Long Run Returns to Government Investment in Africa

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Abstract

Poor public infrastructure is one of the key factors that hinders the development of low-income countries. Higher level of public investment may not be sufficient to solve the problem because these countries also suffer from high levels of graft and inefficient public investments. Empirical estimations show that increases in government investment have large positive effect on output, however it is not clear whether this effect is due to the expansion of public infrastructure or temporary demand shocks. This paper studies the long run effect of changes in government investment on output and finds that long run multipliers are not significant. This means that higher government investment serves as a demand shock and boosts output temporarily, but the effect is short-lived and does not expand the productive capacity of the economy in the long run.

Keywords: Public investment; Efficiency; Low-income countries
JEL code: E22, E23, H11.

1 Introduction

Poor public infrastructure is a huge drag on economic growth in most low-income countries. Unambiguously, the construction of new roads, bridges and other facilities in these countries will increase domestic and international trade and promote growth. However, the construction of these facilities comes at a large cost. It is well known that government revenues are very low in most developing counties and any increase in taxation induces more firms and individuals to engage in informal economic activities, which have negative consequences for long term economic growth. Furthermore, due to the high level of graft, only a fraction of funds actually become public infrastructure and some of implemented projects turn out to be white elephants.[1] Given these constraints, it is important to estimate whether the existing level of public infrastructure investment in developing countries is sufficiently high.

To answer this question Eden and Kraay (2014) estimate the effect from public investment and obtain large multiplier. Based on this finding they argue that most developing countries will experience very large output gains if they increase public investment. This argument is based on the fact that public capital directly enters into the production function, thus an increase in public investment serves as a supply side shock. In this paper I conduct a similar analysis but focus on the long run effect of public investment multiplier and find out that there is no evidence that higher public investment boosts output. The key point is that an increase in public investment may serve as a demand shock and increase output, especially in countries with high level of unemployment. This effect may be stronger in the situations when public investments are financed by foreign loans, which do not have distortionary effects on output in the short run.[2] Consequently, in order to distinguish the supply side effect from the demand side effect, I look at the long run effect of public investment. The advantage of this approach is that an increase in public capital is likely to have long run effects, because capital does not depreciate immediately, while demand side shocks are unlikely to have long run effects. Focusing on the same set of countries as Eden and Kraay (2014), I show that an increase in public investment has very large and positive effect on output in the short run but the effect disappears after one year. Thus, public investments, like other forms of government spending financed by the inflow of foreign funds, affect output by creating more demand rather than creating more capital stock and expanding the productive capacity of the economy.

[1] For evidence and discussion of graft in public investment projects see Olken (2009) and for white elephants Robinson and Torvik (2005).

[2] It is important to note that in their empirical approach, in order to overcome endogeniety problems, Eden and Kraay (2014) instrument changes in government investment with unexpected deviations of disbursements from international creditors.

These findings indicate that governments in developing countries are very inefficient in their choice of projects and their implementation. Many authors have pointed out that the level of government spending is low in developing countries and it is believed that the lack of the state capacity to tax is the main culprit for this phenomenon (see Besley and Persson (2009), Besley et al. (2013)). The findings of this paper point out that the lack of capacity to spend efficiently also plays an important role in explaining low levels of government spending in developing countries.

There are several papers that focus on the problem of inefficient government investment in developing countries. Keefer and Knack (2007) find that public investment (both measured as a share of GDP and as a share of total investment) is higher in countries with low quality of institutions. A possible explanation for this phenomenon is that it is easier to misappropriate funds from investment projects in the form of kickbacks, which creates additional incentives for politicians to favor investment projects. Mauro (1998) demonstrates that education spending is negatively affected by the level of corruption. This finding is in line with the fact that in contrast to construction, educational system is relatively more transparent and there are no sophisticated chains of subcontractors to conceal expenditures. In a related study Cavallo and Daude (2011) find that the partial correlation between public investment and institutions is insignificant, when it is measured as a share of GDP. Meanwhile, the correlation is negative and significant when it is measured as a share of total investment.

