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**Article**

## The determinants of public investment in Ethiopia: An ARDL approach

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## GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

# The determinants of public investment in Ethiopia: An ARDL approach

Solomon Tilahun<sup>1\*</sup>

**Abstract:** Public investment has shown increasing trends both in nominal and as a share of GDP over years in Ethiopia. These upsurges in public investment are believed to be due to factors that have visible impact on the fiscal posture of the country. To investigate the validity of Wagner's law in Ethiopia; this study sets determinants of public investment in Ethiopia as a general objective. Specifically, the study sought to examine the main influencing factors on level of public investment in Ethiopia along three sets of explanatory variables. In order to meet the aforementioned objective, the study employed an autoregressive distributed lag (ARDL) approach over the period 1985–2019. Results from the bound tests show that there is a long-run relationship between the variables. The real per capita GDP is found to be positively and significantly impact on level of public investment which shows that there is an evidence in favour of Wagner's law, i.e. public spending has a high income elasticity of demand. This study also found that there is a positive relationship between public investment and private investment which shows that two are moving in tandem. Again, the study also found that foreign aid has positive impact on public investment implying that additional foreign aid leads to larger spending of the government on capital. Moreover, the study found that the degree

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Solomon Tilahun is a Researcher at Poverty and Social Welfare Studies center of Policy Studies, Addis Ababa, Ethiopia. He has extensive years of experience in teaching, research at different universities and as well as experience in bureaucracy. He has an MSc degree in Economic Policy Analysis from Addis Ababa University and a BA degree in Economics from the same institute. His research areas of interest encompass impact evaluation of development projects, private sector development, review on social protection, poverty analysis and social welfare studies etc.

### PUBLIC INTEREST STATEMENT

The rising of public investment through spending the infrastructures and economic service is receiving big attention at recent times in Ethiopia. In the last two decades, the country is achieving sustainable economic growth that is heralded with international financial institution like IMF and World Bank. Based on this success stories the Government of Ethiopia announced successive Economic Development plan requiring substantial amount of public investment. Many controversies have arisen since the plan was announced. The popular view is that the plan is too ambitious and will disturb the economy by crowding out private investment and by worsening the fiscal structure of the government. In line with this, this study attempt to assess the determinants of public investment spending in Ethiopia using time series data from 1985 to 2019. The study found that public investment plays complementary role to the private investment. In Ethiopia, this study indicated that there is an evidence of rise of public investment with level of economic growth and increase in rate of growth of economy.

of urbanization suggests that levels of public spending are higher in the urban sector than rural economies. These findings give strong policy implication to the policy makers because an increase in public investments in may then help spur economic growth.

**Subjects:** Economics; Political Economy; History of Economic Thought

**Keywords:** ARDL; Ethiopia; Wagner's law; public investment; Economic Growth

## 1. Introduction

The determinants that affect the size of government spending which is commonly known as public investment have been a centre of attention of economists since A. Wagner (1893). The increase in rate of public investment has an impact on the economic growth and development of a country (Cooray, 2009). Mo (2007) found that all other types of government expenditures excluding public investment have negative contribution to economic growth. The negative impact of unproductive government expenditure further is manifested in terms of higher unemployment and low levels of private investment. There are various studies that have recommended the factors that determine the growth of public investment as demographic factors such as population growth and urbanization (Kimakova, 2009; Shelton, 2007) and macroeconomic variables like debt and openness (Mahdavi, 2004). Throughout time investigations on the government spending begun to receive global attention. There has been relatively little research done on the determinants of public investment unlike private investment in developing countries in general and Ethiopia in particular. The main reason behind motivating this research on determinants of public investment is that public spending take the lion share of gross capital investment in Ethiopia and it is important to have an understanding of its determinants. Consequently, the objective of this study is to assess the determinants of public investment in Ethiopia in from 1985 to 2019. Moreover, the findings of this study will provide a platform for future research on the determinants of public investment in Ethiopia.

The main aim of this research is to investigate the key determinants of public investment as well as the validity of Wagner's law in Ethiopian context. This research has two important main contributions. First, it serves as a spring board for same type of studies that will be conducted in Ethiopia and also contributes to the existing literature in the field in general. Second, it also serve as whether public spending through public investment is crucial element of designing appropriate economic development strategies as well as help government of Ethiopia produce evidence based economic policy proposals for poverty reduction strategies. Moreover, by giving glimpse of ideas on factors that determine public investment in Ethiopia, the study will help policy makers to endorse appropriate policy that geared towards sustainable development and economic prosperity.

This study is organized as follows: Section 2 presents background on public investment with brief literature review and Section 3 consists of a discussion on trends of public expenditures in Ethiopia. In Section 4, the theoretical consideration and model specification, the description of variables and empirical techniques while section 5 presents and discussion of the results of the study, while Section 6 gives conclusion of the study.

## 2. Background public investments: a brief literature review

Public investment plays an important role in facilitating developing countries to enable sustain their economic growth and development at the same time letting them to realize their Sustainable Development Goals (SDGs) (UNCTAD, 2016). The importance of public investment to the socio-economic advancement of a country cannot be overstated (Global Infrastructure Hub, 2017). Inadequate or underwhelming public investment hinders the general publics' access to markets, as well as income opportunities and services such as clean water, education, health, transport and communication (ILO, 2010). Increasing public investment is thus generally perceived as a spine in national development strategies of emerging economies (Atolia et al., 2017). Both The World Bank

and African Development Bank (AfDB) promoted for public investment especially in the sector that take lion share in the economy to promote economic growth in sub-Saharan Africa (AfDB, 2020; World Bank, 2020). Retrospectively, the main factors that influence the level of public investments are diverse and differ from one country to another and from one economic region to another and so forth.

Conventional economic theory on public investments and its means of financing believes that offers a basis for nation's social and economic development (African Development Bank (ADB), 2018). These ideas are also forwarded by Nannan and Jianing (2012); they showed that public investment as an instrument to provide the basic framework for a country to sustenance necessary public service in order to get higher economic growth and a better quality of life. The lack of infrastructure such as water, power and transport services has been noted to be one of the major bottlenecks to industrial development in Africa. In reference to economists at the African Development Bank, industrialization is fundamental to ending poverty and generates employment for over 12 million young people in Africa (African Development Bank (ADB), 2018). Jedwab and Storeygard (2016) state these views by further asserting that socially, infrastructure investment leads to increased access to essential services which are meant to reduce inequality, foster inclusion and support poverty reduction efforts. In most cases, the poorest communities benefit the most from public infrastructure development because it brings basic amenities and employment right to their doorstep and thus refining their standard of living (Baum-Snow et al., 2017).

