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Public Investment and GDP Growth in Developing and Advanced Countries: A Panel Data Analysis

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Abstract. This research paper examines the differences between developing and advanced countries in terms of public investment's impact on economic growth. In this regard, we investigate whether or not the macroeconomic impact of government investment spending is tributary to the degree of private-public capital substitutability and the level of the capital-to-GDP ratio. In this perspective, we use a panel data model for two groups of countries that include respectively five advanced economies and five developing ones. Our study provides empirical evidence that public investment expenditures have a larger influence on GDP's evolution in developing countries. Our results also suggest that public investment spending is relatively counterproductive in advanced economies, most likely because of high levels of crowding out; the latter are driven by public-private capital substitutability and the advanced position of these countries in terms of transitional dynamics. The analysis in this paper also sheds the light on efficiency, as a concept that is significantly linked to the level of corruption.
Keywords. GDP growth, Public investment, Crowding out, Panel data.
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1. Introduction

The role of governments in supporting economic growth has been subject to large controversies, particularly when it comes to public spending, starting from the Keynesian-Classical debate in the 1930s. Since then, the differences in terms of perspectives have continued, yet in various forms. In this framework, a particular interest was given to government investment expenditures during the second half of the 20th century, as several industrialized countries were in a post-war reconstruction phase, and colonization was over in most developing countries, bounding them to shape their respective economies.

In both groups of countries, a strong correlation was established between public investment spending, GDP growth and social welfare in several cases. This model was, however, severely criticized during the stagflation episodes in the 1970s. As a consequence, the research regarding public investment's impact on economic growth began to lose momentum in the late 1970s and the 1980s. The cons of public investment spending seemed to have prevailed.

However, the debate regarding the macroeconomic impact of public investment was revived by an empirical study led by Aschauer (1989), which examined the

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productivity growth generated by non-military government investment in the United States. The paper demonstrated, through a Cobb-Douglas econometrical model, that investment in infrastructure drive an upward influence on private firms' productivity, thereby generating a significant crowding in effect. The post-1970 productivity decrease was found to be the result of the drop in public investment in the US.

This finding is relatively supported by the important GDP growth rates in Asia during the 1990s, which were significantly correlated with the substantial rates of public investment that characterized that region. Nonetheless, the causality in this framework –and even the correlation sign in several studies, remained quite controversial. Using the same data as Aschauer (1989) but with all the coefficients of the production function estimated in first differences, Sturn & De Haan (1995) found that the positive relation between public investment and GDP discovered by Aschauer had been overvalued (Sturm, & De Haan, 1995). On the other hand, Mittnik & Neumann (2001) argued in favor of the significant positive impact of public investment on economic growth in the short run and a lesser influence in the long run. Based on a VAR model, the authors discarded the existence of crowding out effects in the cases of six advanced countries. Also using a VAR methodology, Voss (2002) argued that innovations to public investment actually crowd out private investment in developed economies such as Canada and the United States.

An interesting contribution to the debate was made by Perotti (2004), whose study concluded that output and private investment in advanced countries tend to react more significantly to public consumption shocks, than to government investment. According to the author, this puzzle could find explanation in the fact that countries such as the United States, the United Kingdom, Australia, Canada and Germany might have public capital-to-GDP ratios that are beyond their respective optimal levels. As a consequence, further public investment could have a very weak, or even negative, marginal return. Kamps (2004) corroborates this explanation for the case of Japan, where public investment was found to have a downward influence on GDP growth.

The arguments used by studies such as Perotti (2004), Kamps (2004) or Barro (1990) generally support that public investment is not effective, or even counterproductive in certain cases (negative multiplier). They argue that this is mostly due to the existence of a large ratio of public capital. Therefore, it is fair to mention that some of the aforementioned findings could probably not be extended to developing countries, which usually have lower levels of capital stocks and observable infrastructure shortages.

Khan (1996) explored the influence of public and private capital spending on GDP growth in 95 developing countries using panel data methodology and two-stage least squares (TSLS). Both private and public investments were found to have a macroeconomic impact, with the former having a much more significant one than the latter. Ghani & Din (2006) roughly confirmed this conclusion for the Pakistani case, as they discovered that growth is mostly driven by private investment. However, their empirical study revealed that public investment has a negative (although insignificant) influence on GDP, which "raises some concern about the efficiency of public investment" in Pakistan (Ghani, & Din, 2006).