In a recent paper Berg et al. (2015) argue that countries with high-efficiency and low-efficiency in government investment may have similar growth impacts from additional public investment spending. The key point is that in high-efficiency countries the stock of government capital is high, so the returns to additional investment are lower. In low-efficiency countries the stock of public capital is lower, however because of low-efficiency some fraction of investment gets lost during the investment process, which decreases the return to each unit of additional investment.

The rest of the paper is organized as follows: Section 2 introduces a theoretical model to discuss the channels, through which public investment affects output. Section 3 estimates short run government investment multipliers. These results are contrasted with long run multipliers in Section 4. The last section offers concluding remarks.

2 Modeling Productive Government Capital

This section presents the production function introduced by Eden and Kraay (2014) to facilitate the following discussion. Output is produced by a CES function and

depends on the stock of private and government capital:

$$Y_t(k_{g,t}, k_{p,t}) = A(\gamma k_{g,t}^{\sigma} + (1-\gamma)k_{p,t}^{\sigma})^{\frac{\alpha}{\sigma}}, \tag{1}$$

where k_g is the per capita government capital stock, k_p is the per capita private capital stock, α is the aggregate capital share, and A represents aggregate productivity. γ is a share parameter, and the parameter $\sigma \leq 1$ represents the degree of substitutability between government and private capital. Both government and private capital stock evolve according to the following equation

$$k_{i,t+1} = (1-\delta)k_{i,t} + i_{i,t}, \tag{2}$$

where δ is the depreciation rate and $i_{i,t}$ is investment of type $i = g, p$. The authors also make a small open economy assumption, which implies an exogenous interest rate r^*. The optimal level of government investment can be determined by solving the following optimization problem:

$$max_{k_{g,t},k_{p,t}} Y_t(k_{g,t}, k_{p,t}) + (1-\delta)(k_{g,t} + k_{p,t}) - (1+r^*)(k_{g,t} + k_{p,t}). \tag{3}$$

The optimal level of the government capital stock depends on the interest rate, the level of private capital, which an endogenous variable, and the parameters of the model. To derive quantitative implications one needs to take a stand on the values of these parameters. Determining these values directly is a challenging task. For this reason Eden and Kraay (2014) estimated the effect of additional government investment on output and combine this result with the model to determine the optimal level of government capital stock for individual countries. Their calibrations suggest that there is a strong degree of complementarity between government and private capital. They also find that in most countries the level of government capital stock is low, consequently an increase in government investment increases the stock of government capital. Due to the complementarity between both types of capitals an increase in government investment leads to an increase in private investment, which eventually leads to higher GDP. In this environment an increase in government investment acts like a supply shock because it expands the productive capacity of the economy. It is important to note that that there is no other channel through which government investment, or government spending in general, can affect output.

There is a growing literature that studies the effect of government spending on output. Some of those studies use structural models with unproductive government spending and show that even in such environment there can exist positive government spending multipliers and in some circumstances their values care quite large (see

Christiano et al. (2014), Eggertsson and Krugman (2012) and Drautzburg and Uhlig (2015)). Such positive multipliers may arise due to the existence of a combination of the following factors: price stickiness, zero lower bound on the nominal interest rate, borrowing constraints. This channels are important and they should not be ignored.

Furthermore, Eden and Kraay (2014) in their empirical estimation of the government spending multiplier focus on developing countries and use unexpected deviations of disbursements from international creditors as an instrument. This creates additional channels, through which government investment can affect output. First, in these countries the level of unemployment, informal employment and employment in low productive activities is very high. Second, borrowing constraints play a much bigger role in these countries than in the US, where according to the studies motioned above, large multipliers exist. An increase in government investment sponsored by an external source can relax borrowing constraints, create jobs and bring more resources into formal activities, thus increase GDP. Investment financed by domestic distortionary sources may have very different consequences. All these mechanisms are missing from the model presented above.