It is general consensus among economists that public capital investment can have a multiplier effect on productive capacity of an area or place (Cavallo & Daude, 2011). Similarly, public investment boosts the productivity of private capital, raising its rate of return and inspiring more investment. Cohen and Morrison-Paul (2001) indicated that the amount and value of public investment have an impact on the costs and efficiency of private investments, and subsequently on economic dynamism and development. This in turn has brought about postulations that a 10% growth in infrastructure endowment increases output per worker by about 1% in the long run (Calderon et al., 2015). To sum up, infrastructure investment shapes economic activity in a country because it can produce long-standing economic improvements by reducing trade costs and integrating markets, possibly changing the economic setting in poor, remote regions with high trade costs (Gurara et al., 2018). For this aforementioned positive affirmation of public investment in economic growth and social change, Kodongo and Ojah (2016) assert that public investment should be in a sector that has comparative and competitive advantages.

There is a numerous literature available on the study of the determinants of public investment, with different methodologies and techniques used in the studies. Some studies regard foreign aid is one of the reason for rise in demand for public investment (Njeru, 2003; Quattara, 2006; Swaroop et al., 2000), while some of them give credit to the burden of external debt servicing as one of the factors for rise in public investments (Mahdavi 2004; Shonchoy, 2010) and Shelton (2007) argues that rise of populations and urbanization as determining factor for an increase in public investment (Shelton, 2007). Additionally studies (Milesi-Ferretti et al., 2002; Persson & Tabellini, 1999; Shelton, 2007; Shonchoy, 2010), income (Akpan, 2011; Aregbeyen, 2006; Henrekson, 1993; Hong, 2015; Hong & Nadler, 2015; Sideris, 2007) show that political regimes and institutions play determinate role in public spending. Public investments makes substantial contributions in terms of economic growth, productivity improvement, employment, trade competitiveness, environmental sustainability and people's safety (Agénor, 2010; Heintz et al., 2009; Rioja, 2001; Zhang et al., 2011).

Ethiopia envisioned graduating its transition to middle-income country and carbon-neutral economy by 2025. For success of this vision government has introduced prudent macro-policy management and large investments are allocated to provision of infrastructure development. Over the past decade, the average annual gross domestic product (GDP) growth has been 10.6%, that is, double the average in the rest of Sub Saharan Africa (International Monetary Fund, 2015).while also public expenditure has showed considerable increase while at the same time general government deficit expanded only marginally (by 0.2 percentage point) to an estimated 2.8 per cent of GDP. As a result,

their financing needs increased to 7.4 per cent of GDP, while public and publicly-guaranteed debt reached an estimated 50 per cent of GDP in June 2015 (International Monetary Fund, 2015). The rise in need for the public investment and neglect of this issue over the last generation has left Ethiopia with a critical infrastructure deficit. The result of such declining and insufficient investments has been a worsening infrastructure deficit and mounting investment needs. According to the overall competitiveness index in the — 2013–2014 Global Competitiveness Report Ethiopia ranked just 124<sup>th</sup> among 148 countries in terms of infrastructure (World Economic Forum, 2013). To address the country's infrastructure deficit the Ethiopian government began spending huge amount of money in each fiscal year in addition to public enterprises investment. In the 1999/00 fiscal year the total physical public infrastructure investments (on transport, road construction, energy and telecommunication) equalled 5.82 per cent of GDP and the total social public infrastructure investments (on education and health) equalled 0.69 per cent of GDP; in 2009/10 fiscal year the gross capital formation of physical and social infrastructure increased impressively to 10.65 per cent and 2.63 % of GDP, respectively (MoFED, 2013). In the 2013/14 fiscal year the physical and social infrastructure investment was 9.83% and 2.42% of GDP, in this fiscal year the infrastructure investment as percentage of GDP decrease but it doesn't mean the total investment amount decreased rather it is due to the expansion of the country's economic base (MoFED, 2013). The figures above infer that the increment in public infrastructure in Ethiopia is quite impressive. So, this increase in the public investment from time to time has the connotation of how crucial this spending is for development.

### 3. Trends in public expenditure in Ethiopia

Ethiopia has good success story in achieving a consolidated strong record of fiscal and public management (MoFED, 2013) while the fiscal deficit declined from 8.0 per cent of GDP in 2004/05 to 2 per cent in 2012/13, while net domestic borrowing fell from 2.5 to 0.2 per cent of GDP during the same period. In line with the Growth and Transformation Plan (GTP), pro-poor sector spending as a share of the general government budget has increased steadily from 28 per cent in 1999/2000 to reach the target of 70 per cent in 2012/13, although it has stagnated as a share of GDP as a result of the containment of total public sector spending as a share of GDP (MoFED, 2014).