On the other hand, Bédia (2007) found that in Ivory Coast, government investment seems to drive a larger influence on economic growth than private investment. Bédia (2007) dismissed the existence of significant crowding out, along with Agénor & Montiel (1996) and Hemming *et al.*, (2002) who argue that in the case of small and middle income countries, fiscal deficits tend to have a negligible influence on interest rates, while crowding out is more likely to occur in advanced economies. Other studies confirmed this finding, such as Boughzala *et al.*, (2007) and Ismihan *et al.,* (2002), for the Tunisian and Turkish frameworks respectively.

This paper aims to provide the research community with further evidence on the factors that determine the extent of public investment's macroeconomic influence.

The emphasis is laid on the potential differences between developed and developing countries in terms of public capital profitability. In this frame, we test the validity of the rules-of-thumbs developed by Oukhallou (2016) through a panel data econometrical model for two groups of countries, with respectively five advanced economies and five developing ones.

2. Research Methodology

A thorough analysis of the empirical literature, along with Oukhallou (2016), enables us to draw the following hypotheses on the potential determinants of public investment's impact on the economic activity:

Hypothesis 1: Efficiency stands out as a transversal variable, whether through the fight against corruption or the enforcement of macroeconomic profitability-based selectivity of investment projects and government expenses in general. In this context, when further public investment spending does not follow efficiency and profitability-based selectivity, its marginal productivity is most likely to shrink as the negative macroeconomic impact of the crowding-out effect partially –or even totally- neutralizes the supposedly positive effect of said public investment on GDP growth. This can also be applied to government current expenditures.

Hypothesis 2: From a "transitional dynamics" perspective, public investment is likely to have a larger effect in small and middle income countries where the capital stock to GDP ratio is usually the lowest. In this category of countries, the margin of improvement in terms of infrastructure is important, among other development and economic variables. Returns generated by further private or public investment are assumed to be positive but progressively diminishing, *ceteris paribus*.

Hypothesis 3: The higher is the public-private investment substitutability, the more important is the crowding out effect, which drives a downward influence on public investment's effectiveness. The substitutability is more present in advanced economies than in developing ones, which could explain why the public investment multiplier effect is found to go up to 1.4 in middle income countries while it is weak –and even negative in some cases- in advanced economies (Hemming *et al.*, 2002).

The validity of these hypotheses is assessed according to a panel data model tackling the case of two different groups of countries. The first group encompasses five advanced countries, while the second gathers five developing economies. The next subsection provides further explanations on the data, the model's variables and other econometrical aspects.

2.1. Building the data panel model

In this model, we evaluate the correlation between output and public investment expenditures in two panels of countries based on 15-year period data (2000-2015). The first panel consists of five advanced economies, i.e. Denmark, Germany, Spain, Sweden and the United Kingdom. As for the second panel, it includes Chile, Colombia, Jordan, Morocco and Slovenia. The total number of observations is therefore 80 for each panel.

Besides from public investment spending and GDP, we added other exogenous variables, such as gross fixed capital formation (GFCF) and public (non-productive) consumption expenditures. The model also encompasses the demographic evolution, which supposedly adds more explanatory power to its results. The latter is, to a certain extent, based on the works of Reynolds (1985; 1994).

In this frame, allowances are made between productivity-enhancing public spending and other purchases, based on the definition provided by a significant part of the empirical literature.

The data panel model is as follows:

$$Y_{it} = \propto_1 . GI_{it} + \propto_2 . GC_{it} + \propto_3 . GFCF_{it} + \propto_4 . \Delta Pop_{it}$$

Where Y_{it} is the gross domestic product at purchaser's prices for a given country in a given time. Data for all variables are in U.S. dollars, as they were converted from each country's domestic currencies using 2000-2015 average exchange rates. By doing so, the objective was to reduce possible distortions due to fluctuations in exchange rates, which could be wrongfully interpreted by the model as a significant fall or decrease in a given variable. Compared to previous computations, this technique helped improve the quality of the model's outputs. In both panels, GDP's data source is the World Bank's national accounts database.

