of no cointegration against alternative hypothesis rejected, since the computed value of F-statistics (7.3624) is greater than the upper level of bounds critical value of 4.43 and lower bounds value of 63.15 for k=7. This conclusion indicates that there is a long-term equilibrium relationship among variables. Having found a long- run relationship by bound tests, the ARDL method was applied to examine the long- run and short- run parameters.

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Table 6**.** Bounds Test Result

Levels	Bounds		Critical values
10% Level	Lower bound	I(0)	2.12
	Upper bound	I(1)	3.23
5% Level	Lower bound	I(0)	2.45
	Upper bound	I(1)	3.61
2.5% Level	Lower bound	I(0)	2.75
	Upper bound	I(1)	3.99
1% Level	Lower bound	I(0)	3.15
	Upper bound	I(1)	4.43
F-Statistics			7.36244**

Null Hypothesis: No long-run relationships exist

Source: Own computation using EVIEWS 9.

From the above Table 7, we can see that the F-statistics value is equal to 7.3624 which exceed upper bound critical value at 1%, 2.5%, 5% and 10% level of significance. This implies that the null hypothesis of no long-run relationship is rejected and the alternative hypothesis is accepted based on the bounds testing result revealed. From this bounds test result, we conclude that the variables are cointegrated at all level of significance. That means there is long- run relationship among variables at, 1%, 2.5%, 5% and 10% level of significance. Therefore, we have evidence to say the variables move together in the long- run at all level of significance presented in the above table.

The result suggests that the long-run impact of real private capital stock on economic growth is found to be positive and statistically insignificant. Besides to its insignificance, its positive effect is consistent with the theoretical prediction of the classical growth model and the endogenous growth model, as physical capital stock is an engine of economic growth through accumulated investment. The insignificant impact of private capital on economic growth in Ethiopia for the study period may be due to political and macroeconomic instability. In Ethiopia, the trend of physical capital stocks across the two regimes were erratic in performance, because each government that came into power started afresh and followed a different political ideology (Zelealem, 2008). The other reason may be due to crowding out of private capital by government

capital. We can understand that, from the result government capital affects economic growth negatively means, the large share of public capital is invested in unproductive projects.

Long- Run Relationship

Table 7. Estimated Long- Run Coefficients using the ARDL Approach ARDL (2, 1, 1, 2, 2, 2, 2, 2) selected based on Akaike Information criterion

Dependent Variable: LNRGDP				
Regressors	Coefficient	Standard error	t-Statistic	Prob.
LNKPt	0.2062	0.1618	1.2747	0.2170
LNKGt	-0.3218	0.1418	-2.2689	0.0345**
LNHCt	0.2662	0.0828	3.2135	0.0044**
LNLFt	2.5055	0.7301	3.4318	0.0026**
LNTOt	-0.3173	0.0493	-6.4414	0.0000***
LNMIIt	-1.2805	0.5028	-2.5468	0.0192**
LNFAt	-0.1731	0.0983	-1.7602	0.0937*
CON	-29.4845	11.3133	-2.6062	0.0169**

Source*: Own computation using EVIEWS 9. Note; ***, ** and * indicates level of significance at 1%, 5% and 10%.*

The long- run model also shows that the impact of public capital stock on real GDP is negative and significant at 5% level of significance in the long- run. The result suggests that long- run elasticity of real GDP with respect to public capital stock is -0.3218, this implies that a one percent increase in real public capital stock decreases real GDP by 0.3218 percent in the long-run, citrus paribus and statistically significant at 5% level of significance. The effect of government capital stock is negative and significant; supporting the fact that public capital was mostly invested in white elephants and unproductive projects that crowd out private investment by wasting scarce resources, thereby reducing economic growth (Khan and Kumar, 1997). The result is consistent with Akitoby and Cinyabuguma (2004) that found negative impact of public capital accumulation. Investments in public capital may not always be productive (Easterly and Serven 2004; Canning 1999) because of range from administrative inefficiencies to pork barrel politics to corruption. This unobservable factor could cause public capital to be overestimated and the estimated elasticity of output with respect to public capital should reflect this spending inefficiency.