Another important issue that should be taken into account is that according to Pritchett (2000) government capital evolves not according to equation (2) but according to the following expression

$$k_{g,t+1} = (1 - \delta)k_{g,t} + \epsilon i_{g,t}, \tag{4}$$

where $\epsilon \in [0, 1]$ captures inefficiencies associated with government investment, which are especially high in developing countries. One obvious source of low efficiency is corruption. In this case, public officials may actually invest less than officially reported. Another example is waste or inappropriate projects. In this case funds are invested in projects which are not the most efficient ones. Such behavior can be motivated by regional favoritism (Hodler and Raschky (2014)) or by the fact that some industries, in which politicians have stakes, may benefit from the particular project. Inefficient investments may also be made simply because most public official in low-income countries are not competent and are promoted for reasons other than merit. Whatever is the source of inefficiency the efficient stock of capital grows less than the amount that is invested. Nevertheless, even in the presence of inefficiencies the increase of government investment financed by foreign loans still may increase output because it may serve as a demand shocks. In the case of corruption, politicians may use funds for personal consumption or investment purposes. Wasteful projects may increase output by creating construction jobs. Of course such sort-term gains come with long-term costs.

Empirical estimations of the effect of government investment on GDP are likely to

include both supply- and demand- side effects described above. Assuming that any response of output is entirely due to the first channel will yield misleading results. In order to distinguish between the two channels I look at the long run effect of government investment on output. The idea is that government investment increases capital stock and if the depreciation rate is not extremely high it should have positive effect on GDP not only in the current period but also in the following periods. In contrast, an increase in output due to a positive demand shock is likely to be short-lived.

3 Estimating Short Run Multipliers

To estimate the effect of government investment on output Eden and Kraay (2014) use the following equation

$$\frac{Y_{i,t} - Y_{i,t-1}}{Y_{i,t-1}} = \beta \frac{I_{G,i,t} - I_{G,i,t-1}}{Y_{i,t}} + \mu_i + \zeta_t + \epsilon_{i,t}, \tag{5}$$

where μ_i and ζ_t denote country- and time- fixed effects respectively, and $\epsilon_{i,t}$ is the error term. OLS estimates of equation (5) are likely to be biased due to the fact that changes in government investment may be correlated with other contemporaneous shocks and it is not possible to determine the direction of the bias. For example, if the government conducts expansionary investment programs during bad times then government investment will be negatively correlated with shocks and this will cause the estimated coefficient β to be biased downwards. In contrast, if the government is pursuing procyclical investment policy and increases its investments during good times — because the cost of financing is lower during such periods — then the estimated coefficient will be negatively correlated with shocks. In this case, the coefficient β will be biased upwards.

To address these concerns the authors use the IV approach proposed by Kraay (2014) and Kraay (2012). These studies instrument government spending with loans provided by international creditors. According to these studies, the strategy works because a significant fraction of government spending in developing countries is financed by loans from official creditors, and such loans typically disburse over a period of many years following the initial approval of the loan. The instrument, which is described in more detail in those studies, is based on a unique dataset that combines official loans to developing countries by international donor organizations. Following an agreement on a loan funds are not disbursed immediately. The full amount disburses over several years. Using the database on loans and actual disbursements the author constructs an expected path of disbursement. Finally, the instrument is calculated as the difference between actual disbursements and the expected ones. The idea is that this difference

represents an unexpected deviation, which is not correlated with contemporaneous shocks to output.

The disbursement shock data used in the current paper come from Kraay (2014). GDP data are obtained from the World Development Indicators (WDI). Eden and Kraay (2014) estimate equation (5) for a set of 39 low-income countries eligible for concessional lending from the International Development Association (IDA). Separately, they also conduct an estimation for IDA countries in Sub-Saharan Africa. To obtain government investment data, they use an internal IMF database. Since I do not have access to such data I use African Development Indicators (ADI) database which provides government investment data for African countries. The final sample includes 27 Sub-Saharan African countries. So, my sample overlaps with their subsample for Sub-Saharan Africa but it should be mentioned that most IDA countries are in Africa and the results between this subsample and for all IDA counties are not significantly different. The time period covers $1980 - 2000$.

The results of the estimation are shown in table 1. Panel A shows the estimated coefficient β for Ordinary Least Squares (OLS), Panel B reports the results for Two-Stage Least Squares (2SLS) and Panel C present the results from the first-stage regression of changes in government investment on changes in the predicted disbursement instrument.