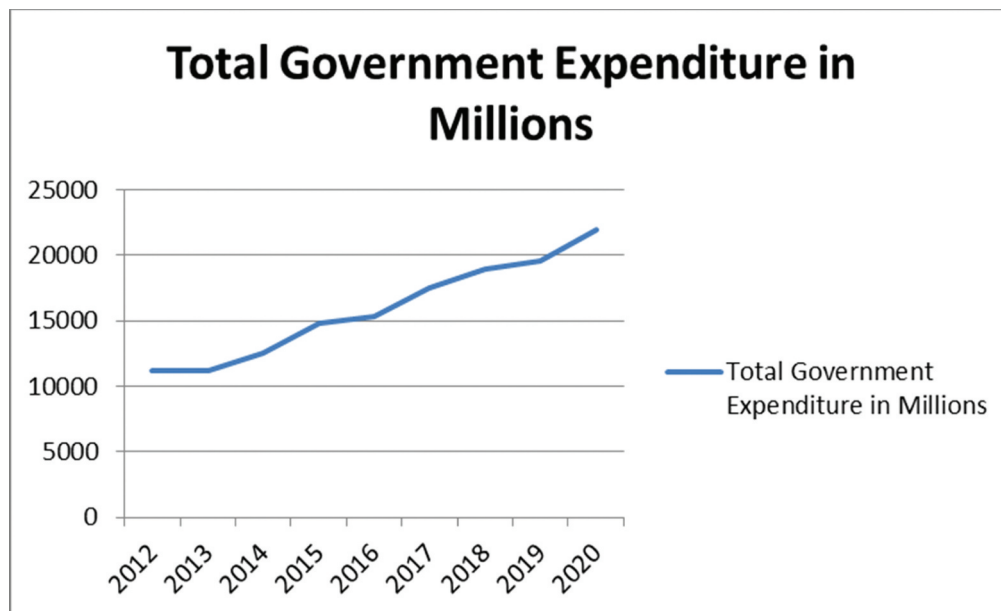
The Government has also stressed that coordination between policymaking, planning and budgeting is crucial to raising the efficiency of public expenditure on poverty-oriented sectors. The fiscal deficit of 2.0 percent of GDP in 2012/13 was kept at a low level as a result of cautious fiscal management. The deficit was largely financed by external borrowing supplemented by a small amount of net domestic borrowing, equivalent to about 0.2 percent GDP (MoFED, 2014). Ethiopia's public finance management can be characterized as having been prudent: it has kept the budget deficit low, while scaling up expenditures on critical sectors of the economy, particularly infrastructure and pro-poor sectors. Public resource mobilization and investment have increased significantly over the past years. Resource mobilization has been largely domestic-focused and supported by measures taken to improve the tax administration (MoFED, 2014). In 1999/00 government expenditure was around 32 per cent of GDP while total government revenue was 19.4 per cent of GDP. This clearly indicates that there is an excess of government expenditure over revenue, which leads to huge budget deficit. As MoFED (2013) represented, the liberalized regime (1992–2012) revealed that the budget deficit has also remained significant even after the introduction of various reform programs during 1992/93.

In simple and brief words, total revenue and expenditure are increasing. However, the increase in latter is much higher than that of the former one and this has created the budget deficit to be widened over time. Figure 1 below indicates that with respect to government expenditure, up to the period 2007/08 the share of current expenditure to total expenditure is greater than that of capital expenditure. In recent years capital expenditures and revenue mobilization were increasing. Specifically in 2008 and 2009 revenue collection was improved leading to fall in budget deficit growth rate. Generally fiscal situation of Ethiopia is determined by its capacity to mobilized revenues, whether conditions, external factors (donors' response). The deficit indicates the country's dependence on external resources (Tadesse 2011).



**Figure 1. Total government expenditure in millions.**

Own calculation Based on NBE data

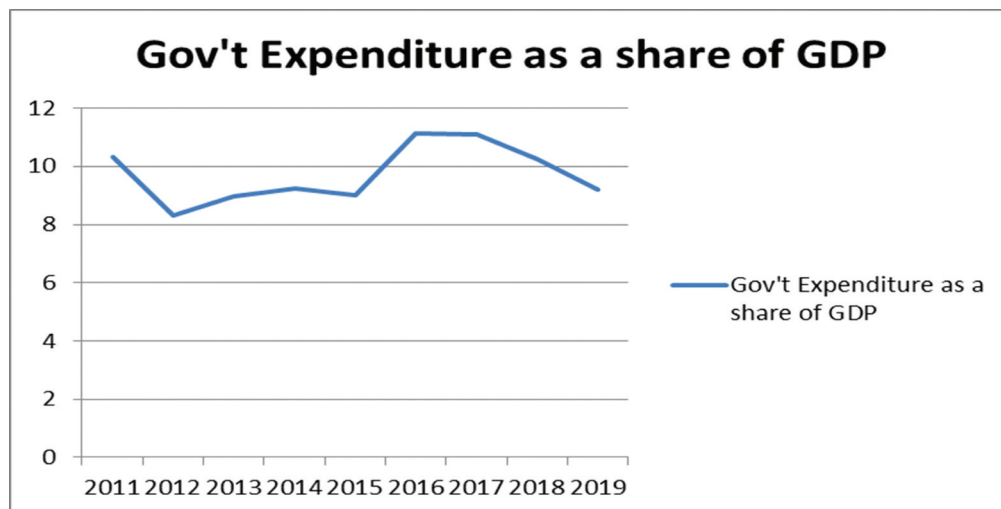


Moreover, so as to have further understanding on the trend of government expenditure in Ethiopia, it is of vital importance to give glimpse of points on the share of government expenditure in GDP of Ethiopia over time. Figure 2 below portrays the updates of graphical illustrations of the share of government expenditure in GDP of Ethiopia between 2011 and 2019. As it seen from the figure the highest share of government expenditure in GDP was recorded in year 2017 which can be attributable to government dire attention to capital expenditure supported by its 5-year growth and transformation plan (GTP). Generally, it is clear observation that the trends of public expenditure show fluctuation over the years pertaining to the effects of different policy programmes of government.

Figure 3 above reveals that the share of government recurrent expenditure averaged between 7 % and 20 % over the period 1999/00–2019/20 while that of capital expenditure has been constantly below 11% throughout the whole period. The relative declining trend of capital expenditure

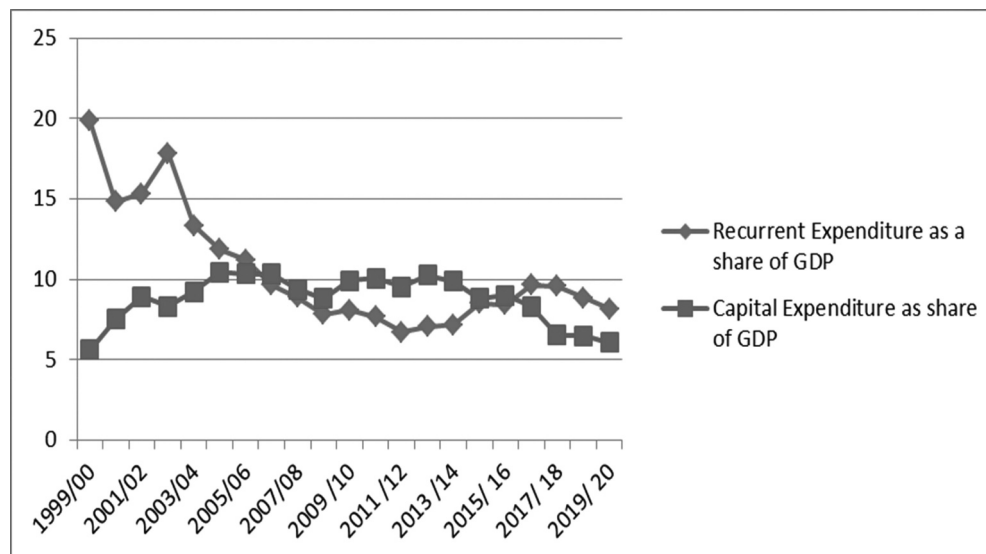
**Figure 2. Trends of government expenditure (as a share of GDP) for Ethiopia, 2011–2019.**