GI_{it} represents government investment expenditures, i.e. the part of public budget that is dedicated to investment spending. For this particular variable and in the absence of reliable data series, we created an alternative series using data mining based on the information contained in government reports (ministries of finance and central banks mostly) for the cases of Chile, Colombia, Germany, Jordan, Morocco, Slovenia, Spain and Sweden. As regards to public investment spending in Denmark and in the United Kingdom, we collected consistent data from their respective statistics offices.

As for GC_{it}, it represents public consumption expenditures' annual evolution in the examined countries. This variable was included in the model since its analysis would enable us to make allowances between productivity-enhancing public spending and non-productive government purchases. This is also supposed to give hints on the degree of crowding out, if public consumption's impact on GDP growth is found to be equal or larger than public capital expenditures'. Unlike government investment expenditures, public consumption is usually not financed by debt. In both panels, the government consumption expenditures' data source is the World Bank's national accounts database.

$GFCF_{it}$ is the gross fixed capital formation per country and per year, which includes both public and private investments. This variable is often considered as a proxy to public investment (see IMF (2015) and Allain-Dupré *et al.*, (2012), among others). However, this research focuses on the degree of effectiveness of the actual public *spending* in term of investments. As a consequence, GFCF was merely chosen in order to enable the comparison between the real impact of variations in the actual capital stock (GFCF) and the one driven by variations in government investment expenditures. It is also an intuitive mean to assess the public investment expenditures' degree of efficiency. At this point, we consider GFCF's impact on GDP as a relatively optimal benchmark. For this variable, data series were taken from the World Bank database.

ΔPop_{it} represents the annual variation of the resident population per country. By introducing this variable in the model, we intend to assess the impact of the demographical influence on GDP growth especially that we do not consider per capita variables in this very estimation. The choice of this variable is also based on theoretical elements discussed in the literature (see Reynolds 1985; 1994) among others).

Table 1 displays the average shares in GDP of public investment, public consumption and GFCF in our panel of advanced countries, while Table 2 shows these figures in the case of developing economies.

GFCF in the developing countries takes larger shares of GDP (an average of 24.13 percent) compared to the advanced economies (21.15 percent). The same goes for public investment (4.09 and 2.97 respectively). On the other hand, public current expenditures take more important proportions in the developed countries, mostly driven by different transfers, including social support to households.

Table 1. *GFCF, Public Investment and Concumption in the 1st Panel (% of GDP)*

	Denmark	Germany	Spain	Sweden	UK	Panel
Pub. Investment	2.38	2.07	4.08	4.32	2.01	2.97
Pub. Consumption	25.68	18.74	18.59	25.35	20.13	21.70
GFCF	20.47	20.07	25.09	22.74	17.40	21.15

Table 2. *GFCF, Public Investment and Concumption in the 2st Panel (% of GDP)*

	Morocco	Chile	Colombia	Jordan	Slovenia	Panel
Pub. Investment	5.14	3.07	3.50	5.73	3.00	4.09
Pub. Consumption	16.73	11.40	16.77	21.04	19.08	17
GFCF	27.29	22.00	22.52	25.03	23.81	24.13

Among the advanced countries, Spain is last in terms of public consumption, in a clear contrast with the two Scandinavian countries and the UK. This finds explanation in the differences in terms of social protection-related expenses and transfers, as an important part of these expenditures is statistically considered as public current spending. As a matter of fact, the social security systems in Denmark, Sweden and the UK are very advanced in this framework compared to Spain's[1].

As regards to public investment, Jordan and Morocco seem to have the largest ratios, at 5.73 percent and 5.14 percent respectively. And in terms of GFCF, Morocco is by far predominant, which could be explained by the substantial investment strategies that characterized the 2000s and helped promote domestic private investments and attract significant FDI.