Table 1: The response of output to government investment

	All Observations	Excluding Influential Observations	Control for Lagged Dependent Variable
Panel A: Ordinary Least Squares (Dependent Variable is Change in Output)			
Change in Government Investment	0.582***	0.551***	0.557***
	(0.104)	(0.120)	(0.114)
Panel B: Two-Stage Least Squares (Dependent Variable is Change in Output)			
Change in Government Investment	1.584***	1.499**	1.596**
	(0.609)	(0.640)	(0.642)
Panel C: First-Stage Regression (Dependent Variable is Change in Output)			
Change in Predicted Disbursements	0.292***	0.291***	0.299***
	(0.092)	(0.107)	(0.108)
First-Stage F-Statistic	10.07	7.44	7.74
Number of Observations	675	671	660

Notes: This table reports the results from a series of regressions of changes in real GDP on changes in public investment. All changes are in constant local currency units and are scaled by lagged GDP. The sample consists of IDA-eligible countries in Africa. Panel A reports OLS estimates, Panel B reports 2SLS estimates, and Panel C reports the corresponding first-stage regressions. Changes in predicted disbursements on loans from official creditors are used as an instrument for changes in government investment in Panel B. Heteroskedasticity-consistent standard errors clustered at the country level are indicated in parentheses. * (**) (***) indicates significance at the 10 (5) (1) percent level.

As can be seen from the table multipliers obtained by OLS are relatively smaller than the ones obtained by 2SLS. The estimated coefficients for 2SLS are large and statistically highly significant. This result is consistent with Eden and Kraay (2014). The results of the first-stage estimation confirm that the relationship between changes in government investment and changes in predicted disbursements is positive, and highly significant. The first-stage F-statistic of the last two columns are around 7.5, falling short of the rule of thumb of 10. In their analysis Eden and Kraay (2014) conclude that the size of the government investment multiplier is around 1.5, which is extremely close to the estimate of β according to 2SLS for all samples in table 1. These results indicate that government investment has very large impact on output in the current period. Eden and Kraay (2014) use this multiplier to calibrate their model and show that most developing countries significantly underinvest in public capital.

There is one important difference between Kraay (2014) and Eden and Kraay (2014) that is worth mentioning. In the former the explanatory variable is government spending, while in the later only government investment. This creates a problem because the instrument affects total output and private investment not only through government investment but also through other forms of government spending. It is true that relatively larger share of international official loans are destined for investment projects, however they also finance other forms of government spending. This implies that the proposed instrument affects the dependent variable not only through the explanatory variable but also through another cannel, which causes the estimated coefficient to be biased upward. For example, I replace the government investment term in equation (5) with non-investment government spending and estimate similar regressions. The results show that the estimated coefficient β is both statistically significant and economically large. To address this issue and the ones described in the previous section, it is more appropriate to focus on the long run effect of government investment because unlike other channels, investment increases the stock of capital and has dynamic implications.

4 Estimating Long Run Multipliers

To estimate the long run effect of government investment I follow Kraay (2014) who employs the local projections approach of Jorda (2005). According to this method the effect of government investment on output can be obtained by estimating the following series of local projection regressions

$$\Delta Y_{i,t+h} = \sum_{s=1}^{p} \rho_s^h \Delta Y_{i,t-s} + \beta^h \Delta I_{G,i,t} + \mu_i^h + \zeta_t^h + \epsilon_{i,t+h}, \tag{6}$$

where $\Delta Y_{i,t+h} = \frac{Y_{i,t+h}-Y_{i,t-1}}{Y_{i,t-1}}$ and $\Delta I_{G,i,t} = \frac{I_{G,i,t}-I_{G,i,t-1}}{Y_{i,t}}$. Following Kraay (2014), I set $p = 1$, so the coefficient rho_s^h captures the effect of the lagged change in output. The inclusion of lagged changes in output has implications for the plausibility of the identifying assumption that loan approval decisions are uncorrelated with future macroeconomic shocks. A potential objection to this assumption is that, while loan commitments are made before subsequent shocks are realized, these shocks may themselves be persistent or otherwise predictable in some way. If, in addition, loan commitments are correlated with contemporaneous shocks, then they will also be correlated with future shocks, in violation of the exclusion restriction. Controlling for lagged growth is a straightforward way of addressing this possibility, and therefore also enhancing the credibility of the identifying assumption.