The estimate of the human capital variable bears a positive sign and significant at 5% level of significance. The result shows a 1% increase in human capital leads a 0.27 % rise in real GDP. In fact, education and health affects economic growth directly through labor productivity and the

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economic burden of illnesses. Different empirical findings support this positive linkage between human capital and economic growth. The finding of this paper concerning the long- run positive impact of human capital is consistent with the endogenous growth theories (mainly advocated by Lucas (1988), and the modified version of Solow Swan model, Mankiw et al. (1992) which argue that improvement in human capital, skilled workers, leads to productivity improvement that enhances output. This finding is consistent with studies by Leoning (2004) and Barro and Xavier (1995), who found that human capital has a significant positive impact on economic growth. With respect to the researches made in Ethiopia, the finding is consistent with Tekilu and Jemal (2019); Kidanemarim (2013) and Teshome (2006).

The study examined the role of labour force; it shows a one percent increase in labor force leads the real GDP to increase by 2.51 percent and statistically significant. This relationship is consistent with both exogenous and endogenous growth models as working age population would help the economy to grow in long- run. The study also found that trade openness negatively and significantly affect real GDP in long- run. The result revealed that a 1% increase in trade openness leads to 0.3173% decrease in real GDP. The result compares well with the findings of Jafari et al. (2012) and Haussmann et al. (2007). The observed negative and statistically significant impact of trade openness on real GDP may resulted from increasing inflation due to increase in trade openness or the country is specializing in production of low quality products as presented in the study of (Jafari et al., 2012; Huwang and Rodrick, 2007).

The long- run impact of macroeconomic instability on economic growth revealed in the above table found to be negative and significant with an elasticity of 1.2805 at 5% level of significance. The result is consistent with theoretical prediction of different authors and empirical studies like (Alemayehu, 2001; Andres 1993; Levine and Rennet, 1992) also supports the existence of negative relationship between microeconomic instability and economic growth. According to Levine and Rennet (1992), the major cost of economic instability can be to reduce economic growth through its depressing effect on capital accumulation. Alemayehu (2001) found that saving and macroeconomic instability are negatively related. Since there is a strong correlation between investment and saving, the negative impact of instability on saving will lead to reduce investment and hence economic growth.

As indicated in Table 7 above foreign aid has negative and significant impact on real growth domestic product in Ethiopia at 10% level of significance. The result shows that a 1% increase in foreign aid leads a 0.1731% decrease in real GDP and statistically significant at 10% level. This shows that the much dependence on foreign aid for different activities of the country has negatively affected the growth of the economy. From the result, we argue that inflow of foreign aid may be used to finance consumption rather than financing investment projects that has positive impact on economic growth which is meaning that if aid is used to finance consumption, it can have negative impact on economic growth through: weakening hard working and creativity which exacerbated dependency on foreign country.

Short- Run Relationship: ECM

The speed of adjustment or the error correction term (ECT) is represented by CointEq (-1) and come up with the expected sign and level of significance.

In an empirical sense, the result of error correction term revealed in the table 3.5 is equal to -1.2208, which is 122.08% > 100%. According to Narayan and Smith (2006) the highly significant error correction term further confirms the existence of a stable long- run relationship even though most economists recommended that ECT < 1. Moreover, the coefficient of the error term implies that the deviation from long- run equilibrium in the current period is corrected by 122.08% in the next period to bring back equilibrium when there is a shock to a steady state relationship. But, 122.08% means it has oscillating type convergence to long- run equilibrium and it takes less than one year to return back to its long- run equilibrium. In addition, the coefficient of determination (R-squared) is high explaining that about 99.25 % of the real GDP is explained by the explanatory variables included in the regression. Moreover, the DW statistic does not suggest autocorrelation and the overall significance of F-statistic is quite robust indicating that all variables are jointly significant.

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Table 8**.** Short- run relationship