2.2. Estimation method and statistical tests

The compound error model used in the present estimation follows this logic:

$$y_{it} = \beta_0 + \beta x_{it} + u_{it} \quad ; i = 1,\ldots.. , n \quad \text{et } t = 1,\ldots., T$$
$$u_{it} = \alpha_i + \epsilon_{it}$$

Where x_{it} is the explanatory variable and y_{it} is the continuous variable with constant β_0. The component α_i represents the characteristic of the individual i,while β is the parameter of interest and ϵ_{it} is the error term that follows a distribution N $(0,\sigma^2)$. The term u_{it} denotes the compound error of the model, hence the name "One-Way Error Component Regression Model". On the other hand, if the parameter α_i is fixed then the panel model is with individual fixed effects, and if α_i is random then we would be dealing with an individual random effects model.

The estimators used in this framework are: the *Within* estimator for the fixed effect model and the generalized least squares (GLS) estimator for the random effect model. The Hausman (1978) test consists of comparing the GLS and *Within* estimates to choose the appropriate model, i.e. a fixed effect model (FEM) or an error components model (ECM). The test statistic is written as follows:

$$H = \left(\hat{\beta}_{FEM} - \hat{\beta}_{ECM}\right)' [\hat{V}(\hat{\beta}_{FEM}) - \hat{V}(\hat{\beta}_{ECM})]^{-1} \left(\hat{\beta}_{FEM} - \hat{\beta}_{ECM}\right) \rightarrow X^2(k)$$

Under the null hypothesis of correct specification, this statistic is asymptotically distributed according to a Chi-square with K degrees of freedom, i.e. the number of time-varying factors introduced into the model. If the test is significant (P-value strictly below 5 percent), the choice falls on the fixed-effect model estimators, since they would be unbiased.

Based on this methodology and as explained below, the estimators proposed in this research are the fixed effect model estimators. This model, also called the

[1] Eurostat (2016), Social Protection Statistics, June.

covariance model, assumes that α_i are constant and non-random effects. Also, it is assumed to have a residue structure that verifies the standard assumptions of OLS.

Before turning into the model's econometrical results for both panels of countries, it is necessary to carry out a number of tests to examine the robustness and the choice of the model. We particularly use the Breusch Pagan tests of the absence of individual specific effects, the Hausman test for the choice of the model and the Modified Wald test for heteroskedasticity and autocorrelation of errors.

In our specific case, the Breusch Pagan test reports an x^2 statistic with a probability of less than 5 percent, thereby allowing the rejection of the null hypothesis of absence of individual specific effects. As for the Hausman test, it yields a p-value that is lower than 0.05, thereby enabling for the rejection of the null hypothesis; hence the model should be a fixed-effect one. And only the *Between* (inter-country) and *Within* (intra-country) estimators would be effective in this case.

We chose the within estimator rather than the *Between*, since it generates more consistent results. Although the *Between* estimator makes it possible to take account of the impact of structural factors in the panel, this relative advantage comes at the expense of cyclical influences, which are highly important in our analysis. In other words, the *Between* estimator does not take into account the persistence of the fixed individual effects. Furthermore, the *Between* estimator reduces the number of observations since each $X_{(k;it)}$ is replaced by its individual mean $\bar{X}_{(k;t)}$ which often leads the estimator to lose some of its effectiveness.

The modified Wald test provides a Chi-2 with a p-value of less than 5 percent, which leads us to accept the hypothesis of residual heteroskedasticity. Globally, the coefficients of the variables of interest are robust and the errors related to the econometric techniques would be substantially reduced.

3. Empirical Results

The estimates of the model are shown in Table 3 below. In both panels, all coefficients are found to be significant at least at the 5 percent level, except for the ones related to population's evolution, which are not found to have any noticeable effect on GDP growth in our pattern.