Own calculation based on NBE data



**Figure 3. Trends of expenditure (as a share of GDP) for Ethiopia, 1999/00–2019/20.**

Own Calculation Based on NBE data



over the 1990s may be credited to austerity measures enacted on the government by the Bretton woods institutions—either in form of World Bank’s structural adjustment programmes or through IMF’s stabilization programmes. As of most recurrent expenditure goes to fixed (salaries and wages, interest on public debt, constitutional offices etc), the only opportunity the government has in the wake of these austerity measures is its development budget. Therefore majority of the expenditure cuts have been implemented through decreases in development expenditure, in which this will in turn contribute to the diminishing trend of total government expenditure particularly in the 1990s. The implication is that it is displeasing trend since capital expenditure is anticipated to offer the needed infrastructure for private sector investment and growth and therefore low budgetary allocation on this item means these services have been under-provided. On the other hand, recurrent (consumption) expenditure has remained relatively high (and could have been much higher had we included the debt redemption component) and shows an upward trend in the 1990s.

However, the share of capital expenditure in GDP began to take its lion share in total government expenditure from 2007/8 onwards. This is so for the reason that prior to year 2008, there was less importance is attached to public sector investment and most of the government expenditure devoted to its current component. However, from recent years onwards the aim has been given due attention for the public sector developments. Consequently, the share of capital expenditure has been increasing. On the other hand, as it is revealed in [Figure 3](#) below the government spending has been growing rapidly in recent years while prioritizing poverty reduction expenditures in the main sectors of health, education and agriculture. Before 2014/15, the national expenditure pattern mainly focused on allocating more resource for building economic and social infrastructure to provide basic services (MoFED 2014). During those periods, the majority of the yearly budget was dedicated to capital expenditure, which is important to bringing potential benefits in long run through development of physical assets and infrastructures, as well as supporting human resources development. In recent times, nonetheless, capital expenditure as a share of total expenditure dropped consistently (MoFED 2014).

It is palpable that expenditures in social sectors are of dire importance in the fight against poverty and even more indispensable for development of social welfare. In essence, public expenditure has been aligned to poverty reduction priorities in Ethiopia. Sub-national expenditures are also consistent with poverty reduction goals. In this regard, the GoE has allocated colossal resources to lift spending in what it refers to as the “main pro-poor sectors”, namely health, education, water and energy (which includes all energy projects, such as the construction of mega dams and power plants), roads, as well



as agriculture and food security (with approximately half of the agriculture budget allocated to the PSNP). As shown in Figure 4 below, the strong commitment to educational development is reflected in expenditure allocated to the sector, which has increased steadily since 2012/13 to reach 27 per cent of total government expenditure in 2016/17. Road construction as well as agriculture and food security each received 10 per cent of national expenditure in 2016/17, while health and nutrition, and water, energy and electricity received 8 per cent and 7 per cent of national spending respectively in the same period.

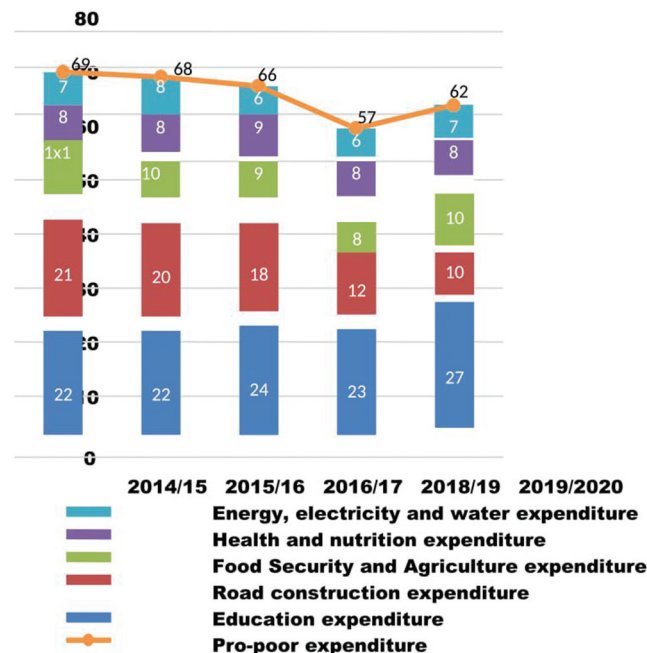
#### 4. Theoretical consideration and model

##### 4.1. Model specification public investment equation

Kirchgassner, (1988), Tanzi and Davoodi (1997) and Sturm (2001) classified main factors that play a detrimental role for the public investment into three natal A summary of the contributing factors to public investments (explanatory variables) was classified into three sets of independent variables: structural, economic and politico-institutional variables. These variables were used to test Wagner's Law which stresses the transformation of traditional societies into industrialized societies with their shift from the family to the public sector of services that is, education and health care (Henrekson & Lybeck, 1988). Thus, this study employed public investment model by borrowing the theoretical foundation of Tanzi and Davoodi (1997) and Sturm et al. (1996). Accordingly, public investment ratio for varied range of countries was modelled by Tanzi and Davoodi (1997) as a function of corruption, real per capita income, and the government revenue to GDP ratio. Their findings suggest that an increase in corruption index increases public investment while reducing its productivity. With his focus on developing countries, Sturm (2001) models public investment using three sets of independent variables: structural variables, such as urbanization and population growth; economic variables, such as real GDP growth, government debt, budget deficits, and foreign aid; and politico-institutional variables, such as political stability and political business cycles. Sturm (2001) investigates that that politico-institutional variables do not seem to be important in explaining public investment in developing economies, in contrast to structural and economic variables. In line with this study uses the real per capita income(LYRPC),foreign aid as a percentage of gross national income(AIDNI), rate of growth

Figure 4. Pro-poor spending.