The coefficient β^h shows the effect of the change in government investment at time t on the change in output at time $t + h$. As in the previous specification μ_i^h and ζ_t^h capture country- and year- fixed effects, which may vary across horizons h. Finally, $\epsilon_{i,t+h}$ is the error term.

The results of the estimation are presented in table 2. It should be pointed out that for the case $h = 0$ the results are the same as in the last column of table 1, which included lagged dependent variables. There are significant differences between OLS and 2SLS estimates.

As can be seen in table 2 according to OLS estimation long run multipliers are positive and significant for both shorter and longer horizons but the coefficients are relatively small and do not exceed 0.6. For the 2SLS procedure the coefficients are positive, large and statistically significant only in the current period and in the following year. The positive government investment multiplier for $h = 1$ may reflect the fact that construction projects are not totally completed immediately and some fraction of the funds may be used at the beginning of the following year (this issue is further discussed below). For $h > 1$, the estimated coefficients lose statistical significance for all following periods and the sign of the coefficient is negative for the second and third periods. So, the most appropriate coefficients that may capture long run effects of government investment on output do not provide any support for the existence of positive multipliers according to 2SLS.

As mentioned above Eden and Kraay (2014) use a value of $\beta = 1.5$ to draw quantitative implications from their theoretical model. However, the estimates of the long run effects of government investment do not justify such high values. At the extreme one can use a value of $\beta = 0.5$ based on the OLS projection regressions but, in addition to the fact that this estimate is biased, its value is too low to generate huge excess returns discussed in Eden and Kraay (2014) (see their table 3). In particular using a value of $\beta = 0.5$, instead of 1.5, average excess returns in their benchmark

Table 2: The long run response of output to government investment

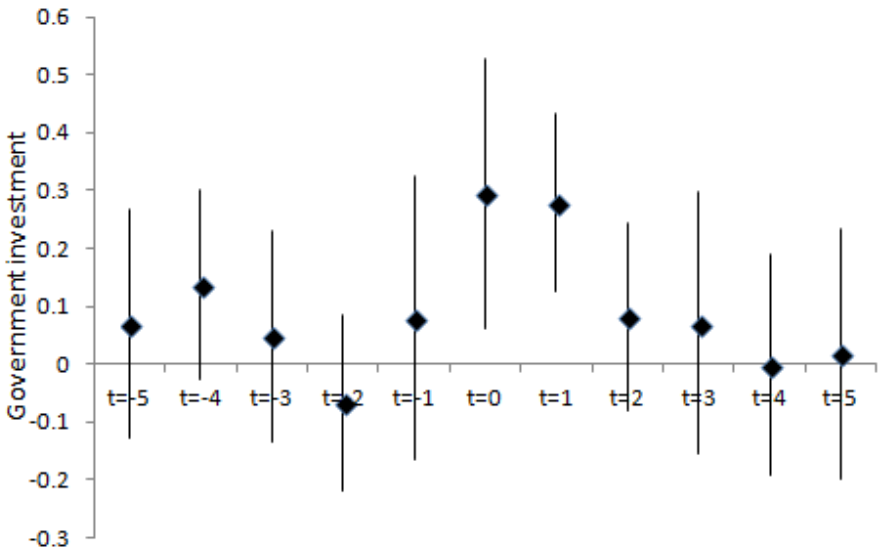
	OLS	2SLS
Cumulative effect on output after h years		
$h = 0$	0.557***	1.596**
	(0.114)	(0.642)
$h = 1$	0.296**	1.743*
	(0.141)	(0.939)
$h = 2$	0.377*	-0.849
	(0.213)	(1.665)
$h = 3$	0.529**	-0.112
	(0.210)	(2.384)
$h = 4$	0.567**	0.895
	(0.232)	(2.539)
Lagged change in GDP (from the	0.056	0.037
$h = 0$ local projection regression)	(0.053)	(0.058)
First-Stage F-Statistic	23.77	7.74
Number of Observations	660	660