Dependent Variable D(LNRGDP)				
Regressors	Coefficient	Std. Error	t-Statistic	Prob.
D(LNRGDP(-1))	0.1907	0.1669	1.1409	0.2674
D(LNKPT)	-0.7019	0.3785	-1.8546	0.0785*
D(LNKGT)	-1.0082	0.5435	-1.8551	0.0784*
D(LNHCT)	0.0121	0.1032	0.1176	0.9076
D(LNHCT(-1))	-0.1708	0.0869	-1.9649	0.0635*
D(LNLFT)	15.3316	12.9658	1.1825	0.2509
D(LNLFT(-1))	28.3033	11.3946	2.4839	0.0220**
D(LNTOT)	-0.0686	0.0506	-1.3549	0.1906
D(LNTOT(-1))	0.1997	0.0805	2.4799	0.0222**
D(LNMIIT)	-0.3356	0.2569	-1.3063	0.2063
D(LNMIIT(-1))	0.5290	0.2478	2.1353	0.0453**
D(LNFAT)	0.1336	0.0967	1.3820	0.1822
D(LNFAT(-1))	0.3749	0.0897	4.1788	0.0005***
CointEq(-1)	-1.2208	0.2070	-5.8971	0.0000***

R-Squared = 0.9964 *Adjusted R-Squared = 0.9925*

F-Statistic = 260.8715 *Prob. (F-statistic) = 0.0000* *DW-Statistic = 1.9448*

Source; Own computation using EVIEWS 9

*Note; ***, ** and * indicates statistical significance at 1%, 5% and 10% level.*

From the above table 4.5, both private physical capital and public physical capital have negative impact on Ethiopian economic growth and statistically significant at 10% level of significance in the short- run. This is might be because the impacts of these capitals may not be seen in the short- run or it needs a long gestation period for capital to bring a sustainable increment in economic growth and the productivity of such capital stocks is only visible in the long- run.

On the other hand the impact of human capital on economic growth of Ethiopia is positive and insignificant in the first period and negative and significant at 10% level of significance with lag one in the short- run. The negative sign of this human capital with lag one supports different

growth theories which emphasize that the impact of such human capital is observed in long- run rather than in short- run.

Conclusions

The main objective of this study is to examine the impacts of private and public physical capital accumulations on economic growth in Ethiopia for the period 1974/75 to 2017/18. To determine the long -run and short -run impacts of private and public physical capital accumulations on economic growth of Ethiopia, Autoregressive Distributed Lag (ARDL) model was applied. As the result indicated the bounds test (F-statistic) value is larger than the upper bound critical value at all level of significance, which indicates the existence of long- run relationship between real GDP and explanatory variables in long- run during the study period.

The empirical result showed that private physical capital stock has positive and insignificant impact on real GDP in the long- run while public capital stock has a negative and significant impact on economic growth at 5% level of significance in the long- run. It tells that private physical capital stock has statistically insignificant impact on economic growth of Ethiopia in the long- run. Likewise, human capital and labor force has a positive and statistically significant impact on economic growth of Ethiopia at 5% level of significance in the long- run. The trade openness, macroeconomic instability and foreign aid have negative impact on economic growth during the study period in long- run. The negative impact of trade openness on economic growth of Ethiopia indicates that the international integration is not a beneficial strategy for economic growth of Ethiopia in the long- run, may be due to imbalanced international trade. The finding confirms that there is the negative impact of foreign aid on economic growth of Ethiopia. We argue that the finding might be resulted from financing of consumption rather than financing investment projects by using inflow of foreign aid which has negative effect on production and productivity in the long- run over the year of the study. Moreover, the short- run finding also revealed that, both private and public physical capital stocks have negative and significant impact on economic growth in the short- run with one- year lag.

Policy Implications

Given the relative higher contribution of the private capital stock than public capital in stimulating economic growth, policies designed to attract private capital and making conducive environment for private investors should be deep enough to stimulate private capital stock and

much focus has to be given to the development of such private sectors so as to improve the role played by these sectors in capital formation and hence, boost economic growth at large.

As can be drawn from the empirical result of this study, public capital stock has negative impact on economic growth in the long- run. The implication is that public involvement has depressing effect in the economy. Therefore, the role played by public capital is directed to promote human resource development that has a positive impact on private investment by increasing productivity and overall innovation capacity in a country and provision of basic public goods like, telecommunication and electricity. Besides, cognizant of the long- run significant role of private capital stock on economic growth of the country, supplementary reforms that will improve the country‘s investment level shall be taken into account. Rather than investing public capital in unproductive projects it is profitable to invest in Public sector investments since it is important for creation of physical assets including economic infrastructure (roads, railways, highways, airports, seaports, power plants, energy network, and so on) and social infrastructure (universities, hospitals, nursing homes, public schools, and so on) to develop a society and promote private investments.

Disclosure statement

No potential conflict of interest was reported by the authors

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