Data from MoF.



of urbanization (URBAN), debt servicing as share of GDP (DEBTSERY), degree of openness (OPEN) and private investment (PIV) as factors determining the growth public investment in Ethiopia. Where as  $V_t$  is the stochastic error term and the model of public investment specified by:

$$PUBINV_t = \beta_1 + \beta_2 LYRPC + \beta_3 AIDNI_t + \beta_4 URBAN_t + \beta_5 DEBTSERY_t + \beta_6 OPEN + \beta_7 PIV_t + V_t \quad (1)$$

Tanzi and Davoodi proxied level country's economic development by the real per capita income variable. The impact of the urbanization rate on public investment is vague. Similarly, it could be argued that as a society turn out to be urbanized, there is a shift from the family to the government with regard to the provision of services like education and health care; thus, one might expect the coefficient on urbanization to be positive. It is acceptable that increasing urbanization leads to more demand for physical infrastructure which the case for LDCs and perhaps more demand for public consumption spending, giving rise to a positive coefficient (Sturm, 2001). It is also anticipated that higher foreign aid allows governments to spend more on public investment. The openness indicator is included as an explanatory variable because more open economies often compete for foreign direct investment by, among other things, trying to invest more in infrastructure; thus, there is likely to be a positive relationship between openness and the public investment ratio.

#### 4.2. Data and variables

Secondary data sources collected for this study. The identification of the data sources was the first step in the data collection process and efforts were made at ensuring that data sources were consistent for all the variables. In order to conduct econometric analysis, the study used secondary data over the period 1985–2019. The sources of the data are World Bank (WDI, 2015 and World Bank, 2020), Ministry of Finance (MoFED, 2014, 2014), National Bank of Ethiopia (NBE). Prior to use of data in the models, time series properties of data set were conducted on the data selected for the analysis.

MoF stands for Ministry of Finance of Ethiopia and WDI stands for World Development Indicators by World Bank. Data are measured in both nominal form and real terms in local currency (Birr) and PIV is converted natural logarithm.

#### 4.3. Econometric model

Now, public investment equation is formulated by an autoregressive distributed lag (ADL) model. The preference of an ADL model over a static one is driven by the necessity to address all the dynamic responses in the dependent variable brought about by changes in its own lags and the contemporaneous and lagged values of the other explanatory variables. Additionally, an ADL model is more appropriate for small samples like in this study. Directly estimating a static long run equation may fail to capture any immediate, short run, and long run responses in the system thus generating imprecise coefficient estimates (Banerjee et al. (1993), Charemza and Deadman (1997), and Johnston and DiNardo (1997). Estimating the model in this way gives a valid *t*-statistics even when some of the right hand variables are endogenous (Enders, 1995).

This paper conducted the ARDL method in two steps (Pesaran and Pesaran, Pesaran. and Shin, 1997) such that in the first step, test of no co-integration hypothesis is done. The method applies the *F*-test, even though the asymptotic distribution of the *F*-statistic in this context is non-standard regardless of whether the variables are *I*(0) or *I*(1). The critical values as provided by Pesaran and Pesaran (Pesaran. and Shin, 1997) would have been used, but this study used those provided by Narayan (2004), due to their suitability for small samples (Boakye, 2008). Two sets of values are presented. The first assumes that all the variables are *I*(1) and the second that they are *I*(0). This band allows for the fact that variables may be stationary, integrated of order one, or even fractionally integrated. In this respect, when the calculated *F*-statistic is above the upper value of this band, the null hypothesis will be rejected, indicating cointegration between the variables irrespective of whether they are *I*(1) or *I*(0). If the *F*-statistic falls below the band, then the null hypothesis of no co-integration cannot be rejected. A value within the band implies the test is inconclusive. The second step involves estimation using the ARDL method for the long and short-run parameters. In this

procedure, co-integration relationship was estimated by OLS once the lag order of the model was identified. Thus, once co-integration was established, the conditional the ARDL ( $r, s_1, s_2, s_3, s_4, s_5, s_6$ ) for long-run model for public investment equation from (1) was estimated as:

$$\begin{aligned} Giv_t = & \beta_0 + \sum_{i=1}^r \beta_{1i} Giv_{t-i} + \sum_{i=0}^{s_1} \beta_{2i} DEBTSE_{t-1} + \sum_{i=0}^{s_2} \beta_{3i} URBAN_{t-1} + \sum_{i=0}^{s_3} \beta_{4i} YT_{t-1} \\ & + \sum_{i=0}^{s_4} \beta_{5i} Aid_{t-1} + \sum_{i=0}^{s_5} \beta_{6i} Piv_{t-1} + \sum_{i=0}^{s_6} \beta_{7i} Open_{t-1} + \varepsilon_t \end{aligned} \quad (2)$$

The short-run dynamic parameters were obtained by estimating an error correction model associated with the long-run estimates. This was specified as follows for Public investment equations: The short run error correction model specified as:

$$\begin{aligned} \Delta Giv_t = & \theta_0 + \sum_{i=1}^n \theta_{1i} \Delta Giv_{t-i} + \sum_{i=0}^n \theta_{2i} \Delta DEBTSE_{t-1} + \sum_{i=0}^n \theta_{3i} \Delta URBAN_{t-1} + \sum_{i=0}^n \theta_{4i} \Delta YT_{t-1} \\ & + \sum_{i=0}^n \theta_{5i} \Delta Aid_{t-1} + \sum_{i=0}^n \theta_{6i} \Delta Piv_{t-1} + \sum_{i=0}^n \theta_{7i} \Delta Open_{t-1} + \pi' ecm_{t-1} + \varepsilon_t \end{aligned} \quad (3)$$

Where  $\theta_1, \theta_2, \theta_3, \theta_4, \theta_5, \theta_6, \theta_7$ , are the short-run dynamic coefficients of the model's convergence to equilibrium, and  $\pi'$  is the speed of adjustment to long-run equilibrium following a shock to the system.