Notes: All regressions are estimated using pooled country-year data and include a full set of country and year fixed effects. Changes in GDP, government investment, and disbursements are all scaled by lagged GDP. Column 1 and column 2 report OLS and 2SLS estimates of the sequence of local projection regressions in equation (6), for IDA-eligible countries in Africa. The table entries report the cumulative sums of the impulse response function for change in output, and so capture the cumulative effect on output at $t + h$ of an additional dollar of government spending in year t. To conserve space, the coefficient on the lagged change in output is reported only for the $h = 0$ local projection regression. Heteroskedasticity-consistent standard errors clustered at the country level are indicated in parentheses. * (**) (***) indicates significance at the 10 (5) (1) percent level.

specification will drop from 111 percent to just 11.[3] Consequently, higher government spending is unlikely to have large positive effects on low-income countries in the long run and provide a path to sustained growth.

One may argue that governments try to keep the level of government capital stock constant. In this situation, if there is an increase in government investment in one period due to higher disbursements from international creditors then the government may decrease its investments in the following periods to bring the stock of government capital back to the long run level. Consequently, an increase in the government investment at time t will not have a positive effect in the long run because the low level of investment in the following periods will undo the initial increase. This question can be

[3]In their analysis Eden and Kraay (2014), in addition to the effect of government investment on output, also study its effect on private investment. In this paper I focus on output only, because in their analysis excess returns to government investment are not very sensitive to the second effect. The results are primarily driven by the multiplier on output (see table 3 in their paper). However, it is important to note that their estimates of the effect of government investment on private investment are likely to be biased upwards as well, because as mentioned in the previous section the authors assume that only government investment affects private investment. This assumption is not realistic because other forms of government spending also affect private investment. Since both types of government spendings are highly correlated, the estimated coefficient will be biased. Correcting this bias is beyond the scope of the current paper.



Notes: This graph reports the estimated coefficients and 95 percent confidence intervals from regressions of changes in government spending on contemporaneous changes in predicted disbursements, as well as five leads and lags of changes in predicted disbursements, and country and year effects.

Figure 1: The response of government investment to the predicted disbursement instrument.

addressed by investigating whether there is a negative serial correlation between unexpected disbursements at time t and government investments in the following periods.

Figure 1 reports the estimated coefficients and 95 percent confidence intervals from a regression of changes in government spending on contemporaneous changes in predicted disbursements, as well as five leads and lags of changes in predicted disbursements, and a full set of country and year dummies. As can be seen from the figure disbursements at time $t = 0$ are not negatively correlated with government investments in future periods, all coefficients are nonnegative. This indicates that governments do not decrease their investments following a positive disbursement shock, so future negative or low levels of government investments do not compensate for the unexpected increase in investment in period $t = 0$. Furthermore, as can be seen from 1 the estimated regression coefficient is positive in period $t = 1$ and it is statistically significant at 1 percent level. As mentioned above this may be due to the fact that not all disbursed funds are spent in the same year, which can explain why according to the results in table 2 government investments have large and positive effect on output in the following period.

Overall, by showing that there is no negative correlation between unexpected disbursement shocks and future government investments, this exercise provides further robustness to the findings presented in table 2 according to which government investments do not have significant long run effect on output.

5 Conclusions

This paper estimates the effect of changes in government investment on output. To overcome endogeniety issues the paper follows Kraay (2014) and uses unexpected deviations of disbursements from international creditors as an instrument. The results reveal that the the government investment multiplier is large in the short run, however the estimated coefficient becomes insignificant after one period. These differences indicate that government investments financed by the inflow of foreign funds generate demand shocks and increase output, but due to low efficiency and graft these investments do not expand the productive capacity of the economy. Consequently, higher levels of public investments in low-income countries are unlikely to deliver excess returns in the long run.

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