Table 3. *The Results of the Data Panel Estimations:*

		Dependent variable: GDP in US dollars (in logarithm)
Explanatory variables	Coefficient for Developing countries	Coefficient for Developed countries
GI	0.016763**	-0.0023062**
	(0.0231834)	(0.0005874)
GFCF	0.2485102***	0.2613728***
	(0.00392708)	(0.0425781)
GC	0.0095641***	0.0228578***
	(0.0448677)	(0.0139976)
ΔPop	0.0133183	-0.007947
	(0.0131295)	(0.0053584)
R-sq	0.9869	0.9809
Number of id	5	5
Number of observation	80	80
Sigma_u	0.3504	0.2202
Sigma_e	0.04726	0.0225

Source: Author's calculation
Note: * Significant at 10%, ** significant at 5%, and *** significant at 1%, respectively

The parameters Sigma_u and Sigma_e represent respectively the intra-country variance (*Within*) and the inter-country variance (*Between*)

The most striking result is the difference between the two groups of countries in terms of the macroeconomic impact of public investment expenditures. In the panel of developed economies, the coefficient that is associated with public investment spending is slightly negative, as opposed to the group of developing countries. The sign of this correlation corroborates evidence provided by Hemming *et al.,* (2002). It finds a plausible explanation in the substantial level of public-private investment

substitutability –in advanced countries, which generates higher crowding out effects; hence the downward influence on public investment expenditures' effectiveness in said countries. This finding is directly linked to the 3rd hypothesis mentioned above, which states that the higher is substitutability the lower is the public investment multiplier effect. This does not apply to the five developing countries in our 2nd panel, since their public investment spending tackles essentially the supposedly existing infrastructure shortages, hence its alleged non-substitutability as regards to private investment. Besides, historical evidence shows that government deficits tend to have very little influence on interest rates in low and middle income countries, thereby generating insignificant levels of crowding out.

Also, GDP seems to react more significantly to government consumption than to public investment expenditures in the advanced economies. This result confirms the existence of significant levels of crowding out, since public current expenses are not financed by public debt in these countries, unlike public investment expenditures. This corroborates the very conclusion of a previous study led by Perotti (2004) on five industrialized countries, including Germany and the UK. As for the panel of developing countries, the coefficient of public investment expenditures is larger than the public consumption's, and it is significant and positive.

The differences between the two panels of countries in terms of GDP's reaction to public investment expenditures can also be discussed from a "transitional dynamics" point of view. The model's results confirm that public investment in the countries with the lower capital to GDP ratio has a larger explanatory power over the economic activity; also, returns generated by (private and public) investment are shown to be indeed progressively diminishing, *ceteris paribus*. This analysis tends to confirm Hypothesis 2 because when compared individually, Denmark, Germany, Spain, Sweden and the UK do have larger capital stocks than Chile, Colombia, Jordan, Morocco and Slovenia.

Nevertheless, said hypothesis is challenged by the model's outputs regarding GFCF, since the latter seems to have a relatively better impact on GDP in the panel of advanced countries (a coefficient at 0.2613 compared to 0.2485), despite their high capital stock to GDP ratio and their position in terms of transitional dynamics. This could be explained by efficiency and profitability-based selectivity (Oukhallou, 2016). The countries of the first panel have lower levels of corruption, which usually helps keep both types of investment at a relatively efficient level[2]. Furthermore, the macroeconomic profitability of GFCF is also tributary to the economic agents' behavior vis-à-vis risk. In developing countries, such as Morocco for instance, an important part of the overall investment is addressed to sectors that generate quick returns and have lower risks (e.g. real estate); the latter are also known to generate lower added value, hence the relatively smaller impact on GDP.

But undoubtedly, GFCF shows a larger impact on GDP than public spending in general. This could be interpreted as the consequence of private investment's effectiveness when it comes to generating economic growth, as it is a significant component of GFCF in all ten countries. It also suggests, to a certain extent, that government investment expenditures are not efficient, seen the tremendous gap between their coefficients and the GFCF's in both sets of countries. This result is in fact different than research works made in developing countries particularly, e.g. Tunisia, where GDP growth was found to rely more on public investment and less on private capital (Casero, & Varoudakis, 2004; Boughzala *et al.,* 2007).

As regards to government consumption expenditures, they hold more explanatory power over GDP growth in the panel of advanced countries, with a

[2] According to the Transparency International's Corruption Perceptions Index 2015, the least corrupt countries amongst our panels are Denmark (ranked 1st), Sweden (3rd), Germany and the UK (both at the 10th position). Spain is the only exception, as it is ranked at the 36th position, behind Chile (23rd) and Slovenia (35th). Jordan is 45th, Colombia is 83rd and Morocco seems to have the highest level of corruption level in the two panels (88th).