## 5. Results and discussions

### 5.1. The unit root test analysis

Prior to conducting ARDL estimation of the model, stationarity status of chosen time series data has to be tested in order to determine their order of integration. Moreover, it is essential to check that in employing ARDL model all the variables to be included in the regression should not be integrated of order two. This indicates that unit root test is the first step in dealing with variables in the estimation of models. This offers an impression that unit root test is a tool that supports us in deciding whether or not the ARDL model should be applied. The Table 1 below displays the results of order of integration for Public Investment equation. The result in Table 2 shows that order of

**Table 1. Description of variables**

Description of variables	Variable Definition	Source	Expected Sign
PUBINV	Shows public investment in per cent of GDP	WDI Database	
AIDGNI	foreign aid in per cent of gross national income	WDI Database	(+)
URBAN	Rate of growth of urbanization	WDI Database	(+)
DEBTSE	total debt service in percent of GDP	WDI Database	(-)
LYRPC	Real Per Capita income	MoF Database	(+)
PIV	Private Investment	MoF Database	(+)
Trade openness	The degree of trade openness is proxy using the ratio of volume of trade (import plus export) to GDP	MoF Database	(+)

**Table 2. Unit root test for public investment equation**

**Augmented Dickey-Fuller Test**

Variables	Intercept	Intercept & trend	Decision
PUBINV	-3.354593*	-3.531657***	I(0)
PIV	-3.713493*	-3.660437**	I(0)
LYRPC	3.227341	1.031054	-
D(LYRPC)	-3.018816**	-4.579657*	I(1)
OPEN	-0.743467	-1.821768	-
D(OPEN)	-4.831671*	-4.723854*	I(1)
DEBTSERY	-3.063864**	-3.626985**	I(0)
URBAN	-1.465974	-1.766727	-
D(URBAN)	-4.193940*	-4.106096**	I(1)
AID	-2.479482	-2.791614	-
D(AID)	-6.381917*	-6.364818*	I(1)

\*, \*\* (\*\*\*)—indicates significance at the one, five and ten per cent level, respectively.

own computation E views 9.

integration is a mix of I(0) and I(1) but none of them is of order two. As it is showed in table variables in the Public Investment equation unveil a mixture of integration order zero and order one. That is, public investment(PUBINV), private investment as a share of GDP(PIV), debt service-(DEBTSERY) are stationary in level while real GDP per capita (LYRPC), degree of trade openness-(OPEN), urbanization rate (URBAN) and AID are stationary in first difference.

Table 2 below implies that variables in the equation have no order of integration which is two, if not it is not possible to use ARDL approach in estimation. Then this result in unit root test give an important clue to use ARDL cointegration technique proposed by Pesaran et al. (2001) which makes it the most appropriate method for estimation or to check the long run relationship among the variables. This is to ensure that the variables should not be stationary at an order of I(2) because the computed F-statistics provided by Pesaran et al. (2001) are valid only when the variables are I(0) or I(1).

## 5.2. Stability and Diagnostic Test

Diagnostic check is undertaken in order to determine consistency of the estimated long run model which essential to know the standard property of the model. Hence, this study conducted the model stability and diagnostic checking which comprised of Serial correlation test (Brush & Godfray LM test), Functional form (Ramsey's RESET) test, Normality (Jaque-Bera test), and Heteroscedasticity test. Additionally, stability of the long run estimates is tested by applying the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ) test. Such tests are recommended by Pesaran et al. (2001). In decision to accept or reject the null hypothesis, the p-values related to the test statistics are taken into consideration. Public investment model passed all the diagnostic tests against serial correlation (Durbin Watson test and Breusch-Godfrey test), heteroscedasticity (White Heteroskedasticity Test), and normality of errors (Jarque-Bera test). The Ramsey RESET test also suggests that the model is well specified.

The above Table 3 shows that the long run ARDL model estimated in this study passes all the diagnostic tests. This is because the p-value associated with both the LM version and the F version of the statistic was unable to reject the null hypothesis specified for each test. Again, detecting the stability of the model for long run and short run relationship is reported by using the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals

**Table 3. Diagnostic tests for public investment model**

Test Statistics	LM Version	F Version
A:Serial Correlation	CHSQ(1) = .58769 (.443)	F(1,19) = .35547 (.558)
B:Functional Form	CHSQ(1) = 1.6971 (.193)	F(1,19) = 1.0641 (.315)
C:Normality	CHSQ(2) = 1.3026 (.521)	Not applicable
D:Heteroscedasticity*	CHSQ(1) = .088546 (.766)	F(1,30) = .083242 (.775)

A:Lagrange multiplier test of residual serial correlation.

B:Ramsey's RESET test using the square of the fitted values.

C:Based on a test of skewness and kurtosis of residuals.

D:Based on the regression of squared residuals on squared fitted values.

(CUSUMSQ) tests. Between two critical lines if the cumulative sum goes outside the bound (i.e. never returns back), the test shows serious parameter instability.

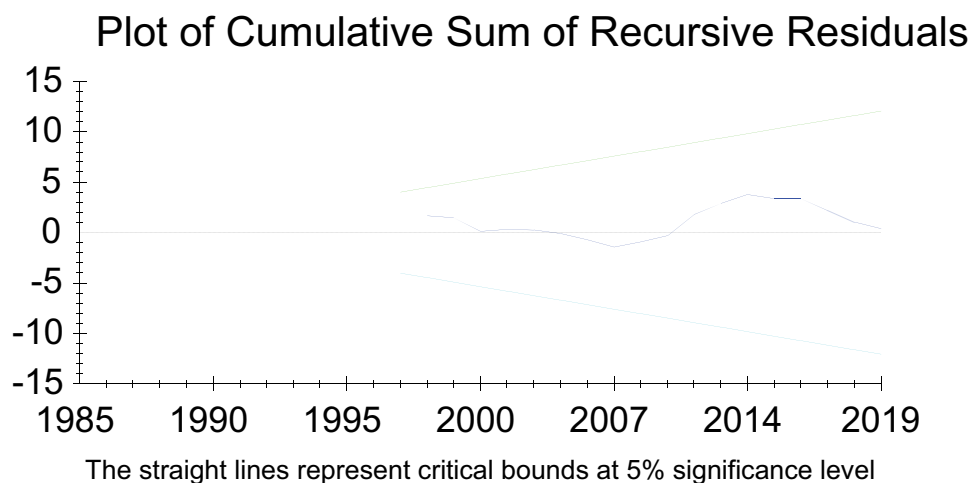
Figure 5 for Stability of Parameters for Public Investment Model.

Figures 5 and 6 above 5 show the plots of both the CUSUM and CUSUMSQ for the public investment model. It can be seen from the figures that the plot of CUSUM stays within the critical 5 per cent bound for all equations, and CUSUMSQ statistics does not exceed the critical boundaries that confirms the long-run relationships between public investment and the other variables. It also shows that the stability of co-efficient plots lie within the 5 per cent critical bound, thus providing evidence that the parameters of the model do not suffer from any structural instability over the period of study. On the similar way, figures critical limits are not crossed with the plot of CUSUM test. On the same way, the lower and upper critical limits are not crossed by the CUSUMSQ test. This has an implication that there are stable long run estimates and no structural break. From the previous diagnostic tests, it is evident that the models passed all the required tests and thus paving way for interpretation of estimates of both the long-run and short-run coefficients as required in an ARDL approach.

### 5.3. Long run ARDL Bounds tests for Co-integration

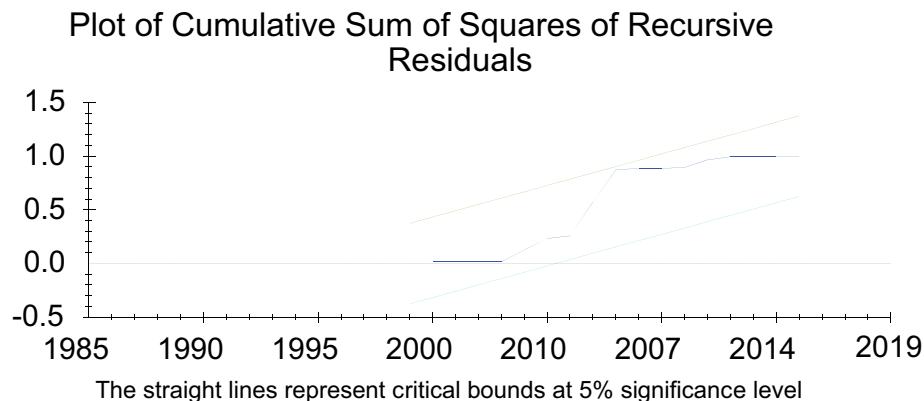
In order to empirically analyze the long-run relationships and short run dynamic interactions among the variables of interest, this study apply the autoregressive distributed lag (ARDL) cointegration technique as a general. The bounds test is mainly based on the joint F-statistic which its asymptotic

**Figure 5. for Stability of Parameters for Public Investment Model**



**Figure 6. CUSCUSQ for Public Investment Model**

Own computation based on Microfit 4.1



distribution is non-standard under the null hypothesis of no cointegration. The long run relationship among the variables exists if the calculated value of F-statistic is greater than the upper critical bound test, and if the calculated value of F- statistic is smaller than the lower critical bound, the long run relationship does not exist, if calculated value of F-statistic comes in between the range of LCB and UCB then the long run relationship is inconclusive (Mintz, 1991; Hassan & Kalim, 2012).

As it is indicated in Table 4 above, the calculated F statistics 7.55 which is higher than both the Pesaran et al. (2001) and Narayan (2004) upper bound critical values at 1% level of significance. This implies that the null hypothesis of no long-run relationship is rejected; rather accept the alternative hypothesis (there is long-run relationship) based on the Pesaran et al. (2001) and Narayan (2004) critical values at 1% level of significance. Therefore, there is co-integration relationship among the variables in long run for the model.

#### 5.4. Long run ARDL model estimation

##### 5.4.1. Dynamic modelling of public investment model

Using an ARDL model, the study began by estimating an overall model (including all relevant variables and lags) and then systematically testing downwards for their significance and other diagnostics such that in the final model, only the most relevant variables remained (Banerjee et al. (1993); Inder (1993), Charemza and Deadman (1997). After confirming the existence of long-run co-integration relationship among the variables, the next step is running the appropriate ARDL model to find out the long run coefficients, which is presented in Table 5 below. Because of many variables in the model and the limited sample size in this study, the number of lags contained into the ARDL dynamic equations was restricted to only one period. Results for each specification are discussed in the following sections. Hence the results of the models of public investment are presented below:

**Table 4. Bound test for public investment model**

Test Statistic	Value	K		
F-statistic	7.555961	7		
Critical Value Bounds				
Significance	I0 Bound	I1 Bound		
10%	2.38	3.45		
5%	2.69	3.83		
2.5%	2.98	4.16		
1%	3.31	4.63		



**Table 5. Estimated long run coefficients using the ARDL approach; ARDL (1,,1,1,1,0,1,0) selected based on akaike information criterion**

**Dependent variable is PUBINV**

Regressors	Coefficient	Standard Error	T-Ratio [Prob]
AID	.023121	.0098513	2.3470 (.029)
LYRPC	.014394	.0021298	6.7587 (.000)
DEBTSERY	.047527	.20422	.23273 (.818)
PIV	.032283	.026784	1.2053 (.242)
URBAN	.11094	.018343	6.0482 (.000)
OPEN	.027669	.0088308	3.1333 (.005)
INPT	16.1706	3.5610	4.5411 (.000)

**Own computation based on Microfit 4.1**

As it is observed from the Table 6 above variables included in determinants of public investment for economic growth have expected signs except debt servicing regardless of their significant level. The real per capita, private sector investment, debt servicing, urbanization rate and aid has positive impact on the level of public investment as a share of GDP without looking into their significance level.

As the long run estimated result of the above table showed, the real per capita GDP has positive and statistically significant impact on level of public investment. As the table result reveals a one per cent increase in real per capita GDP will cause 1.4 % rise in public investment. The positive coefficient of real per capita GDP will be a confirmation to Wagner's law of ever rising public expenditures hypothesized by A. Wagner (1893) applies to Ethiopia. This has an implication that the level of economic growth and development in Ethiopia has significantly affected the level of public expenditure in the long run. As it is shown from the result, with rising level of economic growth, the country will likely increase its public investment which clearly related to an evolving demand for goods and services produced by the public sector. This result is in line findings of earlier produced research papers like Richter and Paparas (2012), Kesavarajah (2012), Aregbeyen and Akpan (2013), and Obeng and Sakyi (2017).