0.023 coefficient compared to around 0.01 in the panel of developing economies. This can be linked to the high level of public consumption in the former group of countries as shown in Table 1, as well as the presence of household income-enhancing transfers among its major components. Said transfers are known to directly support the purchasing power of households with high consumption propensity, thereby improving the demand side of the economy. Moreover, the two groups of countries are put on an equal footing as regards to substitutability and transitional dynamics for this very variable, since public consumption does not crowd out private investment, unlike public investment expenditures. This shows the superiority of developed countries in terms of government consumption's macroeconomic effectiveness.

In a nutshell, the model confirms that public investment is more effective in developing countries. The impact on GDP's evolution is positive in those countries, and despite being econometrically significant, its coefficient remains far below that of GFCF and, by extension, private investment. Our results also suggest that public investment spending is relatively counterproductive in advanced economies, most likely because of high levels of crowding out; the latter is driven by public-private capital substitutability and the respective position of these countries in terms of transitional dynamics.

4. Concluding Remarks

This research paper examines the potential factors that determine the degree of influence laid by public investment on the evolution of GDP. The emphasis is laid on the potential differences between developed and developing countries in terms of public capital's macroeconomic returns. In this perspective, we use a panel data econometrical model for two groups of countries that include respectively five advanced economies and five developing ones.

In our endeavor, we test three main hypotheses based on the analysis elements provided by Oukhallou (2016). The first one stipulates that public investment efficiency is inversely correlated with the level of corruption; and that when public investment projects are not selected based on macroeconomic profitability, their marginal productivity is most likely to shrink as the negative macroeconomic impact of the crowding-out effect partially –or even totally- neutralizes the supposedly positive effect of said public investment on GDP growth. The second hypothesis is that public investment is likely to have a larger effect in small and middle income countries where the capital stock to GDP ratio is usually the lowest. In this perspective, returns generated by further public (or private) investment are assumed to be positive but progressively diminishing, *ceteris paribus.* The third hypothesis assumes that the higher is the public-private investment substitutability, the larger is the crowding-out effect, which drives a downward influence on public investment's effectiveness.

One intriguing result was that in the panel of developed economies, the coefficient that is associated with public investment spending is slightly negative. This finds a possible explanation in the existence of a substantial level of public-private investment substitutability –in advanced countries, which generates higher crowding out effects; hence the downward influence on public investment expenditures' effectiveness in advanced countries. In the group of developing countries, the impact of government investment expenditures is positive and larger than the public consumption's.

However, in all countries, the influence of public investment spending on GDP's evolution remains significantly smaller when compared to GFCF; the impact of the latter is found to be substantial in both groups of countries. This globally suggests, to a certain extent, that government investment expenditures are usually not efficient, seen the tremendous gap between their coefficients and the GFCF's in both sets of countries. On the other hand, government consumption expenditures seem to hold a larger explanatory power over GDP growth in the advanced countries compared to the developing economies. This result confirms

the existence of significant levels of crowding out, since public current expenses are in principle not financed by public debt, unlike public investment expenditures.

In a nutshell, the model confirms that public investment is more effective in developing countries. The impact on GDP's evolution is positive in the latter group of countries, and despite being econometrically significant, its coefficient remains far below that of GFCF and, by extension, private investment. Our results also suggest that public investment spending is relatively counterproductive in advanced economies, most likely because of high levels of crowding out; the latter is driven by public-private capital substitutability and the respective position of these countries in terms of transitional dynamics.

Basically, this empirical examination enables us to confirm Hypothesis 3. It also provides evidence that is consistent with Hypothesis 2, but only for the case of public investment. Moreover, our results suggest that Hypothesis 1 can be confirmed in the case of government consumption. The five advanced economies studied in this paper have the least corruption levels among the overall sample (except for Spain); at the same time, their government consumption expenditures have a better impact on GDP than in the five developing countries, which happen to have higher rates of corruption. Hypothesis 1 cannot however be ascertained when it comes to public investment. The potential effect of such a hardly assessable variable is occulted by the strongly evident impact of crowding out on GDP.

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