**Table 6. Error correction representation for selected ARDL model; ARDL (1,1,1,1,1,0,1,0) selected based on akaike information criterion**

**Dependent variable is dPUBINV**

Regressor	Coefficient	Standard Error	TRatio[Prob]
dAID	.014555	.0064762	2.2474 (.034)
dLYRPC	.023770	.0042553	5.5859 (.000)
dDEBTSERY	-.088330	.11812	-.74777 (.462)
dOPEN	.017418	.0082210	2.1187 (.045)
dPIV	-.014377	.010535	-1.3647 (.185)
dURBAN	.016342	.030918	.52855 (.602)
dINPT	10.1794	2.2945	4.4364 (.000)
ecm(-1)	-.62950	.15447	-4.0753 (.000)

R-Squared .74950 R-Bar-Squared .61172.

S.E. of Regression .17086 F-stat. F(7, 24) 8.5485[.000].

Mean of Dependent Variable .16524 S.D. of Dependent Variable .27420.

Residual Sum of Squares .58385 Equation Log-likelihood 18.6554.

Akaike Info. Criterion 6.6554 Schwarz Bayesian Criterion -2.1390.

DW-statistic 2.1840.

**Own computation Based on Microfit 4.1**

Another variable that shows positive relationship with public investment is private investment and shows that private investment and government capital spending are moving in tandem. Its coefficient shows that the elasticity of private investment was positive and statistically significant at 1 per cent level of significance, suggesting these two series move in tandem. The finding shows that a 1 per cent increase in private investment had the potential to result in a 3.2 per cent increase in public investment. This finding is similar to Mataya and Veeman (1996), who found a positive relationship between private investment and public investment in Malawi. However, the results differs from M'Amanja and Morrissey (2006), who found a negative but insignificant coefficient of private investment, confirming a possible crowding out effect of private investment in the long-run in Kenya. As indicated in Table 5 above foreign aid has statistically significant and positive impact on public investment. Besides alleviating immediate catastrophes, foreign aid is mostly intended to help create a better environment for sustainable economic growth. Donations are often restricted in their use to, for instance, improving infrastructure. Additional foreign aid leads to larger spending of the government on capital.

The result from the table reveals that even though it is insignificant, external debt service has positive impact on the public investment which is against the expectation that countries might have offset increases in debt interest payments by winding back public capital spending. Moreover, the positive sign of the degree of urbanization suggests that levels of public spending are higher in the urban sector than rural economies. Wagner's law also suggests that public investment spending might increase with urbanization Adolf Wagner and Musgrave and Alan T. Peacock (1958). This finding is similar to most studies explaining government sizes include the so-called structural variables to test for Wagner's law, especially in the version that stresses the transformation of the traditional society into the industrialized society with its shift from the family to the public sector of services like education and health care (Henrekson & Lybeck, 1988). However, other studies also showed that in case of government capital spending there is also another demand-side reason for including the degree of urbanization. Most public capital spending concern infrastructure and rural areas are in relatively more need of those.

The table also shows that there is a positive and significant relationship between trade openness and the level of public investment in the long run in Ethiopia. This finding is also confirmed in the earlier researches such as Cameron (1978), Rodrik (1998) and Shelton (2007). The result can be expounded as a country is hit by foreign shocks through openness rises public investment meanwhile government needs to offer additional goods and services to people to moderate the foreign shocks originating from the rest of the world. Moreover, it implies that more openness give an indications to higher demand for various types of infrastructure such as transport facilities, economic services, governmental and established support systems through introduction of new establishments and organizations which have the ability to drive public investment to higher level.

### 5.5. Short run error correction model

The error correction term (ECT) is derived from the corresponding long run model whose coefficients are obtained by normalizing the equation. The error correction term indicates the speed of adjustment to restore equilibrium in the dynamic model. The ECM coefficient shows how quickly variables converge to equilibrium and it should have a statistically significant coefficient with a negative sign. According to Bannerjee et al. (1998), the highly significant error correction term further confirms the existence of a stable long-run relationship.

#### 5.5.1. ECM for public investment model

The result (table below) for Public Investment shows that the expected negative sign of ECM is highly significant. This confirms the existence of the long run relationship among the variables with their various significant lags. The coefficient of ECM =  $-0.629$ , imply that deviation from the long-term growth in Public investment is corrected by 63% by the following year.

The coefficient of determination (R-squared) is high explaining that about 75% of variation in the real GDP is attributed to variations in the explanatory variables in the model. In addition, the DW statistic does not suggest autocorrelation and the F-statistic is quite robust. The short-run result discloses

a positive and significant relationship between real per capita GDP and public investment consistent with the long-run result. This has an implication that at growth in the GDP of Ethiopia has a contribution in explaining the growth of public investment in Ethiopia in the short run. Just like the long run case this finding also implies that Wagner's law applies for Ethiopia as that rate of economic growth and level of development influences to a huge degree that volume of public investment in the economy. The short-run coefficient of openness is found to be positive and significant which shows supporting evidence to the positive and significant nexus found in the long run.

## 6. Conclusion

Similar to other developing countries, public investment through infrastructure development has a pivotal role to lifting up economic growth in Ethiopia. There are several empirical studies that are undertaken to analyze the determinants of public investment in developing countries specially in sub-Saharan Africa; but they came up with different results. This study based on theoretical motivation of Wagner's law by including other important variables that are supposed to be significant in explaining growth of public investment in Ethiopia, it is aimed at investigating the determinants of public investment in Ethiopia using time series data ranging from 1985 to 2019. In order to examine the long run and short run public investment model, the study applied an autoregressive distributed lag (ARDL) approach over the specified period. This is because that ARDL gives reliable estimates even if in the presence of endogenous variables; It's possible to apply whether the regressors are  $I(0)$ ,  $I(1)$  or mixed; it is relatively more reliable and efficient for small size sample, which is the case for this study.

This study found different types of remarkable results that help economic policy makers for informed policy recommendation in public investment decision. The stationary properties of the time series data were tested so that variables were stationary at level and difference which helps to take advantage of employing the autoregressive distributed lag (ARDL) model. At the same time results of the bounds test showed that there is a long-run co-integration among the variables in the model. The short-run and long-run results provide strong evidence in support of Wagner's law. The implication is that an expansion in public investment through embarking on the development of infrastructures shows desire for industrial transformation and economic prosperity which is supported by the theoretical model of Wagner's law to hold for Ethiopia.

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The author declares that He has no competing interests.

## Availability of data and materials

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